BANKSIDE POWER STATION:
PLANNING, POLITICS AND POLLUTION

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Abstract

Electricity has been a feature of the British urban landscape since the 1890s. Yet there are few accounts of urban electricity undertakings or their generating stations. This history of Bankside power station uses government and company records to analyse the supply, development and use of electricity in the City of London, and the political, economic and social contexts in which the power station was planned, designed and operated. The close-focus adopted reveals issues that are not identified in, or are qualifying or counter-examples to, the existing macro-scale accounts of the wider electricity industry. Contrary to the perceived backwardness of the industry in the inter-war period this study demonstrates that Bankside was part of an efficient and profitable private company which was increasingly subject to bureaucratic centralised control. Significant decision-making processes are examined including post-war urban planning by local and central government and technological decision-making in the electricity industry. The study contributes to the history of technology and the environment through an analysis of the technologies that were proposed or deployed at the post-war power station, including those intended to mitigate its impact, together with an examination of their long-term effectiveness. Bankside made a valuable contribution to electricity supplies in London until the 1973 Middle East oil crisis compromised its economic viability. In addition to altered economic externalities, changing environmental and social conditions influenced how Bankside was perceived. Its pollution became increasingly unacceptable and the building itself came to be seen as a major architectural and industrial archaeological achievement. The transformation to Tate Modern in 2000 was instrumental in the social repositioning of the gloomy post-industrial Bankside locality to a modern cultural area. Bankside's central London location, its architectural and technological design, and its role as Tate Modern make this a significant case study in urban history, environmental history and the history of technology.

Acknowledgements and dedication

Firstly, my thanks go to my supervisors Dr Sally Horrocks and Prof. Simon Gunn for their support, encouragement, sound advice and wise guidance; but mostly for their unwavering belief in this project. Thanks to the individuals who have shared their memories of, and material on, Bankside power station, especially Prof. Norma Clarke, Peter Guillery, Barry Henniker, Barry Kett, Dr Geoff Marshall and Peter White. Thanks are due to the staff of the archives and libraries that I have used, and to the organisations responsible for maintaining such rich historical resources. Finally, thanks to Laurence for his tolerance in allowing me to indulge in this obsession for four years.

This thesis is dedicated to the memory of B.S.W. who was killed in an explosion at Bankside power station on 30 September 1956.

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Abbreviations, acronyms and glossary

AC	alternating current
BEA	British Electricity Authority
Btu/lb	British thermal units per pound (energy content of fuel)
CEA	Central Electricity Authority
CEB	Central Electricity Board
CEGB	Central Electricity Generating Board
CHP	combined heat and power
CHP-DH	combined heat and power with district heating
CLELC	The City of London Electric Lighting Company Limited
d.	old pence (12d. = 1 shilling, 1/- ; 20 shillings = £1)
DC	direct current
DSIR	Department of Scientific and Industrial Research
EDF	Électricité de France
ESI	electricity supply industry
FGD	flue gas desulphurisation
ft	foot, feet
GLA	Greater London Authority
GLC	Greater London Council
GWh	gigawatt-hour (1000 MWh or 1,000,000 kWh)
IET	Institution of Engineering and Technology
JEA	Joint Electricity Authority(ies)
kg	kilogram
kV	kilovolt (1000 volts)
kW	kilowatt (power, the amount of energy delivered in a unit of time)
kWh	kilowatt-hour (energy; a 'unit' of electrical energy)
LBS	London Borough of Southwark
LCC	London County Council
LEB	London Electricity Board
LMA	London Metropolitan Archives
LPC	London Power Company
MOMA	Museum of Modern Art
MOSI	The Museum of Science and Industry, Manchester
MW	megawatt (1000 kW)
MWh	megawatt-hour (1000 kWh)
NCB	National Coal Board
psi	pounds per square inch (pressure)
RIBA	Royal Institute of British Architects
therm	100,000 British thermal units (1 therm = 29.31 kWh)
TM2	Tate Modern 2
TNA	The National Archives

Units of measurement (ft, acres, °F, etc) are quoted as they appear in the source documents. Units have not been converted except where this aids comparison.

Details of some of the above organisations are outlined in Appendix B.

Chapter 1 – Introduction

Since it opened in 2000, Tate Modern has attracted over four million visitors a year and is now an established part of London's tourism industry and its art and cultural landscape. Visitors may be aware that this iconic building (see Figure 1.1) was converted from a power station: the former turbine hall forms the gallery's large central space.

Figure 1.1: Tate Modern, 2011.

Source: Stephen Murray.

But surprisingly, there is no detailed exposition of the history of Bankside power station. The Tate Gallery's choice of the building and the conversion process have been examined by the author Karl Sabbagh and the architectural academic Raymond Ryan.[1] These accounts do not take the history much beyond the decaying and derelict power station as 'found' by the Tate in 1993 although its renowned architect Sir Giles

[1] K. Sabbagh, *Power into Art* (London, 2000); R. Ryan, 'Transformation' in R. Moore and R. Ryan (eds), *Building Tate Modern* (London, 2000), pp.13-36; see also M. Craig-Martin, 'Towards Tate Modern' in I. Blazwick and S. Wilson (eds) *Tate Modern: The Handbook* (London, 2000).

Gilbert Scott is acknowledged.[2] This research therefore addresses the hitherto little examined history of a major feature of London's built environment.

The history of Bankside power station is important for the insight it provides into the supply, development and use of electricity in central London. The existing literature is not extensive; therefore the story of Bankside power station and its owners makes a contribution to a limited historiography. The research is also significant because it exemplifies some of the changes to the built environment of London that have occurred since the Second World War. These changes encompass issues of post-war urban planning, the deindustrialisation of the city and the regeneration of post-industrial localities. This was also a period of significant environmental improvements in London, especially reduced air pollution. A large, polluting, industrial building like Bankside was increasingly incongruous in this context. This study also provides fresh insights into the changes that have occurred in the use of, and attitudes to, industrial buildings since the late 1970s. The history of Bankside power station therefore constitutes a case study in urban planning; the demand for, and supply of, electricity; amenity and environmental pollution; changes to London's built environment; and the social impact of technology. The thesis brings together different branches of history in new ways, including urban history; the history of science and technology; economic and social history; and environmental history. It also touches on the disciplines of architecture and engineering.

The principal focus of this thesis is on the post-war Bankside 'B' power station together with the social and political contexts in which it was planned and operated.[3]

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[2] G. Stamp, 'Giles Gilbert Scott and Bankside Power Station' in Moore and Ryan, *Building Tate Modern,* pp.177-90.

The temporal scope extends back to the establishment of the City of London Electric Lighting Company Limited (CLELC) which supplied electricity to the City of London (the City) from their power station on Bankside, and which was instrumental in commissioning and promoting the 1947 building. In the later chapters the time-frame extends to the present day to address the post-operational history of the building and the impact that Tate Modern has had on the area.[4] Tate Modern is currently undergoing a further transformation with the recent demolition of part of the original building and the construction of a new extension; the impact of these plans on the locality is also examined. The research therefore encompasses a time-span from 1878 to 2014, together with the impact of both the power station and Tate Modern on the locality and the City. It also examines the wider changing contexts in which Bankside 'B' operated including the decline of the urban power station as a feature of British towns and cities.

This research addresses how London's, and increasingly Britain's, electricity needs were understood by different actors and how a power station on the scale of Bankside functioned in the middle of the city. This is set in the context of the changes that occurred in the structure of the British electricity supply industry from the inter-war period, through nationalisation, to the closure of Bankside in 1981 and the privatisation of the industry and the disposal of industry assets from 1990. Although the focus is on a single site, points of comparison with other power stations, including Bankside's sister station at Battersea, are made where this reveals pertinent issues

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[3] The original (1891-1959) Bankside power station was designated the 'A' station when the new 'B' station was nearing completion in 1952.

[4] The recent history of the development of the Bankside area has been subject to scholarly attention, see for example: P. Teedon, 'Designing a Place Called Bankside: On Defining an Unknown Space in London', *European Planning Studies*, 9:4 (2001), pp.459-81; P. Crisman, 'From Industry to Culture: Leftovers, Time and Material Transformations in Four Contemporary Museums', *The Journal of Architecture*, 12:4 (2007), pp.405-21; and C. Dean, C. Donnellan and A. Pratt, 'Tate Modern: Pushing the Limits of Regeneration', *City, Culture and Society*, 1:2 (2010), pp.79-87.

associated with urban power stations, particularly the circumstances of their construction and their post-industrial fates.[5]

A central theme of this research is that Bankside power station and its site were enmeshed in a web of complexity. One dimension to this was the large number of actors who had an interest in Bankside including its private and public-sector owners, local residents, statutory bodies, local authorities, and government departments. The thesis demonstrates how, and in what ways, these actors valued Bankside which in turn reflect wider social concerns, economic influences, political forces, technological capabilities and environmental issues. These values, which were often in tension with each other, affected and influenced the existence, location and form of Bankside, both directly and through the agency of legislation. In addition to the influences on the building, the complexity is manifest in the impact of the building on the locality, in both its role as a power station and an art gallery.

Research questions

This thesis addresses three main research questions. These have been framed as broadly as possible, while specifically focused on Bankside power station and Tate Modern, to capture the widest possible range of factors associated with the buildings, the site and the owners. First, what were the economic, political, environmental, social and technological contexts and arguments that influenced the design, approval and operation of Bankside power station, and its later role as Tate Modern? This question seeks to establish the factors which influenced, or were considered, in the decision-

[5] There was considerable opposition to Battersea in 1927-29, as there was to Bankside in 1945-47, although the grounds for the opposition were different. The post-industrial fates of these sister stations, both designed by Giles Gilbert Scott, have also been markedly different, an issue examined in Chapter 6.

making processes around the development and operation of the power station and Tate Modern and how these influenced the form, location and function of the building. The question aims to establish the contexts in which the building was developed and how it functioned. These contexts include an examination of the structure and operation of the British electricity supply industry and the planning processes; the changing physical environments in which Bankside operated; and changing attitudes to industrial buildings. Second, what were the social and environmental impacts and influences of the building on the area and the local community? As the first question is inward looking at the influences *on* Bankside, the second question is outward looking at the impact *of* the building on its locality. This question seeks to establish how Bankside / Tate Modern influenced and affected the immediate built environment and local communities. Issue include industrial pollution and its effects; how pollution was perceived and might be mitigated; and the impact of a major cultural institution on its locality. The third question asks: who were the principal actors, both individual and institutional, involved in these processes; what were their positions and influence; and how, and to what extent, did they value the building and its site?[6] This question aims to identify and examine the principal actors in the history of Bankside and Tate Modern and how they used, or were affected by, the factors identified in the other questions and, crucially, how they interacted with each other. These three broadly based research questions are addressed throughout this thesis and are returned to, and re-examined, in the concluding chapter.

[6] Note that in this study 'value' can be positive and/or negative.

Literature review

This review examines the historical literature on four key topics and demonstrates how these relate to the study of Bankside power station. I examine the literature on power stations and electricity undertakings; then that on the British electricity supply industry; the relevant literature on urban pollution and the environment; and finally the literature on the built environment topics of urban planning, industrial archaeology and regeneration. Surprisingly, few historical studies have been written in the past two decades on the electricity industry, and there is no significant current historical debate on this issue. The historian John Tosh states that 'scholarly historical writing […] concerns all who want informed perspectives on the present'.[7] The current issues and debates in the UK public realm on electricity supply, energy security, renewable energy and nuclear power have little in the way of recent historical literature to provide such an informed context. This research contributes to an informed historical perspective on UK electricity supplies.

The business historian Leslie Hannah, writing in 1979, noted that 'the records of many individual local undertakings have been only selectively examined; and there remains ample scope for work there by local historians'.[8] Despite this call, the history of electricity undertakings and their power stations remains largely unexamined.[9] Research on Bankside power station and its owners therefore constitutes a major addition to an underdeveloped historical field. Only four histories of individual British power stations and their electricity supplies have been identified.[10] Three are 'popular'

[7] J. Tosh, *The Pursuit of History*, fourth edition (Harlow, 2006), p.51.
[8] L. Hannah, *Electricity Before Nationalisation* (London, 1979), p.viii.
[9] One relatively recent local history example is B.J. O'Neill, 'The Development of the Electrical Supply Industry in North-West Kent, 1882-1914', *The Local Historian,* 30:1 (2000), pp.23-38.
[10] M. Stratton, *Ironbridge and the Electric Revolution: The History of Electricity Generation at Ironbridge 'A' and 'B' Power Stations* (London, 1994); R. Cochrane, *Cradle of Power: The Story of*

rather than academic histories, but as the historian of technology David Edgerton has said 'we should take non-academic ideas (high or low) seriously in our academic practice as historians, and reflect on the significance of these ideas for our own work'.[11] The three popular accounts are worth examining for what they reveal about the development of power stations and electricity supplies. The individual stations have many common features, but there are also differences, both of which help to inform the history of Bankside.

The popular accounts are commemorative histories and take a descriptive and narrative approach to the power stations. The histories of Battersea and Deptford were published by the Central Electricity Generating Board (CEGB) at the time of the closure of the two power stations in the early 1980s. The history of Ironbridge was published in 1994 in association with National Power the post-privatisation owner of the power station. All three can be viewed as exercises in public relations celebrating the pioneering role and achievements of the respective stations in supplying electricity to London and the west Midlands. They also highlight the role of the prominent individuals who were involved in their development. These include the electrical engineer Sebastian de Ferranti at Deptford, the engineer Leonard Pearce and the architect Giles Gilbert Scott at Battersea. The Ironbridge book also acknowledges the accounts and memories of 'the 2500 staff who have worked to generate electricity at Ironbridge' some of whose recollections are recounted.[12] The accounts also outline the redevelopment of all three power stations over their operational lives. The history of Bankside reflects many of these issues such as the pioneering nature of the station and

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Deptford Power Stations (London, 1985); R. Cochrane, *Landmark of London: The Story of Battersea Power Station* (London, 1984); B. Luckin, 'The Battersea Controversy' in *Questions of Power: Electricity and Environment in Inter-war Britain* (Manchester, 1990), pp.138-53.

[11] D. Edgerton, *Warfare State: Britain, 1920-1973* (Cambridge, 2005), p.334.

[12] Stratton, *Ironbridge*, p.11.

its growth and redevelopment over time. Furthermore, both Pearce and Scott were involved with Bankside as consultant designer and architect respectively.

The growth of the demand and supply of electricity is a central theme. Rob Cochrane in his account of Deptford power station notes that it was built with the intention of supplying electricity to a large part of London.[13] Michael Stratton argues that both Ironbridge 'A' and 'B', commissioned in 1932 and 1967 respectively, were built in response to a dramatic growth in demand for electricity. He contrasts the belated introduction of electricity to the factories and homes of rural eastern Shropshire in the 1930s and the Ironbridge gorge as the birthplace of the industrial revolution. One observation on Ironbridge 'A' is telling, he states that the power station offered 'clean, modern alternatives to candles, oil lamps and gas'; a reminder that electricity was not widely available in rural areas.[14] Even urban homes in the inter-war period widely used gas for domestic lighting. It was not until after the Second World War that electricity's overall market share for lighting exceeded that of gas lamps.[15] This situation reflects the perceived backwardness of the British electricity industry in the inter-war period, discussed below. The supply of electricity to meet increasing demand was the central driving force for the development of Bankside throughout its operational life, but especially in the mid-1940s. It has been widely argued that electricity was seen as essential for post-war renewal; the Attlee

[13] The promoters, the London Electric Supply Corporation Limited, were established in 1887 to take over the pioneering Grosvenor Gallery station and to build Deptford, see Cochrane, *Cradle of Power*, pp.10-11 and G. Weightman, *Children of Light* (London, 2011), pp.61-73.
[14] Stratton, *Ironbridge*, p.1.
[15] Hannah, *Electricity*, p.182.

Governments of 1945-51 actively pursued a policy of industrial modernisation, including electrification.[16]

The literature on power stations also demonstrates some of the technical and amenity considerations around their location. Deptford, commissioned in 1889, was located on the Thames where ‘unlimited cooling water was available and where land and sea-borne supplies of coal would be cheap’.[17] This was the case for many power stations; Ironbridge was located adjacent to the river Severn for cooling water and was also close to a railway for the delivery of coal.[18] There appears to have been little objection to the construction of either Ironbridge ‘A’ or ‘B’ power stations on planning or amenity grounds. Indeed, Stratton notes that Ironbridge ‘A’ was ‘welcomed locally as a symbol of a cleaner and more prosperous age’.[19] This is in contrast to Battersea and Bankside where the location and amenity issues were the most controversial aspects when they were being planned and during their operational lives.[20] Stratton addresses the visual impact of the chimney and cooling towers at Ironbridge ‘B’.[21] There were concerns that the chimney would rise intrusively above local woodland. The architect wanted the chimney to be as low as possible but the engineers insisted that it should project flue-gases above any possible downdraughts, thereby reducing local air pollution.[22] This demonstrates the interplay between technological requirements, visual amenity and the mitigation of pollution. The tension between

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[16] See, for example, N. Whiteside, ‘Towards a Modern Labour Market? State Policy and the Transformation of Employment’ in B. Conekin, F. Mort and C. Waters (eds) *Moments of Modernity: Reconstructing Britain 1945-1964* (London, 1999), p.82.

[17] Cochrane, *Cradle of Power*, p.11.

[18] Stratton, *Ironbridge*, p.21 and p.27.

[19] Ibid., p.14.

[20] Cochrane, *Landmark*, p.10; see also Luckin, *Questions of Power*, pp.138-39.

[21] At Ironbridge ‘B’ power station the four cooling towers were ‘given a stronger flare to emphasise the contrast of their curved outline against the angular shape of the main building’. Furthermore, a reddy-pink tint was incorporated into the concrete of the cooling towers, reputedly in sympathy with the colour of the local soil. Stratton, *Ironbridge*, pp.81-82.

[22] Stratton, *Ironbridge*, p. 81; Cochrane, *Landmark*, p.10.

competing influences is a recurring theme in this study. At Bankside the number of chimneys and their height, particularly the dominating effect on St Paul's cathedral, was a significant concern.

The technological aspects of power stations are addressed in some of the technical literature and provide points of comparison with Bankside. In 1939 Sir Leonard Pearce, the chief engineer of the London Power Company outlined the progress of power station technology since the turn of the century.[23] This account demonstrates the increasing size of both power station equipment and power stations themselves and their increasing efficiency in generating electricity. The historian of technology Michael Duffy addresses the progress in the scientific understanding of thermodynamics and how this influenced developments in power stations over the period 1890-1960.[24] Both these accounts present a case for the progressive nature of science, engineering and technology over the first half of the century; a theme that this study addresses. The accounts also demonstrate the multiplicity of technologies that are used in power stations. This issue is taken up by the historian of science and technology Stewart Russell who has argued that prior to 1993 no comprehensive account of the history of district heating schemes had existed. He suggests that this:

> reflects a general tendency in historiography and contemporary depiction to rationalize actual social arrangements as somehow natural and inevitable, and to ignore alternatives which remained undeveloped.[25]

This research addresses both the technologies that were assessed and not developed as well as those that were deployed at Bankside 'B' power station, together with the

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[23] L. Pearce, 'Review of Forty Years' Development in Mechanical Engineering Plant for Power Stations', *Institution of Mechanical Engineers Proceedings,* 142 (1939), pp.305-63.
[24] M.C. Duffy, 'Thermodynamics and Powerhouse Design, 1890-1960', *Journal of the Newcomen Society*, 73b (2002), pp.209-39.
[25] S. Russell, 'Writing Energy History: Explaining the Neglect of CHP/DH in Britain', *The British Journal for the History of Science,* 26:1 (1993), pp.33-54.

reasons why such technological choices were made. This study therefore constitutes an insight into the history of technology and the process of technological decision-making. As a counter to the 'inevitable' progress of technology, the CEGB engineers Jan Bettelheim, Bill Kyte and Albert Littler provide a retrospective account of the flue-gas cleaning systems at British power stations, including Bankside.[26] They observe that no further flue-gas cleaning plants were installed in British power stations after Bankside. John Sheail also notes that the flue-gas washing plants at Battersea and Bankside were a blind alley.[27] This research supports this analysis: I demonstrate that while technically successful, the technology was at best of limited efficacy, and at worst failed to achieve the expectations in terms of reducing local nuisance.

The adverse effects of the power stations such as noise and smoke are largely absent from the popular histories; it could be said that the issue of pollution does not fit with these triumphalist accounts of electricity. As the environmental historian Bill Luckin has said, for the electrical *avant garde* the 'boon of electricity was assumed to outweigh even the most pernicious side-effects'.[28] Some of the mitigating measures to reduce adverse effects are discussed, such as the height of Ironbridge's chimney, but the accounts do not address the long-term effectiveness of these measure. The issue of environmental impact was central to the debate about the construction of Battersea power station in the late 1920s and for Bankside 20 years later. In *Questions of Power* Luckin uses the tension between patrician traditionalists and triumphalists (electrical progressives) as a framework to analyse controversies that arose in the electricity

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[26] J. Bettelheim, W.S. Kyte, and A. Littler, 'Fifty Years' Experience of Flue Gas Desulphurisation at Power Stations in the United Kingdom', *The Chemical Engineer*, 369 (1981), pp.275-84.
[27] See J. Sheail, *Power in Trust: The Environmental History of the Central Electricity Generating Board* (Oxford, 1991), p.176.
[28] Luckin makes this point in the context of Battersea (Luckin, *Questions of Power*, p.138), but this is echoed in the 'welcome' given to Ironbridge 'A'.

industry in the inter-war period. Issues include the visual impact of the national grid on the South Downs and the Lake District and the controversy over the proposals for Battersea power station in 1929.[29] Luckin argues that for the patrician order the air pollution from Battersea was seen as less significant for public health than for what the fumes might do to 'palaces, works of art, parks and gardens' and indeed the whole social order.[30] For the triumphalists Battersea represented a 'cathedral of electrical progress' that epitomised the 'imminent victory of electricity over every other form of energy', especially the 'primitive' coal and gas industries. The controversy over Bankside power station in the mid-1940s was also a tension between a pro-electricity lobby and, in this case, progressive arguments about the post-war rebuilding of London. This research therefore complements and builds upon Luckin's arguments about Battersea.

The changing form and physical appearance of power stations is another theme in the literature. Stratton demonstrates how the 'formal almost classical architecture' in brick and stone of Ironbridge 'A' station gave way to 'bold new shapes and metal and glass cladding' of the 1960s Ironbridge 'B'. The monumental form of Battersea and Bankside – so-called 'brick cathedral' power stations – was characteristic of the middle decades of the twentieth century. In 1953 the architect Robert Jordan criticised this style as an example of 'the divorce of structure and design', reflecting a wider view in the post-war period.[31] From the 1950s onwards power station buildings were of a simple 'cladded' style. I suggest that a cladded modernist form of power station

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[29] Ibid., pp.94-114 and pp.138-53.
[30] Ibid., p.153. See for example the letter from H. Tizard (DSIR) to G. Fry (10 Downing Street) dated 11 February 1929 where high concentrations of sulphur dioxide are noted as being 'injurious to vegetation and buildings', TNA, PREM 1/69.
[31] R.F. Jordan, 'Power Stations', *The Architectural Review*, 113:676 (April 1953), p.230. See also the *Ninth Report of the Royal Fine Art Commission 1948-49* (1949) p.12, which states 'a simple housing for the large-scale electrical equipment can be more impressive that a cathedral-like structure'.

would have been no more acceptable on the Bankside site than Scott's brick cathedral.[32]

The literature also addresses the location of power stations in their wider geographical context. Stratton notes that Ironbridge 'A' was built to supply the regional electricity network of the West Midlands via the national grid, and similarly for Battersea also connected to the grid. They are examples of a new generation of power stations built to supply an area or regional demand via the newly constructed grid, and not solely to supply local demand as had early stations.[33] Cochrane in his history of Deptford power station also argues for the significance of location in relation to the supply area. Deptford was located because of the availability of coal and water but this necessitated running innovative high voltage electricity cables into central London.[34] This provides another point of comparison with Bankside 'B' where long cables were discussed when an alternative site at Rotherhithe near Deptford was proposed in 1945. The regional setting of power stations and the increasing interconnectedness of electricity networks is linked to the nature and structure of the British electricity supply industry examined in the following section.

The British electricity supply industry

The historical development of the electricity supply industry (ESI) is significant for an understanding of the context in which power stations, including Bankside, operated and the key actors in the industry. The technological historian Thomas P. Hughes compares the pre-1930 electrical systems in Berlin, Chicago and London. He notes that

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32 Jordan, 'Power Stations', Jordan's idea of the power station as a machine is discussed in Chapter 4. See Figure 4.8 in this thesis reproduced from Jordan, 'Power Stations' which closely resembles the 'cubic masses' of Ironbridge 'B' as shown in Stratton, *Ironbridge*, Figure 52, p.77.

33 Stratton, *Ironbridge*, pp.19-21.

34 Cochrane, *Cradle of Power*, pp.17-19.

in Chicago electrical technology dominated politics whereas in London the reverse was true. He argues that the early British electricity legislation of the 1880s led to the development of monopolistic electricity undertakings with limited areas of supply. This, he claims, restricted them to small-scale technology with little opportunity or incentive for expansion. Whereas the larger interconnected electrical utilities of Berlin and Chicago were able to develop and deploy large-scale and more efficient electrical technology.[35] This was partly true of the CLELC since their supply area was largely limited to the City of London. However, the CLELC were an innovative and profitable business which strove to expand the demand for, and supply of, electricity to the City; furthermore Bankside was not a small-scale power station.

Leslie Hannah has undertaken a comprehensive and analytical 'broad brush' survey of the political, technical and economic structure of the British electricity industry up to 1948 and of the first decades after nationalisation.[36] His position complements Hughes in arguing that the potential of the private and local authority undertakings up to the First World War was greater that their achievements. He notes that the utilisation of electricity by industry was poorly developed and domestic use was an expensive luxury.[37] Hannah examines the political factors around the attempts to address the issue by increasing the consolidation and centralisation of the industry, initially through the establishment of the Electricity Commission in 1919 to secure reorganisation of the industry on a regional basis.[38] Hannah specifically identifies the 'diagnosis of failure' of the early 1920s. Several commentators note that the Electricity

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[35] T.P. Hughes, *Networks of Power: Electrification in Western Society 1880-1930* (Baltimore, 1983), pp.461-62.

[36] Hannah, *Electricity*; L. Hannah, *Engineers, Managers and Politician: The First Fifteen Years of Nationalised Electricity Supply in Britain* (London, 1982).

[37] Nationally, only 5.6 per cent homes were provided with electricity in 1919. Hannah, *Electricity*, p.34, note 72.

[38] Ibid, pp.65-73.

Commissioners were ineffectual in that they had limited powers of compulsion. In 1926 there were still 463 power stations in Britain and only limited interconnections which compared unfavourably with the larger and more integrated networks in Germany.[39] This broad view of the industry, specifically its failure to centralise, does not do justice to some of the achievements at a local and regional level. In London a regional authority was established and many London electricity undertakings including the London Power Company and the CLELC integrated their activities and electricity systems in the mid-1920s.

Hannah reflects on the remedies for the ‘failure’. This entailed further state intervention and control through the establishment of the Central Electricity Board (CEB) in 1926 with a duty to address the lack of integration through the development and operation of the national grid.[40] The construction of the grid in the period 1927-33 was widely recognised as a remarkable achievement, it provided the CLELC and other London undertakings with access to the national network.[41] I make the case that this arrangement of multiple statutory organisations with oversight of the industry led to a structure where strategic and business decision-making by electricity undertakings such as the CLELC were constrained, and the approval and consent for redevelopments was a lengthy and bureaucratic process.

[39] Ibid., pp.75-80 and pp.84-85; B. Bowers, ‘Electricity’ in T.I. Williams (ed.) *A History of Technology Vol. VI*, (Oxford, 1979), p.287; Hinton of Bankside, *Heavy Current Electricity in the UK* (Oxford, 1979), pp.62-65.

[40] Hannah, *Electricity*, pp.107-09

[41] R. Cochrane, *Power to the People: The Story of the National Grid* (Feltham, 1985), pp.16-29.

The nationalisation of the electricity industry in 1948 and its post-nationalisation history has been addressed by several historians.[42] As with the pre-nationalised industry discussed above, these accounts are principally concerned with the structure of the industry, its organisation, and national issues rather than the operation of, or the impact on, individual power stations. The analysis of the operation of Bankside 'B' over the period 1952-81 and the power station's contribution to the supply of electricity in London is therefore a significant local-scale addition to a sparse field of historical study. The close focus of this research reveals how Bankside operated in its urban setting and demonstrates how the City became increasingly dependent on electricity for the effective operation of its financial and commercial operations.

Bankside was the last power station to be built in central London. The literature identifies two principal technological factors for this shift of electricity generation away from urban locations. First, there is what Hannah has called 'the Brown revolution' of 1954-57 which was part of a technological development process towards larger generating sets.[43] Hannah frames this as a story of progress; the development is reflected in the two halves of Bankside power station commissioned 1952 and 1963 respectively which enabled the power station to have a higher output than originally envisaged. The economic historian Chris Harlow extends this 'revolution' by charting

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[42] Hannah notes there are numerous accounts of public enterprises, especially the electricity supply industry which was Britain's largest capital spender in the 1950s and 1960s (Hannah, *Engineers*, p.ix). See for example his own account, Hannah, *Engineers*; also Hinton, *Heavy Current*; C. Harlow, *Innovation and Productivity Under Nationalisation: The First Thirty Years* (London, 1977), pp.54-97; R. Kelf-Cohen, *British Nationalisation 1945-73* (London, 1973), pp.37-54.

[43] F.H. Stanley Brown was appointed as the BEA's generation design engineer in 1953, Hannah, *Engineers*, pp.111-22. Turbo-alternator sets increased from the standard 30 MW and 60 MW sets of the late 1940s to 200 MW, 275 MW, 500 MW and eventually to 660 MW sets in the early 1970s.

the development of new generating plant for individual power stations from 1953-70.[44] Harlow's main argument is that the CEGB became overambitious and ordered underdeveloped plant which affected the generation programme, led to delays in commissioning power stations in the late-1950s and 1960s, and damaged the reputation of British technology abroad.[45] The increased size of generator sets enabled larger power stations to be built, these would have been impracticable and unacceptable in an urban setting.[46] Leslie Hannah and the environmental historian John Sheail both address the second technological factor: the planning and development of the super-imposed grid or 'super-grid' from the early 1960s which facilitated the bulk transfer of electricity across the country. They argue that this enabled new power stations to be built away from the centres of demand and close to the coal fields of the Midlands and Yorkshire.[47] These two technological factors were therefore instrumental in both increasing the size of power stations and their relocation away from urban areas. As Thomas P. Hughes states we 'must consider the internal technical forces that facilitated growth as well as the external, nontechnical, cultural forces that helped shape the electric supply systems'.[48] Although the locational shift was enabled by technology a principal driver was an economic one: larger generating sets were more efficient and it was less costly to transfer energy through the super-grid than by physically moving coal across the country. There is also the political dimension concerning the commitment to using British coal to generate electricity and some of the assumptions behind the planning of the electricity supply industry under nationalisation.

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[44] Harlow, *Innovation*, Table 3.6, pp.78-81.
[45] Ibid., p.93.
[46] See Sheail, *Power in Trust*, pp.133-42 for an account of the power stations built in the Trent valley from the 1950s.
[47] See Hannah, *Engineers*, pp.102-04 and pp.252-53; and Sheail, *Power in Trus*t, pp.127-33.
[48] Hughes, *Networks of Power*, p.462.

The economic historian Martin Chick has undertaken an economic analysis of electricity and energy policy in Britain since the Second World War.[49] Chick argues that economic externalities as well as strategic issues such energy security and the issue of fuel availability were the principal influence on British energy policy in the second half of the century. Chick notes the shifting role of the use of oil and coal as a fuel source in the British ESI. As one of the country's largest consumers of coal, the operation of the ESI was interconnected with that of the coal industry. Government policy shifted from supporting the coal industry through encouraging the use of coal for electricity generation, to specifying the construction of oil-fired power stations. In this research I use the changing relative prices of coal and oil to demonstrate the influence on both the utilisation of Bankside 'B' and the construction phases of oil-fired power station from the early 1950s to the early 1970s. The 1970s was a period of particular interest for British fuel policy. The journalist Andy Beckett identifies the 1970s as the decade 'when the lights went out'.[50] His analysis of this period gives an insight into the miners' strikes and over-time bans of 1972 and 1973-74 and the government's response to these issues. Many power stations were picketed and the consequential social and political effects included electricity power cuts and the imposition of the three-day week. The operation of the ESI in this period has also been analysed by several industry insiders. Frank Ledger and Howard Sallis have addressed how the industry prepared for, and responded to, the coal industry strikes such as the strategic stockpiling of coal at power stations.[51] As an oil-fired station Bankside was

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[49] M. Chick, *Electricity and Energy Policy in Britain, France and the United States since 1945* (Cheltenham, 2007).

[50] A. Beckett, *When the Lights Went Out: What Really Happened to Britain in the Seventies* (London, 2009), pp.64-87 and pp.128-50.

[51] F. Ledger and H. Sallis, *Crisis Management in the Power Industry: An Inside Story* (London, 1995). Ledger was a CEGB system operations engineer during the early 1970s and director of operations during the 1984-85 miners' strike. Sallis was head of industrial relations at the CEGB then the director for industrial relations in the 1980s.

able to continue to operate during the coal strikes of the 1970s. Beckett and Chick also examine the effects of the Middle East crisis of 1973-74 which led to a significant increase in the price of oil. This was a direct cause of the decline of the utilisation of Bankside power station from 1974.

The history of the British ESI therefore constitutes a complex, changing and evolving range of political influences, economic forces, technological possibilities, and institutional structures under which the power stations of the second half of the twentieth century were owned, controlled and operated. This provides a major political-economic context for the research into Bankside power station. The third theme in the literature picks up the issue of amenity discussed above and concerns the pollution impact of power stations and the changing environment in which they operated.

Pollution and the environment

It has been claimed that the environment has only been a significant concern of historical study since the late 1960s.[52] Since then some notable environmental historians have developed the discipline including an examination of urban industrial history.[53] The link between urban history and environmental issues is exemplified in Joel Tarr's *The Search for the Ultimate Sink* a collection of essays in which he examines the interplay between pollution, environment, technology, land use, and how

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[52] J.J. Keyes, 'A Place of Its Own: Urban Environmental History', *Journal of Urban History*, 26 (2000), pp.380-90.
[53] Environmental historians include William Cronon, Martin Melosi, Christine Meisner Rosen and Joel Tarr; see S. Mosley, *The Chimney of the World* (Abingdon, 2008), p.6.

wastes are produced, perceived and deposited in the 'ultimate sink' of the environment.[54]

The environment in which Bankside operated is a key theme of this research and adds a British dimension to Tarr's United States context. As Tarr has argued it 'would be difficult to write urban history without touching on some environmental elements', this is especially so for a significant source of pollution such as an urban power station like Bankside.[55] There is also a connection between environmental history and public health history. A widely quoted example is the 1956 Clean Air Act which was seen as instrumental in reducing British urban air pollution and improving public health. This was part of the response to the London smog episode of December 1952 which caused the deaths of over 4000 people.[56] The history of the 'killer smog' and the path, via the Beaver report, to the Clean Air Act is a well trodden field.[57] It was especially significant for Bankside. The power station was commissioned in December 1952 without its flue-gas cleaning plant which caused considerable controversy. Furthermore, the implementation and effects of the Act correspond to the operational life of Bankside power station. The economic historian Brian Clapp notes that in the decade following the Act British industry reduced smoke emissions by 74 per cent.[58] He also examines the shift from the domestic use of coal towards 'smokeless' fuels

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[54] J.A. Tarr, *The Search for the Ultimate Sink: Urban Pollution in Historical Perspective* (Akron, 1996), see also J.J. Keyes, 'A Place of Its Own'.

[55] J.A. Tarr, 'Urban History and Environmental History in the United States: Complementary and Overlapping Fields', in C. Bernhardt (ed.) *Environmental Problems in European Cities of the 19th and 20th Century* (Münster, 2001), p.25.

[56] Royal College of Physicians, *Air Pollution and Health* (London, 1970), and addressing an earlier period A.S. Wohl, *Endangered Lives: Public Health in Victorian Britain* (London, 1983).

[57] As a result of the 1952 'killer smog' a committee chaired by the civil engineer Sir Hugh Beaver was appointed to investigate the issues, they reported in 1954 on the social and economic costs of air pollution, this led to the 1956 Clean Air Act. See E. Ashby and M. Anderson, *The Politics of Clean Air* (Oxford, 1981), pp.104-16; P. Brimblecombe, *The Big Smoke* (London, 1987), pp.165-72; J. Sheail, *An Environmental History of Twentieth-Century Britain* (Basingstoke, 2002), pp.247-50.

[58] B.W Clapp, *An Environmental History of Britain since the Industrial Revolution* (London, 1994), p.51.

such as coke, electricity and gas, together with social changes such as the growth in the use of central heating, the decline of open fires and the promotion of electric night storage heaters.[59] These changes increased the demand for electricity and the utilisation of power stations including Bankside. An issue that does not feature prominently in the literature is pollution transfer. Although he does not use the term Joel Tarr identifies and provides a definition of the phenomenon as 'how solutions for one pollution problem often generated new pollution problems in different localities or in different media'.[60] For example, each of the industries that produced smokeless fuels: coke and gas works and electricity power stations burnt coal to produce the fuel. The source of pollution was therefore transferred from the consumer to the producer. As the environmental historian Peter Thorsheim has identified, the Beaver report was curiously evasive about the elimination of smoke from these 'smokeless' industries.[61] This research demonstrates that there are several examples of this phenomenon in the history of Bankside power station, including the flue-gas plant that removed sulphur pollutants from the flue-gases and washed them into the river Thames. An examination of the phenomenon of pollution transfer associated with Bankside power station is therefore a significant addition to the existing literature.

There is frequently a tension between pollution and technology; and sometimes aesthetics as well, for example the height of the chimney at Ironbridge power station discussed above.[62] John Sheail specifically addresses environmental and technological issues of the British ESI from the late-1920s, including a detailed examination of the

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[59] Ibid., p.53.
[60] Tarr, *The Search for the Ultimate Sink*, p.8.
[61] Thorsheim suggests that the Beaver committee, in making a case against domestic smoke, downplayed the issue of smoke from 'smokeless' fuel industries, see P. Thorsheim, *Inventing Pollution: Coal, Smoke, and Culture in Britain since 1800* (Athens Ohio, 2006), p.177.
[62] See also J.K. Stine and J.A. Tarr, 'At the Intersection of Histories: Technology and the Environment', *Technology and Culture*, 39:4 (1998), pp.601-40.

flue-gas cleaning processes at London's 'super-stations'.[63] In looking at the environmental opposition to power stations he argues that few industries have been so 'resourceful in responding to this public concern'.[64] This study supports his contention by demonstrating that considerable efforts were made at Bankside to address the issue of air pollution and amenity impact. Bill Luckin, in addressing the controversy around the plans for Battersea, claims that the objective facts about the operation of Battersea such as the volume of gas and dust produced, the technical effectiveness of the plant, and its contribution to smog 'can never be fully recovered or reconstructed'.[65] This project aims to use the data that is available to undertake a partial reconstruction for the operation of Bankside power station and to assess its impact on its surroundings. The issue of Bankside in its urban setting is addressed in the final set of literature concerning the topics of urban planning, industrial archaeology and urban regeneration.

Planning, industrial archaeology and urban regeneration

The urban geographer Gordon Cherry argued that British town planning in the 1930s had not advanced significantly since the early years of the century with the ideas of Ebenezer Howard and Patrick Geddes. It was perhaps useful in the developing areas, but was of little consequence for established cities principally because of compensation liabilities.[66] The Barlow report of 1940 on the distribution of the industrial population has widely been seen as a turning point.[67] Barlow noted that the haphazard urban

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[63] Sheail, *Power in Trust*, pp.18-22 and pp.38-44.
[64] Ibid., p.v.
[65] Luckin, *Questions of Power*, p.152.
[66] G.E. Cherry, *Cities and Plans* (London, 1988), pp.108-09.
[67] Partly in response to the economic depression of the 1930s, the associated high unemployment, and population drift from north to south, the Royal Commission on the Distribution of the Industrial Population was set up in 1937 under the industrialist Sir Anderson Montague Barlow. Cherry, *Cities*, p.110.

development of the past had led people to suffer from *inter alia* bad housing, difficulties of transport, congestion, smoke and noise. The first power station at Bankside provides examples of how smoke, grit, noise and vibration affected local residents and businesses. The extensive war-time bomb damage provided an opportunity for rebuilding London. Yet as the planning historians Ken Young and Patricia Garside say ‘sufficient of London’s fabric remained to prevent those involved in reform from treating the city as though it were a clean sheet’.[68] Furthermore, the planning historian Stephen Ward notes that in 1943 ‘there was a widening view […] that vested interests were blocking any decisive action’.[69]

One visionary proposal for London, which in part addressed the issues identified in the Barlow report, was the 1943 *County of London Plan* by Patrick Abercrombie and J.H. Forshaw.[70] Two specific areas were identified for renewal: the West End and the South Bank, including the Bankside area.[71] Although the *County of London Plan* was never implemented by the LCC, the proposals for the South Bank were used as a key argument against the redevelopment of Bankside power station in the period 1945-47 as discussed in Chapter 3 – Planning Bankside. There is little in the literature on the detailed operation of the planning process for urban utilities, although Luckin’s work does outline the process as it operated at Battersea power station in the

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[68] K. Young and P.L. Garside, *Metropolitan London: Politics and Urban Change 1837-1981* (London, 1982), p.223.

[69] See the ‘Vicky’ cartoon reproduced in Ward that specifically references the Barlow report and the Uthwatt report of the Expert Committee on Compensation and Betterment published in 1942, the Uthwatt report had sought to address the issue of compensation for private landowners. S.V. Ward, *Planning and Urban Change* (London, 1994), pp.90-93 and Figure 4.2, p.93.

[70] J.H. Forshaw and P. Abercrombie, *County of London Plan* (London, 1943). The later *Greater London Plan* (1945) specifically referred to pollution issues in relation to smoke from power stations, see C. Wood, ‘Environmental Planning’ in B. Cullingworth (ed.) *British Planning: 50 Years of Urban and Regional Policy* (Linton, 1999), p.253.

[71] Forshaw and Abercrombie, *County of London Plan*, pp.126-35.

late 1920s.[72] This chapter examines in detail how the planning system, as it was constituted in the mid-1940s, worked in practice. The close focus on Bankside reveals aspects of the reality of planning in the post-war period that are not apparent in the broader view of London's grand plans. The post-war developments that took place in the Bankside area were, I suggest, a reflection of wider social and economic forces. The cultural historian Frank Mort has argued that the lifting of building controls by the Conservative Government in 1954 was the starting gun for a property boom that lasted for a decade.[73] The economic historian Peter Scott also observes that property development was probably the most prosperous sector of the British economy during the 1950s and early 1960s.[74] This study uses these ideas and demonstrates that the changes in the Bankside area in the 1950s to the 1970s were unplanned and piecemeal and reflected the building boom and other trends such as the deindustrialisation of the riverfront.

Another significant period of interest from a planning perspective was that following the closure of Bankside power station in 1981. The town planning geographer John McCarthy has analysed the succession of planning approaches in Southwark.[75] McCarthy uses a framework based on the work of urban geographers Tim Brindley *et al*, who propose a typology of planning styles for the late twentieth century.[76] Each style represents a stance in the debate on planning and identifies

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[72] Luckin, *Questions of Power*, pp.139-40.
[73] F. Mort, 'Fantasies of metropolitan Life: Planning London in the 1940s', *The Journal of British Studies*, 43:1 (2004), p.122.
[74] P. Scott, 'The Evolution of Britain's Urban Built Environment', in M. Daunton (ed.) *The Cambridge Urban History of Britain Vol. 3* (Cambridge, 2000), p.518.
[75] J. McCarthy, 'The Evolution of Planning Approaches: North Southwark 1971-1994', *Land Use Policy*, 13:2 (1996), pp.149-51.
[76] Brindley *et al* suggest a two dimensional categorisation comprising the nature of the urban areas (buoyant, marginal or derelict) and the attitude to market processes whether market-critical or market-led. T. Brindley, Y. Rydin and G. Stoker, *Remaking Planning: The Politics of Urban Change* (London, 1996), p.9.

particular policy goals and methods. McCarthy uses the framework to examine some of the developments in the Bankside area during the 1980s and 1990s. He identifies three periods: trend planning in the period from 1971-82, popular planning from 1982-87, and leverage planning for the period 1987-94. The research on Bankside uses and builds on this planning framework to analyse the proposals for the redevelopment of redundant Bankside power station and its site from 1981 to 1994.

From around the time of its closure Bankside power station acquired an industrial archaeological value. The timing was significant. The historian of technology R. Angus Buchanan claims that industrial archaeology had come of age in 1979 with thriving local societies, a national organisation and a growing academic recognition of the subject.[77] The town planning and urban conservationist John Pendlebury also identifies that the 1970s had seen the establishment of industrial archaeology as worthy of serious study, in part related to rapid deindustrialisation of Britain.[78] Some power stations, including Bankside, were seen as examples of buildings of historical or architectural value. In this research study I examine the attitudes to the building and the attempts that were made to have Bankside formally protected by ‘listing’. Although its architectural value was noted, the listing applications were rejected for wider political and economic reasons associated with the privatisation of the electricity industry in 1990. Martin Chick identifies the issue of ‘stranded assets’, mainly the nuclear power stations which the market would not purchase and which were retained in public ownership.[79] Bankside can also be seen as

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[77] See R. Angus Buchanan, ‘The Origins of Industrial Archaeology’ in N. Cossons (ed.), *Perspectives on Industrial Archaeology* (London, 2000), p.28; the Newcomen Society had first published the *Journal of Industrial Archaeology* in 1964 and the national organisation the Association of Industrial Archaeology had first published *Industrial Archaeology Review* in 1976.
[78] J. Pendlebury, *Conservation in an Age of Consensus* (London, 2008), pp.70-71.
[79] Chick, *Electricity and Energy Policy*, p.115.

a 'stranded asset' which Nuclear Electric (the post-privatisation owner) wished to sell. Formal listing may have devalued the building by constraining the uses to which it could be put by a prospective purchaser. This issue is addressed by the historian Stephen Heathorn in his comparative study of attitudes to Battersea and Bankside power stations; both at the time of their construction and their later preservation and reuse.[80] Heathorn's study provides a framework for the comparative analysis of power stations, and indeed other industrial buildings.

The conversion of industrial buildings to museums and the associated impact on the regeneration of the locality has been the subject of recent academic scrutiny. The planning geographer Paul Teedon has argued that in the 1990s the London Borough of Southwark was increasingly keen to give a specific identity to, and to promote, the Bankside area.[81] This project adds to this position by examining the extent to which the Borough's aspirations were met and how the Tate Gallery engaged in this process. The urban historian Rebecca Madgin has examined examples of changes to the built environment of post-industrial cities and the fate of historic buildings, this also provides points of comparison with Bankside.[82] Tate Modern was one of a number of global conversion projects. The architectural academic Phoebe Crisman asks questions of these industry-to-museum buildings, including what it is that is being preserved; a question that this thesis addresses.[83] The development of Tate Modern was the key to the regeneration of the area. It has been argued that this was a two-way process: Tate Modern both stimulating and benefiting from the infrastructural

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[80] S. Heathorn, 'Aesthetic and Heritage Nostalgia: Electrical Generating Superstations in the London Cityscape since 1927', *The London Journal*, 38:2 (2013), pp.125-50.
[81] Teedon, 'Designing a Place called Bankside', p.465.
[82] R.M. Madgin 'Urban Renaissance', unpublished PhD thesis, University of Leicester (2008).
[83] Crisman, 'From industry to Culture', p.405.

investment in the area.[84] This research examines these processes and extends the analysis to the present day. One result of the regeneration process was that the Bankside area became gentrified. The urban geographer Andrew Harris has claimed that Bankside did not have a 'large stock of degraded 19th-century houses' and therefore gentrification did not follow the classic form outlined by Ruth Glass.[85] The literature provides points of reference for the analysis in this study of the changes in the Bankside area from 1994 when the plans for Tate Modern were announced.[86]

As this review demonstrates the research on the CLELC and Bankside is a significant contribution to the historiography on the role and effects of generation and use of electricity in an urban setting. Pertinent topics in the literature have been identified such as the structure and operation of the electricity supply industry; issues around the problems of pollution and the environment; and the historiography of the disciplines of planning, industrial archaeology and urban regeneration. These topics are used to set the research on Bankside power station in an appropriate historical context. The following section identifies some of the major sources that have been drawn upon in the research.

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[84] Dean *et al*, 'Tate Modern: Pushing the Limits', p.82.

[85] R. Glass, *London: Aspects of Change* (London, 1964) quoted in A. Harris, 'From London to Mumbai and Back Again: Gentrification and Public Policy in Comparative Perspective', *Urban Studies*, 45 (2008), p.2412.

[86] In addition to the above literature see also T. Brindley, 'Community Roles in Urban Regeneration: New Partnerships on London's South Bank', *City*, 4:3 (2000), p.368; W. Davidts, 'Art Factories: Museums of Contemporary Art and the Promise of Artistic Production, from Centre Pompidou to Tate Modern', *Fabrications: The Journal of the Society of Architectural Historians, Australia and New Zealand*, 16:1 (2006), p.35.

Sources

Prior to the nationalisation of the electricity industry in 1948 Bankside power station was owned and operated by the City of London Electric Lighting Company Limited (CLELC). The surviving records of the company are held at the London Metropolitan Archives (LMA); these include files relating to statutory planning applications, early operational accounts, plans of the early power stations, and a selection of the company's board minutes.[87] These provide an insight – albeit a partial and selective one – into the management of the company and their power station at Bankside. Only some of the Board of Directors minute books have survived; unfortunately there is no coverage of years 1919 and 1926 when the views of the company directors' to the Electricity Acts of those two years would have been of considerable interest.[88] Neither do the records include detailed long-term operational information on the power station nor the finances of the company, although some of this information is available elsewhere.[89] The records of the London County Council (LCC) and the Greater London Council (GLC) relating to Bankside power station and the Bankside area are also held at the LMA and include case files compiled under the Building Acts and the South Bank development control plans from the late 1940s.[90] These include internal reports by the LCC Town Planning committee and the Public Control department; the minutes of the main Council meetings; and correspondence between the LCC and ministries, statutory bodies such as the Electricity Commission, and local authorities

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[87] For example, London Metropolitan Archive (LMA), LMA/4278/01/609, City of London Electric Lighting Company, Plans of substations and lighting areas, 1894-1900.

[88] The only surviving Board minutes appear to be: LMA, LMA/4278/01/589, City of London Electric Lighting Company, Board of Directors Minute Book no. 4, 1901-6 and LMA/4278/01/590, City of London Electric Lighting Company, Board of Directors Minute Book no. 10, 1937-48.

[89] Operational and financial data on electricity undertakings are given in Garcke, *Manual of Electrical Undertakings*, annual volumes from 1896 to 1947/8.

[90] LMA, GLC/RA/D2G/12/553, South Bank Comprehensive Development Area: Bankside Power Station (with alternative Rotherhithe Site), 1947 and LMA, GLC/AR/BR/17/033211/01, /02 & /03, Bankside Generating Station, City of London Electric Lighting Company, Building Act case file, 1892-1944.

including the Borough of Southwark. Their scope is particularly useful for demonstrating the policy and position of the LCC to the development plans for Bankside 'B' together with some of the public health issues in the Bankside area from the early 1900s.

Key sources for the debates around the planning and approval for Bankside 'B' power station are the records of the two principal government ministries involved in the decision-making process. Files of the Ministry of Fuel and Power (Class POWE 12 & 14) and the Ministry of Town and Country Planning (Class HLG 79) are held at the National Archives (TNA). The Ministry of Fuel and Power's records include some of the correspondence with the pre-nationalisation CEB and the Electricity Commissioners, as well as the post-nationalisation British Electricity Authority (BEA), Central Electricity Authority (CEA) and Central Electricity Generating Board (CEGB).[91] Both ministries were also responsible in 1947 for planning control for the power station, and the files include verbatim transcripts of the Bankside public inquiry held in January 1947.[92] The Bankside redevelopment was discussed by the Cabinet and the Lord President of the Council's committee. Minutes of meetings and memoranda are all official Cabinet papers (TNA, Class CAB 128 to 132).[93] The development was debated in both Houses of Parliament (transcripts in *Hansard*) both at the time of approval in 1947 and when the power station commenced operation in 1952.[94] There

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[91] The BEA, CEA and CEGB were successively the nationalised owners of most British power station and the national grid, see Appendix B for details of these organisations.
[92] For example: TNA, HLG 79/916, Ministry of Town and Country Planning, Bankside power station development Southwark: application to minister, 1945-47; TNA, HLG 79/918, Ministry of Town and Country Planning, Bankside generating station: inspector's report, 1944-47; Verbatim transcripts of the evidence taken at the public enquiry are in TNA, POWE 12/798, Electricity Commission, Bankside Reconstruction and extension, 1945-50.
[93] For example: TNA, CAB 128/9, Cabinet Office, Cabinet Minutes for 01 April 1947; 15 April 1947; 22 May 1947. Also TNA, CAB 129/11, Cabinet Memoranda Location of Power Stations, 1946.
[94] See, for example: *Hansard*, House of Commons debates, 22 April, Vol.436 cc780-83; 29 April, Vol.436 c219w; 30 April, Vol.436 cc237-38; and 1 May 1947, Vol.436 c255w.

were discussions and correspondence about the power station by learned societies, local councils, and by the public. Surviving records include editorials and letters in the national and local press, articles in professional engineering and architecture journals, and Southwark Borough Council minutes.[95] The records provide an insight into the position of organisations and individuals in the controversy over the proposed development and the decision-making and approval process. These records are held at the British Library, St Paul's cathedral library, the Institution of Engineering and Technology (formerly the Institution of Electrical Engineers), and the Southwark local history library.

One notable lacuna in the records are the archives of the CEGB and its post-nationalisation predecessors the CEA and the BEA. The whereabouts of the archives is unknown following the privatisation of the electricity industry in 1990.[96] Some correspondence with these bodies survives in the ministry files at the TNA (Class POWE and HLG) and some in the Electricity Council archives held at the Museum of Science and Industry in Manchester. This correspondence enables a limited reconstruction of the position of the national electricity bodies to be undertaken. Operating data for Bankside 'B' power station is given in published CEGB Statistical Yearbooks, this has been used to demonstrate its utilisation over its operational life.[97] These records constitute a partial substitute for the absence of the detailed CEGB records of the operation of Bankside. The effectiveness of the flue-gas washing plant at the power station was regularly monitored as part of its consent conditions.

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[95] Anon, 'Lords Attack Bankside Power Station Plan', *Daily Telegraph*, 20 May 1947, p.3; Anon, 'Rotherhithe Power Station CEB Apply for Site', *South London Press*, 12 August 1947; Anon, 'Power Station Raises Real Planning Principle', *The Architects' Journal*, 15 May 1947, p.404; Anon, 'A Station Worthy of London! Bankside "B" Goes on Load', *Electrical Times*, 22 January 1953, pp.143-49.
[96] Ironically, for a study of Bankside power station, the BEA / CEA / CEGB and their archives were based at Bankside House immediately adjacent to Bankside power station until 1964.
[97] CEGB, *Statistical Year Book*, various editions 1964-1986/7 (London, 1965-1987).

Commentaries on the operation of the flue-gas washing plant and its local impact are available in the records of Ministry of Fuel and Power (from 1957 the Ministry of Power) (Class POWE 14) and the Department of Scientific and Industrial Research (Class DSIR 8) both held at TNA, together with the records of the LCC deposited at the LMA, and the records of the Pollution Inspectorate.[98]

The influence of political control and the internal operation of the electricity industry are revealed in the diaries, biographies and autobiographies of several key actors. These are significant for the insight they provide into policy strategies and decision-making processes. However, as the historian Arthur Marwick cautions, there may be issues about the fallibility of memory and the need to cross-check with other material.[99] These sources also provide insights into the occasional clash of personalities. This is particularly relevant at the time when Bankside 'B' was approved when there was a disagreement between the Chancellor of the Exchequer Hugh Dalton and the Minister of Fuel and Power Emanuel Shinwell over the latter's handling of the 1947 fuel crisis.[100] Other industry insiders include Lord Citrine the chairman of the BEA / CEA from 1948 until 1957 whose autobiography provides details of the thinking behind the development of the super-grid and nuclear power in the 1950s.[101] Sir Francis (Frank) Tombs the chairman of the Electricity Council from 1977-80 also

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[98] TNA, POWE 14/141, Ministry of Fuel and Power, Gas washing plant Battersea: Bankside, 1947-63; TNA, DSIR 8/93, DSIR, Removal of sulphur compounds from the flue gases of electricity generating stations, 1944-49; LMA, LCC/PC/GEN/01/052, Electricity Generating Stations; Health and Safety Executive, *Industrial Air Pollution,* various editions 1976-81 (London, 1976-82).

[99] A. Marwick, *The New Nature of History* (Basingstoke, 2001), p.157.

[100] E. Shinwell, *The Labour Story* (London, 1963), pp.182-84. B. Pimlott (ed.), *The Political Diaries of Hugh Dalton 1918-40, 1945-60* (London, 1986), pp.389-90. In a biography of Shinwell written in the 1990s Peter Slowe states that 'Shinwell must take a good deal of blame for this disastrous procrastination', P. Slowe, *Manny Shinwell: An Authorized Biography* (London, 1993), p.220.

[101] Lord Citrine, *Two Careers* (London, 1967), pp.263-70, pp.278-80, pp.303-05.

provides an insider's view of the structure and operation of the electricity industry.[102] There are also insights into the operation of the industry from an ongoing project on the oral history interviews of the British electricity supply industry.[103] I have attempted to locate and interview people who worked at Bankside power station. Only a few have been found identified in the 'Interviews and personal correspondence' section in the bibliography. There is therefore a paucity of personal testimonies on the working life of Bankside.

Following its closure in 1981 there were occasional proposals for the power station to be demolished, 'listed', or redeveloped. Memoranda, correspondence and articles related to these proposals exist in the national and local press, in professional journals and in organisations such as English Heritage.[104] The government departmental files on the proposed 'listing' of Bankside in 1988 and 1992 are currently closed but would repay further study when they are opened for public access.[105] Documents associated with the 1994-2000 conversion of Bankside power station to Tate Modern are public records held by the Tate Library and Archives (Class TG). Plans, consultation documents and correspondence for the Tate Modern 2

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[102] F.L. Tombs, *Power Politics: Political Encounters in Industry and Engineering* (London, 2011), pp.67-75, pp.132-35.

[103] Available interviews include those with Glyn England and Frank ledger. England was Chairman of the CEGB from 1977 to 1982. As noted above Ledger was a CEGB system operations engineer during the early 1970s and director of operations during the 1984-5 miners' strike. British Library, Industry: water, steel & energy, Electricity industry oral history interviews, http://sound.bl.uk/Oral-history/Industry-water-steel-and-energy [accessed November 2013].

[104] Anon, 'Power Play at Tate', *Building Design*, No. 1141, 10 September 1993, p.1. J. Glancey, 'The Powerhouse for Modern Art?, *Independent II*, 10 November 1993, p.22. Some English Heritage files are available in Statutory Planning files at the LMA, LMA/4441/01/4842, Bankside Power Station Statutory Planning File, 1992-9, for example the letter from Jocelyn Stevens (Chairman of English Heritage) to D du Parc Braham dated 12 January 1993.

[105] A listing application for Bankside power station was made to the Department of the Environment in 1988 and to the Department of National Heritage in 1992. These files should be open in 2015 and 2017 respectively under the 20-year rule.

development, from 2007, are held by the London Borough of Southwark.[106] These records enable aspects the post-closure history of Bankside power station and the on-going development of Tate Modern to be addressed. Full details of the archives, records and sources consulted are given in the Bibliography.

Chapter plan

In addition to this introductory chapter, the thesis comprises five main chapters examining aspects of the early electricity supplies to the City of London; the decision-making and approval process around the proposal for Bankside 'B'; the technology deployed at Bankside; the operation of the power station; and the transformation of Bankside to Tate Modern and associated consequences; plus a concluding chapter. The chapters comprise a broadly chronological sequence and the structure, scope and main arguments of each chapter are as follows.

Chapter 2 entitled 'Electrifying the City' examines the electricity supplies in the City of London from the 1880s to the late 1940s, i.e. the period before and leading up to the decision to build Bankside 'B', together with the contexts in which these supplies operated. The topics examined in this chapter pre-figure several issues in the post-war period such as the power station's location; the nuisance of pollution; and the impact on the local area. The chapter demonstrates that the location of Bankside was determined and fixed in 1891 as a solution to a number of technical and financial factors. Bankside acquired 'momentum of place' which predisposed the site to the continuation of its electricity supply and distribution function. The growth of electricity demand and development of the power station up to the Second World War

[106] London Borough of Southwark, Documents for Planning Application (09/AP/0039 Tate Modern Extension, London SE1, 2008-2009), http://planningonline.southwarksites.com/planningonline2/AcoINetCGI.exe?ACTION=UNWRAP&RIPNAME=Root.PgeDocs&TheSystemkey=9530974 [accessed July 2012].

are examined. Contrary to the perceived backwardness of the British electricity supply industry in the inter-war period identified in much of the current historiography, this chapter demonstrates that the CLELC was a financially profitable business and was successful in attracting electricity consumers and investors. The company co-operated and integrated its operations with other London undertakings. The statutory oversight of the ESI established after 1926 created a bureaucratic system that subjected the CLELC to control of both its strategic and commercial decision making.

Chapter 3 – 'Planning Bankside' analyses the decision-making and approval process for the development of Bankside 'B' power station over the period 1944 to 1947. The arguments around the redevelopment proposal are framed as a conflict – the battle for Bankside – between two strategic post-war plans for the modernisation of London. Electricity was seen as important for the economic recovery of the country through the expansion and modernisation of British industry; yet the electricity industry was poorly placed to meet this demand. The proposed new power station at Bankside was part of the ESI's response to an energy supply shortage. On the other hand, the war had provided the opportunity to re-plan and rebuild war-damaged London on a modern, rational and visionary basis. The *County of London Plan* had proposed the deindustrialisation and redevelopment of the South Bank of the Thames including the Bankside area. The development proposal for Bankside 'B' was located at the nexus of these two plans. The essentially un-resolvable dilemma escalated from private local discussions to a public debate of national interest. This research illuminates in detail the decision-making and approval process, as it operated in the mid-1940s, for a significant element of London's infrastructure. It provides an insight into the operation of local and national government, the relative power of the ministries involved, and on the influence of politically powerful individuals. This complements and extends Luckin's work on the planning around Battersea power station in the 1920s. At Bankside the protracted decision-making process was a result of the planning laws as they were then constituted and I propose that the decision was resolved in favour of the electricity lobby through the random contingency of the 'bleak midwinter' of 1947, which had turned a fuel shortage into a crisis.

Chapter 4 – 'Technology at Bankside' analyses some of the technologies that were proposed or installed at Bankside 'B' power station. A theme of the chapter is the process of technological decision-making; it therefore complements the political decision-making examined in Chapter 3. Technological decision-making not only encompassed the technological possibilities that could be drawn upon – themselves a product of the state of technical and scientific knowledge – but decisions were influenced by an interplay of social concerns about amenity, economic considerations around the cost of plant and the price of fuel, and political influence and direction from the government. This chapter is arranged around a number of moments of significance and change for the power station. These moments constituted a particular set of circumstances that influenced the technological decisions that could be, and were, made. The chapter examines a number of proposed technologies at Bankside and the reasons for their selection or rejection. Many of the technologies deployed had the primary aim of generating electricity in an efficient and economical manner, but Bankside also used several technologies to mitigate its impact on its surroundings. The chapter includes an analysis of some of the wider developments in power station technology over the second half of the twentieth century and the impact these had on the form, size and location of British power stations. These developments led to the demise of the urban 'brick cathedral' power station, of which Bankside 'B' was one of the last examples.

Chapter 5 – 'Bankside in Operation' examines the working life of Bankside 'B' power station from 1952 to 1981. In this chapter I show that Bankside 'B' largely functioned as an effective and efficient power station for the first two decades of its operational life. This is conceptualised as the ideal model of operation. In its later working life the ideal model was affected by wider external issues. This led to a decline in the utility of the power station, and its eventual closure. The technology at Bankside was fixed at an early stage to operate under specific conditions, but effective operation became problematic when the externalities changed. The economic viability of Bankside was crucially linked to variations in the cost of fuel oil. This in turn relates to issues on the national policy on fuel availability and its use, and wider national and international political events identified in the existing literature. Other external factors that influenced the perception of Bankside included improvements in air quality and the condition of the river Thames. The air and water pollution produced by Bankside 'B', which had been tolerable, or at least tolerated, in the early 1950s, became increasingly unacceptable by the end of the power station's working life. The chapter examines the concept of pollution transfer whereby unwanted effluents are shifted to other media or other locations.

Chapter 6 – 'Transforming Bankside' examines the post-closure history of Bankside power station and sets this in the context of the changes that took place in the immediate area over the operational life of the power station and up to the present day. Bankside power station, as a private industrial place, had largely stood apart from its surroundings. By 2000 the building had been transformed into a new public space that was being integrated into the material, social and cultural fabric of the neighbourhood. Its surroundings underwent a transformation, a regeneration process that was largely driven by the presence of Tate Modern. The Bankside area evolved from a gloomy, run-down post-industrial locality to a popular cultural centre with new office, commercial and residential developments and improved transport connections. This research complements the current literature on urban regeneration of the South Bank. The transformation of Bankside to Tate Modern was crucially dependent both on its location and of the timing of the redevelopment; several contingent factors made the transformation viable. The redevelopment of Bankside – both the power station and the locality – is contrasted with the post-industrial fates of two other Thames-side power stations whose operational lives had paralleled Bankside. The conjunction of location, timing and finance were key factors in the fate of Battersea and Brunswick Wharf power stations. The success of Tate Modern – with four million visitors a year – drove another transformation: the on-going redevelopment of Tate Modern through the addition of a major extension.

Chapter 7 – 'Conclusions' summarises and synthesises the findings from this research and relates these back to the historiography. It also returns to, and addresses, the research questions outlined above. This study, in focussing on an individual electricity undertaking and its power station, has examined a neglected area in the history of modern Britain. It has identified several aspects that Bankside had in common with other power stations. Issues include the location of power stations and their growth and redevelopment to meet an ever increasing demand for electricity. An important finding from this study is that the close focus on Bankside power station is an approach that reveals issues that are not evident in the more broadly scoped historiography on the British electricity supply industry. The research has identified examples that qualify or contradict the more broadly based findings of Leslie Hannah and Thomas P. Hughes concerning the size, structure and operation of the early electricity industry and its power stations. The chapter summarises the changing contexts in which Bankside functioned and how these influenced how Bankside was operated. The theme of change also encompasses the changing perceptions and value of Bankside power station and Tate Modern by a number of actors, including the transition of the building from a largely unwanted eye-sore to a modern cultural icon.

Chapter 2 – Electrifying the City: the City of London and its electricity supplies

This chapter examines the electricity supplies to the City of London from 1878 to 1948 together with the wider context in which these supplies operated. This early history is significant because several factors and issues in the post-war period, such as Bankside power station's prominent central London location and its impact on the locality, were determined or were prefigured during this period. The first unsuccessful attempts at electric lighting in the City are set in the context of the early electricity legislation and the Corporation of London's policy to use private capital to finance electricity supplies. The chapter addresses how the location of Bankside power station was determined. The site was selected at an early stage as an optimum solution to a number of requirements. This exemplifies a theme that runs through the thesis concerning the interplay of technological possibilities, political interests, economic forces, and social concerns. Once established at Bankside, the location predisposed the site to its continuing use for the generation and distribution of electricity: the Bankside site acquired a 'momentum of place'.

The chapter demonstrates how the growth of electricity demand was stimulated by the City of London Electric Lighting Company (CLELC). This was a financially profitable business and was successful in attracting both electricity consumers and investors. This is contrary to the views in the existing literature that London's electricity suppliers were small-scale and had no incentive for expansion. The high demand for electricity was aided by the compact nature and relative wealth of the company's area of supply in the City. The increasing demand for electricity drove the redevelopment and expansion of Bankside power station and its site from the 1890s to the late 1930s. This had adverse social effects as the CLELC bought and demolished adjacent properties and displaced local residents. The power station was not a good neighbour: there were frequent complaints about smoke, dust, noise and vibration. Some of these problems continued throughout the operating life of the station.

This chapter aims to demonstrate how government policy on electricity supplies, enacted through statute, operated in practice and affected an individual electricity undertaking. The inter-war period saw significant changes to the British ESI. Its structure and nature shifted from autonomous private enterprise and municipal electricity undertakings to increased integration together with oversight and control by statutory bodies. The CLELC co-operated with other London undertakings to partly integrate their electricity supplies and commercial activities. The political structure subjected the CLELC to control of both its strategic and commercial decision making and curtailed the company's commercial independence. The statutory structure resulted in a complex system in which official decision-making and approvals became protracted and bureaucratic. Increasing state control culminated in the nationalisation of the industry in 1948 which dissolved the CLELC and other private and municipal undertakings, but by which time Bankside 'B' was under construction.

Early schemes and the City of London Electric Lighting Company

The early schemes for electric lighting in the City were small-scale privately financed systems that supplied electricity to individual streets, buildings or bridges. None of these schemes proved to be financially viable in comparison with gas lighting. For example, in 1878 the Streets Committee of Corporation of the City of London (the Corporation) contracted the Société Générale d'Electricité of Paris to install 16

Jablochkoff candles to light Holborn Viaduct. The lighting was about four times as expensive as gas lighting and the system was decommissioned in May 1879.[1] Other schemes for lighting three City bridges had been tried in 1880-81 and had also been found to cost more than gas lighting.[2] In this respect the City of London was little different to many British towns and cities where electric lighting schemes had been proposed but had failed to become established in this period.

The early lighting schemes had entailed a number of Private Bills being introduced in Parliament through which companies and local authorities sought powers to break-up streets to lay cables. To regularise the nascent industry the Electric Lighting Act 1882 empowered the Board of Trade to authorise by Licence or Provisional Order any local authority, company or person to supply electricity and to install a system of supply, including a provision for the breaking up of roads.[3] The Act also provided for maximum prices, and the option for local authorities to purchase the electricity undertakings at their scrap value after 21 years. It was seen at the time, and has been argued since, that this buy-out provision stifled private enterprise by deterring potential investors from committing their capital.[4] However, the business historian Leslie Hannah has argued that 21 years would have been ‘an eternity to most investors’ and therefore was no deterrent to investment.[5] For early undertakings it was

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[1] The Jablochkoff (or Jablochkov) candle was an electric arc light comprising two carbon rods separated by a layer of kaolin or gypsum, the candle burned down in about 1½ hours, see W. Schivelbusch, *Disenchanted Night* (Berkeley CA, 1995), p.53 and R.H. Parsons, *Early Days of the Power Station Industry* (Cambridge, 1939), p.5.
[2] London, Southwark and Blackfriars bridges. See R. Bourne, ‘The Beginnings of Electric Street Lighting in the City of London’, *Engineering Science and Education Journal*, 5:2 (1996), pp.82-83.
[3] Licences were granted to local authorities or to private companies with the consent of local authorities to provide electricity supplies in a given area for a renewable seven year period; Provisional Orders were for an unlimited time and did not need the consent of the local authority but had to be confirmed by Parliament. Parsons, *Early Days*, pp.187-88.
[4] See for example Weightman, *Children of Light*, pp.51-56; and Electricity Council, *Electricity Supply in the United Kingdom* (London, 1987) p.17.
[5] Hannah, *Electricity*, pp.5-6

rather a question of making electricity schemes financially viable by having sufficient customers and deploying the appropriate technology. Recent work by the economists William Kennedy and Robert Delargy has demonstrated that it was the inflated expectations of 1882 stock market boom in electricity stocks and the subsequent downturn that led to the lack of investment in the industry throughout the 1880s.[6] Nevertheless, the reversionary period was extended to 42 years under the Electric Lighting Act 1888, which also valued a company's assets as a going concern rather than the scrap value of the plant.[7] It was under this Act that the electricity supply industry, including that for the City of London, began to develop.

The Corporation of London, mindful of the failure of the early schemes, had not wished to take on the financial risks of providing an electricity supply. As one contemporary noted:

> the most sanguine advocates of electric lighting considered the prospects of successfully supplying electrical energy in the City of London were not so certain as to justify the large outlay required.[8]

The Corporation favoured the use of private capital. In 1889 they invited tenders from manufacturers of electrical plant to provide electric lighting throughout the City. The terms of the contracts were onerous. These included the lighting of the City practically at cost; the provision of reserve funds; and the reduction of charges after a certain profit had been made. In return the contractors had the exclusive right to supply electricity for private purposes – as opposed to public lighting – for 21 years from 1890.[9] The City was divided into three districts and two contractors were selected to

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[6] W. Kennedy and R. Delargy, *Shorting the Future: Capital Markets and the Launch of the British Electrical Industry, 1880-1892*, University of Essex, Department of Economics, Discussion Paper Series (2011).
[7] Parsons, *Early Days*, p.182.
[8] 'The City of London Electric Lighting Company's Works', *The Electrical Review*, 44 (1899), p.339.
[9] Ibid.

supply equipment for electric lighting. The Laing, Wharton and Down Construction Syndicate Limited were to supply the eastern district and the Anglo-American Brush Electrical Engineering Company Limited had the central and western districts. To enable the contractors to proceed with the development of electricity systems Provisional Orders were obtained under the 1888 Act; and to provide finance the City of London (Pioneer) Electric Lighting Company was formed in February 1891 with a capital of £50,000. With funding and legal permissions in place the contractors started to develop permanent electricity supplies in the City.

Electricity supplies can be conceived as comprising of three elements, each of which had an impact on the cityscape and the urban environment: the power station where electricity was generated; the network of electricity distribution cables that radiated from the power station; and the electricity consumers and users. Once installed the electricity distribution system was largely invisible beneath the streets, but was disruptive while the cables were laid, and was potentially lethal when faults developed.[10] Electricity was used for the public lighting of streets and for private supplies to homes, public buildings, commercial premises and industry. Initially private electricity supplies were used solely for lighting; but 'power' uses and appliances were soon developed such as cookers and electric fires together with electric motors for industry. While lighting was the most visible manifestation of

[10] Between December 1891 and July 1892, 271 miles of electricity mains had been laid within the City, causing significant disruption; in one incident in 1894 a horse was electrocuted and two junction boxes exploded throwing kerb-stones into the air. C. Otter, *The Victorian Eye: A Political History of Light and Vision in Britain, 1800-1910* (Chicago, 2008), pp.246-48.

electricity, the element that had the most adverse impact on urban environment were the electricity generating stations.[11]

The choice of location for the generating stations was based on a number of operational, political and economic considerations.[12] The two City contractors took similar but slightly different approaches to the location of their power stations. Several operational factors were addressed. Large quantities of coal were required which was most easily, and cheaply, brought by river. Sea-going colliers were unloaded down-river at Blackwall into barges which were then towed up-river to the riverside wharves. This arrangement also provided a route for the coal ash from the boilers to be taken away for disposal, or for sale as a building aggregate.[13] The power stations also required large quantities of water for steam-raising and for cooling; a virtually unlimited supply was readily available from the tidal reach of the Thames. Increasing quantities of water were needed for developments in technology from the turn of the century. Steam turbines rather than steam engines began to be used in power stations and a vacuum condenser at the outlet of a steam turbine increased the efficiency of the plant.[14] The condenser used large quantities of water for condensing and cooling. The first steam turbine was not installed in Bankside until 1910, but the riverside location of the power station enabled it to exploit the availability of water.

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[11] The social aspects of electric lighting have been extensively examined. For example, Otter, *Victorian Eye;* Schivelbusch, *Disenchanted Night*; Weightman, *Children of Light*, and L. Nead, *Victorian Babylon: People, Streets and Images in Nineteenth-Century London* (Yale, 2000).
[12] See for example C.D. Harris, 'Electricity Generation in London, England', *Geographical Review*, 31:1 (1941), p.128 and E.M. Rawstron, 'The Distribution and Location of Steam-driven Power Stations in Great Britain', *Geography*, 36 (1951), pp.249-63.
[13] In 1946 the CLELC had approached the Borough of Southwark and the Ministry of Works to offer the coal ash from Bankside for use in the Government's post-war rebuilding programme, but there was no interest. LMA, LMA/4278/01/590, CLELC, Board of Directors Minute Book, minutes dated 16 January 1946, f.233.
[14] Duffy, 'Thermodynamics and Powerhouse Design', pp.216-18.

Another locational consideration for the power stations was that they had to be close to the area they supplied. The transmission of electricity over long distances resulted in losses, especially at the relatively low voltages that early enterprises had generated and distributed electricity. A location close to the consumers in the City was therefore desirable, however, land prices in the City were relatively high. The running of underground cables, or more specifically the breaking-up of streets to install cables, required the consent of the local authority. Way-leaves through neighbouring local authority areas could be difficult to obtain.[15] The City of London Provisional Orders had provided the authority to do this, but multiple orders would have been necessary if the power stations had been located further away. The location therefore entailed a compromise between the availability of water, the transport costs of fuel, land prices, the cost of cables and distribution losses.

Given these considerations the Laing, Wharton and Down Syndicate chose a site within the City of London and established their electricity generating station at Wool Quay, a riverside location on Lower Thames Street, between the Custom House and the Tower of London (see Figure 2.1).[16] The Wool Quay site soon became crowded.[17] Although this site was satisfactory for the initial supply of electricity to the eastern part of the City, the demand for electricity grew rapidly. The site was too small to allow for the storage of large quantities of coal and for the expansion of the generating station. Wool Quay was a short term solution to the immediate need for a

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[15] The engineer C.E. Webber claims that for supplies to the City there had been three years of negotiations with local authorities on the Surrey side of the river, see C.E. Webber, 'Some Notes on the Electric Lighting of the City of London', *The Electrician*, 23 February 1894, p.450.
[16] The Wool Quay station provided a 50 kW supply for arc lighting and a 120 kW 'private' supply for the eastern part of the city and started operating in December 1891. Parsons, *Early Days*, p.115.
[17] The generating equipment had to be arranged vertically; the basement, where the generators were located, was 20 ft below the high-water level; the boilers were on the floor above; and the coaling equipment above them. Webber, 'Some Notes on Electric Lighting', p.447.

local electricity supply, but the site was too restricted for a viable long-term supply. The Wool Quay station was closed in 1893 and its equipment was sold or transferred to the station at Bankside.[18] The site was retained by the CLELC as a warehouse and stores area into the 1940s.[19]

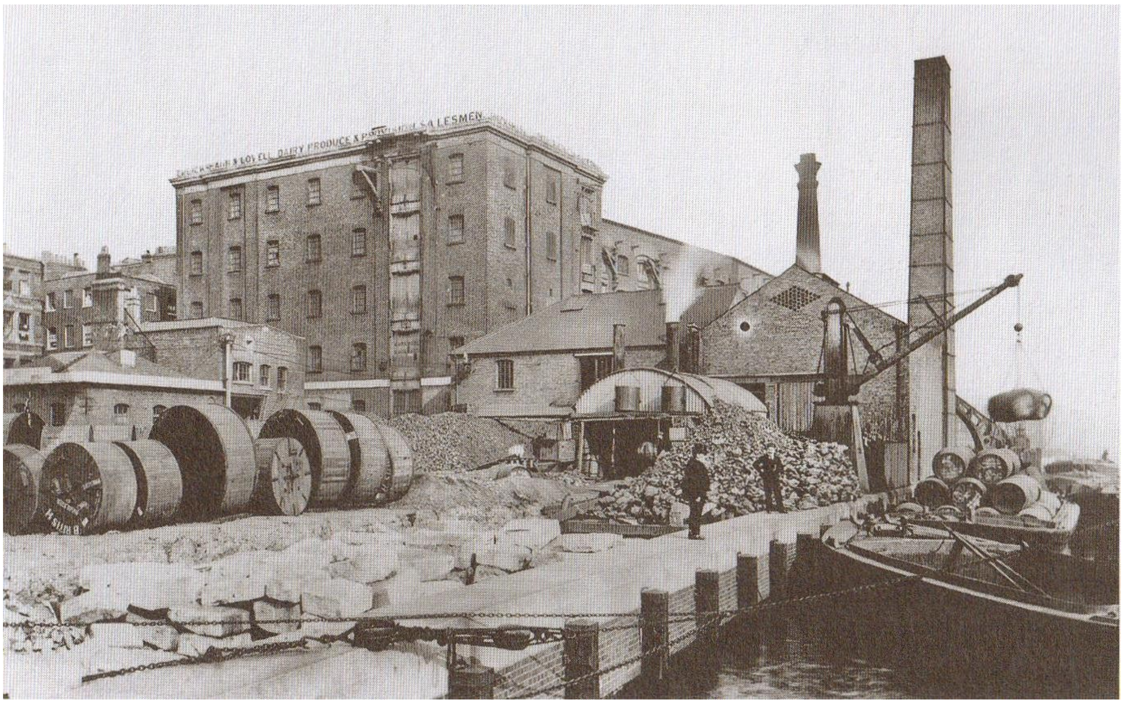

Figure 2.1: Wool Quay generating station, *c*.1892.

Source: G.B. Marshall, 'Tate Modern Its Industrial History', unpublished (2004), Southwark Local History Library, Illustration 8 (CEGB photo library).

Note the piles of coal, the drums of electricity cables, and the congested nature of the quay.

The other contractor, the Brush Company, selected a site for their generating station at Meredith Wharf on Bankside on the south side of the river in Southwark. This location necessitated running cables to the City across several London bridges but the advantages of the site outweighed this disadvantage. Bankside at the turn of the

[18] Parsons states that Wool Quay was closed in January 1898 (Parsons, *Early Days*, p.115); but Bourne states it closed in January 1893 (Bourne, 'The Beginnings', p.87); Webber, writing in February 1894, states 'Wool Quay (since abandoned)', see Webber, 'Some Notes on Electric Lighting' 1894, p.447.

[19] The CLELC noted that a warehouse at Custom House and Wool Quay had been destroyed by enemy action in December 1940, LMA, LMA/4278/01/590, CLELC, Board of Directors Minute Book, minutes dated 15 January 1940, f.118.

century was an industrial area of wharves, warehouses and manufactories, together with some poor-quality housing. Industry in the area included the South Metropolitan Gas Works which had operated at Bankside since 1814. Bankside generating station was therefore in keeping with the industrial nature of the location. The power station site included a wharf where coal was unloaded and transferred to a coal store adjacent to the power station buildings.[20] Water was delivered into the power station by a pump house located in the lower floor of the coal hoist.

The two contractors had therefore taken somewhat different approaches to the issue of location, but they had much in common. Their riverside locations were ideal for fuelling and water supplies. In the short term, the capital cost of running cables across the bridges and the associated electrical losses were higher for Bankside, but were compensated by the cheaper site in Southwark. In the longer term, the expansion of the power station at Bankside was facilitated by its location where adjacent land could be bought relatively cheaply, whereas development at Wool Quay was limited because of its restricted site. This examination of the locational considerations for the City's power stations supports and exemplifies the early literature on the subject by the economist Chauncy Harris and the geographer E.M. Rawston.[21] It also extends the literature by identifying that the advantage of the Bankside site was that it could be expanded through the purchase of relatively cheap neighbouring properties.

[20] The coal store had a capacity for 2000 tons of coal; 'City of London Electric Lighting Co, Bankside, Southwark', *Proceedings of the Institution of Mechanical Engineers*, III-IV (1900), p.476.
[21] Bourne, 'The Beginnings'; Harris, 'Electricity Generation in London'; and Rawstron, 'The Distribution and Location of Steam-driven Power Stations'.

Public electricity supplies to the City commenced from the Bankside site on 12 June 1891.[22] The following month the CLELC was formed with a capital of £800,000 and, with the consent of the Corporation and the Board of Trade, the electricity supply contracts and Provisional Orders and the assets of the Pioneer Company were transferred to this new company. The shareholders of the Pioneer Company were given a bonus of £25,000 for the financial risk they had run. There was clearly no lack of interest, and considerable rewards, for potential shareholders willing to invest in the new industry. By 1899 the company had about 3000 shareholders.[23]

The CLELC supplied an area of 1.25 square miles (see Figure 2.2), principally in the City. The Southwark Lighting Order was obtained to enable the company to run their cables from Bankside generating station through Southwark and across to the City. As Figure 2.2 shows, the distribution system in Southwark was only along principal roads such as Southwark Street and Union Street, and the approach roads to the bridges. The Borough of Southwark was a poor, less lucrative area for the electricity company. In 1897 there were only three private supplies in Southwark.[24] Having established how the CLELC had selected an optimum site for their power station and commenced electricity supplies to the City the next section addresses how the company expanded their business by providing electricity supplies to a wide range of users, together with the consequences of the physical expansion of the power station and its site.

[22] Bourne, 'The Beginnings', p.86.
[23] 'The City of London Electric Lighting Company's Works', *Electrical Review* (1899), p.339.
[24] Supplies were to the Free Library, the Southwark Water Company, and to Epps and Company a cocoa and chocolate manufacturer. LMA, LMA/4278/01/609, CLELC, Plans for substations and lighting areas, 1896-1900.

Figure 2.2: Supply area of the City of London Electric Lighting Co., 1897.

Source: Garcke, *Manual of Electrical Undertakings* (London, 1897), facing p.138.

Note that Bankside generating station is shown in red (labelled 'CLELCo's Works'), the broken red line is the boundary of the supply area and the solid red lines are the main cables of the distribution system.

Growth and development of electricity use and supply

From its earliest days the CLELC had sought to increase the supply and the consumption of electricity. It was an innovative and profitable business and actively promoted and developed the expansion of electricity supplies in the City. The company was financially successful and reinvested in their business to keep pace with demand and to reduce their operating costs. This position is in contrast to much of the existing literature which claims that London's electricity suppliers were small-scale and had little incentive to expand and develop their businesses.[25]

The density of potential users in the compact area of the City was an advantage because a relatively small electricity distribution network could supply a large number of customers. The City was unusual as a consumer area in that it had a large commercial daytime load, a residential population and some industry. The City's role as the financial and commercial centre of the empire had led to the development of office buildings from the 1840s. These had displaced residential properties and precipitated a long term decline in the resident population between the mid-nineteenth and mid-twentieth century; this contrasted with a significant increase in the daytime population.[26] In 1891 the residential population was about 38,000 and the day population about 300,000, but it was estimated that about 1.2 million people came into, or passed through, the City every working day on business.[27] The daytime office and commercial population continued to rise and had reached a peak of about 500,000 in 1935, not including visitors entering on business.[28]

The large number and high concentration of users led to a significant growth in demand for electricity. In the mid-1890s demand was increasing by about 1000

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[25] Hughes, *Networks of Power*, pp.461-62.
[26] Scott, 'The Evolution', p.500.
[27] J. White, *London in the Nineteenth Century* (London, 2007), p.166. 'Charles Booth, for example, found that, of 301,384 people working in the City by day, only 37,964 stayed at night' quoted in Otter, *Victorian Eye,* p.244. In 1901 the residential population of the City was 27,000 and had fallen to 5000 by 1951 largely due to war damage in the early 1940s, see H. Clout, 'Prologue to the Present' in H. Clout and P. Wood (eds), *London: Problems of Change* (Harlow, 1986), p.33.
[28] J.H. Dunning and E.V. Morgan (eds), *An Economic Study of the City of London* (London, 1971), Table 1.2, p.34. In 1937 the CLELC estimated that they served a day population of 550,000 and a night population of 25,500, Garcke, *Manual of Electrical Undertakings*, Vol.41, p.290.

additional electric lamps per week.[29] There was a wide range of customers including households, banks, offices, shops, institutions and public buildings. In 1894, for example, the South Eastern Railway Company contracted the CLELC to install, maintain and supply electricity for 24 electric lamps on the platforms and forecourt of Cannon Street railway station.[30] By 1896 the company had 5303 customers as well as public lighting including thirteen miles of streets.[31] In contrast to many electricity undertakings where the peak supply for lighting was in the evening, the CLELC had a large electricity load throughout the day. Demand continued to grow and by the end of 1899 the company were supplying 430,000 incandescent lamps plus 540 arc lamps for street lighting.[32] Although the CLELC initially had a monopoly in the City the Charing Cross and Strand Electricity Supply Corporation obtained powers in 1899 to supply electricity in the City from 1901. Despite charging less for electricity, the Charing Cross Company only achieved some penetration into the electricity market, it supplied between a quarter and one third of the electricity in the City. The CLELC retained the majority of the supply including all the public lighting.[33]

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[29] The growth is demonstrated by data from the electricity sub-stations in the City. The sub-station at St Benet Fink supplied the Bank of England, the Royal Exchange and the banks in Lombard Street. In October 1894 there were 13,000 connected lamps, by October 1896 there were 22,500 an increase of about 5000 per year or doubling every three years. LMA, LMA/4278/01/609, City of London Electric Lighting Co Ltd, plans of substations and lighting areas, 1896-1900, f.14.

[30] TNA, RAIL 635/440, South Eastern Railway Company, Agreement between the SER and the CLELC for Lighting at Cannon Street Station dated 13 June 1894. The penetration, or lack of penetration, of electric lighting at London's railway termini is illustrated in Chris Otter's *The Victorian Eye*. In 1907 Victoria Station was still lit by gaslight (Figure 5.2, p.177), in 1909 Liverpool Street station was lit by arc lights (Figure 5.4, p.180). Liverpool Street was in the City of London and therefore within the supply area of the CLELC.

[31] Garcke, *Manual of Electrical Undertakings*, Vol.2 (London, 1897), p.141; Otter, *Victorian Eye*, p.245.

[32] 'City of London', *Proceedings of the Institution of Mechanical Engineers*, p.477.

[33] In 1903 the Charing Cross company charged 3.37d. per unit whereas the CLELC charged 3.87d. The price of electricity in this period was falling as part of a long term trend of decreasing prices (see Figure 2.4). In 1903 the Charing Cross company supplied 3.557 MWh to the City, whereas the CLELC supplied 14.806 MWh of which 1.210 MWh was for public lighting. In 1931 the Charing Cross company sold 43.501 MWh to the City, and the CLELC 97.303 MWh of which 1.159 MWh was for public lighting. London County Council, *London Statistics 1904-5*, Vol. XV (London: 1905), pp.434-35; LCC, *London Statistics 1932-3*, Vol.37 (London: 1934), pp.348-49.

The City also had a significant, although declining, number of factories. In 1907 the City's factories employed around 40,000 people. The largest industrial employer, with 25,000 employees, was the paper and printing trade, largely associated with the Fleet Street newspaper industry on the western fringe of the City.[34] This provided a profitable night-time load for the Company. The printing presses required a direct current (DC) supply and the CLELC provided this from a new DC power house at Bankside built in 1900. The DC supply to printing works continued until 1984, by then most of the printing machines had been converted to alternating current (AC) and Bankside power station itself had closed.[35]

The CLELC were also innovative in encouraging the use of electricity by private and commercial users. From the earliest days they advertised a range of electrical appliances including kettles, saucepans, irons and hotplates. They hired out electric ovens at 7 to 12 shillings per quarter (normally retailing at £7 to £14) and in 1894 charged 4d. per unit for electricity for cooking, half of the standard change of 8d.[36] An 1894 advertisement stated that by using electricity there would be 'no poisonous gases around food while cooking' and that electric cooking was 'invaluable in restaurants, luncheon bars and refreshment buffets'. These claims reflect the perceived cleanliness of electricity over gas and the commercial nature of consumers in the City where there

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[34] The next largest factory employer was associated with 'dress' employing 5077 people. Census of Factory Employees in London County Council, *London Statistics,* Vol.XXII, pp.56-65 reproduced in Dunning and Morgan, *An Economic Study,* Table 1.3, p.38.

[35] In 1936 Bankside power station had 85 MW of AC and 9 MW of DC generating plant, see London County Council, *London Statistics 1936-38,* Vol.41 (London, 1939). By 1984 the remaining AC-to-DC conversion was undertaken in a local sub-station. 'Last DC supply switched off', *Electronics & Power*, 30 (1984), p.194.

[36] CLELC advertisement dated 1894 reproduced in B. Bowers, *A History of Electric Light & Power* (Stevenage, 1982), pp.231-34.

was an extensive service industry to cater for the large daytime population.[37] The CLELC also had a scheme of free installation of wiring and fittings for a moderate rental; as one commentator noted:

> a number of premises are now wired upon this method which would otherwise have had to remain without it, as owing to the short leases held by present tenants, and the apathy or indifference of the landlords to spend the necessary money.[38]

The company encouraged the use of electricity and brought it to as many consumers as possible and laid mains ‘throughout almost every street, court, and alley within the City boundary’.[39] The CLELC were innovative in this approach as ‘wiring and hiring schemes’ for many districts were only established by local authority undertakings in the mid-1920s.[40]

The above examples demonstrate that the CLELC had a diversity of consumers providing a day-time, evening and night-time load for their power station at Bankside, thus increasing its utilisation factor. The growth of demand for electricity in the City is demonstrated by the sales of electricity by the CLELC (see Figure 2.3). Although the increase in sales over the first two decades of the century appears to be modest, sales more than doubled in the nine years between 1904 (14 GWh) and 1913 (29 GWh). The demand was static for the duration of the First World War but increased rapidly during the 1920s and 1930s, doubling every decade.

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[37] In 1911 ‘services’, that is retail, transport, secretarial and maintenance, accounted for 98,436 workers out of a total daytime population of 357,361. R.C. Michie, *The City of London: Continuity and Change, 1850-1990* (Basingstoke, 1992), Table 2, p.17.

[38] ‘City of London’, *Electrical Review* (1899), p.425.

[39] Ibid.

[40] For example the relatively poor area of Hackney had established an assisted wiring and hiring scheme in the mid-1920s. Hannah, *Electricity*, pp.206-07.

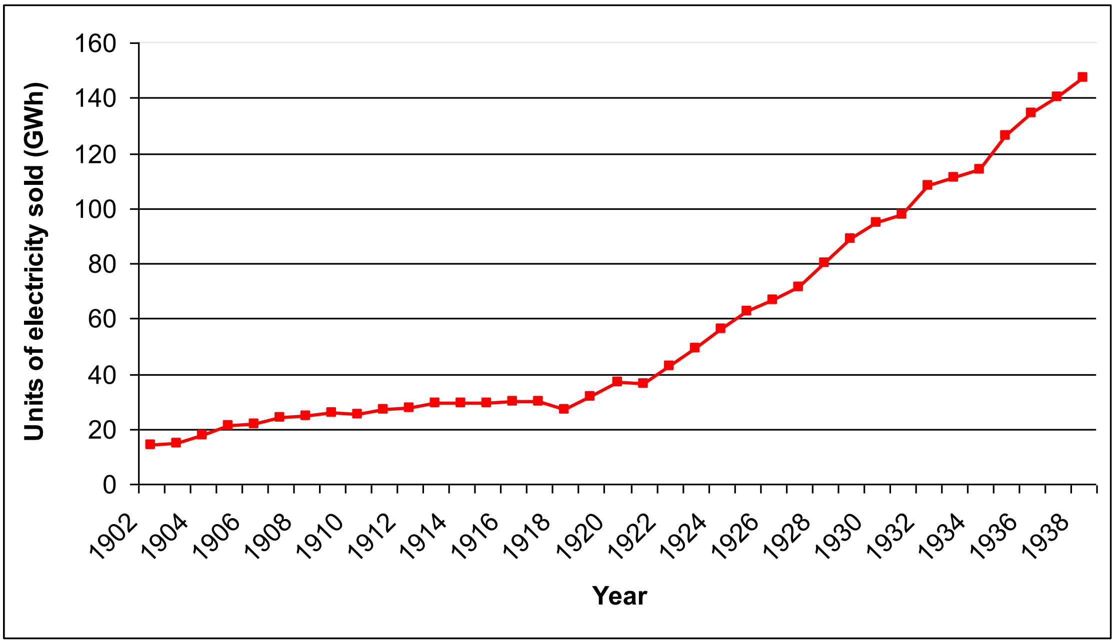

Figure 2.3: Sales of electricity by the CLELC, 1902-38.

Source: Data from Garcke, *Manual of Electrical Undertakings*, various editions 1902-39.

The historian of technology Thomas P. Hughes has argued that electricity supplies and power stations in London were smaller than those in Chicago and Berlin. Contemporary data support this contention. Hughes demonstrates that in 1911-12 the mean size of power station in the three cities were: Berlin 23 MW, Chicago 37 MW and London 4.67 MW.[41] However, the aggregate figures mask the data for individual power stations. In 1909 Bankside power station had an installed capacity of 25 MW and by 1915 it was 34.5 MW.[42] The size of Bankside was therefore comparable with the average size of power station in the USA and Germany. Given the small mean size of London power stations, Bankside was at this time one of the largest generating stations in London.

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[41] George Klingenberg's article in *The Electrician* 72 (1915) reproduced in Hughes, *Networks of Power*, Figure IX.9, p.258.

[42] Anon, 'Bankside, L.E.B Seventy Years at Bankside', *The Borough* (Southwark Borough Council, November 1961), p.20.

To meet the growing demand for electricity in the City the CLELC added new generating equipment and rebuilt and increased the size of Bankside power station. Technological innovations meant that the new plant was significantly more efficient than the older plant. The improvement in efficiency is demonstrated by the cost of producing electricity at Bankside power station (the red line in Figure 2.4).

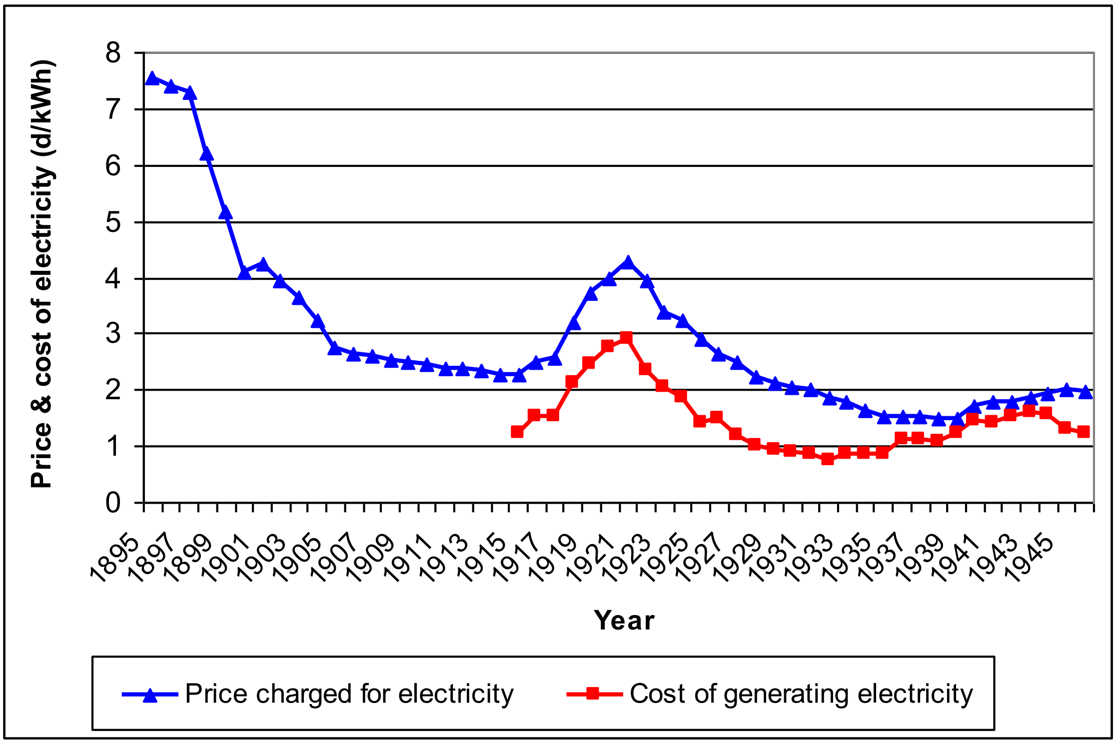

Figure 2.4: Price and cost of electricity at the CLELC, 1895-1946.

Source: Data from Garcke, *Manual of Electrical Undertakings*, various editions 1897-1946.

Note the cost of generating electricity was only recorded from 1915.[43]

The rising costs due to First World War restrictions of coal supplies and aging plant had turned into a significant fall in costs during the late 1920s and early 1930s when commodity prices fell. The 1920s was also the period when the new and therefore more efficient plant at Bankside was commissioned. It is notable that although the cost

[43] Data in Figures 2.4 and 2.5 are the actual costs, prices and revenue, and reflect changes in commodity prices, i.e. coal, and inflation. This thesis has not included a detailed financial analysis of the CLELC which would repay further study.

of generating electricity began to rise again in the 1930s the cost remained well below the peak it had reached in 1921 before the new equipment was commissioned. The price charged for electricity by the CLELC (the blue line in Figure 2.4) was set to match the variations in the cost of production. The economic historian Ian Byatt states that electricity suppliers ‘did not regard themselves as having significant monopoly power’, but rather had the objective ‘to get costs down to prices at which electricity would be competitive with gas’.[44] The data shows that the efforts by the CLELC to drive down its costs appear to have been sustained from 1921 to the mid-1930s. The prices charged by the CLELC also demonstrate the long term fall in the price charged for electricity which reflects a national trend.[45] In 1937 the CLELC’s street lighting supply was the cheapest in London and its private electricity supply was the third lowest in the capital.[46]

Changes in the generating cost and the price charged for electricity, together with the rising demand, resulted in a steady increase in revenue from sales of electricity for the CLELC throughout most of the inter-war period (see Figure 2.5). The difference between the revenue and the cost represents the company’s profit. The effect of the new plant installed from 1921 is again demonstrated in the large margin between revenue and cost that continued until the mid-1930s. With further expansion in mind the company had raised further capital by issuing 400,000 additional £1 shares in 1931 by which time there were about 4000 shareholders.[47] Preliminary plans were

[44] I.C.R. Byatt, *The British Electrical Industry 1875-1914* (Oxford 1979), p.131.
[45] Ibid., pp.131-35.
[46] In 1937 the CLELC’s standard charge for street lighting was 0.633 d/kWh and its private supply was 1.735 d/kWh. The private supply of the South Metropolitan Company was 1.294 d/kWh and the London Power Company’s was 1.676 d/kWh. LCC, *London Statistics 1936-38*, Vol.41, p.396.
[47] Garcke, *Manual of Electrical Undertakings*, Vol.35 (London, 1932), pp.301-02.

made to extend Bankside power station but the war prevented these being developed in detail until 1944.

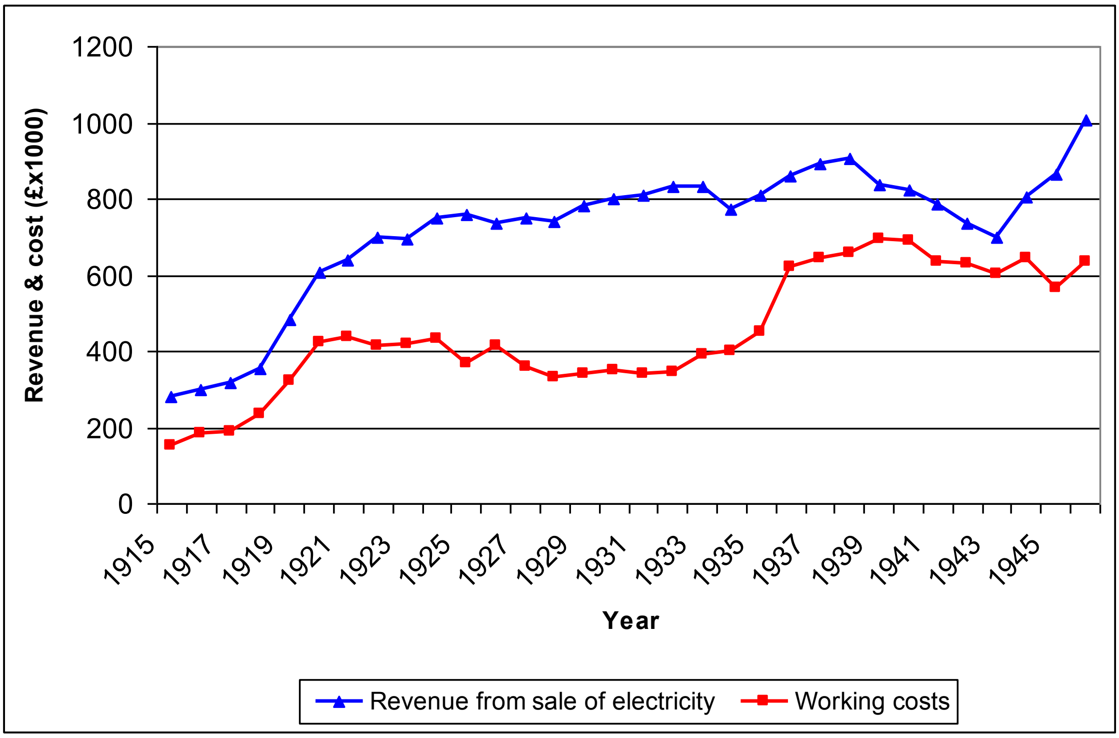

Figure 2.5: Sales revenue and working costs of the CLELC, 1915-46.

Source: Data from Garcke, *Manual of Electrical Undertakings*, various editions 1915-47.

The British ESI made a significant contribution to the war effort. Nationally, electricity demand by industry increased throughout the war, especially by munitions and other war factories.[48] War-time damage to both power stations and the national grid was slight with air attacks accounting for only eight per cent of supply fault problems from 1939-45. Generally electricity supplies were brought on again within hours or days.[49] However, for the City the effect of the war was dramatic. The amount of electricity sold declined in the early years of the war, the first time since the formation of the CLELC that this had occurred. This was partly due to wartime

[48] Industrial electricity supply in 1939 was 11,672 GWh, this nearly doubled to 20,516 GWh by 1943. Domestic demand had only increased slightly from 5936 to 6709 GWh. Hannah, *Electricity*, Table A.1, pp.427-28.
[49] Cochrane, *Power to the People*, pp.31-34.

economy measures. Under the 1939 Fuel and Lighting Order, customers had been asked to reduce their usage of electricity and gas by one quarter, domestic and commercial users were asked to switch off from 9 am to midday and from 2 to 4 pm; although the restriction was difficult to enforce.[50] The connected load and the power sold by the CLELC over the period 1937-46 are shown in Figure 2.6.

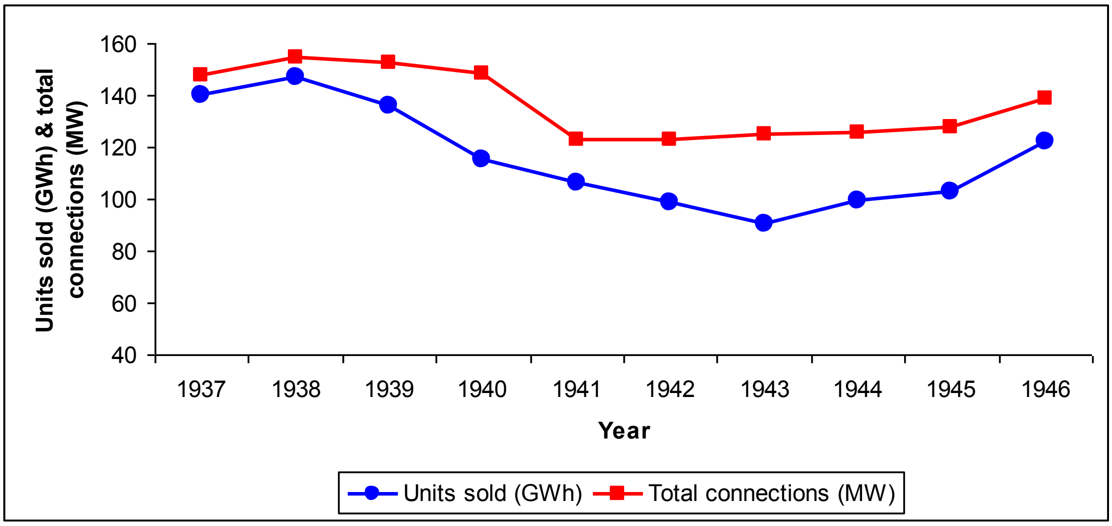

Figure 2.6: The connected load and units sold by the CLELC, 1937-46.

Source: Data from Garcke, *Manual of Electrical Undertakings*, various editions 1937-46.

The large reduction in connections between 1940 and 1941 was due to the Blitz. On the night of 29/30 December 1940 Bankside lost some of its ancillary plant from bombing, but the main generating plant was undamaged. Electricity supplies had been interrupted for just two and half hours.[51] However, by the morning the destruction of buildings in the City was such that 40 per cent of the company's connected load had disappeared.[52] It was estimated that the premises of 2500 consumers had been destroyed and the cost to the CLELC in lost revenue was estimated at about £100,000

[50] Hannah, *Electricity*, p.302.
[51] LMA, LMA/4278/01/590, CLELC, Board of Directors Minute Book, minutes dated 15 January 1941, f.118.
[52] Southwark Local History Library, Bankside File, 'Bankside, L.E.B. Seventy Years at Bankside', *The Borough* (November 1961), p.21.

per annum.[53] The years 1942-44 were the only ones when the CLELC did not pay their shareholders a seven per cent dividend. The ‘full moon’ blitz of 10/11 May 1941 was one of the most destructive raids of the war for London destroying more of Bankside’s connected load. New connections were only slowly established throughout the remainder of the war; and the amount of electricity sold by the CLELC only reached its pre-war levels in 1948.

This micro-scale analysis of an individual undertaking’s policy on electricity provision and their operating costs and profits provides evidence to counter the general assertion that British electricity undertakings were small-scale and did not have the incentive to increase electricity supply and demand. The CLELC was an innovative and profitable business and actively promoted and developed the expansion of electricity supply and use in the City. The CLELC was in an advantageous position: the density of potential users in the compact area of the City meant that a relatively small, and dense, distribution network could supply a large number of customers. The company was financially successful and reinvested in their business to keep pace with demand and to reduce their operating costs. Having examined the social, financial and political contexts of electricity supply, I now address how the CLELC went about meeting electricity demand.

To meet the growing demand for electricity the CLELC had to develop and expand their generating station at Bankside. Since electricity cannot be stored in large quantities there is an immediate and direct relationship between the use of electricity and its generation and supply. Furthermore, the generating equipment had to be

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[53] LMA, LMA/4278/01/590, CLELC, Board of Directors Minute Book, minutes dated 15 January 1941, ff.117-8.

designed to meet the maximum or peak demand.[54] The growing demand for electricity was met by the CLELC through the addition of new plant and equipment and the construction of new extensions to Bankside power station. This entailed significant changes to the built environment of the Bankside area. The growth of the power station was in turn associated with social changes in the Bankside neighbourhood as streets and courts were extinguished, housing was demolished and people were displaced. The displacement of urban populations by infrastructure developments is a widely examined field. The physical and social effects of mid-nineteenth century urban railways and roads are classic examples, and the displacement of the residential population by office developments in the City has already been mentioned.[55] This study demonstrates that electricity generating stations also had a physical and social impact on their locality.

As early as 1892 a new engine room and boiler house were constructed at Bankside with larger boilers and more powerful alternators, and in 1895 the engine house was extended to the south. Bankside outgrew its original site, evidence from trade directories and large-scale maps from the 1890s shows how houses, roads and courts disappeared as the company bought neighbouring properties.[56] In 1899 a commentator noted that the power station was well sited since ‘there is but little residential property, and what little there is, is of the poorer class, and such as can be

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[54] Some early DC systems had used batteries located in sub-stations and consumers premises to meet the peak demand, therefore the generating station had only to supply continuously the average daily demand. Bowers, *A History of Electric Light*, pp.141-42.
[55] The impact of the railways on urban infrastructure is outlined in R. Porter, *London: A Social History* (London, 2000), pp.278-79; B. Trinder, *The Making of the Industrial Landscape* (Gloucester, 1987), pp.229-30; see also J. White, *London in the Nineteenth Century*, pp.46-47 for the impact of new roads and bridges in the City.
[56] See for example LMA, LMA/4278/01/609, Plans for substations and lighting areas, 1896-1900.

bought, in case of necessity, at comparatively small cost'.[57] In 1897 the CLELC purchased and demolished a row of shops and residential properties on the north side of Sumner Street (see Figure 2.7). This provided the company with better access to their site, an improvement on the restricted access from Bankside itself.

Figure 2.7: Sumner Street, Southwark, *c*.1895.

Source: G.B. Marshall, 'Tate Modern Its Industrial History', unpublished (2004), Southwark Local History Library, Illustration 9 (CEGB photo library).

Note the south chimney of Bankside power station can be see top left, much of the property on the north (left) of Sumner Street was demolished by 1897 as the CLELC bought up property and expanded its site.

In 1898 a further extension was added to the engine house bringing the building line to Sumner Street, a DC power house was constructed at this time. In 1900 the company obtained an Act of Parliament to compulsorily purchase some surrounding properties

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[57] 'The City of London Electric Lighting Company', *The Engineer*, 87 (1899), p.232.

and to divert local roads such as Pike Gardens.[58] Some protection of working class housing was provided for: the company were obliged to erect 'artizan's or workmen's dwelling-houses' sufficient for 200 people within St Saviour's district.[59] The company also bought local properties as they came onto the market, for example, in 1904 the company paid £600 for the freehold of the property at No.15, 16 & 17 Noah's Ark Alley adjacent to the power station.[60] Charles Booth's survey of the area at the turn of the century identified some of the courts and alleys near the power station as places of criminality and chronic want.[61] The power station was also seen as providing a benefit to the area. A local minister, interviewed as part of Booth's survey, noted that the area had improved and that business premises such as the CLELC had cleared away some of the courts classed as criminal.[62] However, parts of Bankside were still described as a 'slum area' just prior to the First World War when arrangements were made for re-housing some of the tenants.

Expansion of Bankside power station continued and by 1909 the capacity of the station was 25 MW. The first turbo-alternator was installed in 1910 and others followed; the turbo-alternator was more efficient and quieter than the old reciprocating engines. By 1912 Bankside was the ninth largest generating station in Britain. The

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[58] TNA, BT 31/31254/34406, Board of Trade, Companies Registration Office, CLELC, 63 & 64 Victoria, Chapter lxxxviii, City of London Electric Lighting Act 1900. The Act, which had a 'drop-dead' clause, was in force for three years from 10 July 1900.

[59] One of the provisions of the Act was that the company was prohibited from acquiring twenty or more houses occupied by 'the labouring class as tenants or lodgers' except with the consent of the Home Secretary, see Section 10 of the 1900 Act.

[60] LMA, LMA/4278/01/589, CLELC, Board of Directors Minute Book, minutes dated 5 October 1904, f.262.

[61] White Hind Alley, Moss's Alley, Pitts's Place, Ladd's Court, Taylor's Yard and Noah's Ark Alley are marked as dark blue (very poor, casual, chronic want) and black (lowest class, vicious, semi-criminal) on the maps. In the commentary on Southwark Walk 7 it was noted that 'there is in this round a set of courts and small streets which for number viciousness, poverty and crowding is unrivalled in anything I have hitherto seen in London'. J. Steel (ed.), *The Streets of London: The Booth Notebooks – South-East* (London, 1997), p.40.

[62] Booth Notebook, Interview with the Reverend W.A. Corbett vicar of St Peter's Southwark, B269 pp.198-211, Bankside and Borough then and now http://banksidethenandnow.co.uk/#/st-peters-church/4565913970 [accessed November 2012].

biggest stations were mostly city-wide undertakings supplying large municipal areas such the Corporations of Manchester, Glasgow, Birmingham and Liverpool.[63] Bankside was therefore a large station supplying a physically compact area which demonstrates the density of electricity use in the City. By 1915 the output capacity at Bankside was 34.5 MW; the First World War halted further development and demand for electricity was static throughout the war (see Figure 2.3).

Following post-war recovery, further turbo-alternator sets replaced older machinery. Over the period from 1921 to 1928 a new boiler house was built alongside the east face of the power house.[64] The old boiler house was decommissioned and the three chimneys of the original power stations were later demolished (see Figure 2.8). By 1928 the total output from Bankside was 89 MW, and this remained its maximum capacity until the ‘A’ station closed in 1959.

The CLELC continued to purchase properties and adjacent land with a view to future extensions and expansion. In the mid-1930s the opportunity arose to purchase two large plots of land adjacent to the power station, some of the issues around the purchase of this land are examined below. The CEB, by then responsible for the oversight of the national electricity industry, had in mind the redevelopment of the Bankside site with a modern station of 180 MW, twice the capacity of the existing station.[65]

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[63] Byatt, *British Electrical Industry*, Table 22, p.114.

[64] The new boiler house was to have 18 boilers, the coal strike of 1921 led to six of the boilers being specified for oil-firing although two were later returned to coal firing. The operational experience of using oil-fired boilers was useful when the new Bankside ‘B’ was being designed. Southwark Local History Library, Bankside File, ‘Bankside, L.E.B.’, p.20.

[65] TNA, POWE 12/464, Electricity Commission, Bankside extension of site: purchase of additional land, 1936-37, Letter from the CEB to the Electricity Commission dated 17 April 1936.

Figure 2.8: Bankside power station from across the Thames, *c*.1934.

Source: National Maritime Museum, Eagar Collection, P27562. Reproduced with permission. © National Maritime Museum, Greenwich, London.

Note the power station is a dominating presence on the South Bank. The 1921-28 boiler house with its eighteen 115 ft high chimneys in two rows and the three 150 ft chimneys of the old station.

The redevelopment and expansion of Bankside power station from 1891 to 1928 was therefore directly related to the increase in the use of electricity in the City. This was a period of almost continuous change at Bankside with the installation of larger and more powerful and efficient equipment. The power station site increased in size as properties were bought by the CLELC and small lanes and courts were extinguished as the company acquired and demolished adjacent properties. In addition to demolition of property the other significant impact of the power station on the neighbourhood were the effects of pollution and the nuisance of noise and vibration.

Local nuisance: noise, vibration, smoke and grit

Pollution was a significant concern when the new Bankside 'B' station was being planned in the mid-1940s. The concern was not unfounded: power stations had created a local nuisance from the early days of the industry.[66] Throughout the life of the first Bankside power station complaints about smoke, grit, noise and vibration were frequent.

The Waterman's Arms was a public house located at No.60 Bankside adjacent to the power station. Both the leaseholder, William Shelfer, and the owners, Meux's Brewery Company, sought injunctions against CLELC in 1894 to prevent the company from operating their machines which they claimed had given rise to a significant nuisance. Shelfer claimed that there was noise from an exhaust pipe; clouds of steam which caused showers of moisture to descend on his premises; and that the power station's engines had caused the rooms, furniture and bedsteads to vibrate so much as to interfere with sleep, comfort and health. Two witnesses claimed that the vibration caused actual sickness and Shelfer also claimed that the vibration interfered with business in the pub. The Brewery claimed that a crack, up to two inches wide, had appeared in the wall of the building extending through two stories. They also noted that the building had formerly listed to the east but that the erection of the power station had caused the building to list to the west. After lengthy litigation, eventually taken to the Court of Appeal, damages were awarded to the claimants in lieu of an injunction.[67]

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[66] In 1885 residents near Paddington power station complained that 'the tremendous vibration and noise, added to the fumes of smoke and steam, and the dirt caused by the machinery, produced such a nuisance as to be almost unbearable', Parsons, *The Early Days*, p.47.

[67] The Shelfer law suit became a case for establishing whether damages could be awarded instead of an injunction. Court of Appeal, Chancery Division 1895 Volume 1, *Shelfer v. City of London Electric Lighting Company* [1894 S. 840] and *Meux's Brewery Company v. City of London Electric Lighting*

Smoke was another problem. In October 1901 the CLELC paid the Corporation of Southwark £250 in settlement of the costs of the Corporation taking a smoke nuisance action against the company. Then in January 1903 the company were fined £20 plus costs for 'creating smoke'.[68] The CLELC challenged some of these nuisance actions. In May 1910 an officer of the Public Control Department of the LCC stated that he had observed black smoke issuing from the centre chimney and 'in such volumes as to constitute a nuisance'.[69] This was contested by the company which said the information was inaccurate, since this was after sunset 'any vapour or gas would assume a dark appearance […] and the absence of light would not ensure accuracy'.[70]

Vibration and smoke were not the only problems. In 1920 a company whose premises abutted the power station complained to the LCC that the CLELC's chimney was 'pouring forth huge volumes of thick smoke and enormous quantities of grit'. They said that in clearing their gutters about one ton of coal grit 'where it lies to a depth of 1 to 7 & 8 inches was removed'.[71] They claimed that their drain pipes were blocked by the grit, and that water had soaked through the roof, walls and woodwork. If anything was done it appears to have been ineffective. The company complained to the LCC again in January 1922 of 'the dreadful damage done to these premises by the disgraceful and enormous quantities of smoke and coal grit' from the power station.[72]

Company [1894 M. 610]. The CLELC eventually purchased the trading covenant of the Waterman's Arms for £500 in 1902. LMA, LMA/4278/01/589, CLELC, Board of Directors Minute Book, minutes dated 18 June 1902, f.92.

68 LMA, LMA/4278/01/589, CLELC, Board of Directors Minute Book, minutes dated 30 October 1901 f.33; and minutes dated 21 January 1903, f.133.

69 In this period the control of smoke nuisance was the responsibility of local authorities under the Public Health (London) Act of 1891, see Ashby and Anderson, *The Politics of Clean Air*, p.83.

70 LMA, LCC/PC/GEN/01/052, Bankside Generating Station LCC Committee reports and correspondence, Letter from CLELC to the Town Clerk Borough of Southwark dated 17 June 1910.

71 Ibid., Letter from The London Mineral Water Trade Protection Society Ltd to the LCC dated 9 December 1920.

72 Ibid., Letter from The London Mineral Water Trade Protection Society Ltd to the Clerk of the LCC dated 27 January 1922.

This part of the power station and the offending chimneys were demolished in the 1930s after the new boiler house had been commissioned. But the new boiler house was later the cause of another nuisance.

In the late 1940s the Metropolitan Borough of Southwark had received numerous complaints about smoke and grit from the power station. The LCC undertook tests to measure the deposition of grit in the area during the summer of 1950.[73] They estimated that up to 235 tons per square mile of grit was deposited in the area from Bankside 'A' power station. The Borough of Southwark – the statutory smoke abatement authority – decided to obtain specialist scientific advice to address the issue and support any action they might take. The Town Clerk wrote to the Director of Fuel Research at the Department of Scientific and Industrial Research (DSIR) to ask whether they could investigate the emission of grit and to advise if it was possible to reduce it. The DSIR, with the cooperation of the BEA – the post-nationalisation owner of Bankside power station – examined the boilers at Bankside.[74] Their report cast some doubt on the LCC's figures for grit deposition, but concluded that the 1920s boilers were of a poor design and were not to modern standards, they consumed nearly twice as much coal per unit of electricity generated as newer boilers. The DSIR concluded that grit eliminators could be fitted at a cost of about £10,000 per boiler. However, since the construction of the replacement Bankside 'B' was underway, these measures were uneconomic as the old station was due to close. But problems with the old station continued and the MP for Southwark, George Isaacs, frequently raised the issue of pollution from Bankside in Parliament. For example, in

[73] Ibid., Letter from the Clerk of the LCC to the Town Clerk of Borough of Southwark dated 18 December 1950.

[74] TNA, AY 6/168, Department of Scientific and Industrial Research, Fuel Research Station Report: 'Grit emission from Bankside generating station', March 1952.

1955 he stated in the Commons that 76 tons of grit per square mile had been deposited over a four week period from the old power station. In response to Isaacs the Minister of Housing and Local Government said he would arrange for inspectors to visit the power station, but again practical measures were not economically viable.[75]

Smoke, grit, noise and vibration were not originally thought by the promoters to be a nuisance issue for the new Bankside 'B' power station. However, local atmospheric pollution became an issue during the planning phase and proved to be problematic throughout the power station's operational life (see Chapter 3 – Planning Bankside and Chapter 5 – Bankside in Operation). Air pollution was mitigated by washing the flue-gases prior to discharge. Despite the CLELC's assurance that the chimney of Bankside 'B' would emit a 'smokeless shimmer of vapour' fumes often descended onto the local streets and over the City.[76] Pollution and nuisance were therefore long-standing issues for both Bankside 'A' and 'B' power stations throughout their operational lives. The final issue addressed in this chapter concerns the changing structure of the ESI during the inter-war period and the impact this had on the CLELC and Bankside power station. There are two aspects to this: the integration of the industry and co-operation between undertakings, and the impact that increased control had on the CLELC and Bankside.

Inter-war electricity legislation: co-operation, control and complexity

The period from 1919 to 1948 was a time of significant change in the legislative basis and oversight of the British electricity industry. To a large extent these changes were

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[75] *Hansard*, House of Commons debates, Vol.538 cc140-1, 8 March 1955, the Minister was Duncan Sandys. See also 'Soot Increase from Old Power Plant', *The Times*, 9 March 1955, p.4.
[76] The smokeless shimmer quote is from 'The Bankside Power Station: Sir Giles Scott Explains', *The Builder*, 23 May 1947, p.493.

driven by a contemporary perception of the backwardness of the British ESI compared to other countries.[77] The issue was seen as being due to, and manifest in, the plethora of small sometimes inefficient undertakings that had arisen in Britain. These were the result of the provisions of early legislation which had restricted undertakings to individual local authority areas, whereas in the USA and Germany large scale integrated electricity systems had been the norm.[78] As I have demonstrated above, this legislative framework did not impair the profitability or effectiveness of the CLELC, the company was however exceptional in serving a compact and wealthy area with a high usage of electricity.[79]

Towards the end of the First World War several Board of Trade committees had considered the future of the British ESI. The Williamson committee reported in 1917 and proposed the centralisation of the industry – with its 600 electricity undertakings – into 16 mainly publicly owned electricity districts.[80] It was envisaged that new electricity authorities would construct 'super' power stations of greater efficiency, and provide interconnections which would increase the diversity of supply. The resulting Electricity (Supply) Act 1919 established the Electricity Commissioners with a duty of 'promoting, regulating and supervising the supply of electricity'. Several commentators have observed that the Commissioners were only partly

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[77] See R.E. Catterall, 'Electrical Engineering' in N.K. Buxton and D.H. Aldcroft (eds), *British Industry Between the Wars* (London, 1979), p.242. Catterall notes that in the mid-1920s the per capita consumption of electricity in Britain was 200 kWh, which was projected to rise to 500 kWh by 1940; other 'major countries' in 1925 had per capita annual consumptions of 500 to 1200 kWh.
[78] See, for example, Hughes, *Networks of Power*, Chapters 7, 8 and 9.
[79] Comparison of the per capita electricity consumption of the City of London with figures for national consumption is not particularly meaningful because of the large variation between the residential and day population of the City. The output of the Bankside power station in 1931 was 97.3 GWh; given a residential population of about 11,000 gives a very large per capita annual consumption of 8845 kWh, yet distributed across a day population of 482,000 give a consumption of 202 kWh, this is very close to the average British consumption in the mid-1920s. Population figures from Dunning and Morgan, *An Economic Study of the City of London*, Table 1.2, p.34.
[80] Hannah, *Electricity*, p.63.

effective in that they had limited powers of compulsion, and could act only as promoters of change.[81] The Commissioners identified Electricity Districts together with a number of regional schemes for centralising generation in fewer but larger generating stations owned and 'operated to the best advantage of the area as a whole' by Joint Electricity Authorities (JEAs).[82]

There was no compulsion to establish a JEA, undertakings were, in any case, concerned about their loss of autonomy, despite a safeguarding provision in the legislation.[83] Only four JEAs were established; the largest was the London and Home Counties JEA (hereafter the London JEA) established in 1925 with *inter alia* the duty 'to provide or secure the provision of a cheap and abundant supply of electricity within its district'.[84] This duty was to be discharged by constructing generating stations and main transmission lines and by acquiring the undertakings of authorised distributors. However, the London JEA only acquired a few suburban and rural undertakings, the majority, the urban undertakings, remained independent.[85] The Act also deferred the reversionary purchase of the undertakings. The LCC had been empowered to purchase undertakings such as the CLELC in 1931 but the undertakings were given an extension of tenure until 31 December 1971 when they were to be transferred to the London

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[81] See for example Hannah, *Electricity*, pp.75-80; Bowers, 'Electricity' in Williams, *History of Technology,* p.287; Hinton, *Heavy current*, p.43-45.
[82] Parsons, *Early Days*, p.197.
[83] The safeguarding provision stated that no scheme 'shall provide for the transfer to the Authority of any part of an undertaking without the consent of the owners'.
[84] The four JEAs were: North Wales and South Cheshire; London and Home Counties; North West Midlands; and West Midlands JEA. The latter promoted the construction of Ironbridge power station commissioned in 1932 as described in Chapter 1 – Introduction. The London and Home Counties JEA covered an area of 1841 square miles and included the counties of London and Middlesex and parts of Surrey, Buckinghamshire, Hertfordshire Essex and Kent, it served a population (in 1931) of 9,088,764. LCC, *London Statistics 1932-3*, Vol.37, pp.330-31.
[85] By 1934 the London JEA had acquired six undertakings in southwest London and Surrey. LCC, *London Statistics 1932-3*, Vol.37, p.331.

JEA.[86] The JEA had to be consulted on any proposal by an undertaking to spend more than £5000 on new assets. The London JEA planned to build a super-station at Chiswick, however disputes about alternatives sites were protracted and nothing came of this plan.[87] As Herbert Morrison, the Labour leader of the LCC, commented after serving on the London JEA, they had far too much 'joint' and not enough 'authority' about them.[88]

The 1919 Act also permitted undertakings to exchange electricity supplies, to work together or amalgamate. For example, in 1923 the CLELC supplied electricity to the County of London Electricity Supply Company.[89] Most of the undertakings in central London chose to work together but they took different approaches to the extent of amalgamation. The CLELC and three companies in south and east London promoted the London Electricity (No.1) Act 1925.[90] This established a joint committee to direct the way in which the generating stations of each company were to be operated. The companies remained distinct electricity generation and supply undertakings.[91] The companies were however physically joined with interconnecting cables to exchange electricity. In 1925 the CLELC claimed that the other companies had 'received valuable assistance from this Company's Bankside Station'.[92] In 1923 Bankside had the largest generating capacity of any of the electricity companies or

[86] See Garcke, *Manual of Electrical Undertakings*, Vol.45 (London, 1948), p.227.
[87] Hannah, *Electricity*, p.83.
[88] Hannah, *Electricity,* p.87 and p.331. Hannah also notes that Morrison's experience convinced him that the conflicts of interest inherent in divided ownership (as with the JEAs) could only be resolved by effective publicly-owned boards like the CEB.
[89] In 1923/24 the CLELC supplied 656,170 kWh to the County of London Company, although this represents only 1.1 per cent of the electricity generated at Bankside that year. LCC, *London Statistics 1924-25*, Vol.30, p.290.
[90] TNA, BT 31/31254/34406, Board of Trade, 14 & 15 George V, London Electricity (No.1) Act, 1925.
[91] The four companies of the 'No.1' group were: the CLELC; the County of London Electric Supply Company Limited; the South London Electric Supply Corporation Limited; and the South Metropolitan Electric Light and Power Company Limited.
[92] LMA, LMA/4278/01/596, CLELC, Report of the Directors and Statement of Accounts, 31 December 1925, p.5.

municipal undertakings in the London area although it was soon overtaken by Barking power station.[93] The four companies envisaged that their power stations would provide sufficient capacity for their combined electricity requirements without the necessity to build a super-station. The Act also established the principle of equal consideration for the interests of shareholders and consumers of each company. Dividends to shareholders were limited to seven per cent per annum and the amount carried forward in the accounts was also restricted. Profits over and above these conditions formed a ‘consumers’ benefit’ in the form of lower prices (see Figure 2.4).[94]

In an alternative model, a more integrated approach was taken by ten undertakings in central, south and west London. The London Electricity Joint Committee (1920) Limited was established and promoted the London Electricity (No.2) Act 1925. Under this Act the London Power Company (LPC) was formed which purchased or leased the generating stations of the individual undertakings and supplied electricity in bulk to the undertakings for distribution and sale. The LPC aimed to replace the comparatively small, old and inefficient power stations of its constituent members by large and efficient ones, specifically the LPC built the new super-station at Battersea.[95]

Battersea was an iconic structure, the flagship power station of the 1930s. It was the direct precursor of Bankside both in the controversy during the planning stage,

[93] Bankside was rated at 64 MW, the County of London company had a generating capacity of 39.7 MW, but commissioned the first 100 MW of their Barking ‘A’ power station in 1925, the capacity of Barking was 200 MW by 1930. LCC, *London Statistics 1924-5*, Vol.30 (London: 1926), pp.298-99. Electricity Council, *Electricity Supply*, p.44. Horne, M.C.A., *London Area Power Supply: A Survey of London’s Electric Lighting and Power Stations*, www.metadyne.co.uk/pdf_files/electricity.pdf [Accessed June 2012].
[94] Two-thirds of the consumer’s benefit was to consumers and one sixth each for the company’s employees and for the shareholders. LMA, LMA/4278/01/597, CLELC, Chairman’s statement dated 6 March 1948.
[95] Electricity Council, *Electricity Supply*, p.45.

and in some of the technologies that were deployed. Much of the controversy at Battersea centred on the effects of pollution. The environmental historian Bill Luckin claims that the controversy was an argument not just about the damaging effects of gas and dust on health but that the power station would harm buildings, works of art and parks and gardens, and hence damage part of the social fabric of London.[96] An alternative location in the East Kent coalfield was considered to be impracticable because of the additional cost and the adverse visual impact of transmission lines. In addition to supplying a large part of west London, the station was designed to be an integral part of the newly established national grid to supply the wider region.[97] This account of electricity supplies in London demonstrates that the lack of integration of the British ESI identified in the literature should be tempered by consideration of the voluntary attempts made by many London undertakings to integrate their operations.[98]

The electricity interconnections and joint working arrangements that had been instituted by the London undertakings were the exception to the continuing disjointed operation in other areas. In 1924 the Government appointed Lord Weir to investigate the ongoing issues of electricity supply that had not been adequately addressed by the 1919 Act. Weir's key recommendation was the construction of a national 'gridiron' of high voltage transmission lines interconnecting power stations under the responsibility of a new national electricity board. He also proposed that the Commissioners' powers should be increased.[99] The Electricity (Supply) Act 1926 established the Central Electricity Board (CEB) with responsibility for interconnecting power stations by

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[96] Luckin, *Questions of Power*, p.4 and p.153.
[97] C. Bowler and P. Brimblecombe 'Battersea Power Station and Environmental Issues 1929-1989', *Atmospheric Environment*, 25B (1991), p.143.
[98] See Hannah's 'diagnosis of failure', Hannah, *Electricity*, pp.85-95 and Hughes, *Networks of Power*, pp.461-62.
[99] Hannah, *Electricity*, pp.93-94.

building, owning and operating the national grid. The CEB bought electricity from 'selected' private and municipal stations, planned the construction of new stations and sold electricity wholesale to electricity undertakings that distributed and sold it to their consumers. The CEB was a public body largely independent of ministerial control.[100] Under the 1926 Act Bankside became part of the South-East England grid scheme and was connected to the 66 kV London 'ring' of power stations (see Figure 2.9). In 1934 Bankside became a 'selected' station operated under the direction of the CEB. Bankside no longer generated electricity solely for the City or for the other companies in the 'No.1 group', but supplied electricity for distribution throughout the London region. The effect of the completed grid was, nationally, to reduce the generating costs by 11 per cent and reduce the costly reserve plant at power stations which made more efficient use of the generating plant.[101]

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[100] Lesley Hannah notes that the independence of the CEB reflected ministers' own beliefs that they were not competent to interfere in the details of industrial affairs and that, as Stanley Baldwin had said: the Board should be managed by 'practical men closely in touch with the industry'; see Hannah, *Electricity*, p.101.

[101] Cochrane, *Power to the People*, p.20. Reserve plant was reduced from 75 per cent to 15 per cent of installed capacity, formerly only 25 per cent of the installed capacity was used to generate electricity, the remaining 75 per cent was kept in reserve to meet peak demand and to provide for unexpected shutdowns and for maintenance. Following connection to the grid individual power stations no longer needed as much reserve capacity as other stations could be used to meet any shortfalls in output.

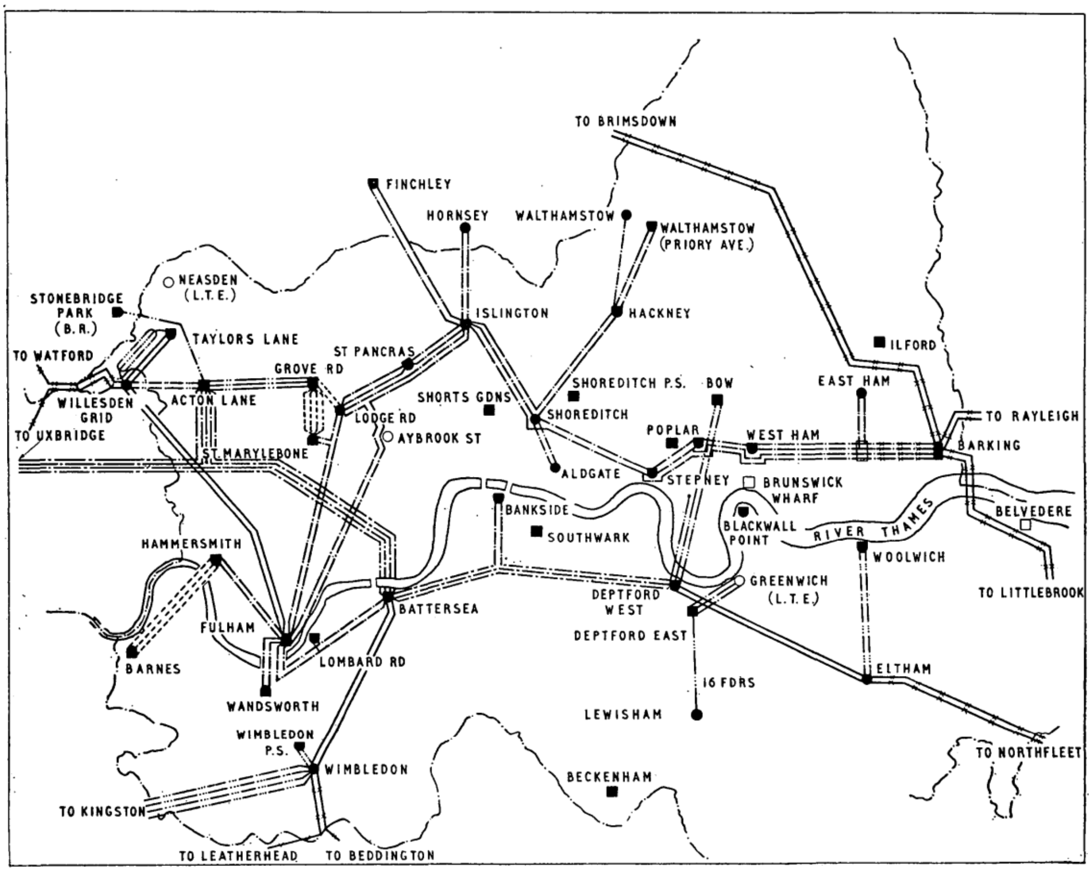

Fig. 1.—Generating stations and transmission system vested in the London Division.

■ Generating station.
● Transforming station.
▲ Generating and transforming station.

	Overhead lines	Underground cables
132 kV	—×———×———×—	———————
66 kV	—×—·———·—×—	——·——·——
33 kV	—×—··———··—×—	——··——··——
22 kV	—×—·—×—·—×—	——·——·——
6·6 kV		— — — — — —

Figure 2.9: Electricity generation and transmission in London, 1948.

Source: H.V. Pugh, 'The Generation of Electricity in the London Area', *Proceedings of the Institution of Electrical Engineers – Part A: Power Engineering*, 105:23 (1957), Figure 1, p.485. Reproduced with permission. Institution of Engineering and Technology.

Note that Bankside power station is centrally located in the 'London ring'.

The grid interconnections of the 1930s supported the further commercial integration of the 'No.1 group', principally because the companies were now supplying the wider London area. In 1937 a quadripartite agreement was made between members of the group.[102] The agreement 'in the interests of consumers of electricity' was to

[102] LMA, LMA/4278/01/606, Agreement dated 21 July 1937 between the CLELC and The County of London Electric Supply Company Limited and the other companies in the No.1 group.

establish a joint committee; to institute a common commercial procedure; to unify methods of charging consumers; and to avoid duplication and conflicting systems of supply mains involving unnecessary expenditure. The agreement envisaged the establishment of joint showroom premises to promote the use of electricity.[103] The CLELC continued to sell electricity to other undertakings and in the mid-1930s were supplying most of the electricity to north Southwark.[104] The CLELC also continued to promote the use of electricity. In May 1938 they took over the management of the Finsbury and Holborn areas of the County of London Company.[105] One result of this agreement was that the CLELC undertook to provide free wiring to the Peabody Buildings in Finsbury and Holborn but on condition that all gas lighting was removed. They estimated that the cost of providing electricity for 1263 flats would be £10,000 but that revenue from lighting alone would be £3000 per annum, and more if tenants used electricity for cooking and heating.[106] A further agreement was made in 1946 between the CLELC and Central London Electricity Limited.[107] This agreement was also in the 'interests of consumers' for joint planning and execution of distribution systems; providing a common tariff of charges; and providing a single system of meter reading. Therefore the promotion of the use of electricity, the provision of supplies and the integration of operations by undertakings in London continued right up to nationalisation in 1948. The number of formal agreements that had to be made by

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[103] Ibid. In the late 1930s the CLELC's showroom was at 33 Ludgate Hill, Garcke, *Manual of Electrical Undertakings*, Vol.41, p.290.

[104] In 1931/32 the CLELC supplied 2.17 million kWh to Southwark Metropolitan Council, in 1936 this had increased to 13.92 million kWh or about 9.5 per cent of the electricity generated at Bankside. LCC, *London Statistics 1932-33*, Vol.37, p.336; LCC, *London Statistics 1936-38*, Vol.41, p.373.

[105] LMA, LMA/4278/01/597, CLELC, Report of the Directors and Statement of Accounts, 31 December 1938, p.4.

[106] This scheme was a joint venture between the CLELC and the County of London Electric Supply Company. LMA, LMA/4278/01/590, CLELC, Board of Directors Minute Book, minutes dated 12 October 1938, f.45.

[107] LMA, LMA/4278/01/606, Joint Working Agreement dated 24 June 1946.

undertakings reveals a downside to the benefits of integration, that of increasing complexity between organisations.

The co-operation between the electricity undertakings in London masks a bureaucratic relationship between the undertakings and the inter-war statutory electricity bodies. Four cases concerning the purchase of land and equipment at Bankside by the CLELC illustrate how these relationships worked in practice. The examples show how the CLELC was no longer an autonomous company but had to consult and be directed by the statutory bodies sometimes against the company's intent. This shows that the CLELC was now enmeshed in complex bureaucratic relationships with these bodies where decision-making became protracted.

The first example concerns the purchase of land adjacent to Bankside power station and demonstrates the time-consuming complexity of the exchanges between the organisations. In 1911 the Corporation of London had considered building a new bridge across the Thames near St Paul's cathedral and obtained compulsory powers of purchase for land owned by the CLELC to the east of Bankside power station.[108] The purchase included provision for re-housing the tenants of the 'slum area' land for which the Corporation built a block of flats in Southwark.[109] The terms included a provision that the CLELC should bear one-third of the annual loss on these flats. A stipulation was that if no parliamentary Act for constructing the bridge had been obtained by January 1935 the CLELC could repurchase the land at a specified value,

[108] 1 & 2 George V, Corporation of London (Bridges) Act, 1911.
[109] LMA, LMA/4278/01/596, CLELC, Report of the Directors and Statement of Accounts, 31 December 1930, p.6. The buildings appear to be Winchester Buildings at the junction of Great Guildford Street and Orange Street (now Copperfield Street), see G. Golden, *Old Bankside* (London, 1951), p.171.

together with other contiguous land acquired by the Corporation for the bridge (shaded green in Figure 2.10).

Figure 2.10: Land owned and acquired by the CLELC, 1936-38.

Source: TNA, POWE 12/570, Electricity Commission, Bankside extension of site: purchase of additional land, 1938. Reproduced with permission. The National Archives.

Note the land owned by the CLELC in 1935 upon which the original Bankside power station stood is shaded pink, the land purchased from the City Corporation in 1936 is shaded green, the land owned by the South Metropolitan Gas Company upon which the Bankside gas works stood and which was purchased by CLELC in 1938 is shaded blue.

However under the 1919 and 1926 Electricity (Supply) Acts the CLELC could no longer purchase the land outright but had to have a ‘direction’ from the CEB for the purchase, and furthermore this direction had to be agreed by the Electricity Commissioners. In April 1936, the CEB wrote to the Electricity Commissioners seeking the Commissioners' approval for the CEB to give a direction to the CLELC to purchase this land.[110] The land amounted to 44,900 square feet at a price of £34,520. The site was of interest to the CEB as it was favourably located for a possible extension of Bankside power station, not only to meet the electricity load of the CLELC but also to provide electricity for other parts of London. To this end the CEB produced a plan for a prospective 180 MW generating station on the extended site. An internal Electricity Commission minute notes that if the Commissioners:

> are willing to consider the setting up of a big power Generating Station in the heart of the City the occasion of this purchase might present an opportunity of securing the prior approval of the City Corporation to the establishment of such a Generating Station.[111]

The Commissioners were equivocal on the issue of raising the matter of a new power station with the Corporation. They suggested that the CEB should consider whether it would be possible to get an undertaking from the City that they will not object, or whether it 'would be unwise to force the City at the present time' and leave the matter until 'the need can be shown to be urgent'. The Commissioners were concerned that the Corporation of London, rather than approving a new power station, might object to the proposal. There is no evidence that the question of the new power station was raised with the Corporation; but they must have been aware that in selling this land to the CLELC further development of the site was likely. A decade later the Corporation were vociferous in their objections to the proposed Bankside 'B'.

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[110] The direction was given under Section 5(1) of the 1926 Act. TNA, POWE 12/464, Electricity Commission, Bankside Extension of Site: purchase of additional land, 1936-7, Letter from the CEB to the Electricity Commission, dated 17 April 1936.

[111] Ibid., Electricity Commission minute from H.V. Chapman to Mr Douglas dated 29 April 1936, see also minute from J.R. Brooke to Mr Kennedy, dated 4 May 1936.

In December 1936, the CEB wrote to the CLELC directing them to purchase the land from the City of London Corporation at the prices mentioned. The letter states:

> the Electricity Commissioners have approved pursuant to Section 5 of the 1926 Act of the issue by the Board to your Company of a direction to extend the existing site of Bankside Generating Station [...] a copy of this direction should accompany your application to the Electricity Commissioners for their consent, under Section 11 of the Electricity (Supply) Act, 1919, to the extension of the site of the generating station.[112]

Thus the CEB had to seek the approval of the Electricity Commissioners to give the CLELC a direction to purchase land, the CLELC then had to apply to the Commissioners to seek their consent to extend the site. This was the consent to purchase the land, a further application would have to be made if the CLELC wished to seek approval to extend the power station itself. Given this complexity of directions, considerations, consents and approvals it is unsurprising that the process took eight months to complete. The Corporation of London had not been pressing to sell the land but it is conceivable that there may have been cases where land purchase would have failed given such a time delay.

Another example demonstrates such a situation but also shows that, when necessary, the approval process could be achieved quickly. In June 1938 the opportunity arose to purchase 79,000 square feet of land immediately to the west of Bankside power station (shaded blue in Figure 2.10).[113] This land belonged to the South Metropolitan Gas Company which had operated a gas works at Bankside but

[112] Ibid., Letter from the CEB to CLELC, dated 21 December 1936.
[113] TNA, POWE 12/570, Bankside Extension of Site: purchase of additional land, 1938, Letter from the CEB to the Electricity Commission, dated 14 June 1938.

which had closed in the mid-1930s.[114] The additional land would have enabled the construction of a bigger 250 MW power station on the site. The CEB noted that the plant at Bankside was already old and would have to be 'written off within the next five or six years' and again sought the approval of the Commissioners to issue a direction to the CLELC to purchase the land at a price not exceeding £120,000. On the same day the CLELC wrote to the Electricity Commissioners to apply for their consent to purchase the land. In closing the CLELC asks the Commissioners 'to give the matter their immediate consideration' as the auction was to take place the following week.[115] The CLELC also wrote to the London JEA, as they were legally required to do, to give notice of the imminent purchase and to give the JEA the opportunity to submit objections.[116] As the CLELC observe in a letter it was important that the vendors should not know of the Company's intentions and asked the JEA 'to consult as few of your Members as possible […] [and] in strictest confidence'. Subject to the JEA having no observations the Commissioners gave their approval under Section 5 of the 1926 Act and their consent under Section 11 of the 1919 Act.[117] The auction took place on 23 June, and the manager of the CLELC wrote again to the Commissioners saying, with some satisfaction, that they had been able to purchase the land for £45,000 'which is considerably less than my advisers and I expected to pay' and asked for the Commissioners' formal consent to the purchase.[118] This example demonstrates that the formal directions and approvals system could be made to work quickly when required,

[114] F. Goodall, 'Gas in London: A Divided City', *The London Journal*, 27:2 (2002), p.35. This was the first London gas works south of the Thames when it was first built in 1814. Kelly's *Street Directory of London 1930*, p.119 mentions The South Metropolitan Gas Co at No.70 Bankside. The gas works had been decommissioned and demolished by 1938.
[115] TNA, POWE 12/570, Bankside Extension of Site, Letter from the CLELC to the Electricity Commission dated, 14 June 1938.
[116] Ibid., Letter from CLELC to the London and Home Counties JEA, dated 14 June 1938.
[117] Ibid., Letter from London and Home Counties JEA to the CLELC, dated 15 June 1938. The London JEA formally had one month in which to submit objections or observations, in the circumstances the JEA stated that 'the Authority does not desire to submit any observation'.
[118] Ibid., Letter from the CLELC to the Electricity Commission, dated 23 June 1938.

although it did circumvent statutory consultation periods. Nevertheless this legislative regime obliged the CLELC to consult several bodies and to make formal applications to purchase land which, as a company, it had previously been able to do without recourse to consultation.

Two further examples are instructive of the control exercised over the CLELC; and concern some of the equipment that was being purchased for Bankside 'B' in 1947. In the first case the CLELC was compelled to enter into a contract against their intent. The CLELC has sought tenders for the new boilers from two companies: Babcock & Wilcox and Foster Wheeler. There was little technical or cost difference between the two tenders, but the CLELC favoured Babcock & Wilcox because they already had a good working relationship with them, and they believed they had better financial resources. They were concerned that the financial structure of the British arm of Foster Wheeler was 'quite inadequate to support the responsibilities of a contract of this magnitude', the value of the contract was over £1½ million.[119] They expressed these reservations to the CEB. After discussion with both tenderers the CEB said that their concern was primarily about the probability of completion of the order. They believed that Babcock's had a very heavy work load, and stated they were already maintaining 'very high pressure on them' to complete existing contracts. The CEB believed that there were better prospects of early delivery from Foster Wheeler and therefore instructed the CLELC to place the contract with this company. The CLELC were therefore obliged to place the contract against their board's intent. The early delivery was an important consideration given the shortage of generating capacity in the post-war period, as discussed in Chapter 3 on the planning Bankside. The second

[119] The contact with Foster Wheeler was £1,554,470. See LMA, LMA/4278/01/590, CLELC, Board minutes dated 17 December 1947, ff.289-290.

example is the turbo-alternators being purchased by the CLELC for Bankside 'B'. In 1947 some British turbine manufacturers were idle while others had more orders than they were able to meet.[120] In an attempt to speed up manufacture a national standard was imposed by the Government; this stipulated that all steam turbines over 10 MW had to conform to one of two standard ratings of 30 or 60 MW.[121] As a consequence Bankside's turbo-alternators were re-specified from a custom size of 52.5 MW to standard 60 MW machines. This exemplifies the transition in this period from individual, sometimes unique, specifications by privately owned electricity undertakings to the standardised specification of equipment under centralised state control by the BEA following nationalisation in 1948.

The issues of complexity and conflicting interests highlighted above had long been recognised. In a speech in the Commons in 1936 Herbert Morrison suggested that the 600-odd electricity supply undertakings should be abolished together with the CEB and the Commissioners, and that the whole ownership of the industry should be vested in a national electricity corporation, a business concern that would own and run the industry.[122] A government committee also considered the matter.[123] They recognised that reorganisation into regional boards would cause 'an unnecessary dislocation of many well-managed undertaking which have proved to be economic'.[124] It was recognised that at some point in the future the electricity industry would be in public

[120] Hannah, *Electricity*, p.322.
[121] The Control of Turbo-Alternators (No.1) Order 1947 (Statutory Rule and Order No.2386). By 1950 the BEA and manufacturers wished to order and build larger 100 MW sets and lobbied the Government to revoke the order, it was revoked on 1 August 1950, see Hannah, *Engineers*, p.105; and Harlow, *Innovation and Productivity*, pp.66-70.
[122] *Hansard*, House of Commons, 25 November 1936, Vol.318 cc474-475.
[123] The committee had been convened to examine the recommendation of the McGowan report which had proposed compulsory powers for reorganization, the absorption of smaller undertaking by larger ones, and ultimate public ownership of all undertakings.
[124] TNA, CAB 24/268, Cabinet Office, Committee on electricity distribution, C.P. 64(37), dated 17 February 1937, see paragraph 13.

ownership. The matter was considered again by several government committees during the war. A reconstruction sub-committee of the Coalition Government, chaired by the Minister of the newly established Ministry of Fuel and Power reported in 1943 on the future of the ESI.[125] The committee commented that the divorce between ownership and control of generation had ‘inevitably involved many complications, some financial and some practical’. They also noted that the CEB had little control over the design of generating plant, and that there could be conflicts between commercial expediency and the national interest, as demonstrated by the Bankside examples described above. The committee recommended ‘centralising in the hands of a single generating authority the ownership, and not merely the control, of the stations generating for public supply’. These recommendations informed the structure of the industry under nationalisation which was taken forward by Attlee’s post-war Government.

As a well-managed and financially successful undertaking the CLELC opposed nationalisation. Representatives of the industry met with the Minister of Fuel and Power in December 1945 to discuss the implications of nationalisation. The minutes of a CLELC Board meeting in January 1946 recorded that ‘the London Companies should combine to oppose the Government’s nationalization proposals’.[126] Although the objections were unsuccessful, the CLELC were concerned about their ongoing liabilities following nationalisation. Clauses 15 and 25 of the draft Electricity Bill allowed the proposed British Electricity Authority (BEA) to disclaim any contracts if they disagreed with their terms. The CLELC were concerned that if this were to happen their shareholder’s compensation might be reduced and the directors made

[125] TNA, CAB 87/4, Cabinet Office, Report of the sub-committee on the future of the electricity industry, R.P (E.S.) (43) 36, dated 30 December 1943, see paragraphs 3, 7, 8 and 9.
[126] LMA, LMA/4278/01/590, CLELC, Board minutes dated 16 January 1946, f.234.

personally liable for large sums. They were therefore reluctant to place expensive contracts for the construction of the new Bankside ‘B’ power station until they had reassurances about their position.[127] The Electricity Commissioners responded that the CLELC’s position would be ‘reasonably safeguarded’ and that the Minister of Fuel and Power would be prepared to approve the contracts ‘provided that they are submitted to him with a certificate from the CEB that they are reasonable’.[128] This was a pragmatic response by the Commissioners to a matter that could have further delayed the construction of Bankside ‘B’. On 1 April 1948 most of the private and municipal electricity undertakings and statutory bodies including the CLELC, the CEB, the London JEA and the Electricity Commissioners were dissolved. Ownership of all public supply power stations and the national grid was vested in the BEA. The London Electricity Board (LEB) became the owners of the local distribution system and the local showrooms as well as being the face of the electricity industry for consumers in London.

Conclusion

Over the period 1878 to 1948 the electricity supplies to the City of London developed from small, local, financially unviable systems into a successful and profitable electricity generating and supply undertaking. This chapter demonstrates how the CLELC and its power station at Bankside operated in changing political and economic environments. The existing literature suggests that London’s electricity supplies were un-integrated, small-scale and the electricity undertakings had little opportunity or

[127] TNA, HLG 79/916, Ministry of Town and Country Planning, Letter from CLELC to the Electricity Commission, dated 17 April 1947.

[128] Ibid., Letter from Electricity Commission to CLELC dated 18 April 1947, see also LMA, LMA/4278/01/590, CLELC, Board minutes dated 2 July 1947, f.275, this identifies that under the 1926 Act any expenditure incurred by the Company on the new power station at Bankside would be ‘guaranteed as to principal and interest’ by the CEB.

incentive for expansion.[129] Contrary to this view I demonstrate that the CLELC was an innovative, financially successful and profitable organisation. Bankside was by no means small-scale; its output capacity was comparable to the average size of power stations in Berlin and Chicago. The company actively stimulated demand for electricity in the City by promoting consumption and providing an extensive network of electricity supplies. The particular nature of the City with its compact area, its mixture of commercial, institutional and industrial enterprises and relatively wealthy consumers, generated a high demand for electricity. In a later period in the 1950s and 1960s the effectiveness and efficiency of Bankside 'B' power station was again useful to provide electricity for London.

The location of Bankside power station was determined and fixed at an early stage as an optimum solution to a number of requirements. The electricity distribution to the City radiated from Bankside and this became an argument for retaining a power station on this site when Bankside 'B' was being planned, and later when the redevelopment of the redundant power station was being considered during the 1980s and 1990s. This exemplifies the 'momentum of place' that the site acquired. The rising demand for electricity in the City led to the development and redevelopment of Bankside power station from 1891 to the late 1920s. However, the expansion of the power station had adverse social effects as the CLELC demolished adjacent properties and displaced local residents. The existing literature on power stations barely addresses their adverse local effects. Bankside was not a good neighbour: there were frequent complaints about smoke, dust, noise and vibration. The effects of Bankside on its

[129] Hannah, *Electricity* and Hughes, *Networks of Power*.

surroundings were a major factor in the 'battle for Bankside' in the 1940s and the pollution effects continued to be a nuisance until the power station closed in 1981.

The inter-war years were a period of increasing oversight and control of the industry. The Electricity (Supply) Act 1919 aimed to achieve a greater co-operation between electricity undertakings. The CLELC became enmeshed in a web of complexity. The existing literature identifies the 'diagnosis of failure' of the fragmented ESI which led to the Electricity (Supply) Act 1926 that established the CEB and the development of the national grid.[130] The most efficient 'selected' stations, including Bankside, were connected to the national grid; older stations were closed; and the super-station at Battersea was built. The close focus on the CLELC and Bankside power station reveals details not evident in the existing broad picture of the industry. The new regime introduced a complex statutory relationship between electricity undertakings, the London JEA, the CEB, and the Electricity Commissioners. These bodies directed the CLELC in its strategic decisions whereas the company had, before 1919, been largely autonomous. This restricted the latitude of the CLELC to manage its business. The post-1926 system resulted in lengthy delays in seeking approval for developments, and limited the commercial freedom of the company to purchase plant and equipment.

The ESI of inter-war period was radically changed by nationalisation in April 1948. The CLELC, despite protests, was dissolved along with other undertakings and the statutory electricity bodies. Generation and bulk distribution of electricity was vested in a single body the BEA. By the time of nationalisation Bankside 'B' power

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[130] Chapter 3 of Hannah's *Electricity Before Nationalisation* is entitled 'The Diagnosis of Failure' and covers the period between the 1919 and 1926 Acts.

station was already under construction having been authorised in May 1947. The next chapter addresses how the approval for this controversial addition to the London's urban landscape came about.

Chapter 3 – Planning Bankside: post-war development and the battle for Bankside

This chapter examines the decision-making and approval processes for the redevelopment of Bankside power station that took place in the period 1944 to 1947 and again in 1958. The debates about the initial redevelopment proposal are framed as a conflict – the battle for Bankside – between two strategic post-war plans for the modernisation of London.[1] On one hand electricity was seen by the Government as an important factor in the post-war economic recovery of the country through the growth and modernisation of industry. Yet, as a result of the war, the electricity industry was poorly placed to meet even the existing demand for electricity. On the other hand the war had provided the opportunity to re-plan and rebuild war-damaged London on a modern, rational and visionary basis. The *County of London Plan* of 1943, commissioned by the LCC, had proposed the deindustrialisation and redevelopment of the South Bank including the Bankside area.[2] Bankside 'B' power station was situated at the intersection of these mutually exclusive plans.

This chapter demonstrates that the planning process for Bankside was lengthy, complex and involved a large number of actors. This was partly due to the structure of the electricity industry – as demonstrated in Chapter 2 – and the planning system as they was constituted at this time. During informal discussions the parties sought to reach common ground with alternative proposals, compromise solutions and mitigating measures. However, the principle of rational, long-term urban planning, was of such importance that the approval decision escalated to a debate of national significance.

[1] The battle for Bankside was seen as such in some contemporary accounts, e.g. 'The Bankside Battle Continues', *The Sphere*, 31 May 1947, pp.262-63.
[2] Forshaw and Abercrombie, *County of London Plan*, pp.126-35.

Even at the highest level of Government the two sides of the debate were closely argued, with Ministers taking opposing positions. This chapter illuminates the detailed workings of local and central government in the planning process, the influence of Ministers and their Ministries, and the political manoeuverings in Parliament and elsewhere supporting and opposing the proposal. Given the number of actors in this process and the different ways in which they valued the Bankside site, this chapter continues the theme of Bankside being enmeshed in a web of organisational complexity.

The planning decision was resolved in favour of the electricity lobby through the random contingency of the 'bleak midwinter' of 1947 which turned a fuel and energy shortage into a crisis. To mitigate its amenity impact conditions were attached to the approval of Bankside 'B' but which had a long-term impact on its operation. The chapter concludes with an examination of the consequences of Bankside's approval decision on the 'zoning' of the local area and the fate of the grand plans for London. It also reflects on the wider political context of the changes that took place in both the planning system after 1947 and in the electricity industry following nationalisation in 1948.

Planning London's electricity

In the immediate post-war period the need for electric power in London was both crucial and urgent and became the most compelling argument for the redevelopment of Bankside 'B' power station. The use of electricity had grown significantly since the inter-war period, but the British ESI was poorly placed to meet both the projected post-war increase in demand and the expectations of industry, commerce and the public for a secure and plentiful supply of electricity.

Electricity was a modern enabling technology which transformed the factory, the home and the urban environment. The electric motor had made motive power for industry lighter, cleaner and more flexible than the steam engine.[3] Electrically powered factories, it is claimed, 'opened up new possibilities of 'clean' smoke-free industry' located close to housing 'without the pollution problems which was characteristic of nineteenth-century industrial districts'.[4] The mid-twentieth century electric factory with its modern, clean lines succeeded the grimy, smoky, steam powered factory of the nineteenth century. However, as I argue, the generation of electricity could entail significant local air pollution. The expansion of north-west London in the 1930s had been enabled by the combination of electric power and a revolution in road transport.[5] Electricity had allowed new applications to be realised and made possible new modes of production such as the assembly line.[6] The new factories included 'light' – electrically powered – industries which produced mass-market goods, many of them electrical, such as vacuum cleaners and wirelesses and made use of mass production techniques. In the inter-war period, 256 electrical engineering plants had been established in Greater London employing nearly 31,000 people.[7] As the geographer Denis Linehan has observed the Great West Road as a 'focus of intense industrial development outside London, was perhaps *the* landscape of success in 1930s Britain', where modern factories produced new consumer goods, and the buildings themselves

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[3] Byatt, *The British Electrical Industry*, pp.67-68.
[4] Scott, 'The Evolution', p.513.
[5] S. Alexander, 'A New Civilisation? London Surveyed 1928-1940s', *History Workshop Journal*, Issue 64 (2007), p.305.
[6] D.E. Nye, *Electrifying America* (Cambridge MA, 1990), p.188.
[7] P. Scott and P. Walsh, 'Patterns and Determinants of Manufacturing Plant Location in Interwar London', *Economic History Review*, LVII:1 (2004), p.113.

'flaunted their modernity with floodlights and a new architecture'.[8] In the post-war period economic commentators noted that 'much planned industrial expansion depends upon an increase, pari passu, of electrical power supplies'.[9]

In the retail sector too, modernity was manifest in prestigious shops, for example Simpson in Piccadilly which used electric lighting to maximise the potential of display and had electrically powered lifts and escalators.[10] For the consumer, electrical appliances were presented as clean, modern, convenient and desirable.[11] Both the number and the range of electrical appliances in use increased significantly in the middle decades of the century (see Table 3.1). A government report on electricity in 1942 identified that 'the public have increasingly come to regard electricity as a necessity and not a mere luxury'.[12] The 'all-electric' house had a significant place in the post-war housing programme with the construction of large numbers of prefabricated homes.[13] These domestic, commercial and industrial developments required increasing amounts of electricity. Demand for power was rising, and was expected to continue to rise, typically doubling every ten years.[14] However, in the mid-1940s the British ESI was poorly placed to meet this demand, principally because of the effects of the war.

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8 D. Linehan, 'An Archaeology of Dereliction: Poetics and Policy in the Governing of Depressed Industrial Districts in Interwar England and Wales', *Journal of Historical Geography*, 26:1 (2000), p.104.
9 R.C. Estall, 'The Problem of Power in the United Kingdom', *Economic Geography*, 31:1 (1958), p.85.
10 B. Edwards, 'A Man's World? Masculinity and Metropolitan Modernity at Simpson Piccadilly', in Gilbert *et al* (eds), *Geographies of British Modernity* (London, 2003), p.156.
11 D. Matless, 'Appropriate Geography: Patrick Abercrombie and the Energy of the World', *Journal of Design History*, 6:3 (1993), p.175. See also, for example, C. Haslett and J. Snell, *The Electrical Handbook for Women* (London, 1936).
12 The Jowitt Committee report of April 1942 quoted in Chick, *Electricity and Energy Policy*, p.68.
13 A.J. Robertson, *The Bleak Midwinter 1947* (Manchester, 1987), p.107.
14 R. Kelf-Cohen, *Twenty Years of Nationalisation* (London, 1969), pp.105-06.

Table 3.1: Ownership of domestic electrical appliances, 1933-78.

Electrical appliance:	Percentage of households owning appliances in the given year				
	1933	1946	1955	1966	1978
Fire	21.8	60.9	60.5	79.7	76.1
Iron	56.4	81.9	90.0	99.8	96.0
Kettle	10.7	18.9	30.0	49.3	75.7
Oven	11.2	16.6	24.5	36.6	43.8
Radio (mains)	11.2	88.5	90.6	45.0	47.9
Refrigerator	–	2.2	8.1	47.4	72.6
Television	–	0.2	34.7	91.2	Note[15]
Vacuum cleaner	–	38.2	–	82.4	92.8
Wash boiler	1.3	5.2	11.8	13.8	6.8
Washing machine	–	2.0	17.5	60.1	72.9
Water heater	2.3	10.3	20.6	52.6	66.6

Source: The Electricity Council, *Handbook of Electricity Supply Statistics 1989*, London (1990), Table 50, p.84.

Prior to nationalisation the strategic planning of future electricity supplies was the responsibility of the CEB. One of its duties was to develop supplies through promoting the construction of new power stations and extensions to existing ones. To inform its planning the CEB undertook annual reviews of future electricity demand. Since the negotiation, design and construction of extensions took two or more years, and new power stations three to four years to come 'on-load' the annual reviews looked four years ahead. The review in 1939 had identified that additional plant would be required at Bankside power station by 1943, and discussions with the CLELC had started. However long-term planning was suspended during the war because of the Government's policy of fighting the war with a total commitment of resources.[16] The construction of new electricity plant was restricted to the minimum necessary to support the war effort. Furthermore, to maintain electricity supplies the repair and

[15] In 1978 51 per cent of customers owned a black and white television and 59.7 owned a colour television.
[16] Hannah, *Electricity*, p.307.

maintenance of generating station equipment was reduced which meant that at the end of the war the plant was in poor condition. As a result there was a shortfall in generating capacity. In 1944 the CEB produced plans for new generating plant to be commissioned in three tranches in 1946 to 1948.[17] A significant increase in demand for electricity in the post-war period was anticipated. In 1946 the CEB noted that since the war there had already been a rapid recovery of demand in the south-east. They estimated that demand in the London area would rise from 1680 MW in 1944/45 to 2808 MW by 1950/51 an increase of 67 per cent (see Figure 3.1).[18]

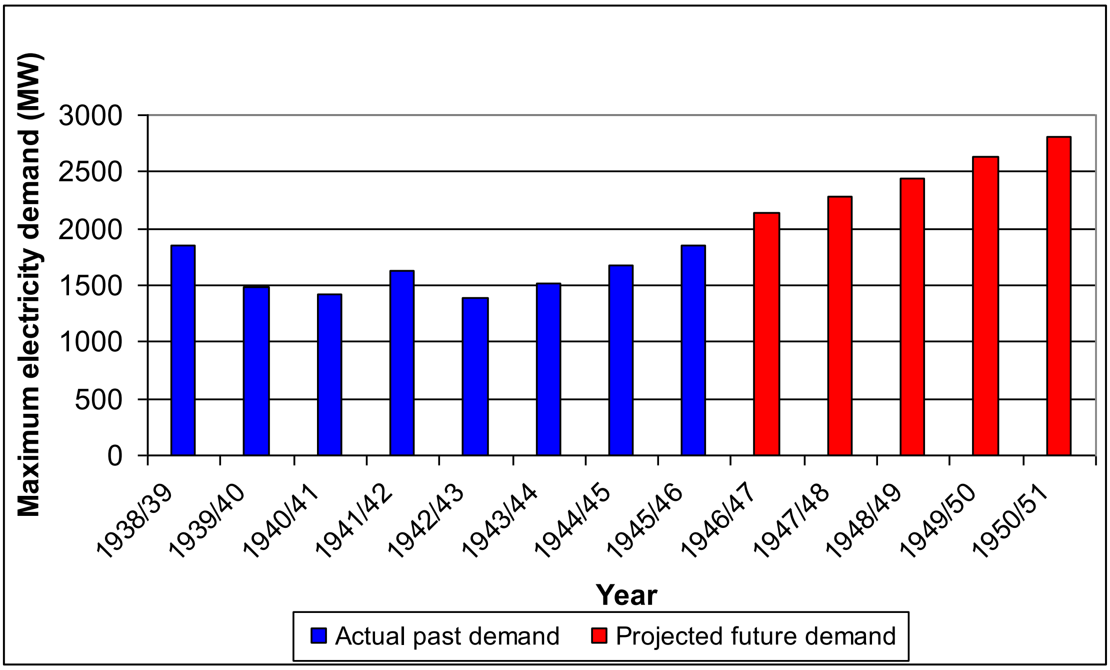

Figure 3.1: Actual and projected electricity demand in London, 1938-50.

Source: Adapted from TNA, HLG 79/918, Ministry of Town and Country Planning, Table JH.1, public inquiry, Proof of Evidence of Mr. J. Hacking.

Note the data was compiled at the end of 1946.[19] The London area was defined as that supplied with electricity from CEB grid points within a 12 mile radius of Charing Cross.

[17] Ibid., pp.308-10.
[18] TNA, HLG 79/918, Ministry of Town and Country Planning, Application for the Extension of Bankside, public inquiry, proof of evidence of Mr. J. Hacking, Chief Engineer of the CEB.
[19] The actual past demand is the usage of electricity in each of the previous eight years, the projected future demand is an estimate of the demand for the following five years.

The deficit and poor condition of generating plant meant that in the winter of 1945/46 demand in London had exceeded the available supply by 72 MW and supplies had to be curtailed resulting in power cuts. With a lead time on new plant of two to four years the situation was projected to get worse over the following winters. The shortfall was aggravated by the aging and increasingly inefficient and unreliable plant: during the war all the usable plant was retained regardless of its age and inefficiency. The CEB estimated that between the end of the war and 1950 about 400 MW of plant in the London area would have to be decommissioned, much of it more than 25 years old and life-expired. This was the case at Bankside where the output from the 'A' station was projected to fall from 75 MW in 1944 to 36 MW in 1950/51. The coal consumption per unit of electricity generated at Bankside was more than double that of newer plant thereby making electricity more expensive.[20] The CEB noted that 1220 MW of additional generating plant was required in the London area by 1950/51, this was equivalent to six new 200 MW power stations or extensions of this capacity.[21] The need for new generating plant in London was therefore critical and urgent.

In 1944, as part of their strategic planning, the CEB held discussions with the CLELC about steps to be taken to meet the future demand in their area of supply in the City of London. The Bankside site was thought to be capable of redevelopment with a power station of ultimate capacity of 300 MW.[22] The CEB included the proposed Bankside 'B' in their programme for 1948/49, and asked the CLELC to draw up detailed plans and submit these to the planning authority, the London County Council (LCC). The urgency of getting the new station on load is evident in the CEB's

[20] The 75 MW capacity was itself significantly less than the peak capacity of 95 MW when modernisation of the boiler house at Bankside power station had been completed in 1928.
[21] The scale of the demand was such that by 1950 it was expected that London would account for 22 per cent of the total electricity used in Britain.
[22] See Chapter 2 for an account of the land purchases adjacent to Bankside.

comment that the 'board was anxious that all this should be done as soon a practicable'.[23] In February 1945 the CLELC submitted their plans to the LCC and formally requested planning consent to redevelop the power station.[24] The LCC responded in May 1945 that they could not accept these plans because they would 'have a very harmful effect' on proposals for the redevelopment of the South Bank. To take the matter forward discussions on the proposal took place throughout 1945 and 1946. The CEB recognised that objections on planning and amenity grounds would delay the approval, the Bankside development was therefore deferred in the programme until the winter of 1950/51. The deferral at that stage had further adverse consequences for London's electricity supplies. In place of Bankside the proposed new power station at Brunswick Wharf in Poplar was brought forward into the 1948/49 plan; this late substitution served to further accentuate the shortage of future generating capacity.[25] The redevelopment of Bankside power station was therefore part of the proposed solution to the critical and urgent need for electricity generating capacity in London. It was apparent that the redevelopment of Bankside power station would be contested as a result of the urban planning opportunities that had been brought about by the war.

Planning the built environment: the *County of London Plan*

The LCC's principal objection to the Bankside application was that it would compromise the redevelopment plans for the area. This section demonstrates how the re-planning of Britain's major industrial cities had long been an unachieved aspiration, and that war-time bomb-damage had provided the opportunity to re-plan and rebuild London. Several strategic master plans had proposed how specific areas might be

[23] TNA, HLG 79/918, Letter from the CEB to the CLELC, dated 28 July 1944.
[24] Ibid., Letter from the CLELC to the LCC, dated 13 February 1945.
[25] Ibid., public inquiry, proof of evidence of Mr J. Hacking, p.3.

redeveloped; a common theme was the deindustrialisation of city centres. The planned redevelopment of Bankside power station was intended to address the shortfall in electricity supplies brought about by the war, but the war had also provided the opportunity to rebuilt and deindustrialise London. The proposals for Bankside power station therefore sat at the intersection of these two conflicting plans.

In view of the disparities between Britain's industrial cities, and the north to south drift of employment opportunities, the Government had set up a Royal Commission in 1937 to examine the distribution of industrial population. The resultant Barlow report of 1940 acknowledged that the haphazard urban development of the past had led people to suffer from *inter alia* poor housing, difficulties of transport, congestion, smoke, dirt, fog and noise.[26] The report specifically identified the role of electricity in attracting industry and increasing migration into London which was 'an area in which electrical power is universally available' and noted that for 'some of the industries that are highly concentrated in Greater London […] the use of electricity is an important cause of their growth there'.[27] The report suggested that this movement represented 'a serious drain on the rest of the country'. Urban problems such as smoke pollution were identified as having financial costs as well as harmful effects on health, traffic congestion, and the fabric of buildings. It was also noted that London 'still contains a large number of unfit houses'.[28] The Barlow report recommended:

> continued and further redevelopment of congested urban areas, where necessary [and] decentralisation or dispersal, both of industries and industrial populations, from such areas.[29]

[26] Royal Commission on the Distribution of the Industrial Population, Report, Cmd. 6153 (1940).
[27] Ibid., p.164, p.43 and p.170.
[28] Ibid., p.84, p.78, and p.83.
[29] Ibid., p.201.

The relocation of industry would also serve to reduce its vulnerability to air attack.[30] This was a significant pre-war and wartime concern and would continue to be a strategic consideration in the post-war era of the atomic bomb. The urban geographer Gordon Cherry notes that the Barlow report caught the tide of public opinion as it demonstrated how Britain's cities could and should be changed to improve economic, social and environmental conditions. As part of the process of turning these ideas into practice Lord Reith, the wartime Minister of Works and Buildings, asked the LCC to develop a reconstruction plan for London. One result was the 1943 *County of London Plan* by the LCC architect John Forshaw and the UCL professor of town planning Patrick Abercrombie.

The *County of London Plan* acknowledged that the war had provided an opportunity to rebuild London in a rational manner. Wartime bomb-damage was extensive, for example, only nine per cent of the 98,000 dwelling administered by the LCC were un-damaged, and 25 per cent were seriously damaged or uninhabitable, and a third of the City of London had been levelled.[31] Bomb-damage had offered London a 'unique stimulus to better planning' yet, 'sufficient of London's fabric remained to prevent those involved in reform from treating the city as though it were 'a clean sheet''.[32] This was the case for the Bankside area which had been damaged by bombing, particularly the area immediately south of the power station (see Figures 3.2 and 3.3), yet it still contained many business and residential properties.

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[30] The Minister of Labour, Ernest Brown, in announcing the appointment of the Barlow commission, had specifically referred to the strategic vulnerability, see Young and Garside, *Metropolitan London*, pp.221-23. Chapter VII of the Barlow report addresses the strategic implications.

[31] Cherry, *Cities*, p.113 and M. Hebbert, *London: More by Fortune than Design* (Chichester, 1998), p.70.

[32] Forshaw and Abercrombie, *County of London Plan*, p.1; Young and Garside, *Metropolitan London*, p.223.

Figure 3.2: Bankside 'A' power station and its surroundings, January 1947.

Source: TNA, HLG 79/918, Application for the Extension of Bankside, Inspector's report, Photo No.3. Reproduced with permission. The National Archives.

Note the empty plots and war-damaged property, the dome of St Paul's cathedral is just visible through the mist.

One of the concerns of the *County of London Plan* was 'indeterminate zoning' or mixed-use land which comprised a 'jumble of houses and industry'.[33] The Bankside area was an example, it included houses, flats, shops, a school, a church, plus industrial, manufacturing and commercial premises and wharves and warehouses along the river front.[34] Bankside exemplifies the type of area that the town planning historian

[33] Forshaw and Abercrombie, *County of London Plan*, p.3.

[34] A pre-war trade directory demonstrates the number and range of industrial and commercial businesses in the area: wharfingers and lighter-men were based along Bankside with associated businesses such as steel, tea, wood, wool, sand, brick and tile, carpets and rugs, and wine and spirit merchants and several hop factors (a traditional Southwark trade) together with shipping and forwarding agents and road transport contractors. There were also small manufacturers of ink, tubes, knitted goods, lingerie, chamois leather, manufacturing chemists, coffee roasters, hat blocks makers and a significant number of printers and stationary manufacturers and suppliers. Tradesmen included grocers, greengrocers,

Michael Hebbert has called the ‘nooks and crannies of inner London, the older traditions of small-scale manufacturing and craft production’.[35] Forshaw and Abercrombie attacked this ‘veritable peppering of whole districts with factories, in which the domestic and industrial were unhealthily intermixed’. They argued that removal of industry from central areas, as identified in the Barlow report, would also remove both atmospheric pollution and noise.[36] As discussed in Chapter 2 air pollution and noise were issues for the neighbours of the Bankside ‘A’ power station. The post-war character of the Bankside area is illustrated in a spatial analysis of land-use undertaken in 1947 by the LCC Architect’s Department (see Figure 3.3). Although badly damaged during the war, the area was still a mixture of industry and housing. The area was predominantly industrial (shaded mauve) together with warehouses (light blue). Businesses included printers, hop and general warehousing and small-scale industry such as brush-making, small wood-working and hat making.[37] There were significant areas of residential properties (shaded salmon) and plots of bomb-damaged (grey) and vacant land (white).[38] The area was described by the LCC as ‘hideous, squalid and a hotch-potch of mere utilitarianism’ and as ‘notoriously ugly’.[39]

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chandlers, tobacconists, ironmongers, drapers, boot repairers, hairdressers, newsvendors, cafes, coffee rooms and seven pubs. *Post Office Street Directory London, 1937*.

[35] Hebbert, *London*, p.146.

[36] Forshaw and Abercrombie, *County of London Plan*, p.112.

[37] TNA, POWE 12/798, Electricity Commission, Evidence of Alderman L.J. Styles of Southwark Borough Council, public inquiry, day 3, pp.16-17.

[38] The twelve blocks of five-storey Peabody flats had been built in 1876, http://www.peabody.org.uk/your-estate/your-estate-detail-page.aspx [accessed April 2012], one block had been damaged in the war and was subsequently demolished, the Sumner Buildings had been built by the Corporation of London in the early 1930s, Hopton’s almshouses date from 1752. L. Reilly and G. Marshall, *The Story of Bankside* (London, 2001), p.70.

[39] The quotes are from the counsel for the LCC at the public inquiry and from the inquiry inspector’s report, and therefore are not entirely impartial, but are typical of descriptions of the area, TNA, POWE 12/798, public inquiry, counsel for the LCC, day 4, p.22; and Inspector’s Report, p.9.

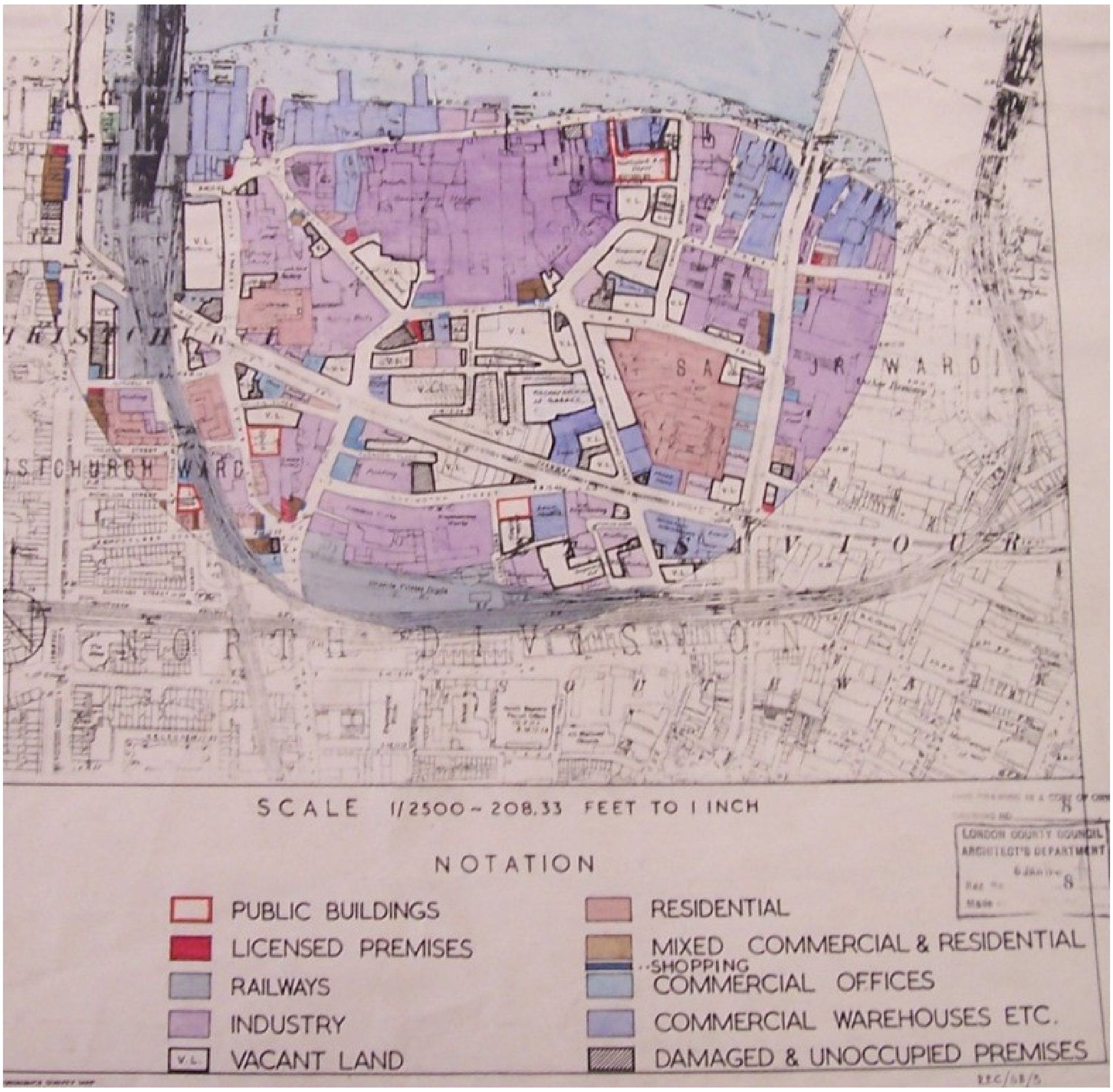

Figure 3.3: Land use around Bankside power station, 1947.

Source: LMA, GLC/RA/D2G/12/553, South Bank Comprehensive Development Area: Bankside power station (1947). Extract from plan. Reproduced with permission. City of London, London Metropolitan Archives.

Bankside power station is at the centre of the coloured circle.

For central London the aim of the *County of London Plan* was to define the function of specific areas. Two localities were identified for renewal: the West End, and the South Bank of the Thames including the Bankside area where the *Plan* states: the 'dreary industrial scene […] calls for drastic action'. As the *Plan* notes, one of the great anomalies was that the north side of the Thames from Westminster eastwards was lined with magnificent buildings yet the corresponding South Bank presents 'a dreary industrial scene'.[40] In the South Bank plan all of Southwark's river frontage was to be open space with public access. Between County Hall and London Bridge the South Bank was to comprise:

> a riverside embankment, a series of building of varying character, starting, perhaps, with a great cultural centre, followed by theatres, concert halls and assembly halls; with offices at the new Waterloo Bridge head, terminating at the eastern extremity with commercial and other buildings, with Southwark Cathedral in a worthy setting as the completion of the scheme.[41]

The riverside embankment would consist of a continuous strip of public gardens and a wide boulevard, behind this would be blocks of offices and flats and cultural institutions, with commercial and light industrial buildings behind (see Figure 3.4).

A project of the scale of the South Bank scheme, particularly in the context of post-war austerity and shortages of materials and labour, could not be undertaken or completed quickly. The *Plan* took a pragmatic approach manifest in the proposal that the scheme as a 'means of reviving a great sector of London to the benefit of the community generally' would be a long-term one, spread over the next fifty years, although it was noted that 'the river embankment with its grass strip and road behind, could be proceeded with at once'.[42] However, as Cherry has remarked there was a gap between the strategic thinking of academic planners, exemplified in the *Plan* and the practical capabilities of local government.[43] This point is also made by other commentators who noted that the 'administrative jungle' of local government structures prevented effective planning. The planning historian Ken Young and

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[40] Forshaw and Abercrombie, *County of London Plan,* p.126.
[41] Ibid., p.12, also see p.131.
[42] Ibid.*,* p.135 and p.19.
[43] Cherry, *Cities*, pp.112-13 and p.123. Hebbert states that Abercrombie was a synthesis of modernist, traditionalist and pragmatist (Hebbert, *London*, p.65).

Patricia Garside identify that this was partly due to the failure of central government to resolve the question of whether planning should be locally or nationally directed.[44] The two conflicting plans for the Bankside power station site exemplify this situation; it was a case that could not be resolved by the local authorities, but escalated to central government for direction.

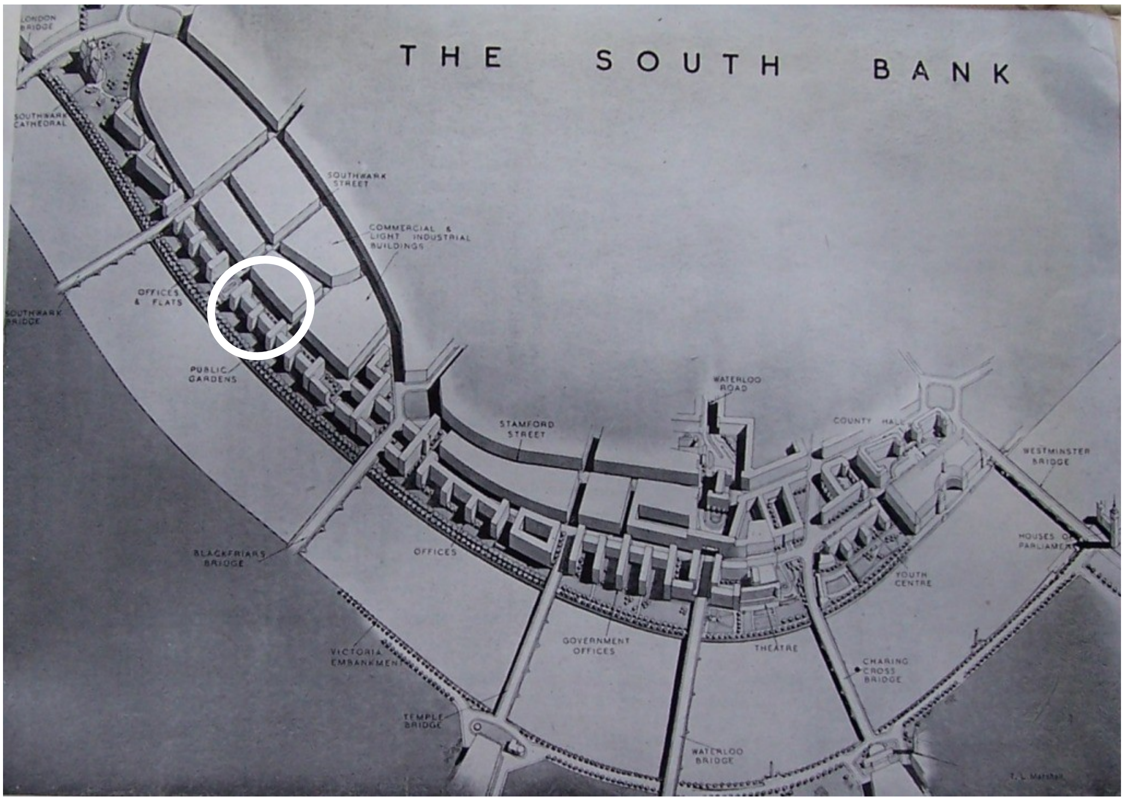

Figure 3.4: The proposed redevelopment of the South Bank.

Source: J.H. Forshaw and P. Abercrombie, *The County of London Plan* (Macmillan, 1943), Plate XLVIII. Reproduced with permission of Palgrave Macmillan. This material may not be copied or reproduced without permission from Palgrave Macmillan.

The site of Bankside power station is highlighted.

The *Plan* has few specific references to the role of electricity in the future development of London. The electrification of railways is mentioned, and in the context of smoke abatement reference is made to new factories ‘which would probably

[44] Young and Garside, *Metropolitan London*, pp.243-45.

be run on electricity'.[45] Power stations and other elements of utility infrastructure are referred to in the context of their location 'particularly where they are discordant with their surroundings'.[46] The *Plan* did not oppose industrial buildings but rather insisted on their appropriate location and design. To illustrate this the *Plan* included a dramatically lit image of Battersea power station with a caption stating:

> the reconstruction of industrial premises, particularly on the river front, must offer great opportunities for a modern treatment expressing, by form and silhouette, the character and importance of their function and service.[47]

This statement suggests that new power stations were not seen as antithetical to the vision for the riverside, but that they should be appropriate to their location and should express their function.[48] But it was the specific location of the proposed Bankside 'B' power station in the midst of the South Bank scheme that was especially problematic and contentious.

Other strategic plans for the rebuilding of London included the Corporation of London's 1944 plan for the reconstruction of the City. As the cultural historian Frank Mort has said, this plan 'dealt in visionary streetscapes and river views' and one of the aims was to improve the southern perspective of St Paul's cathedral from the river (see Figure 3.5).[49] Access to the riverfront on both the north and south bank was a common theme in London's grand plans. Figure 3.5 illustrates how the vista to St Paul's would be opened up and framed by monumental modernist buildings.

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[45] Forshaw and Abercrombie, *County of London Plan,* p.65 and p.124.
[46] Ibid., p.16.
[47] Ibid., Plate XLI facing p.111.
[48] The functionality of the design of power stations was insisted on by the Royal Fine Art Commission who stated that 'the architectural treatment of such buildings should be more functional and less monumental', TNA, BP 3/8, Royal Fine Art Commission, *Eighth Report of the Royal Fine Art Commission 1946 to 1947* (London, 1949), p.13.
[49] Mort, 'Fantasies of metropolitan life', p.140.

Figure 3.5: St Paul's cathedral from the 'proposed embankment on the Southwark side of the river'.

Source: Corporation of London, *Report of the Preliminary Draft Proposals for Post War Reconstruction in the City of London* (1944), facing p.13. Reproduced with permission. City of London, London Metropolitan Archives.

Note that working barges and tugs still appear as a feature of the riverscape.

The scale of the issue is demonstrated in an analysis of riverfront usage. The Borough of Southwark, where Bankside was located, had a total river frontage of 4300 ft of which 3400 ft was wharves and warehouses and 900 ft was railways, with no open space on the riverfront.[50] In July 1945 the LCC adopted a resolution that 'in relation to the County of London Plan […] there should be greater access to the river front' and noted that 'the removal of a certain amount of riverside industry including the

[50] Forshaw and Abercrombie, *County of London Plan,* p.177. The riverfront of the City was barely less developed with 5200 ft of wharves and warehouses, 800 ft of railways and 1700 ft of public and business buildings.

Bankside Generating Station would undoubtedly be necessary'.[51] The LCC were therefore clear about the future of Bankside power station. They indicated that access to the river front would provide a much needed lung for north Southwark and would permit development opposite St Paul's cathedral 'appropriate to the importance of the historic site'. It was hoped that the vista from St Paul's across the river to the South Bank could be terminated in 'an important edifice of appropriate character and design, as, for instance, King's College', but specifically not the power station.[52]

Although the *County of London Plan* contained specific proposals about the long-term, large-scale treatment of the South Bank, other smaller-scale concepts within the *Plan* were taken up by local authority planners and architects. One of the concepts was 'neighbourhood units' which might comprise houses, flats, shops, a school, church and gardens.[53] Just such a unit was identified in the 'quadrilateral' that included Bankside power station.[54] The Borough of Southwark proposed a modification to the South Bank plan in that light industry should be based south of Southwark Street and that the 'quadrilateral' should be 'general business development'.[55] The CLELC's architect Sir Giles Gilbert Scott suggested a possible treatment of this quadrilateral but which included Bankside power station (see Figure 3.6). Scott proposed screening the power station by planting trees along Sumner Street and developing the bomb-damaged area to the south with houses, flats and a grass area with shops fronting

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[51] TNA, HLG 79/916, Ministry of Town and Country Planning, Bankside power station development Southwark: application to Minister, Letter from the LCC to the Ministry of Town and Country Planning, dated 3 September 1945.
[52] LMA, LCC/PC/GEN/01/052, LCC, Architect to the Council's report to the Town Planning Committee, dated 1.5.47.
[53] Forshaw and Abercrombie, *County of London Plan*, p.9.
[54] The quadrilateral was the area bounded by the Thames to the north, Southwark Bridge Road to the east, Southwark Street to the south and Blackfriars Road and the railway to the west (Figures 3.3 and 3.6), see TNA, POWE 12/798, Electricity Commission, public inquiry, day 2, pp.9-10.
[55] Ibid., Evidence of George E. Hardy, Borough Engineer and Surveyor for Southwark and Cyril H. Walker Director of Housing and Valuer to the LCC, public inquiry, day 3, pp.20-24 and p.58.

Southwark Street. There were concerns about the impact that the proposed power station would have on such a neighbourhood. The Borough of Southwark thought that offices would be an appropriate development for the area but were concerned that these would be 'frightened away' by the power station'.[56] The argument about the appropriate use of the area was examined during the public inquiry, as discussed below.

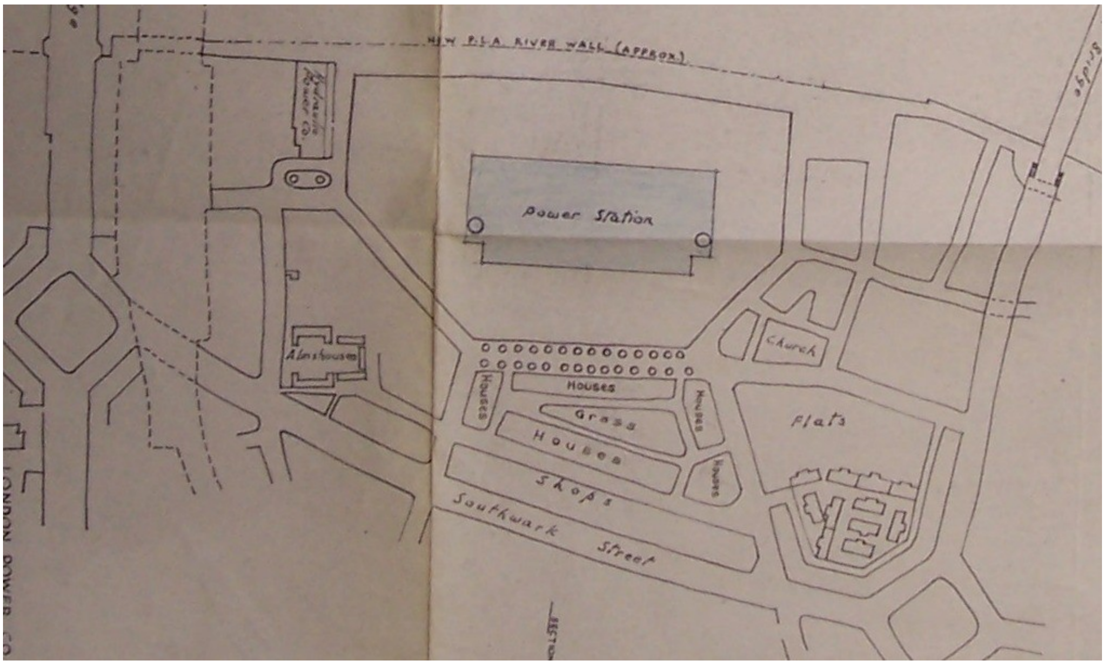

Figure 3.6: Scott's plan for the Bankside 'quadrilateral'.

Source: TNA, HLG 79/919, Ministry of Town and Country Planning, Bankside Generating Station: Plan's illustrating inspector's report, 1944-47, Extract from Plan No.8. Reproduced with permission. The National Archives.

The two positions on the future development of the Bankside area had now been established. The LCC, the Borough of Southwark and the Corporation of London with their vision for the redevelopment of the South Bank and the riverfront anticipated the removal of the existing Bankside 'A' power station. The CEB and CLELC had, respectively, strategic and detailed plans to meet the critical and pressing

[56] Ibid., Evidence of Alderman Leonard Styles, Leader of Southwark Borough Council, public inquiry, day 3, pp.16-17.

need for electricity in London through the redevelopment of Bankside power station and the construction of Bankside ‘B’. The two positions were discussed by the interested parties over an extended period in an attempt to find a solution to what appeared to be two mutually exclusive proposals for the future use and development of the area.

The battle for Bankside: discussion, compromise and escalation

The decision-making and approval process for Bankside ‘B’ power station involved a large number of actors. These included local government bodies, ministries and government committees, statutory authorities, influential individuals, the CLELC, and its consulting engineers. In this section I discuss that the ‘administrative jungle’ and the structure of the planning and approval system as it existed in the mid-1940s which led to a complex and lengthy decision-making process for the Bankside redevelopment. The parties entered into correspondence and held meetings in an attempt to find a resolution to the planning dilemma. The principal actors offered alternative and compromise solutions together with mitigating measures to resolve, at a practical level, the issue of the location and the impact of the power station. However, at a strategic level the principles were of such significance, i.e. rational long-term urban planning versus the pressing need for electricity, that the decision escalated to Ministerial level and to the Cabinet.

The first stage of the process occurred in September 1945 when the LCC notified the Ministry of Town and Country Planning that they had reviewed the CLELC’s proposal for the new Bankside ‘B’ power station. They considered that apart from any question of amenity it would ‘completely spoil the County of London Plan proposals for the South Bank', and they wished to draw the attention of the Minister to the proposal for 'his preliminary consideration and in particular for his guidance'.[57] The LCC had the support of the Borough of Southwark whose position was that any extension of the existing station would 'lose forever the opportunities for redevelopment' and that the presence of a large generating station was 'absolutely incompatible with the County of London Plan or as desired by the council'.[58] The LCC proposed an alternative solution and suggested that it would be practicable to relocate the power station to a riverside location in Rotherhithe between the Surrey Docks and the river Thames about four miles east of Bankside.[59] Because of the important urban planning considerations the LCC and the CLELC were asked to formally submit their proposals to the Ministry for consideration. The Electricity Commissioners also had an interest in the matter since they would have to give their formal consent to any power station. The Ministry and the Commissioners, sensitive to the opposing positions of the parties, held three 'without prejudice' meetings between September 1945 and July 1946: firstly with the LCC and Ministry of Fuel and Power (as observers); then with the CEB, the CLELC and the company's architect Sir Giles Gilbert Scott; and finally with all the interested parties. The discussions at the meetings demonstrate the positions and concerns of the main parties – broadly good town planning versus the need for electricity. However, the discussions also raised a number of issues such as alternative proposals and potential compromises.

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[57] TNA, HLG 79/916, Letter from the LCC to the Ministry of Town and Country Planning, dated 3 September 1945.

[58] Southwark Local History Library, Southwark Borough Council Minutes, report from Works Committee, dated 23 Oct 1946; see also Council minutes item 36/11/46 paragraph 50, 76/12/46 paragraph 181, and 181/1/47 paragraph 302. TNA, HLG 79/324, Ministry of Town and Country Planning, Bankside power station proposals: letters of protest etc, 1947-48, Letter from the Borough of Southwark to the Ministry of Town and Country Planning, dated 7 May 1947.

[59] TNA, HLG 79/916, Letter from the LCC to the Ministry of Town and Country Planning, dated 3 September 1945.

At the first meeting on 28 September 1945 the Ministry of Town and Country Planning stated their view that *prima facie* it was desirable that the power station should be built elsewhere. This position served to focus attention on the proposed alternative site at Rotherhithe which was the main subject of this meeting, and was a recurring issue in later discussions. The LCC said they were prepared to buy the Rotherhithe site and exchange it for the Bankside site, but would not commit to any expenditure on this proposal unless Bankside power station was entirely removed. In response the Electricity Commissioners emphasised the importance of ensuring that the cost of electricity was not increased and that the time factor for getting the power station on-load should not be affected. The concerns here were about the relative costs of building on the Bankside and Rotherhithe sites, the latter was thought to be more expensive. Also, a power station at Rotherhithe might take longer to complete since new plans would have to be drawn up. The Ministry identified three points for further consideration: was the transfer to Rotherhithe desirable and technically possible; was it desirable on planning grounds; and the financial differences between the two proposals.[60]

The second meeting was held the following week with the CEB, the CLELC and the Electricity Commissioners – what may be termed the electricity lobby.[61] This meeting raised further social, technical and economic issues. The Rotherhithe proposal was discussed and it was noted that several existing buildings would have to be demolished including flats, a school and a church, there was also a road and a sewer through the site which would have to be diverted, all of which entailed extra cost.

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[60] TNA, HLG 79/916, Note of a meeting at the Ministry of Town and Country Planning on 28 September 1945.
[61] Ibid., Note of a meeting at the Ministry of Town and Country Planning on 5 October 1945.

Technical problems were also foreseen in routing electric power cables away from the site because of the difficulty of running them through the docks and across swing bridges, together with the additional costs associated with running cables from Rotherhithe to Bankside from where the electricity distribution system to the City radiated. The latter 'problems' can be contrasted with Deptford power station, commissioned in 1889, which had successfully used innovative high voltage cables to transmit electricity a similar distance into central London.[62]

The CEB's position at the meeting was that further riverside power stations would be needed to meet projected electricity demands so the Rotherhithe site might be in addition rather than an alternative to Bankside. There were also wider social amenity and economic implications for electricity supplies. The CEB stated that they were reluctant to give up any riverside site because new riverside power stations would allow smaller and less efficient stations such as St Pancras and Islington to be demolished. The CEB argued that if these stations were not replaced they would have to be renewed which would involve the use of cooling towers; these were expensive, needed a large area of land and would raise amenity issues (see Appendix A for a discussion on the requirements for cooling towers). At the meeting Sir Giles Gilbert Scott insisted that the Bankside site was a 'grand opportunity for fine architectural treatment' for the proposed power station. He suggested that continuous gardens along the riverside could be dull and the coal wharf would add interest to the scene.[63] His comments were championing his client's case, although the *County of London Plan* had not envisaged any industry, even an interesting coal wharf, on the river front at this

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[62] Cochrane, *Cradle of Power*, pp.17-19.
[63] Scott had been recommended to the CLELC by their consulting engineer and the engineer-in-chief at the London Power Company, Sir Leonard Pearce, who had worked with Scott on Battersea power station.

point. Nevertheless, Scott's views were consistent with statements in the *Plan* concerning the architectural treatment of industrial buildings described above. It was identified that if the power station at Bankside could be set back 190-200 ft this would allow the riverside promenade and gardens to be constructed. On a technical matter Sir John Kennedy, one of the Electricity Commissioners, asked whether the CLELC had considered the pneumatic intake of coal which would eliminate dust and dirt and the unsightly unloading apparatus. Three matters were identified for further investigation: the pneumatic transport of coal; the possibility of having embankment gardens at Bankside of the width envisaged in the *County of London Plan*; and the additional costs of the Rotherhithe site.

Compromise provisions and amenity mitigation measures for the Bankside site had therefore been proposed and considered during these two initial meetings. The complexity of the issues and the inter-relationship with the wider context of economics, amenity and security of electricity supply is apparent in the CEB's point about the implications for other power stations such as St Pancras. There were also issues about the economics of the potential relocation, and the crucial current and future need for electricity. Despite the claims about the need for electricity the next meeting was not held until July 1946, nine months after the two initial meetings. There is no evidence that the electricity lobby pressed for further discussions, despite their insistence that Bankside was required to address critical electricity shortages. Since Bankside 'B' had been deferred in the generating station programme it is possible that these discussions were not seen as a priority by the CEB or the Commissioners. The LCC enquired several times between March and June 1946 about the status of the decision.[64] It was claimed that the delay was due to difficulties in estimating the additional cost of the Rotherhithe site, and in providing details of the pneumatic coal facility.

Discussions reconvened in July 1946 between all the interested parties. The CEB said that the additional expenditure for the Rotherhithe site would be £662,000.[65] To put this in context, the estimated capital cost of the first half of Bankside 'B' was £6,362,000, the additional cost of Rotherhithe was therefore about one tenth of the total project cost and was financially unattractive to the CLELC and the CEB.[66] The pneumatic coal handling proposal was rejected for technical and economic reasons.[67] The LCC conceded that they were unlikely to be able to implement the riverside promenade scheme for many years, but stated that any development should be considered with the long term view in mind. The CLELC proposed to set back the station and offered to provide a space of 180 ft between the riverside and the building which would permit the public gardens to be developed. The principle of providing a riverside boulevard was therefore agreed, but the redevelopment proposal for the power station was still contested. The Ministry of Town and Country Planning indicated that, in recognising the importance of the issues involved, it would be

[64] TNA, HLG 79/917, Bankside Power Station, File note Time Table – Bankside Generating Station, dated 13 May 1947.
[65] TNA, HLG 79/916, File note on Transmission arrangements and costs for alternative Generating Station Sites at Bankside and Surrey Docks, dated 25 March 1946.
[66] TNA, HLG 79/918, Bankside - Revised Estimated Capital Expenditure, dated 10/12/46.
[67] The facility was thought to be incapable of handling wet coal and would cost considerably more than a conventional system to install and operate. TNA, HLG 79/916, Note of a meeting at the Ministry of Town and Country Planning on 23 July 1946. The CLELC had installed a system for the pneumatic handling of coal when they redeveloped Bankside power station in 1920 at a cost of £14,754, but the system had proved to be unreliable and had been decommissioned, the CLELC paid a company £52 to scrap it in September 1945. 'Developments in Power Station Design', *The Engineer*, 132, 2 Dec 1921, pp.600-01; LMA, LMA/4278/01/590, CLELC, Board of Directors Minute Book, minutes dated 26 September 1945, f.225.

necessary to hold a public inquiry before any formal decision could be made.[68] This represents a further escalation of the decision-making process.

One topic that was notably absent from the earlier discussions was the issue of air pollution from the proposed power station. The CLELC's assurance that their new station would 'incorporate the latest processes for the elimination of grit, smoke and sulphurous fumes' appears, initially, to have been accepted.[69] This is in contrast to the proposals for Battersea power station in 1927-29 where the main concern was not the issue of planning but rather the effect of smoke and fumes. The environmental historian Bill Luckin argues that those who opposed Battersea, while not dismissing the impact of fumes on health, thought that this was less important than the impact on the physical fabric of London which was recognised and revered as the heart of the Empire.[70] The issue of pollution from Bankside was raised at the meeting in July 1946, particularly the emission and effects of sulphur fumes from the proposed station. This was not seen in terms of public health but rather as one of damage to property. In this case the issue was the additional annual cost of repair and maintenance of the stonework of buildings in the City of London, due to corrosive fumes, which was estimated to be about £300,000.[71] There is no evidence that the Ministry of Health was involved, nor that any medical opinion on the effect of fumes on health was sought or considered at this stage. The issue was addressed in detail at a later stage of the development, as discussed in Chapter 4 – Technology at Bankside.

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[68] TNA, HLG 79/916, Note of a meeting at the Ministry of Town and Country Planning on 23 July 1946. This meeting was attended by representatives of the Ministry of Town and Country Planning, the Ministry of Fuel and Power, The Electricity Commissioners, the CEB, the LCC, the CLELC, and the London Power Company.
[69] TNA, POWE 12/798, Letter from the CLELC to the LCC, dated 13 February 1945, paragraph 7.
[70] Luckin, *Questions of Power*, p.153.
[71] TNA, HLG 79/916, Note of a meeting at the Ministry of Town and Country Planning on 23 July 1946.

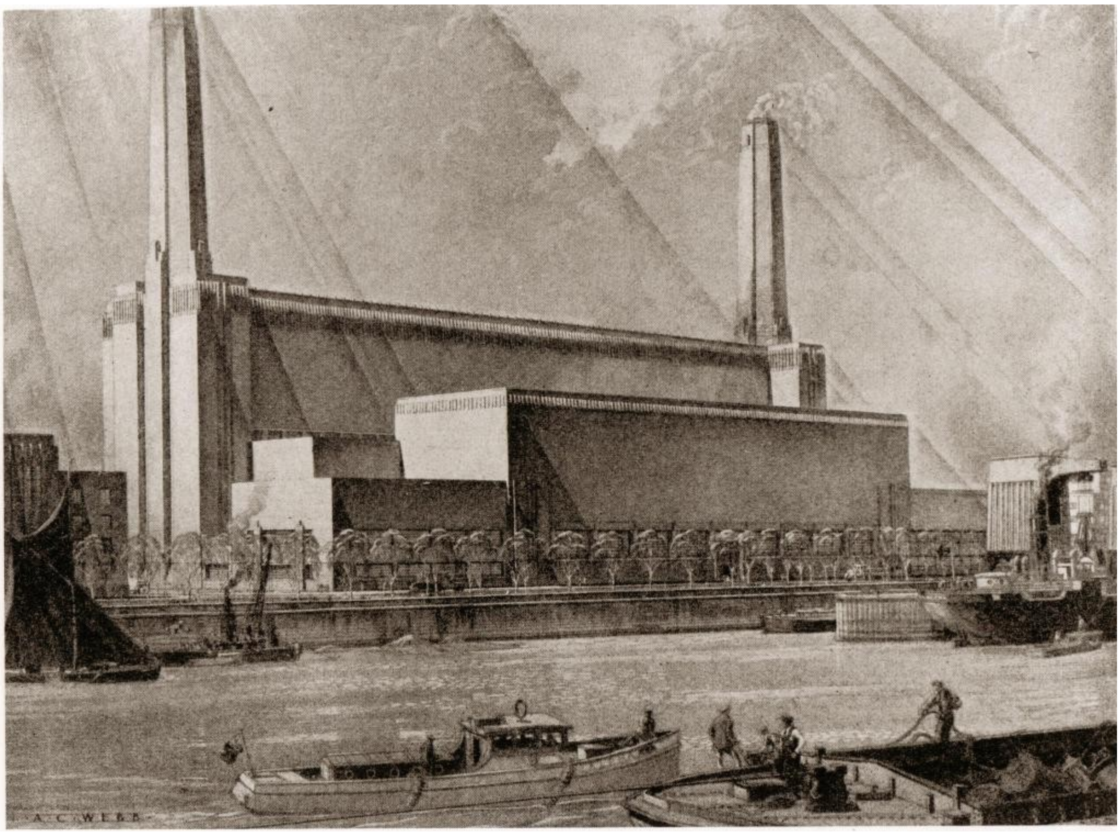

Figure 3.7: The proposed coal-fired Bankside power station, 1946.

Source: 'The Bankside Controversy', *Architects' Journal*, 15 May 1947, p.400. Reproduced with permission. Architectural Press Archive / RIBA Library Photographs Collection.

In preparation for the public inquiry, and to present the Bankside development in the best possible light, the CLELC produced revised plans for the power station (see Figures 3.7, 4.2 and 4.3).[72] From these plans it is apparent that the CLELC were fully conscious of the importance of the Bankside site and its relationship to the proposed plans for the development of the City and of the South Bank. Specifically they noted that the new station would be sited at 'a sufficient distance inshore to permit the proposed uninterrupted riverside road and gardens' and that they would entrust the architectural designs to Scott. To improve the amenity of the power station they proposed that coal from the jetty would be transported in an underground tunnel

[72] TNA, POWE 12/798, Memorandum describing the proposals for the proposed reconstruction of the Bankside generating station, dated 7 November 1946.

beneath the embankment to a coal store at the rear of the station, and ash would be similarly handled in the reverse direction (see Figure 4.2). They also reiterated that the flue-gases would undergo ‘very careful treatment’ to remove grit, fly ash and sulphurous compounds.

The complex formal relationships between the CLELC and the statutory electricity bodies are demonstrated in the directions, approvals and consents that were required for the prospective redevelopment. These interactions are examined in Chapter 2 in relation to the purchase of land by the CLELC in the late 1930s. Under the legislation in place in 1946 the Bankside ‘B’ proposal required consent from both the Electricity Commissioners and the Ministry of Town and Country Planning.[73] These legislative requirements added to the complexity of the decision-making system since two bodies, rather than a single authority, had to determine the case.

As part of their application for consent the CLELC were required to give public notice of their proposals. In this context, the requirements of the Electricity (Supply) Act 1919, had not kept pace with technological developments in the electricity industry. The CLELC were required to place notices in the press and to display notices within 300 yards of the power station. Owners or lessees of properties within this radius could raise objections to the power station development. When this legislation had been enacted electricity generating stations were relatively small and their impact

[73] For the Bankside redevelopment the CEB applied to the Electricity Commission in July 1946 for approval to issue a direction to the CLELC under Section 5(1) of the Electricity (Supply) Act 1926. On 6 August the Commissioners gave their approval and on the 8 August the CEB issued to the CLELC a direction for the extension of the station by the addition of two 50 MW turbo-alternator sets to be completed by September 1950 (TNA, HLG 79/916, Letter from the CEB to the CLELC, dated 8 August 1946). On 16 August the CLELC made a formal application under Section 11 of the Electricity (Supply) Act 1919 for the consent of the Commissioners to the extension (TNA, HLG/916, Letter from CLELC to the Electricity Commission dated 16 August 1946). On 2 September the CLELC applied for planning consent to the LCC (TNA, HLG 79/16 Letter from CLELC to The Clerk of the LCC dated 2 September 1946) and on the same day copied this application to the Ministry of Town and Country Planning.

was local, i.e. typically within 300 yards.[74] A large super-station such as Bankside would have an impact over a much larger area, yet the 300-yard criterion remained. Bill Luckin makes the point about the absurdity of the 300-yard rule in the earlier Battersea power station controversy in 1929. The situation had not changed in the intervening two decades. Notwithstanding the opportunity to object there were, as discussed below, few local protests about the Bankside 'B' development.

The Commissioners and the Ministry took a pragmatic approach by holding a joint public inquiry over five days in January 1947.[75] The main protagonists of the earlier discussions were represented by legal counsel at the inquiry and expert witnesses were called to support the case of the respective parties.[76] The inquiry examined and cross-examined the evidence and addressed the various concerns, together with practical issues about the proposed development. However, despite the important planning principles and the significant local impact, the inquiry 'was remarkable on account of the small number of objectors'.[77] Only three written protests were made, and no members of the public, nor any learned societies or institutions made representations.[78] Local residents, businesses and other interests, were either

[74] Luckin, *Questions of Power*, p.139 and p.144.
[75] The inquiry was held before two Electricity Commissioners, Sir Cyril Hurcomb and Sir John Kennedy, and the Commission's chief engineer, Mr. H. Nimmo, together with an inspector from the Ministry of Town and Country Planning, Mr K.S. Dodd; the latter was the author of the inquiry report. TNA, POWE 12/798, public inquiry.
[76] Counsel represented the CLELC as the promoters – legally the appellants – of the scheme, and the LCC as respondents, as well as the two local authorities most immediately concerned with the development, the City of London Corporation and the Borough of Southwark. Evidence was given by the architect Giles Gilbert Scott and the engineer Sir Leonard Pearce for the promoters; the architect and professor of town planning Patrick Abercrombie for the LCC; the architects Charles Holden and William Holford for the City of London Corporation; and the Council Leader and the Borough Engineer of Southwark.
[77] TNA, HLG 79/918, Report on the public inquiry, para.1.
[78] The three written protests were from: Southwark Chamber of Commerce; the Provost of Southwark; and Messrs Wakeley Brothers & Co Ltd of Honduras Wharf. Wakeley's were concerned that the new jetty at Bankside would lead to the silting up of their wharf, see TNA, POWE 12/798, public inquiry, day 1, p.3 and day 2, pp.3-4. The Chamber of Commerce objected that the development would prejudice

largely unaware of the proposals or were unconcerned about them. The inquiry was reported in the press but there is no evidence of any public reaction in the local or national newspapers, this also suggests that the matter was of little interest or concern to anyone other than the main parties.[79]

The inquiry reiterated the main issue of the two alternative concepts. John Hacking the Chief Engineer of the CEB argued that the 'Bankside site is technically one of the best for electricity generation in the London area'.[80] This was because the site adjoined the river; it was in the middle of a large consumer area; the electricity distribution system to the City radiated from there; and ample land was available. The suitability of the site was unsurprising. As I argued in Chapter 2 the location was selected by the CLELC in 1891 as the optimal location for generating electricity for the City. These factors still applied in 1947 and demonstrates the 'momentum of place' that the Bankside site had acquired.

On the other side of the debate, the public inquiry noted several factors that militated against the generating station. Firstly, the visual effect on St Paul's cathedral; secondly, that the power station would prevent the realisation of the South Bank redevelopment; and finally, amenity issues. The threat to St Paul's was especially significant at this period: the cathedral had acquired an important symbolic value since

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the *County of London Plan* and would 'attract industrial development only', TNA, HLG 79/918, Bankside Application, Resolution from Southwark Chamber of Commerce dated 13 January 1947.

[79] 'LCC opposes Bankside extension', *South London Press* (13 December 1946); 'Southwark power station: inquiry into plan for extension', *The Times* (15 January 1947), p.2.

[80] John Hacking notes that the generation and distribution of electricity for London presents a major planning problem and that: (a) there is a very large concentration of consumers; (b) the electricity consumption per head of population is already high; (c) the rate of consumption is growing rapidly and is expected to continue doing so; (d) in the very extensive urban area there is a limited number of existing power stations, originally designed to supply a much smaller demand than is now anticipated; (e) in that extensive area there are extremely few potential sites for new power stations; (f) transmission is abnormally costly as in general underground cables must be used instead of overhead lines which are cheaper. TNA, HLG 79/918, public inquiry, proof of evidence of Mr. J. Hacking.

the blitz when it became 'the pre-eminent symbol of national resistance and sacrifice'.[81] The inquiry not only considered the riverside boulevard but also the practical consideration of attracting other developments to the area if the power station was to be built.[82] Patrick Abercrombie was asked whether, if the station was built, it would be possible to 'attract good class businesses and commercial premises and institutions'. Abercrombie replied that the power station 'would have a damaging effect on any attempt to attract that type of development' and said it would be appropriate to keep the Bankside area free from major industry.[83] There were also concerns that if it were built the whole area would remain industrialised. As one observer at the public inquiry noted, it 'would inevitably lead to the whole area between the two bridges being given over to industry'.[84] An amenity objection was to the use, handling and storage of large quantities of coal at the power station. This was discussed at considerable length. Notwithstanding Scott's 'interesting coal wharf' there were concerns about the generation of dust, smoke from colliers at the jetty, and the view from the windows of neighbouring properties.[85] The inquiry report stated that some of these objections would be obviated if oil were used instead of coal, although the inspector noted that 'the extra cost of burning oil would be considerable; indeed it would probably be prohibitive'.[86] The power station was later specified to be oil-fired,

[81] R. Thorne, 'The Setting of St Paul's Cathedral in the Twentieth Century', *The London Journal*, 16:2 (1991), p.118.
[82] This was framed as a question about whether potential developers would be willing to risk their capital in erecting business or residential buildings, or indeed whether potential tenants could be attracted to such property if the power station was built. TNA, HLG 79/918, inquiry report, paragraphs 27-31.
[83] Abercrombie appeared as a witness for the LCC. TNA, POWE 12/798, Evidence of Sir Patrick Abercrombie at the public inquiry, day 3, p.33 and p.44.
[84] The two bridges referred to were Southwark bridge and Blackfriars bridge. The quote is by J.M. Richards who attended the inquiry and wrote a summary note to the architect Charles Holden dated 28 January 1947. Royal Institute of British Architects Archive, AHP/30/7, C.H. Holden papers.
[85] The coal store was to be located at the rear of the station, it was about one acre in extent and was to contain 40,000 tons of coal.
[86] TNA, HLG 79/918, Inspector's Report, paragraph 57.

a decision ostensibly based on the concerns about the amenity issue of the unsightly coal store.

The scope of the issues raised at the inquiry addressed both the strategic planning principles and the practical considerations of the development. The inquiry inspector's report was perceptive in identifying that although the two proposals were mutually exclusive in space, it did not follow that they were in time. The need for electricity was immediate and had a more limited timeframe than the redevelopment and deindustrialisation of the South Bank. It was noted that the life of the power station equipment was perhaps thirty years, yet the *Plan* had recognised that the South Bank scheme might take fifty years to come to fruition.[87] As counsel for the LCC had argued, the Minister of Town and Country Planning was the 'Minister of Posterity' and should take a longer view: 'planners might think in terms of generations or centuries'.[88] The Minister adopted this position when he later decided the case. In the post-war context the inquiry report was realistic in identifying that the redevelopment of the South Bank scheme would depend on the availability of building labour and materials and might in any case be behind the 'urgent need for new houses, new schools, new factories [...] and so on'.[89] The report also recognised practical issues by identifying that bricks in the quantity and quality required for Scott's 'brick cathedral' would be difficult to obtain. As an alternative, the report stated that heavy structural steel and 'cladding' of various kinds were more readily available than bricks. The inquiry inspector proposed a compromise solution and recommended that the application should be rejected and that consideration should be given to a power

[87] Bankside 'B' power station had an operational life of less than 30 years from 1952 to 1981.
[88] TNA, POWE 12/798, public inquiry, day 4, p.19.
[89] TNA, HLG 79/918, Inspector's Report, paragraph 39.

station of about 105 MW in a temporary ‘cladded’ building with a life of 15 or 20 years. Although this proposal provided a possible solution to the Bankside dilemma, the public inquiry had not resolved the essential conflict between good planning and the need for electricity.

Following the public inquiry the Bankside proposal was escalated to a higher political level as Ministers became involved in the decision-making process, thus further expanding the proposal’s web of complexity. The Electricity Commissioners conclusion after the inquiry stated that ‘the Commissioners see no sufficient ground for withholding their consent’ and justified this by noting that:

> it was not disputed and cannot be disputed that there is urgent need for a substantial and rapid expansion of the generating plant […] especially in the area of Greater London.[90]

They were ‘satisfied that Bankside is a suitable site for the installation of approximately 200,000 kW of plant’, i.e. 200 MW and observed that the new power station ‘would in itself effect a vast improvement upon the present disorderly and disagreeable appearance of this part of the south bank’ thereby making a virtue of Scott’s proposed building. Furthermore, they considered that it was essential to take advantage of every suitable site and that in the interests of electricity supply the Rotherhithe site should be secured for use in any case. The Commissioners were therefore minded to give their consent for the new power station at Bankside. The Minister had now to decide the case.

The inquiry inspector’s report was submitted to the Minister of Town and Country Planning, Lewis Silkin, in February 1947 for his consideration. Between 1940

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[90] TNA, POWE 12/798, Letter from the Electricity Commissioners to the Ministry of Town and Country Planning, dated 29 January 1947, paragraphs 1 and 11.

and 1945 Silkin had been chairman of the LCC Town Planning Committee which had endorsed the *County of London Plan*, he was therefore not disinterested in the matter he was to adjudicate. His position on Bankside was set out in a memorandum in which he reiterated two of the arguments against the power station, namely the interference with the *Plan,* and the 'thoroughly inappropriate neighbour' for St Paul's. He said he attached 'by far the strongest objection to the first point' and was concerned that the power station would continue the industrialisation of the South Bank. Despite the Commissioners' statement about using every suitable site, Silkin claimed that the Rotherhithe site was 'a perfectly good alternative'. He acknowledged that any power station at Rotherhithe was not expected to be in commission before spring 1951 whereas Bankside could be ready by autumn 1950, i.e. there would be an additional shortfall in generating capacity over the winter of 1950/51. Silkin argued that this slight delay for completing Rotherhithe should not be regarded as crucial, although the additional capital cost of Rotherhithe was now estimated to be £907,000. He overruled his inspector's compromise solution of a temporary power station and disregarded the Electricity Commissioners' opinion. He urged his Ministerial colleagues 'to concur in my proposal to refuse permission for a new power station on Bankside'.[91]

A new actor, the Ministry of Fuel and Power, now joined the battle for Bankside. The Ministry, together with the random contingency of the weather, was to play a decisive role in the decision-making process. The Ministry had not, until March 1947, contributed to the Bankside discussions: electricity policy and the consent for

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[91] TNA, HLG 79/916, Memorandum by the Minister of Town and Country Planning, dated 1 March 1947, paragraphs 4 and 12. This memorandum was also submitted to the Lord President's committee by the Minister of Town and Country Planning as memorandum L.P.(47)41, dated 4 March 1947 (TNA, Prime Minister's Office, PREM 8/591, Proposal to construct Power station Bankside).

power stations was the responsibility of Electricity Commissioners.[92] In early 1947 the country was suffering the worst peace-time fuel crisis of the twentieth century. The Minister of Fuel and Power, Emanuel Shinwell, was under pressure for his perceived poor management of the situation.[93] The crisis had been brought about by a spell of exceptionally bad weather with storms and heavy snow between the end of January and late March. Coal stores were empty or frozen solid and supplies could not be moved. The weather had compounded existing fuel shortages caused *inter alia* by the poor productivity of the coal industry following the war.[94] There were severe shortages of domestic and industrial coal and there were power cuts for five hours every day.[95] The crisis had undermined the ambitions for post-war economic recovery, endangered the export drive and had temporarily increased unemployment.[96] In this context the approval of the new power station at Bankside would have helped Shinwell's position in that he would be able to demonstrate that new stations were being authorised. While he did not comment directly on the matter, Shinwell sent the Electricity Commissioners' letter in support of Bankside 'for information' to the Lord President's committee.[97] This countered Silkin's paper proposing that permission be refused. A meeting of the Lord President's committee, including Shinwell and Silkin, discussed the matter but there was no consensus. Hugh Dalton, as acting Lord President, noting

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[92] Representatives of the Ministry of Fuel and Power had attended the three pre-public inquiry meetings in 1945-46 as observers. TNA, POWE 14/496, Ministry of Fuel and Power, New Bankside Station, Circumstances in which the decision to proceed was taken, Memorandum dated 11 August 1948.
[93] See for example: Robertson, *Bleak Midwinter*, pp.68-70; also Hugh Dalton's acerbic comments about 'Shinbad' in Pimlott, *The Political Diaries of Hugh Dalton*, p.390.
[94] See Robertson, *Bleak Midwinter*, pp.44-60; and Hannah, *Electricity*, pp.314-17. Battersea power station normally kept 10-12 weeks supply of coal in storage, by December 1946 the stock was down to 10 days supply, Cochrane, *Landmark*, p.42.
[95] D. Kynaston, *Austerity Britain 1945-51* (London, 2008), pp.193-200. The domestic restriction on electricity remained in force until the end of April.
[96] A temporary rise in unemployment to over two million, see Hannah, *Electricity*, p.317.
[97] TNA, PREM 8/591, Prime Minister's Office, Memorandum by the Minister of Fuel and Power, L.P.(47)48, dated 11 March 1947. The Commissioner's letter was addressed to the Ministry of Town and Country Planning not to the Ministry of Fuel and Power. Silkin had not circulated the Commissioners' letter which had argued against his proposal, but Shinwell had ensured that it was brought to the attention of the Lord President's committee.

that 'Ministers being somewhat divided' proposed that the issue should go to the Cabinet for colleagues 'to decide one way or the other'.[98]

Meanwhile, a precursor to a decision of significant consequence for Bankside 'B' power station was raised. The Prime Minister, Clement Attlee, had seen Shinwell's note to the Lord President's committee. In a characteristically terse personal note he asked Shinwell, 'should not the new Station be designed for oil fuel?'[99] Attlee's question was in reference to part of the Commissioners' paper concerning the visual screening of Bankside's coal store. Substituting oil would eliminate the unsightly coal store. I suggest that Attlee's thinking must also have been influenced by the ongoing fuel crisis: an oil-fired power station could continue to operate during a coal shortage. Another context for Attlee's question was the Government's coal-to-oil conversion programme for industry which had begun in 1946 as an earlier response to the coal shortage.[100] Attlee's comment was therefore not solely about the amenity advantage but also about availability and diversity of fuel supplies.

Approval and aftermath

At their meeting on 1 April 1947, the Cabinet were given a précis of the two positions. Silkin in his role as 'Minister for Posterity' argued that the (by then) two winter's delay for the Rotherhithe site was a small price to pay for preserving the

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[98] TNA, CAB 129/18, Cabinet Office, Memorandum by the Chancellor of the Exchequer C.P.(47)110, dated 26 March 1947.

[99] TNA, PREM 8/591, Personal Note from Prime Minister to the Minister of Fuel and Power, dated 15 March 1947.

[100] The issue of using fuel oil in place of coal for industry, the railways and the electricity industry had been discussed within the Ministry of Fuel and Power and raised in the House of Commons in spring 1946. This was in response to the national shortage of coal. See TNA, POWE 14/494, Ministry of Fuel and Power, Central Electricity Board, Conversion of power station boilers from coal to oil firing, Letter from the CEB to the Ministry of Fuel and Power, dated 22 July 1946. Also Robertson, *Bleak Midwinter,* pp.70-72.

South Bank redevelopment plan.[101] However, the rising cost and lengthening delay was not helping Silkin's case that the Rotherhithe site was a viable alternative to Bankside. Shinwell argued that his efforts to expedite the provision of new generating capacity – already in a critical position as a result of the fuel crisis – would be frustrated if he constantly faced objections on grounds of amenity. The issue of oil-firing was also discussed at this meeting, although there is a discrepancy between the sources about who raised the issue.[102] It was noted that oil-firing would improve the amenity aspects of the power station. The Cabinet also discussed the military vulnerability of Bankside.[103] The Air Ministry had said there were strong objections to both the Bankside and Rotherhithe sites from a strategic viewpoint as they were likely to be wartime targets and there were vulnerable facilities nearby that might also be damaged.[104] Attlee dismissed these objections and observed that this was a '1937 argument' (referring to the Barlow report on the strategic benefits of industrial relocation) that was now out of date because 'an atom bomb dropped there will make such a mess that a few power stations less won't matter'.[105] Having rejected the strategic argument and Silkin's planning argument the Cabinet resolved that a new 210

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[101] TNA, CAB/128/9, Cabinet Office, Conclusions of a Meeting of the Cabinet held on 1 April 1947, C.M.(47)34, f.237.

[102] According to the published minute on the Cabinet conclusions, The Minister of Labour and National Service, George Isaacs, said that the main features of the plan could be preserved if the station was constructed to burn oil and was set back from the river. Isaacs, as the MP for Southwark, had a particular interest in Bankside and a knowledge of the area. However the contemporaneous Cabinet Secretary's notes of this meeting shows that it was Attlee who first raised this point at the start of the discussion: 'If it were oil burning, it wd. make a big difference'. This comment is consistent with Attlee's note to Shinwell of two weeks earlier. Compare TNA, CAB/195/5, Cabinet Office, Minutes of C.M. 34(47) ff.188-9, with TNA, CAB/128/9, Cabinet Minute C.M.34(47), f.237 both on 1 April 1947.

[103] In 1946 the Air Ministry had been asked to consider the strategic implications of the new power station at Brunswick Wharf in Poplar. They concluded that Poplar was 'about the worst possible site for a big power station', the reasoning was that the docks were an easy target and the two mile radius likely to be affected by an atom bomb included 14 gas and electricity stations and 120 other key points whose destruction would affect the country's war potential. TNA, CAB/129/12, Cabinet Paper Location of Power Stations, C.P.(46)307, dated 29 July 1946.

[104] These included the docks at Rotherhithe and at Bankside the railway lines, stations and the seat of Government. TNA, CAB/129/18, Memorandum by the Secretary of State for Air, C.P.(47)119, dated 31 March 1947.

[105] TNA, CAB/195/5, Cabinet Secretary's minutes C.M.34(47) f.189 on 1 April 1947.

MW station should be erected at Bankside.[106] This was conditional on the electricity being generated by oil, ostensibly for amenity reasons, and that the building would be set back from the river.

The decision to make Bankside oil-fired was therefore imposed on the owners, the CLELC, without consultation or discussion. It was a political decision made without a technical or economic evaluation of the implications. The intent was to improve the amenity, but the decision was to have an impact on the design and long-term implications for the economic viability of the power station. There were both benefits and disadvantages as a consequence of this decision. The CEB noted that the change enabled substantial capital economies to be made but it would entail a considerable increase in the cost of the fuel.[107] A major advantage of oil-firing was that there was less equipment associated with the boilers which allowed the height of the main building to be reduced from 140 ft to 85 ft. Scott's re-design for the oil-fired station is shown in Figure 3.8. The substantial height reduction significantly reduced the visual impact of the main building, cf. Figure 3.7, as did gathering the boiler flues into a single chimney or as Scott insisted a 'slender tower, or campanile'.[108]

[106] The planning historian Stephen Ward states that 'Silkin was a distinctly uncharismatic figure and rather a boring speaker' which may not have helped his case, see Ward, *Planning and Urban Change*, p.101. Silkin's DNB entry also mentions his 'lack of personal charisma' and being 'no orator himself'. R. Weight, 'Silkin, Lewis, First Baron Silkin (1889-1972)', Oxford Dictionary of National Biography, OUP, 2004, online edition, Oct 2008, www.oxforddnb.com/view/article/31684 [accessed February 2012].

[107] TNA, HLG 79/917, Letter from J. Hacking to Sir John Kennedy, dated 15 May 1947.

[108] 'The Bankside Power Station: Sir Giles Scott Explains', *The Builder,* 23 May 1947, pp.492-93.

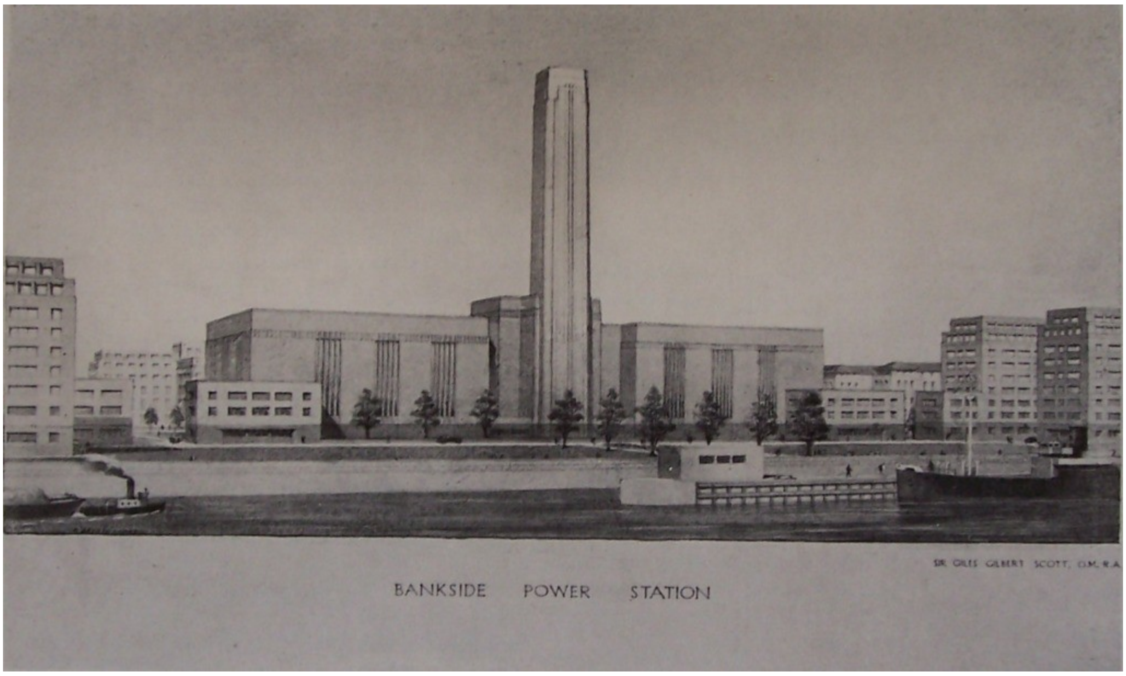

Figure 3.8: The redesigned oil-fired Bankside power station, May 1947.

Source: TNA, POWE 12/798, Electricity Commission, Bankside reconstruction and extension, 1945-50. Reproduced with permission. The National Archives.

Note the single chimney and the lower building height compared to Figure 3.7. The perspective suggests that the power station would not dominate neighbouring buildings.

Until April 1947 the decision-making and approval process for the Bankside had only been of interest to those directly involved, even at the public inquiry no significant public objections had been raised. The decision then entered the public realm. No public announcement of the Cabinet's decision of 1 April was made, perhaps in view of the possible objections. The matter was raised in the House of Commons on 22 April when Silkin was asked whether he was aware of the threat to the dominance of St Paul's from the power station. Silkin, bound by collective Cabinet responsibility, was in the position of having to defend the approval of the power station against which he had consistently argued. He maintained that the future of the South Bank would not be prejudiced and that the Government 'gave long and careful thought to the matter'. On the basis of the evidence it is apparent that the Government and the statutory bodies had engaged in detailed and lengthy discussions on the decision. However, I suggest that some aspects of the decision such as oil-firing had been made precipitately and without much 'careful thought'. The Bankside decision, having been raised in the Commons, was reported in the press.[109] In response, a number of prominent individuals deplored the proposal in letters to the newspapers. The objections were to both the interference to the *County of London Plan* and the dominance of the new power station over St Paul's. A leader in *The Times* was hostile to the plans it spoke of a 'hasty opportunism, grasping for brief temporary advantage at the expense of the future, which makes havoc of ordered planning'.[110] The architectural historian James Lees-Milne did not so much object to the power station but rather to the way the matter was decided and announced by the Government which he said smacked of 'totalitarianism'.[111] The decision was defended in the letters pages of the press by the developers who pointed to the crucial need for electricity.[112] There were also private letters of protest addressed to Silkin from several organisations, notable architects and planners.[113] Typical of the institutional responses is that of the Royal Institute of British Architects (RIBA) which asserted:

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[109] 'Bankside Power Station: conditional assent given: threat to St Paul's', *The Times*, 23 April 1947, p.4.

[110] Letters include: Lord Latham, the leader of LCC to *The Times*, 24 April, p.5; Leonard Styles, the Leader of Southwark Council and Albert Gates, Chairman of the Housing and Town Planning Committee, *The Times* 26 April, p.5; Charles Holden, *The Times*, 28 April, p.7; W.R. Matthews, the Dean of St Paul's, *The Times*, 17 April, p.5 and 2 June, p.5. *The Times* leader 'The Bankside Power Station', 30 April 1947, p.5.

[111] James Lees-Milne noted in his diary: 'I think the wholesale onslaught on the Bankside Power Station proposal is stick-in-the-mud nonsense also. What I do object to is the Government's high-handed manner of announcing the *fait accompli*. It is irritating and smacks of totalitarianism. Probably the power station will be a great work of art'. J. Lees-Milne, *Caves of Ice:Diaries 1946-47* (London, 1983) entry for 18 May 1947, p.164. Lees-Milne was noted for 'his almost self-caricaturing far-right views', J. Fergusson, 'Obituary: James Lees-Milne', *Independent* (29 December 1997), p.12.

[112] Defenders included H.J. Randall, the Managing Director of the CLELC, *The Times*, 1 May, p.5; Sir Giles Gilbert Scott, *The Times*, 13 May, p.5; and Leonard Pearce, the consulting engineer for the CLELC, *The Times*, 5 May, p.5.

[113] Private letters include: The City of Westminster which stated 'the Council profoundly regrets the decision made by the Government in this matter' as the 'eastern part of the City of Westminster would

> this scheme would not be in the truest and most lasting interests of the public […] it would seriously prejudice the South Bank scheme of the County of London Plan as cultural institutions, university authorities or business firms would not wish to take adjoining sites and the area would have to be zoned for industrial purposes.[114]

This criticism again addressed the wider issue of attracting businesses and institutions to the Bankside area which had been raised during the public inquiry. The consequences of the approval decision on the zoning of the area by the LCC are discussed below.

In the face of public criticism the Government held an 'open day' press conference at the old Bankside 'A' power station on 6 May to argue the case for the new station. Silkin again had to defend the proposal. His main argument in support of the development was the issue of the critical lack of power, a position he had previously dismissed. On the relationship with St Paul's Silkin pointed out that the two buildings were half a mile apart and there were only a few places where it was possible to see both at one time. As one correspondent noted 'he convinced everyone that whatever was done with the site it could hardly be used for an uglier building than the one now on it'.[115] But Silkin's efforts in support of Bankside were countered by former colleagues at the LCC.

Political influence and connections were deployed in an attempt to change the Government's decision. John Forshaw, the LCC planner and co-author of the *County of London Plan*, was 'extremely concerned' about the damage which the decision

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be injuriously affected by the emission of smoke, grit, fumes, etc.'. TNA, HLG 79/916 and 79/917, Letters from the City of Westminster to the Ministry of Town and Country Planning dated 27 January 1947 and 13 June 1947. Letters of protests were also sent by the Society for the Protection of Ancient Buildings; the Royal Society of Arts; The Provost of Southwark; The London Society; the Corporation of London; and the Dean of St Paul's cathedral, see TNA, HLG 79/916 and HLG 79/324.

[114] TNA, HLG 79/917, letter from RIBA to Lewis Silkin, dated 6 May 1947.

[115] 'On-the-spot arguments for Bankside power station', *Manchester Guardian*, 7 May 1947, p.3.

would cause to the *Plan* and met with Lord Latham the Leader of the LCC.[116] As a result Latham wrote to the Lord President, Herbert Morrison, and said ‘we here are very disturbed at the prospect of a new and larger power station’ which would ‘strike at the very heart of good planning’.[117] He went on to claim that the two year delay for the Rotherhithe site was ‘to say the least of it, very doubtful’.[118] Silkin’s discomfort at his enforced *volte-face* was made explicit in a note to Morrison regarding Latham’s intervention. Silkin said that re-opening the Bankside question would ‘place me personally in a somewhat embarrassing position’ having opposed the project in Cabinet. He also made the point that ‘not only I myself but the Government as a whole, I feel, [would] be discredited if we were to deviate from that position now’.[119] The approval decision had now acquired a momentum of its own; it would be difficult to change without embarrassing or discrediting the Government.

The Cabinet’s decision of 1 April appears to be unequivocal, but in the face of the hostile reactions both in public and private, Ministers appear to have had doubts about the wisdom of the decision. The Cabinet returned to the matter on 15 May as a consequence of Lord Latham’s intervention.[120] There was to be a Motion in the House of Lords to call attention to the Bankside proposal. Latham indicated that he would feel bound to express the objections of the LCC during the ensuing debate. The Cabinet noted that it would be important for the Lord Chancellor Viscount Jowitt in defending the Government’s position, to know whether there was any prospect for the Cabinet’s

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116 TNA, CAB 124/432, Proposed construction of electricity generating station at Bankside, 1946-48, Cabinet Office note to Lord President, dated 30 April 1947.

117 Ibid., Letter from Lord Latham to Herbert Morrison, dated 2 May 1947.

118 Latham had suggested that the Government could requisition the Rotherhithe site and use double shift construction working and employ the Royal Engineers to bring the proposal forward.

119 TNA, CAB 124/432, Letter from Lewis Silkin to Herbert Morrison, dated 6 May 1947.

120 The Cabinet minutes of 1 April state: ‘The Cabinet agreed that a new 210,000 k.w. power station should be erected at Bankside’. TNA, CAB/128/9, Cabinet meeting on 1 April 1947 C.M.34(47), f.237.

decision being reconsidered.[121] The points raised at this Cabinet meeting included whether additional capacity could be provided by London's municipal undertakings, and whether the Rotherhithe site could be developed with less delay than had at first been thought. The Cabinet invited Morrison and other interested Ministers to determine whether it would be desirable to modify their decision of 1 April.[122]

The debate in the Lords addressed the same arguments such as the disharmony between the power station and the *County of London Plan* and of its domination over St Paul's.[123] In this context Lord Llewellin likened the power station to 'an alligator in a lily pond' a remark that was widely reported.[124] Lord Jowitt based his support for the decision on the critical need for electricity and dismissed the domination of St Paul's and echoed Silkin's earlier comment by saying the two buildings were far apart and that the chimney at Bankside would be limited to a height of 300 ft.[125] This Parliamentary debate demonstrates that the core arguments about Bankside – planning versus power – had not changed significantly in the two years since the LCC first objected to the proposal. There were still two mutually exclusive and well-matched cases. On the same day as the Lords' debate the CLELC held a press conference at their City offices. [126] They took pains to promote the redesigned power station and especially to demonstrate that it would not dominate St Paul's cathedral. A model of

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[121] TNA, CAB/128/9, Cabinet meeting on 15 May 1947, C.M.47(47), f.35.
[122] Although the official printed minutes of the 15 May Cabinet meeting show this matter under the heading 'Town and Country Planning' the Cabinet secretary's minutes (in TNA, CAB/195/5, f.255) describe this matter under the heading 'Parliament', which may explain why Silkin – who did not have a Cabinet post – and Shinwell were not present.
[123] *Hansard*, House of Lords debates, 19 May 1947, Vol.147 cc.813-60.
[124] See, for example, 'Lords attack Bankside power station plan', *Daily Telegraph*, 20 May 1947, p.3.
[125] *Hansard*, House of Lords debates, 19 May 1947, Vol.147 cc.846-7. See Appendix A for a discussion of the height of Bankside's chimney.
[126] 'Power Station as a Planning Asset', *The Times*, 20 May 1947, p.6; 'The Bankside Battle Continues', *The Sphere*, 31 May 1947, pp.262-63.

the power station and the surrounding area including St Paul's was displayed, see Figure 3.9.[127]

Figure 3.9: Sir Giles Gilbert Scott (pointing) and the Bankside model.

Source: Anon, 'The Bankside Power Station Sir Giles Scott Explains', *The Builder*, 23 May 1947, p.492. Reproduced with permission.

The principal speaker at the press conference was Scott who claimed that it would be more a question of the other buildings overshadowing the station than the station overshadowing them, he said the scheme would provide superb views of St Paul's and was far superior to the suggestions in the *County of London Plan*.[128] The conference was reported in the press together with photographs of the model, *The Sphere* noted of

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[127] The model had been built at the suggestion of Anthony Eden in a Commons debate on the planning issues, so that Members 'could judge for themselves in this matter', *Hansard*, House of Commons debates, 22 April 1947, Vol.436 c.781. The model cost the CLELC £250 to build, LMA, LMA/4278/01/590, CLELC, Board of Directors Minute Book no.10, 1937-48, f.274. As the architect Andrew Lowe states 'Regarding the feared intrusion against the beauty of St Paul's, the tall, slender, vertical form of the tower is so diametrically different to the large circular dome that there is simply no conflict whatsoever on the skyline', A.J. Lowe, 'Battersea Power Station and the Introduction of Modernism into Britain', *Edinburgh Architectural Research*, 22 (1995), p.88.

[128] 'Power Station as a Planning Asset Sir Giles Scott's Views on Bankside Project', *The Times*, 20 May 1947, p.6 and 'The Bankside Power Station Sir Giles Scott Explains', *The Builder*, 23 May 1947, pp.492-93. Also TNA, HLG 79/916, Notes for Press Conference, n.d.

the relationship between Bankside and St Paul's that 'modernity and antiquity face each other across the Thames'.[129]

The long-term economic implications of oil-firing decision soon became apparent. At a meeting on 21 May, Morrison, Isaacs, Silkin and Shinwell discussed the implication of this decision. The additional running cost was estimated to be about £450,000 a year.[130] It was noted that on this occasion the amenity advantage of oil-firing would warrant the additional expense but this cost should not be over-looked, as it had in this case, when future decisions were made. Also, as oil contained more sulphur than coal the meeting noted that it was 'essential that plant be installed to eliminate the sulphur'. The implications of the high sulphur oil and the technology used at Bankside 'B' to wash the flue-gases are examined in Chapter 4 on technology at Bankside. These issues were reported to the Cabinet meeting on 22 May where there were further discussions about the relative cost of coal and oil. It was thought that future price increases were likely to be higher for coal thus improving the prospect for oil. The relative fuel costs over the operational life of Bankside 'B' power station, and the implications for its economic viability, are discussed in Chapter 5 on the operation of Bankside. The Cabinet noted that there were advantages in having at least one oil-fired power station on the Thames to provide a diversity of supply. The Minister for Health, Aneurin Bevan, stated he still regretted the original approval decision but acknowledged that it would be inexpedient for the Government to reverse that decision at this stage: thus giving further momentum to the approval decision. The Cabinet

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[129] 'The Bankside Battle Continues', *The Sphere*, 31 May 1947, p.262. In a later context this contrast was also noted, the Millennium Bridge 'unites the noble bosom of St Paul's with the brick phallus of Tate Modern in a happy synthesis of yin and yang, ancient and new', J. Walsh, 'Welcome to the Indiana Jones Memorial Bridge', *Independent* (12 June 2000), p.5.
[130] TNA, CAB/129/19, Lord President's Memorandum, C.P.(47)160 dated 21 May 1947.

therefore reaffirmed their decision to proceed with the erection of the new oil-fired power station. [131]

With final Cabinet approval for the development the Electricity Commissioners gave the CLELC their formal consent for Bankside 'B' power station, but with conditions to mitigate its amenity impact.[132] The decision was announced in the Commons on 23 May 1947 and there was a lengthy debate, again largely hostile to the proposal. In his defence of the decision Silkin noted that democracy 'is a very complex system' and he had been called upon 'to make a decision on this most difficult matter after having heard all the evidence'.[133] The evidence presented in this chapter demonstrates that the decision-making and approval process for Bankside 'B' power station was indeed complex and lengthy. It involved compelling arguments on both sides, a large number of interested parties, and a multiplicity of political, social, economic and technical considerations.

The controversy about Bankside 'B' power station was relatively short-lived. Leaders and letters in the press appeared between 23 April and mid-June 1947. After this there were very few comments in the press and no further letters of protest to Silkin. The *fait accompli* may have led to the lack of public interest in the Bankside

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[131] TNA, CAB/128/9, Cabinet Minutes 22 May 1947, C.M.(47)49, f.49.
[132] The Commissioners consent was subject *inter alia* to the following conditions: 'the company shall work the extension so as not to occasion nuisance and to that end the Company shall use continuously the most efficient methods which may for the time being reasonably practicable for all the following purposes: (i) the elimination of smoke and sooty emissions; (ii) the prevention of the discharge of sulphur and its compounds into the atmosphere; and (iii) the avoidance of noise and vibration'. TNA, POWE 14/496, Commissioners Consent dated 23 May 1947.
[133] *Hansard*, House of Commons debates, 23 May 1947, Vol.437 cc2688-725. Silkin's comments are at c2717.

controversy. There were occasional questions in Parliament about the oil fuel or sulphur fumes from Bankside but no further debates.[134]

I have argued here that the battle for Bankside took place at the nexus of two strategic plans for the renewal of London. The grand plans for the re-planning and rebuilding of London were relatively short-lived. The *County of London Plan* was never adopted by the LCC which developed a new plan in 1951 under the framework of the Town and Country Planning Act 1947.[135] The changes that took place in the Bankside area after 1947 were piecemeal rather than planned and reflected wider factors such as deindustrialisation, these aspects are examined in Chapter 6 – Transforming Bankside. In the City of London, Holden and Holford's plan was not adopted 'in the face of market freedoms and a new fashion in architecture'.[136] Yet as the planning historian John Gold has said, Abercrombie's plans did have a considerable influence on the shape of post-war planning legislation even if the specific proposals were not implemented.[137] For example, the Town and Country Planning Act 1947 brought significant development under government control by making it subject to planning permission.[138] Also under the 1947 Act developments such as power stations no longer required consent from several bodies. Deemed planning consent could be given solely by the Ministry of Fuel and Power without recourse to the Ministry of Town and Country Planning. Furthermore, public inquiries for power stations were only held if a local authority raised objections.[139] This new

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[134] For example: *Hansard*, House of Commons, 3 July 1948, Vol.439 cc175-76W; 23 September 1948, Vol.456 c1070; 11 July 1949, Vol.467 c5; 11 December 1950, Vol.482 c115W.
[135] J.R. Gold, 'In Spite of Planning', *Journal of Urban History*, 26 (2000), p.549.
[136] J. White, *London in the Twentieth Century* (London, 2008), p.42.
[137] Gold, 'In Spite of Planning', p.549.
[138] Scott, 'The Evolution', p.516.
[139] For example, the nuclear power station at Berkeley, on the Severn estuary, was granted consent in 1956 without a public inquiry having been held, Sheail, *Power in Trust*, p.94.

planning regime meant that Bankside 'B' was the last power station to undergo such a lengthy and complex process through the 'administrative jungle' of meetings, correspondence and a joint inquiry involving a multiplicity of statutory bodies in local and national government. The Bankside case and the retention of the Departmental files as being of 'historic interest' have provided an insight into the operation of the planning system in this period and the position of the interested ministries as well as the tensions between government departments for such developments.[140]

The simplification of the planning process after 1947 is demonstrated in the application to complete Bankside 'B' in 1958. This development was remarkable for being uncontroversial in marked contrast to the 1945-47 process. In 1958 the owners of Bankside power station, the CEGB, applied to the Ministry of Power for permission to build the second, eastern half of the station.[141] In this case the LCC simply required confirmation that the material on external surfaces, walls and fences will 'match in colour, texture and type that of the existing station'.[142] The Ministry of Housing and Local Government offered no observations on the siting or the design of the buildings.[143] Neither the Borough of Southwark nor the Royal Fine Art Commission offered any comments or observations on the proposal.[144] Notices were published in

[140] The front cover of the Ministry of Town and Country Planning files associated with Bankside such as HLG 79/916, 918 and 919 are marked 'Historic Interest Sample'. One of the Ministry of Fuel and Power files, POWE 14/496 is marked 'Material used by official historian DO NOT DESTROY'. These are fortuitous survivors for this research, and for future historians, in view of the missing CEGB archival material.

[141] On 18 April 1958 the CEGB applied to the Ministry of Power for consent under the Electricity Acts for the completion of the Bankside 'B' generating station and the demolition of the old 'A' power station. TNA, POWE 14/1116, Ministry of Power, Siting of new power stations: extension to Bankside Borough of Southwark, Letter from the CEGB to the Ministry of Power, dated 18 April 1958.

[142] Ibid., Letter from the CEGB to the Architect to the LCC, dated 27 June 1958.

[143] The Ministry of Housing and Local Government was the successor of the Ministry of Town and Country Planning. Ibid., Letter from the Ministry of Housing and Local Government to the Ministry of Power, dated 22 July 1958.

[144] Southwark Borough Council minutes of 25 June 1958, f.27, the Council had been consulted by the LCC for the application (806/5/58) made under the Town and Country Planning Act 1947.

the national and local press and public notices were displayed inviting comments from 'any person wishing to object to the application'; the 300-yard consultation criterion having been abolished. No objections were raised.[145] The speed of the process is also evident; the CEGB submitted their application on 18 April and on 7 August 1958 the Ministry of Power stated 'that permission for the aforesaid development shall be deemed to be granted' under the Town and Country Planning Act 1947.[146]

A number of factors had changed since 1947 that made this application uncontroversial. Firstly, the urban planning battle had been lost by the 1947 consent: the redevelopment of an industry-free South Bank had been compromised by the approval and construction of the first half of the new Bankside 'B' power station. Secondly, there were no longer any grand plans that could be deployed in arguments against the building, and locally the revised zoning of the area had specifically included the power station. Lastly, and most significantly, the 1958 approval enabled the old Bankside 'A' power station to be demolished. This had been a long-running source of complaint about smoke and grit (see Chapter 2) and it was a notoriously ugly building. The 1958 approval for the completion of Bankside 'B' consequently effected an improvement in the amenity of the area. Bankside was the last power station to be built in central London and one of the last 'brick cathedral' power stations of the mid-twentieth century. It was at the physical size limit of what was possible, and acceptable, to build in an urban location. Technological developments enabled larger power stations to be built away from urban areas. The subject of the influence of technology on power stations is examined in Chapter 4.

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[145] Ibid., Ministry of Power internal note dated 21 June 1960.
[146] Ibid., Ministry of Power, Form of Consent, dated 7 August 1958.

Conclusion

This chapter demonstrates how the application to redevelop Bankside power station in 1945 placed it at the nexus of a conflict between two plans for the post-war recovery, renewal and modernisation of London. Both plans were a direct consequence of the war. Bomb damage had provided the opportunity to re-plan and rebuild London and the *County of London Plan* provided a blueprint for the reconstruction of the capital. The war also meant that the electricity industry was poorly placed to meet the expected growth of demand for electricity to aid the economic recovery of the country. The proposal for the new Bankside power station was a response to a looming energy crisis of rising demand and an inadequate supply. Elements of both these plans are addressed in the existing literature.[147] However, these existing accounts focus on the strategic aspects of the plans: how they came about, what they entailed, and how they were viewed and acted on (or not) by interested parties. This chapter takes a fresh approach to the plans. It brings the two plans together and demonstrates how they interacted with each other in the battle for Bankside. It also addresses the specific details of the plans. From the *County of London Plan* the proposals for the South Bank and the concept of the 'neighbourhood unit' have been used to examine what these concepts specifically meant for the Bankside area. This chapter addresses how the generality of projected post-war demand for electricity in London identified in the literature was made manifest in the plans for new Bankside 'B' power station: electricity made visible.

The decision-making process for Bankside escalated through a complex web of procedures, legislation, organisations and influential actors. I demonstrate how the

[147] For an account of post-war planning in London see Mort, 'Fantasies of Metropolitan Life', pp.125-42; Cherry, *Cities and Plans*, pp.123-31; Ward, *Planning and Urban Change*, pp.95-98; for an account of the state of the British ESI in the immediate post-war period see Hannah, *Electricity*, pp.299-328.

planning system in the mid-1940s worked in practice. It exemplifies the administrative jungle identified by Young and Garside.[148] There is little in the literature on the detailed operation of the planning process in respect of urban utilities. The close focus on Bankside reveals aspects of the reality of planning that are not apparent in the broad strategic accounts of urban planning. The efforts to resolve the conflict were protracted – from February 1945 to May 1947 – partly because of the inherent un-resolvability of the two mutually exclusive plans and the principle of 'good planning' that was at stake. The interaction of the planning process as it was then constituted and the pre-nationalisation structure of the ESI contributed to the length and complexity of the decision-making and approval process for Bankside.

The planning decision was resolved in favour of the electricity lobby through the random contingency of the weather in early 1947. These conditions had turned a fuel and energy shortage into a crisis. The research also reveals the positions and actions of influential individuals: Shinwell circulating a minute that furthered his position; the discomfort of Silkin at his *volte-face* over the Bankside decision; Lord Latham's attack on the Bankside decision in the House of Lords; and Attlee's intervention on oil firing. In contrast to the lengthy discussions on the planning principles, and Scott's 'grand opportunity for fine architectural treatment', the decision to make Bankside oil-fired was taken, for amenity reasons, without technical consultation or consideration of the economic implications. The causes, progress and consequences of the Bankside decision-making and approval process were a conjunction and interaction of social concerns, political expediency, technological possibilities, economic considerations, together with the significance of timing.

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[148] 'The Abercrombie Greater London Plan', *Public Administration* 23 (1945), p.38 quoted in Young and Garside, *Metropolitan London*, p.244.

Finally, Bankside 'B' marked the end of an era for the brick cathedral power station; it was at the physical size limit of what was possible, desirable or permissible to construct in an urban setting. Technological progress would take power stations in a different direction.

Chapter 4 – Technology at Bankside: amenity, innovation and progress

This chapter constitutes an extended case study in the history of technology. Specifically the technologies that was proposed or installed at Bankside 'B' power station over the period 1945 to 1975. As demonstrated in Chapter 3, a number of conditions were imposed on the Bankside development. In order to meet these requirements, together with its operational needs, a range of technologies were assessed, selected and deployed or discounted by the designers and engineers of Bankside. This chapter analyses these technologies and the technological decision-making processes around their selection or rejection. The chapter therefore complements the analysis of the political decision-making processes associated with Bankside addressed in Chapter 3.

Many of the technologies deployed at Bankside had the primary aim of generating electricity in an efficient and economical manner; in this respect Bankside 'B' was little different to other power stations. But Bankside was viewed as a development which would have a significant adverse impact on its surroundings: it would be a nuisance to the City of London and to the Borough of Southwark, and would degrade St Paul's cathedral.[1] Given its sensitive central London location, Bankside used several technologies which aimed to mitigate its amenity impact.

The chapter is structured around a number of technological moments of significance and change for the power station. In 1945-46 Bankside 'B' was conceived as a conventional coal-fired power station but with some concessions to its amenity

[1] 'Degrading St Paul's', *Manchester Guardian*, 26 February 1947.

impact. This design was significantly altered in 1947 by the condition that it should be oil-fired and that the flue-gases should be cleaned. During the period 1949-52 in which the power station was constructed a number of innovative and alternative technologies were examined. Bankside was viewed by some in the scientific community as a potential test site for novel technologies. This created a tension between technological innovation and the BEA's primary aim to generate and supply electricity. The operation of technological decision-making is addressed through the demonstration of how and why some technologies were installed and others were rejected. The second half of Bankside 'B', constructed between 1957-63, reflects several technological developments that had taken place in the electricity supply industry in the preceding decade. Finally, this chapter examines the period 1972-75 when an often-proposed district heating scheme was partly constructed at Bankside, but then abandoned in the political-economic conditions of the time.

Bankside 'B': a conventional coal-fired power station, 1945-46

The proposed Bankside 'B' of 1945-46 was conceived as a large conventional coal-fired power station. Technological solutions, both well-tried and novel, were incorporated into the design to mitigate some of the adverse impact of the station on its sensitive location. The design was a typical 'brick cathedral' characteristic of the middle decades of the century although this style of building was coming under criticism from some in the architectural community.

Coal had been the principal fuel used in electricity generating stations since the early days of the ESI, and the 1945-46 design for Bankside 'B' was for a 210 MW coal-fired power station. There were two issues associated with the fuel that had a bearing on the design of the station. First, amenity issues associated with the handling and storage of coal; adverse impacts included noise, dust and the unsightly nature of the equipment and the coal store. Secondly, the design and the physical form of the station was influenced by the equipment that was used to process and burn the coal and to dispose of the ash. Bankside 'A' power station was supplied with coal by barges which were unloaded by crane, coal was transferred by an overhead conveyer to a open store and thence to the boiler house (see Figure 4.1). This operation was noisy, dirty and unsightly.

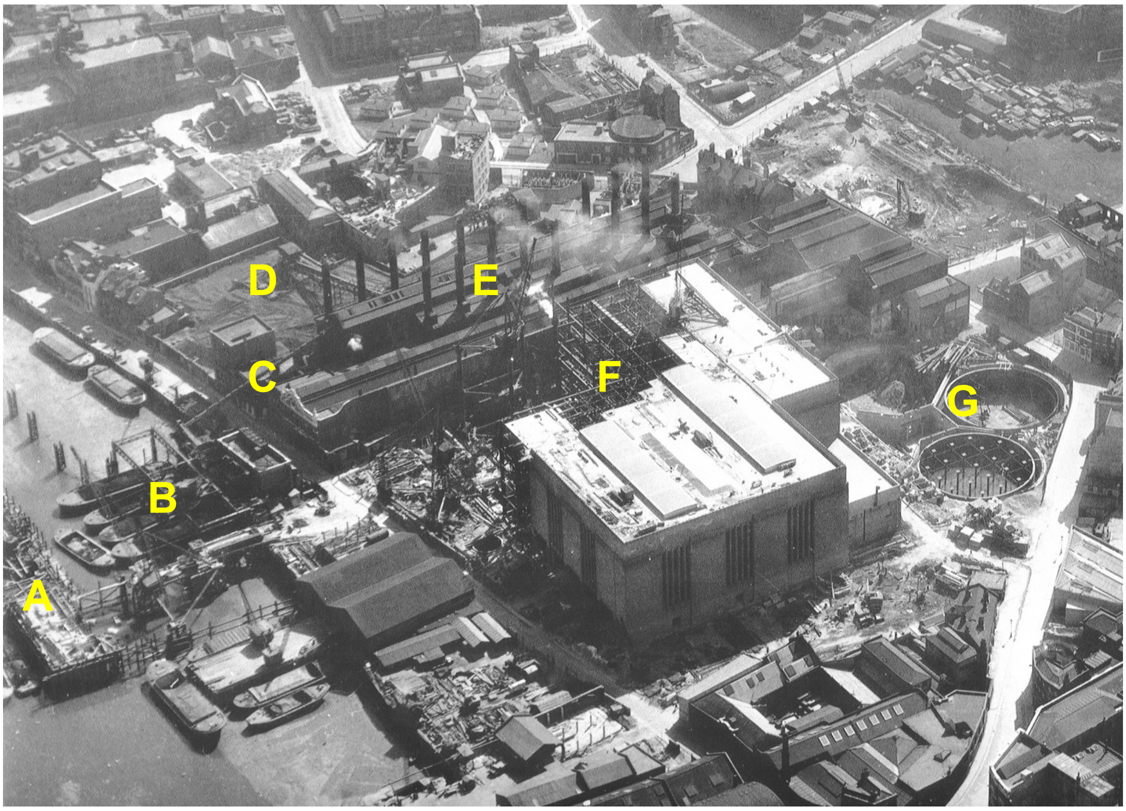

Figure 4.1: Bankside power station, *c*.1951.

Source: English Heritage, Aerial view, Bankside power station, London. © English Heritage (Aerofilms Collection).

Key: A= new river jetty under construction, B=coal barges, C=overhead conveyor, D=coal store, E='A' station boiler house, F='B' station under construction, G=oil storage tanks.

The 1945-46 design of Bankside 'B' attempted to reduce the amenity impact of coal handling. The new station would use much larger amounts of coal which could be more effectively delivered by colliers rather than barges. This had meant constructing a new jetty in the deeper water of the river where coal would be unloaded and transported to the coal store to the south of the station.[2] The coal store was about one acre in extent and its machinery was to rise to 40 ft above ground level; it was to hold up to 40,000 tons of coal, sufficient for about one month's usage in the power station. The unsightly nature of the coal store was examined in detail during the public inquiry. It was suggested that the store would constrain or prevent the development of flats and offices to the south of the station because they would overlook the area.[3] Aside from the coal store, the CLELC assessed the merits of several schemes for handling and transporting coal around the site. This assessment included the aesthetic impact of each proposal as well as technical matters and this demonstrates that the company, in seeking approval for the power station, had considered, and wished to minimise, its amenity impact.[4] A 'transporter system' was selected as the least obtrusive option. Most of the equipment such as the coal crushers and weighing equipment would be located underground (see Figure 4.2). This system was more expensive than an overhead conveyor because of the tunnelling involved. The cost of the coal tunnels, coal store, conveyor and ashing system was estimated to be £215,000.[5] The promoters were prepared to bear the additional cost because of the amenity benefits of this scheme, which also avoided interfering with the proposed riverside boulevard and

[2] At full load the station would use about 100 tons of coal per hour or about 450,000 tons annually. TNA, HLG 79/916, Ministry of Town and Country Planning, Bankside power station development Southwark: application to Minister, Town and Country Planning Acts 1932-1944, 'Memorandum - technical information relating to the proposed reconstruction of the Bankside electric generating station', dated 7 November 1946, f.4.
[3] See for example TNA, POWE 12/798, Ministry of Fuel and Power, Evidence of Sir Giles Gilbert Scott at the public inquiry, day 2, p.11.
[4] TNA, HLG 79/916, Memorandum describing proposals, 7 November 1946.
[5] TNA, HLG 79/918, Bankside generating station inspector's report, Appendix B Cost and Life of Power Station.

gardens. This was therefore a technological solution to address an amenity issue, but one which had a significant financial cost.

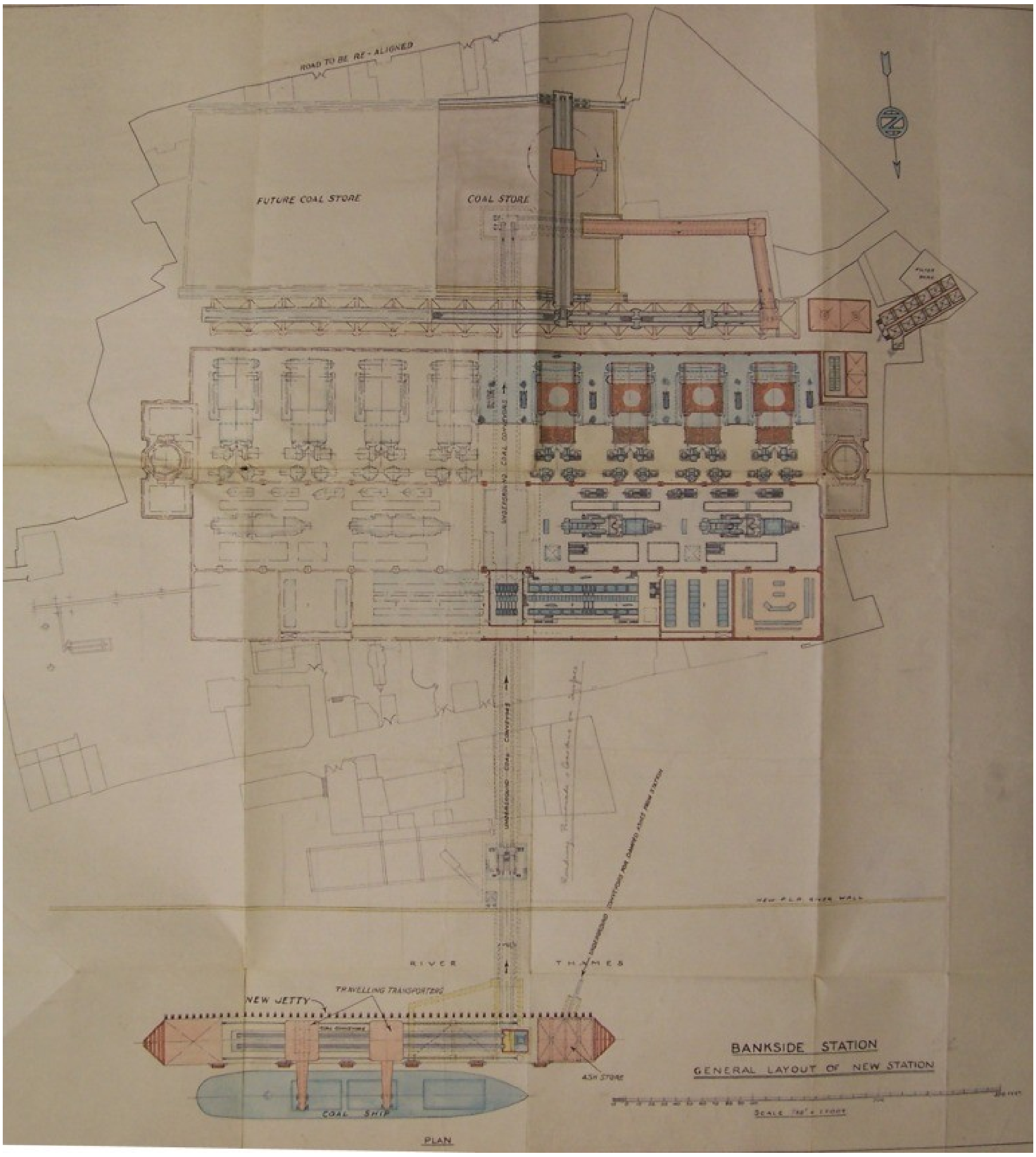

Figure 4.2: Plan of the proposed coal-fired Bankside power station, 1946.

Source: TNA, HLG 79/919, Ministry of Town and Country Planning, Bankside Generating Station: Plan's illustrating inspector's report, 1944-47, General layout of new station. Reproduced with permission. The National Archives.

Note the coal ship moored at the jetty (bottom), the underground coal tunnel, and the coal store (top) at the south side of the station. The building is orientated with the boiler house at the south and the switch house to the north; the opposite of the final configuration. Note also the two chimneys (circles), one at each end of the building (see Figure 3.7). Only the western, upstream half of the power station is coloured as this was to be built first.

The technology for burning coal also had an impact on the form of the building. Pulverised coal fuelling had been introduced to Britain in the early 1920s as it provided a more intense combustion that took place throughout the furnace rather than just on the grate, this provided a greater heat output.[6] The electricity industry used a low-grade coal known as electricity slacks which other industries would not burn. Slacks were cheaper but their high mineral content meant that more ash and dust were produced.[7] Pulversised coal produced a significant quantity of fly-ash which was carried out of the boilers with the flue-gases and had to be removed before discharge into the chimney.[8] Electrostatic precipitators to remove fly-ash had been introduced in Britain in 1929.[9] Pulverised fuel and precipitators are an example of linked technologies: one technology provided the solution to environmental issues created by another.

The 1945-46 design for Bankside 'B' included equipment for both pulverising coal and electrostatic precipitators for the removal of fly-ash. This plant, as well as having a significant capital cost, took up a large amount of space within the boiler house which, as a result, was 140 ft high (see Figure 4.3). The capital cost of the boiler house plant was estimated to be £3,524,000 which was the largest single item in the total capital cost for the power station of £11,247,000.[10] Ash from the boilers and precipitators was to be returned to the jetty via the underground tunnel and loaded onto barges for disposal.

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[6] The first use of pulverised fuel was at St Pancras power station in 1922. Pugh 'The Generation of Electricity in the London Area', p.485.

[7] Citrine, *Two Careers*, p.274.

[8] Since 1934 the Electricity Commissioners had set a standard of solids discharge from power stations of 0.4 grain per cubic foot (0.92 g/m^3), this was reduced to 0.2 grain per cubic foot in 1958; Ireland notes that in some cases the standard was achieved by 'converting to oil burning', F.E. Ireland 'Cleaning the Air', *Transactions of the Institution of Chemical Engineers*, 49 (1971), p.37.

[9] Precipitators has first been installed at the power station at Taylor's Lane, Willesden. Electricity Council, *Electricity Supply,* p.47.

[10] TNA, HLG 79/918, Inspector's report, Appendix B Cost and Life of Power Station.

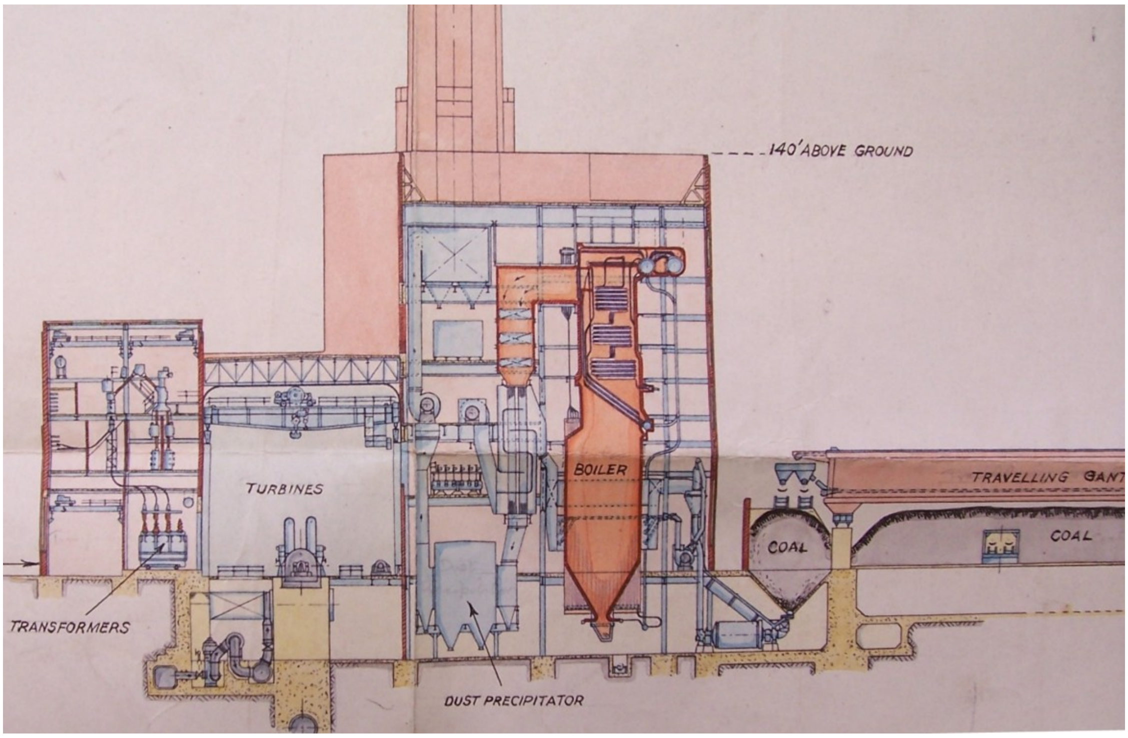

Figure 4.3: Cross-section of the proposed coal-fired Bankside power station, 1946.

Source: TNA, HLG 79/919, Ministry of Town and Country Planning, Bankside Generating Station: Plan's illustrating inspector's report, 1944-47, Extract from Plan No.9. Reproduced with permission. The National Archives.

Note the dust precipitator (lower centre) and the height of the boiler and the boiler house compared to the turbine hall and switch house (left).

The appearance of the 1945-46 Bankside 'B' was a conventional so-called 'brick cathedral' power station. It was a steel-frame structure with brick skin walls, characteristic of large buildings of the middle decades of the twentieth century. The steel-frame construction allowed the large volumes required in the boiler house and the turbine hall to be created. In the post-war context there were some concern that the quantity of bricks required – about 4.2 million in the completed building – would be difficult to obtain, and for this reason the public inquiry had recommended a 'cladded' building.[11] The potential shortage of bricks also led to a suggestion by one MP that the building should be constructed from Portland stone which, it was said, would have the

[11] 4.2 million bricks is quoted in Moore and Ryan, *Building Tate Modern*, p.194; see also TNA, HLG 79/918, Inspector's report, paragraph 45.

advantage of 'avoiding the brick to stone contrast with St Paul's'. This was dismissed by the Ministry of Town and Country Planning as being impractical and costly, furthermore it was noted that 'masons are even rarer than bricklayers'.[12] The 'bare walls of immaculate brickwork' were built as Sir Giles Gilbert Scott intended.[13] Part of Scott's remit was to make the station 'as pleasant and dignified a feature of the river bank as was humanly possible'.[14] He observed 'there is a variety of colour and interesting texture in brickwork that is lacking in Portland stone' and went on to say 'I propose a pearl grey brick for Bankside […] which will enable it to blend with Portland Stone buildings, if these are erected around it'.[15] As the architect Andrew Lowe observes the dimensions of a single brick can be used to give a 'human scale in contrast to the monumentality of the power station'.[16] The design of the building therefore encompassed technical, financial, aesthetic and practical considerations.

Despite Scott's aesthetic justifications for the building the Royal Fine Art Commission had concerns about the style. They argued that 'a simple housing for the large-scale electrical equipment involved can be more impressive than a cathedral-like structure', echoing the 'cladding' proposal of the public inquiry.[17] They also argued for 'a more careful choice of an architect', but not naming or criticising Scott, 'who has a

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[12] TNA, HLG 79/917, Letter from Lord Hinchingbrooke to Lewis Silkin, dated 8 May 1947. The response is from an official (Mr Beaufoy) in the Ministry of Town and Country Planning, dated 4 June 1947. Hinchingbrooke was the MP for South Dorset and had an interest in the Portland stone industry in his constituency.
[13] Scott said he thought Portland stone was better for a building having 'architectural enrichment like St Paul's' than to a 'large and simple building relying on its effect upon massing combined with colour and texture of its wall material', see TNA, HLG 79/917, letter from G.G. Scott to H.J. Randall of the CLELC, dated 10 July 1947.
[14] See Stamp, 'Giles Gilbert Scott and Bankside Power Station' in Moore and Ryan, *Building Tate Modern,* pp.180-81, see also TNA, POWE 12/798, public inquiry, day 2, pp.39-40
[15] 'The main impression is of stunning scale of the bare walls of immaculate brickwork', B. Cherry and N. Pevsner, *The Buildings of England: London 2:South* (1983), p.582.
[16] Lowe, 'Battersea Power Station', p.92.
[17] TNA, BP 3/9, Royal Fine Art Commission, *Ninth Report of the Royal Fine Art Commission 1948 and 1949* (London, 1950), p.12.

knowledge of modern construction', so that the design 'shall be an expression of the engineering problems involved, rather than something extraneous to them'. The Commission maintained that there was 'still a tendency to give too much consideration to architectural design to the exclusion of the engineering problems'.[18] Despite these comments the Commission offered no specific observations on the design of Bankside which they 'considered eminently suitable for the site selected'.[19] A simple housing as an expression of the engineering problems is unlikely to have been any more aesthetically acceptable at Bankside than Scott's brick cathedral, perhaps less so. The point about addressing the engineering problems in the design of power stations was made again in the mid-1950s, as discussed below.

The 1945-46 design of Bankside 'B' which was submitted to the public inquiry was therefore a conventional, urban brick-cathedral power station, using the standard coal-fired technology of the time. The design had made some concessions to the amenity impact on its immediate surroundings through the facility of an underground coal transfer system. This design was to undergo a major transformation by the decision to make the power station oil-fired.

Technological responses to new requirements, 1947

The Cabinet's insistence in 1947 that Bankside should be oil-fired (see Chapter 3) had ostensibly been made for amenity reasons. It would eliminate the riverside coal handling equipment and storage facility and the associated noise and visual intrusion. The designers and engineers of Bankside 'B' were able to respond to this, and a

[18] TNA, POWE 14/148, Ministry of Fuel and Power, Consultation with the Royal Fine Art Commission for new stations or extensions to existing stations, 1945-57, Letters from the Royal Fine Art Commission to the Electricity Commissioners, dated 1 April 1947 and 19 November 1947.
[19] TNA, BP 3/8, Royal Fine Art Commission, *Eighth Report of the Royal Fine Art Commission 1946 to 1947* (London, 1949), p.13.

number of other challenges, imposed by the changing specifications and requirements for the power station. Many of these responses entailed technological solutions and some, although technically feasible, were rejected on economic grounds.

The specification for oil-firing enabled a major saving on capital costs to be realised, as well as improving the visual amenity of the station. A financial advantage for the CLELC was that a significant amount of the plant within the power station, such as the coal pulverisers and dust precipitators, were no longer required. On a technical point the engineers noted that since the intensity of combustion of fuel oil is greater than that for coal, smaller furnaces could be used for the same heat output, thus reducing the physical size of the boilers.[20] The reduction in the amount and size of equipment needed inside the station had the consequential benefit of reducing the weight loading on the structural steelwork in the boiler house: the engineers noted that 'column loads have been reduced by more than 50%' thus reducing the mass and cost of the steel and the foundations that were necessary.[21] As well as a considerable saving in capital cost for equipment and steelwork, less boiler house equipment enabled the designers to significantly reduce the height of the boiler house from 140 ft to 85 ft. This provided an un-envisaged visual amenity advantage as it enabled Bankside's roof-line profile to be significantly reduced (compare Figures 3.7, 3.8 & 4.3).[22] On the riverfront, the jetty was still required, but since coaling cranes were no longer needed the jetty would be a lighter structure, thus providing further cost savings.[23] Oil was to

[20] CEGB, *Advances in Power Station Construction* (Oxford, 1996), pp.58-59.
[21] TNA, POWE 12/798, Ministry of Fuel and Power, Memorandum 'Possible Reduction in the time for use of Alternative Site at Rotherhithe' Paragraph 4 re-designing of Bankside Station for Oil Consumption, dated 9/5/1947.
[22] TNA, POWE 12/798, Bankside power station, 'Preliminary Sketch Design' by Sir Giles Gilbert Scott dated May 1947.
[23] Ibid., Memorandum 'Possible Reduction in Time', dated 9/5/47.

be delivered to the jetty by shuttle tankers.[24] Bunkering hoses were connected to the tankers and pumps transferred the oil in pipes via an underground tunnel to the oil storage tanks (see Figure 4.4). Oil would therefore be transferred cleanly and quietly and would avoid noise and dust and reduce the visual impact of the station thus providing, as intended, a significant amenity advantage.

In 1947 there was little experience in Britain of operating oil-fired boilers of this size, although they were used extensively in the United States and other countries.[25] The CEB had insisted that because of delivery concerns the order for the boilers should be placed with Foster Wheeler (see Chapter 3). The company was able to draw on the experience of their parent company, the Foster Wheeler Corporation of New York, for the design and operation of oil-fired boilers and were able to incorporate appropriate facilities into Bankside's boilers and the oil handling equipment.[26] It was also noted that the oil-fired station could be started-up much more quickly than was possible with a coal-fired one. This increased the usefulness of Bankside 'B' as peak load power station which was better able to meet the rapid changes in demand for electricity that are a characteristic of electricity networks.[27] The designers were therefore able to address some of the technological aspects of the oil-firing decision, and to identify operational advantages. There were concerns about the storage of oil but engineering solutions were established and developed.

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[24] Southwark Local History Library, Bankside file, H.V. Pugh, Bankside "B" Power Station, British Electrical Authority – London Division, memorandum from the Divisional Controller dated 14.1.53, p.8.
[25] TNA, HLG 79/917, Bankside Power Station, Letter from John Hacking to Sir John Kennedy, dated 15 May 1947.
[26] Institution of Engineering and Technology Archives, Foster Wheeler Limited, *Reconstruction of Bankside Generating Station* (London, n.d but *c.*1951).
[27] Anon, 'Bankside 'B'', *Engineering and Boiler House Review*, March 1953, p.76.

Figure 4.4: Access tunnel from Bankside 'B' power station to the river jetty.

Source: English Heritage, National Monuments Record, Image No. BB93_14523, Bankside power station access tunnel, 1993. Reproduced with permission. © Crown copyright, English Heritage.

Note the oil transfer pipes are at the sides of the tunnel.

One concern, that had not been an issue for the coal-fired station, was the potential pollution of the river Thames from oil spills. This matter was first raised by the Public Control Department of the LCC which was concerned about oil storage particularly since 'there might be serious trouble from the outflow of burning oil'.[28] In

[28] The LCC Public Control Department made the following points for consideration: a) that above ground tanks will be unsightly; b) the prevention of spread of fire from the premises, or escape into the sewers; c) prevention of spread of fire from the premises in the event of ignition. LMA,

rebutting these concerns the CEB argued that large quantities of oil were already stored at several riverside locations in London, therefore Bankside was not unusual.[29] Nevertheless, the CEB obtained information about the war-time experience of fighting oil tank fires. It was originally intended to locate the oil tanks on the north side of the station closest to the river where they would be 'more accessible for fire fighting from river floats', although as the LCC observed they would be unsightly.[30] The designers re-thought this design and devised the elegant solution of constructing the oil storage tanks below ground level to the south of the power station The tanks were grassed over, thus giving no outward sign of their presence. This provided both a visual amenity advantage by hiding the tanks, reduced the fire risk and made provision for the proposed riverside boulevard.[31] There were three oil tanks each holding 4000 tons of oil (see Figure 4.2), a proposed second set of tanks was never constructed.[32]

The oil-firing decision had therefore realised several amenity advantages for the power station. There was also a financial benefit in the reduced capital costs, but

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LCC/PC/GEN/01/052, Electricity Generating Stations 1910-63, Public Control Department note on 'Bankside – storage of fuel oil', dated 28 April 1947.

[29] Oil was stored downstream at Beckton (30,000 tons) and 'a somewhat similar capacity' at Angerstein Wharf, as well as upstream at Fulham, Hammersmith and Wandsworth, see TNA, POWE 14/496, Ministry of Fuel and Power, Electricity Generation: siting of generating station, Bankside, 1945-1949, Letter from the CEB to the Ministry of Fuel and Power, dated 3 May 1947. A review of petroleum storage on the Thames is given in D. Roberts, 'River Thames and London's Petroleum', unpublished paper, Birkbeck London, 2007 (personal correspondence).

[30] The issue had been raised by the Ministry of Fuel and Power in a letter to the CEB dated 21 April 1947, this letter is not in the file but is referred to in the CEB's letter to the Ministry, dated 3 May 1947, TNA, POWE 14/496, Electricity generation: siting of generating station Bankside.

[31] The chief inspector at the Ministry of Town and Country Planning noted in April 1947 that the tanks were to be partly buried but thought the Ministry should press for them to be put underground with lawns above them, see TNA, HLG 79/916, Bankside Power Station – Oil storage, note by K.S. Dodd, dated 30 April 1947.

[32] Each tank was 92 ft in diameter and 24 ft high. BEA, *Bankside Power Station* (London, n.d. but *c.*1952). It was originally intended that there would be six tanks, three for each half of the station to provide one month's supply of oil. The second set of tanks was never constructed when the power station was completed in 1959-62. There is no evidence of why these second set of tanks were never built. Operating experience may have shown that the oil supply from Shell Haven refinery in the Thames estuary was reliable and therefore the 14 days supply, available from the original three tanks, would have been an adequate reserve. Furthermore, there was limited space on the south-east corner of the Bankside site and there would have been a significant cost saving.

this was offset against the higher cost of oil compared to coal, this is discussed further in Chapter 5 – Bankside in Operation. A disadvantage of oil was its sulphur content which, at up to four per cent, was higher than coal at about 1.0-1.5 per cent. In May 1947 Herbert Morrison in discussions on Bankside power station had noted that because of the composition of the oil it was ‘essential that plant be installed to eliminate the sulphur’; this became one of the formal consent conditions.[33] The only viable technology available in 1947 for cleaning the flue-gases was to wash them with river water or a chalk solution. This technology had been used at the coal-fired Battersea and Fulham power stations before the war, but this would be more challenging to achieve at Bankside because of the higher sulphur content of the flue-gases. Despite Morrison’s insistence, not everyone was convinced that treatment was necessary. Sir Leonard Pearce, the chief engineer at the LPC and the consultant engineer for the CLELC, noted that:

> no-one has yet been able to show that flue-gas washing is more than an imaginary benefit to the community. There is something to be said in its favour when the gases can be discharged with a very low content of sulphur dioxide, as at Battersea. But when they contain a good deal more sulphur dioxide, it is possible to argue with some force that it is better to discharge them unwashed at 300°F from tall chimneys, and thus ensure that they rise clear of the town.[34]

Pearce went on to argue that flue-gas scrubbers should not be constructed at Bankside but that space be left for installing them later after the results from experiments on a pilot plant were available. It was stated at the public inquiry that ‘the descent of gas to ground level near the station was not to be feared’, but in the light of the oil-firing decision and the installation of the flue-gas washing plant, Pearce said that ‘this

[33] TNA, CAB/129/19, Cabinet Office, C.P.(47)160, f.51, Memorandum by the Lord President of the Council, dated 21 May 1947.

[34] TNA, POWE 14/496, Electricity generation: siting of generating station Bankside. Memorandum by Sir Leonard Pearce ‘The effect which the proposal to burn oil fuel may have upon plans for flue gas washing’, dated 8 May 1947, paragraph 11.

opinion must now be withdrawn'.[35] A system to remove sulphur from the flue-gases had therefore to be installed, although as Morrison had noted:

> how this is to be done has not yet been worked out, but the technical experts who have been consulted are convinced that it is practical (although it would probably not be possible to have plant ready quite so soon as the power station).[36]

This reflects Bill Luckin's contention, in relation to Battersea power station, that there was a widespread belief that it was the role of scientists to solve such problems.[37] The design of the flue-gas treatment system at Bankside would engage the engineers for some time. Morrison's comment about the timing also proved to be correct: the power station was started in November 1952 before the flue-gas washing plant was ready. In the context of the London smog of early December, this proved to be controversial (see Chapter 5).

In addition to the requirement for oil-firing, there was also political influence on the specification of generating equipment in the power station. The original direction from the CEB to the CLELC had been for a 300 MW power station at Bankside. However, in 1945-46 the engineers did not believe that it would be possible to build a station of this capacity on Bankside's restricted seven acre site, despite the purchase of additional land in the 1930s. As a result the station specification was reduced to 210 MW.[38] This output was to be achieved by four turbo-alternators each with a capacity of 52.5 MW. This would be a custom-made size, typical of the period when electricity undertakings specified the plant and machinery. As discussed in Chapter 2, in 1947 the Government imposed a specification for standard machine

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[35] Ibid., paragraph 8.
[36] TNA, CAB/129/19, Cabinet Office, C.P.(47)160, f.51, Memorandum by the Lord President of the Council, dated 21 May 1947.
[37] Luckin, *Questions of Power*, pp.152-53.
[38] TNA, POWE 12/798, Evidence of Sir Leonard Pearce at the public inquiry, day 1, p.47.

sizes.[39] Bankside's turbo-alternators were re-specified as 60 MW machines. As a consequence the generating capacity of Bankside 'B' was greater than it would otherwise have been; an advantage given the shortfall in electricity supply.

The urban location of Bankside was a stimulus to another technological innovation in the immediate post-war period. It was thought that heat from the power station could be used to provide space heating and hot water to neighbouring commercial and domestic users. The issue was first raised during the public inquiry in January 1947, when the Corporation of London suggested the possibility of providing district heating to parts of the City.[40] The CLELC recognised that such a provision would help in their arguments in support of the proposed station. They noted that Bankside would, within a few years, be surrounded by new buildings and that this offered an excellent opportunity for district heating.[41] On the other hand they were concerned that the plant at Bankside must, in the first instance, be designed solely for the generation of electricity to prevent any delays. This position was supported by the Electricity Commissioners who observed that unless the local authorities could state 'what their definite heat requirement are likely to be', the matter of district heating should be deferred until the second half of the station was considered.[42]

Following the approval of Bankside 'B' in May 1947 several district heating proposals were put forward. These schemes sought to make a virtue of the presence of

[39] The Control of Turbo-Alternators (No.1) Order 1947 (Statutory Rule and Order No.2386) stipulated that all steam turbines over 10 MW had to conform to standard ratings of either 30 or 60 MW. See Hannah, *Engineers*, p.105; and Harlow, *Innovation and Productivity*, pp.66-70.
[40] TNA, HLG 12/798, Evidence by the counsel for the CLELC at the public inquiry, day 1, p.11, and day 5, p.14.
[41] TNA, HLG 79/917, Bankside power station, Letter from the CLELC to Ministry of Town and Country Planning, dated 14 May 1947.
[42] TNA, POWE 14/265, Ministry of Fuel and Power, City of London District heating Scheme, Letter from Electricity Commission to the LCC, the Corporation of London and Southwark Borough Council, dated 23 May 1947.

the proposed power station, but none proved to be practicable. In June 1947 the Ministry of Reconstruction suggested that Bankside could be used for space heating in the 200 acres of destroyed and bomb-damaged property that was to be redeveloped in the City of London. It was claimed that the addition of boilers would require less than a quarter of an acre at Bankside and would 'not hold up the present programme for the station'.[43] The science administrator Henry Tizard, who had formerly been the secretary of the Department of Scientific and Industrial Research (DSIR), supported the proposal. He observed that the slight reduction in electrical efficiency would be more than offset by 'an enormous improvement in fuel efficiency in the area to be district heated and by a very valuable reduction in the use of electrical appliances and also in coal'.[44] Tizard's observation demonstrates how individuals in the science community used their insight into the wider implications of energy use. This case also illustrates the relationship between, and the interests of, the pre-nationalisation bodies which had oversight of the ESI. Tizard went on to ask the Ministry of Fuel and Power whether the Electricity Commissioners could be persuaded to take a broader view of fuel efficiency. Wider energy considerations – the responsibility of the Ministry of Fuel and Power – are in contrast to the narrower remit of the Electricity Commissioners. The issue of district heating was also raised in Parliament. In July 1947 in the wake of the approval decision the Minister of Fuel and Power was asked whether Bankside could be converted to a thermal-electric station to supply hot water as well as electricity to the adjoining area, with the aim of reducing the size of the station – which would bring about a further amenity benefit. The Minister, Emanuel Shinwell, skirted around the issue of size and took the narrower view in stating that the

[43] TNA, CAB 124/432, Cabinet Office, Ministry of Reconstruction, Location of power stations, file note R. Ferguson to H.T. Tizard, dated 1 July 1947.
[44] TNA, POWE 14/265, City of London District Heating Scheme, Bankside, Letter from H.T. Tizard to Sir Ronald Fergusson (Ministry of Fuel and Power), dated 2 July 1947.

purpose of Bankside was to generate electricity at the earliest possible date and that the owners of Bankside would consider district heating when the local authorities were in a position to state their heat requirements.[45] The issue of district heating was therefore not developed in 1947 because of the imperative of providing electricity and the uncertain requirements of local authorities. Responses to the issue suggested that the matter could be considered later, and district heating became a recurring topic for Bankside 'B' power station over the following decades.

In summary, the engineers at Bankside 'B' were able to respond to the challenge of the imposed oil-firing decision with a number of design changes to the power station. These changes were mostly advantageous in terms of cost, amenity and visual impact. The main issue that remained for the designers and engineers was the treatment of the sulphurous flue-gases. In addition, in the following years, several alternative and experimental technologies were proposed for the power station.

Refining choices: alternative and experimental technologies, 1949-52

Bankside, as an innovative and high profile power station, was seen as a potential test ground for new ideas by the scientific and engineering community. Many of these ideas were not developed beyond an initial assessment, although some entailed considerable effort by the engineers or by the Ministry of Fuel and Power to evaluate the proposals. One technology in particular, the flue-gas desulphurisation (FGD) or flue-gas washing plant, was crucial to the power station since it was a consent condition. This technology underwent a rigorous and comprehensive evaluation,

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[45] *Hansard*, House of Commons debates, 3 July 1947, Vol.439 cc.175-6, the matter of district heating was also raised in November 1948 but Hugh Gaitskill (the Minister of Fuel and Power) responded 'We cannot reopen that subject now', *Hansard*, House of Commons debates, 18 November 1948, Vol.458 cc.556-8.

together with a pilot-plant assessment before being installed. This section provides a detailed account of how the process of technical decision-making operated at Bankside power station.

Although oil-firing had been specified by the Cabinet, several alternative forms of technology and fuel options were subsequently considered by the BEA (the post-nationalisation owners of Bankside power station from April 1948) and by the Ministry of Fuel and Power for their potential economic, strategic or amenity benefits. In January 1949 the Chief Scientist's Division of the Ministry raised the issue of whether the use of gas-fired gas-turbines had been investigated since they 'would obviate many of the objections now being met with in the present plans for an oil-fired steam station', i.e. the sulphur emissions in the flue-gases.[46] In 1949 the gas-turbine was a new technology that would have been of especial interest to the Ministry's Chief Scientist Harold Roxbee Cox. Cox had formerly been director of the National Gas Turbine Establishment which had undertaken research on aero-engines and other gas turbine applications.[47] Cox noted that some industrial gas-turbine sets were in operation running on gas.[48] Gas-turbines had been discussed at the public inquiry and the inquiry report mentioned 'the probability that the gas turbine will supplant the steam turbine as a prime-mover for the production of electricity'.[49] (See Appendix A for details of the operation of steam and gas turbines). In the late 1940s, experimental gas-turbines were being planned for some British power stations. It was envisaged that operating experience would be necessary before larger machines could be built – an

[46] TNA, POWE 14/202, Ministry of Fuel and Power, Bankside power station coal tar fuel, 1949-55, File note by D.J. Bolton, dated 18 January 1949.
[47] A.P. Baker, 'Harold Roxbee Cox (1902-1997)', *Oxford Dictionary of National Biography*, (2010) www.oxforddnb.com/ezproxy.lib.le.ac.uk/view/article/68788 [accessed December 2013].
[48] TNA, POWE 14/202, File note 8, H. Roxbee Cox to Mr Marston, dated 12 February 1949.
[49] TNA, HLG 79/918, Report of the public inquiry, paragraph 13. The inquiry report goes further and mentions the 'speculative possibility of using atomic energy'.

example of the evolutionary nature of technological developments. A 15 MW gas-turbine was commissioned at Trafford power station Manchester in August 1952 but did not enter commercial service until 1957. Similarly gas-turbines at Dunston and Dundee power stations were commissioned in 1955 – much later than planned – but they proved to be problematic and it was noted that 'reliable commercial operation seemed unlikely' and they were taken out of service in 1960.[50] Furthermore, these were small machines with an output of 12-15 MW; in comparison the first half of Bankside 'B' had two steam turbines each rated for 60 MW. Commercially successful gas-turbines were not developed until the mid-1960s where they were used in conventional power stations to meet the peak loads.[51] Thus the suggestion about gas-turbines at Bankside was not viable under the economic conditions and with state of technological development in 1949. However, the future context was different: advances in technology have led to the large-scale use of gas-turbines for electricity generation since the early 1990s.[52]

In response to the question raised in January 1949 of using gas-turbines at Bankside it was noted that there was not sufficient town gas available in south London to run such turbines.[53] Furthermore, it was recognised that although burning gas 'may be the answer to the amenity problem' the price of gas varied too much for it to be a viable economic proposition.[54] The question of amenity advantage in this case is of interest because of the pollution, fuel supply and financial issues it raises. Although

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[50] Electricity Council, *Electricity Supply*, p.66 and p.71.
[51] Harlow, *Innovation and Productivity*, pp.82-84.
[52] The use of the more advanced combined cycle gas-turbine increased considerably in the 'dash for gas' in the early 1990s. M. Winskel, 'When Systems are Overthrown: The 'Dash for Gas' in the British Electricity Supply Industry', *Social Studies of Science*, 32:4 (2002), pp.563-98.
[53] TNA, POWE 14/202, Minute from A.N. East to M.P. Murray, dated 14 February 1949.
[54] The price of gas varied from 3d. to 10d. per therm, see TNA, POWE 14/202, internal note from C.H. Secord to Dr. H. Roxbee Cox dated 10 February 1949.

town gas contains only small amounts of sulphur, its production required coal to be burned which added to atmospheric sulphur emissions. A by-product of the gas industry was coke which was burned in furnaces and domestic fireplaces, and which added further sulphur to the air. A calculation made in 1963 demonstrated that to generate one million therms in a power station by burning coal would release 208 tons of sulphur into the atmosphere. To generate the same amount of heat from town gas, 82 tons of sulphur would be discharged to the atmosphere from the secondary burning of coke by factories and households.[55] In this case instead of a local emission of sulphur from the power station, using town gas to run gas turbines would reduce overall sulphur emissions by a factor of 2½ and the sulphur would be more dispersed – and therefore more diluted – across a wide area from local chimneys. It was therefore true that 'making gas from coal did not release as much sulphur into the air as did the process of burning coal in large quantities […] [to] generate electricity'.[56] However, to produce a million therms would require over 3½ times as much coal to be carbonised at a gas works than burning coal directly at the power station.[57] Given the critical shortage of coal in the post-war period, using town gas to run a power station would be an extravagant use of a limited resource. Furthermore, the production and distribution costs of town gas made it about five times more expensive than coal for the same amount of energy.[58] Although town gas as a potential fuel for Bankside power station

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[55] M. Falkus, *Always Under Pressure, A History of North Thames Gas since 1949* (London, 1988), p.54.

[56] LMA, LCC/PC/GEN/01/052, Electricity Generating Stations, LCC meeting notes, dated 30 July 1947.

[57] One ton of coal produces 77 therms of town gas, E.G. Stewart, *Town Gas: Its Manufacture and Distribution* (London, 1958), p.2. Assuming the calorific value of coal is 12,241 Btu/lb or 274.2 therms per ton, then for the same amount of energy (therms) the amount of coal needed to produce town gas is 274.2/77 = 3.56 times the amount by burning coal directly. The value of 12,241 Btu/lb is based on the mean calorific value of supplied to Bankside 'A' over the period 1953-9 from *Garcke's Manual of Electricity Supply*, various volumes, 1953-9.

[58] In 1950 the cost of coal was about 64/3d. per ton, Falcus, *Always Under Pressure*, Table 3.1, p.47. Given that the calorific value of coal is 274.2 therms per ton, the thermal cost of coal is therefore about 2.81 d./therm. In 1950 the average selling price of town gas by the North Thames Gas Board was 14.15 d./therm (Falcus, *Always Under Pressure*, Table 3.2, p.48.). Town gas was therefore five times as expensive per therm as coal.

had an advantage in terms of air pollution, it was the lack of availability of sufficient quantities of town gas and its cost which ruled out the proposal for its use in gas turbines.

Other fuels were also considered for Bankside ‘B’ for their amenity or economic benefit. Alternative fuel suggestions included creosote pitch – a coal tar fuel produced as a by-product at gas works and tar distilleries.[59] An official in the Ministry of Fuel and Power learned that a considerable quantity of creosote pitch was available.[60] The advantage of this fuel was its relatively low sulphur content of 0.5-1.0 per cent, this was attractive since it was thought that the need for flue-gas washing for the second half of Bankside could be re-examined, and if adopted would reduce the running costs of the station. Creosote pitch would provide a dollar saving. Fuel oil had to be bought on the world market and a home produced fuel would have an economic and strategic advantage.[61] However, the ‘considerable quantity’ of creosote pitch available in mid-1949 appears to have been less certain by the end of the year.[62] One reason was the political-economic issue of the devaluation of Sterling in September 1949 and the resulting increase in fuel prices. This had led other fuel users to make enquires about creosote pitch.[63] Suppliers in the southern Britain had been prepared to make available 60,000 tons a year for Bankside, the remainder was to come from northern suppliers. These suppliers already had a profitable market in the chemical

[59] TNA, POWE 14/202, Letter from the BEA to the Ministry of Fuel and Power, dated 3 November 1949.
[60] Ibid., Personal note from M.P. Murray (Ministry of Fuel and Power) to Carpenter (BEA), dated 16 September 1949.
[61] BEA, *British Electricity Bulletin*, January 1950.
[62] The annual production of creosote pitch mixtures in 1949 was 0.43 million tons compared to a consumption of 0.36 million tons, in 1950 all the production of 0.58 million tons was being consumed, R. Stone and K. Wigley, *The Demand for Fuel 1948-1975 A Submodel for the British Fuel Economy* (Cambridge, 1968), Table A.7, pp.106-07.
[63] TNA, POWE 14/202, Letter from the BEA to the Ministry of Fuel and Power, dated 15 November 1949. The devaluation was announced by Stafford Cripps on 18 September 1949, see for example D. Kynaston, *Austerity Britain 1945-51* (London, 2008), pp.347-51.

industry and the BEA were unable to obtain any assurances about the amounts available. One official suggested that the creosote pitch people had ‘whetted our appetites with a story of large supplies’ and then said that supplies were restricted to give the impression that they were not anxious to get rid of their surplus so as to maintain prices.[64] There was also the technical issue that fuel oil and creosote pitch could not be mixed, so there would have to be two entirely separate fuel systems at Bankside ‘B’, thereby adding to the cost and complexity of the power station.

Despite the cost and supply issues of creosote pitch, a technical evaluation of the fuel was undertaken. Two of the oil-fired boilers at Bankside ‘A’ was adapted and converted on an experimental basis in December 1949 as part of the pilot gas-washing plant using creosote pitch from the gas works at Beckton and Greenwich.[65] These experiments showed that no major problems were experienced with handling or burning the fuel.[66] This demonstrates how the BEA were prepared to assess these suggestions and to experiment with alternative fuels. The experience of the Palace of Westminster, where creosote pitch was used in the boilers, was also drawn upon. An official at the Ministry of Fuel and Power commented that the BEA had been forced by Parliament – actually the Cabinet – to use expensive gas-washing at Bankside to prevent harm to the fabric of St Paul’s, yet Parliament ‘does not require any particular precautions to be taken in regard to their building’.[67] The comment was not entirely fair: the Palace of Westminster used 2500 tons a year of creosote pitch compared to

[64] TNA, POWE 14/202, File note by M.P. Murray, dated 20 February 1950.
[65] TNA, POWE 14/142, Ministry of Fuel and Power, Gas washing plant Battersea: Bankside, 1948-49, Letter from the BEA to the Ministry of Fuel and Power, dated 2 February 1949.
[66] TNA, AY 6/168, Department of Scientific and Industrial Research (DSIR): Fuel Research Station, Report: ‘Grit emission from Bankside generating station’ (1952), Table 1. One drawback was noted, there was an excessive deposition of carbon on the burners which required frequent cleaning. BEA, *British Electricity Bulletin*, January 1950.
[67] TNA, POWE 14/202, Minute from M.P. Murray (Ministry of Fuel and Power) to G.A. Gardner (Ministry of Works), dated 1 June 1950.

about 120,000 tons a year that would have been required for Bankside ‘B’. Despite the promising practical results an analysis indicated that burning creosote pitch without gas-washing would create more sulphur pollution than oil with gas-washing. This undermined the case for operating the second half of Bankside without the flue-gas washing plant. Again it is notable that the suggestions about alternative fuels and technologies was made by the Ministry of Fuel and Power with its wide remit rather than the BEA which, in 1949-50, was reluctant to change the design of Bankside ‘B’ as it would have delayed commissioning. The focus of the BEA at this time was on the national shortage of generating capacity, although they were prepared to assess and even to experiment with these alternative technologies.[68] The cost and supply issues of the alternative fuel, together with the additional pollution, proved to be the deciding factors and the BEA concluded that the creosote pitch proposal would have to be abandoned.[69]

One technology that had to be deployed at Bankside ‘B’ was the flue-gas washing or flue-gas desulphurisation (FGD) plant. This technology was comprehensively assessed to provide an optimum plant for Bankside. FGD is an example of a technology that is provided for a social amenity benefit but which had significant technological implications and economic costs. The technology was not innovative as it had been installed in two earlier London power stations. The operational experience from these stations enabled a more effective plant to be designed for Bankside.

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[68] In 1950 British generating capacity was 13,518 MW, and the maximum potential load was 13,840 MW, a capacity deficit of 2.4 per cent, see Hannah, *Engineers*, Table A.1, p.291.

[69] The price of the coal tar fuel was 6⅝d. per gallon and Bunker ‘C’ fuel was 6⅛d. per gallon, its was noted that the latter price would fall as a result of the new refinery programme, TNA, POWE 14/202, Letter from the BEA to the Ministry of Fuel and Power, dated 9 February 1950.

As discussed in Chapter 2, power stations, including Bankside 'A', had been the subject of complaints about atmospheric emissions of smoke, soot and grit from the early days of the industry. The increasing size of urban power stations from the 1920s, particularly the 'super-stations', made this issue more acute. In 1927 the LPC had applied for consent to build the first phase of Battersea power station. This was designed to burn 2000 tons of coal a day. There were concerns about the damage that the smoke and sulphur dioxide (SO_2) in the flue-gases would have on the fabric of buildings by causing stone erosion and on plants and trees.[70] The complexity of socio-technological interactions is demonstrated in the counter-argument, made by the Electricity Commissioners, that the new Battersea station would enable inefficient and more polluting plant to be closed down, and that the wider availability of electricity would enable large numbers of smoky domestic fires and small inefficient factory boilers to be decommissioned. The Commission's argument was not convincing.[71] The LPC had to install a desulphurisation process at Battersea to remove sulphur dioxide from the flue-gases by washing them with a large quantity of river water. This dissolved the sulphur dioxide and produced a dilute calcium sulphate solution that was discharged as effluent into the Thames. A non-effluent process was developed in 1936 at Fulham power station, also on the Thames two miles upstream of Battersea. This scheme was devised because Fulham was not permitted to discharge any effluent into the river at this point.[72] The plant was known as the Howden-ICI process in which the flue-gases were scrubbed by a circulating suspension of lime or chalk in water. This produced calcium sulphate as a sludge which was disposed of at sea. Both of these technological solutions had financial and amenity disadvantages. The plant for both

[70] Luckin, *Questions of Power*, p.142 and pp.452-53.
[71] Part of the counter-argument was that domestic coal was less noxious that the coal burned in power stations. Sheail, *Power in Trust*, p.8, see also Luckin, *Questions of Power*, p.146.
[72] TNA, DSIR 8/93, DSIR, Removal of sulphur compounds, Electricity Commissioners note on 'Elimination of sulphur compounds from flue gases', dated 21 February 1944.

systems had significant capital and operating costs which increased the cost of generating electricity. The Battersea process cooled the flue-gases to such an extent that under certain atmospheric conditions the fumes would sink to the ground and cause a local nuisance. Both systems produced distinctive white chimney plumes and during the war neither of the gas-washing plants were operated as it was thought that the plumes would aid location by enemy aircraft.[73] The Fulham plant was not restarted after the war because of the high capital cost of renewing the equipment which had been 'cannibalised' to aid the war effort. Two viable but potentially problematic types of plant were therefore available to the designers of Bankside power station.

As demonstrated in Chapter 3, the issue of fumes from Bankside was not framed as a public health issue but rather in terms of the effect on stonework in the City of London. The effects are illustrated in Figure 4.5 which shows the stone erosion that had taken place on St Paul's cathedral as a result of London's polluted atmosphere.

[73] Sheail, *Power in Trust*, p.52; Cochrane, *Landmark*, p.31.

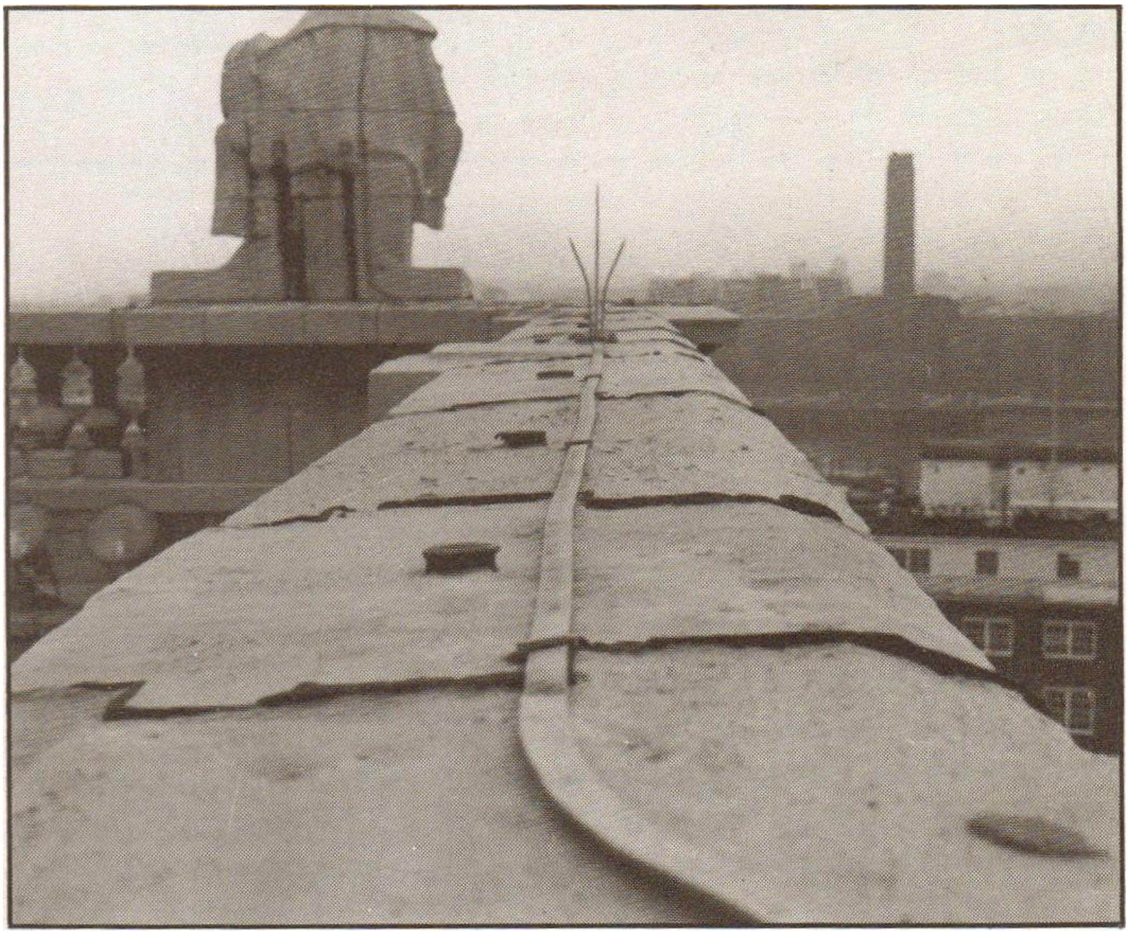

Figure 4.5: Stone erosion on the parapet of St Paul's cathedral.

Source: M.J.R. Schwar and D.J. Ball, *Thirty Years On: A Review of Air Pollution in London* (London, 1983), p.21. Reproduced with permission. London Metropolitan Archives.

Note the extent of stone erosion is revealed by the dark lead plugs originally flush with the surface, Bankside power station is in the background.

The secondary nature of the public health issue echoes that at Battersea, both when it was being planned and the recorded experience from the power station. In 1947 it was claimed that since commissioning in 1933 there had only been six complaints about vapour descending from Battersea's chimneys.[74] There is a distinction to be made between nuisances and recorded complaints; complaints are likely to be only a fraction of the number of actual nuisances caused by the power station. The decision to make

[74] TNA, POWE 12/798, Evidence given by Sir Leonard Pearce at the Bankside public inquiry, day 1, p.36.

Bankside oil-fired had been made for visual amenity reasons but the wider implications of this decision soon become apparent. The high sulphur content of oil, and the ways this should be dealt with in the flue-gases, presented a considerable challenge to the designers at Bankside 'B'.

In the late 1940s the DSIR were considering the wider use of flue-gas desulphurisation to address the issue of air pollution and sulphur dioxide. They noted that the total amount of coal burned in Britain in 1949 was 193 million tons and the total amount of sulphur dioxide released into the atmosphere was about five million tons of which electricity generating stations accounted for about 17 per cent. In the London area the greater concentration of urban electricity generating stations meant that they accounted for 29 per cent of the total amount of sulphur dioxide discharged to the atmosphere. The DSIR suggested that if all the sulphur compounds were removed from all of the power stations in the London region the amount of sulphur emitted would be reduced by less than one third.[75] They were making a case for not installing FGD in power stations, as doing so would not only be costly but would leave a large residual amount of air pollution. But a counter-argument of this analysis is that FGD would be most effective in reducing pollution if it were deployed at the London power stations. However, FGD was not an option for Bankside 'B', it was a mandatory consent condition.

The BEA undertook a thorough, comparative, economic and practical analysis of FGD systems before installing the technology at Bankside. The BEA used operating

[75] TNA, POWE 14/130, Ministry of Fuel and Power, 'Report of the Department of Scientific and Industrial Research working group on the removal of sulphur compounds from the flue gases of electricity generating stations', dated 1951.

data from the pre-war Battersea and Fulham Howden-ICI processes scaled to a hypothetical 200 MW oil-fired power station – simulating Bankside – and using a coal-fired station operating the Battersea process as a comparative benchmark. Some of the results of this analysis are shown in Table 4.1.

Table 4.1: Technical comparison of flue-gas treatment processes.

Operating parameter	Fuel and flue-gas process:		
	Benchmark	Bankside options:	
	Coal-fired, Battersea process	Oil-fired, Battersea process	Oil-fired, Howden-ICI process
Sulphur in fuel, per cent	0.9	2.8	2.8
Sulphur in flue-gases, tons/hr	0.688	1.67	1.67
Sulphur discharged from chimney, tons/hr	0.069	0.167	0.167
Sulphur discharged into river, tons/hr	0.619	1.503	0
Discharge temperature of flue-gases, °F	85-110	65-90	130-140
Waste solids produced, tons/hr	0	0	21
Total energy required to run the treatment plant, kWh per hour	800	1095	458+
Total energy required as percentage of units of electricity sent out, %	0.40	0.54	0.23+

Source: Museum of Science and Industry (MOSI), A1989.338/17/2, BEA, 'A short account of the London Flue gas washing processes', dated 3 March 1949, adapted from Tables 1, 2 & 3.

Note the figures are the peak hourly rates on the basis of a 200 MW power station. The sulphur removal efficiency is 90 per cent, this was later increased to 95 per cent. The energy use for the Howden-ICI plant is marked as shown; these figures appear to be too low in view of the actual operating costs in Table 4.2 and the estimated costs in Table 4.3.

The data shows that the Howden-ICI process offers advantages in terms of river pollution, running costs and in the discharge of warmer flue-gases. The figures do not include the costs associated with the chemicals required for the process, nor the capital cost of equipment. Cost data was available from the pre-war operations at Battersea and Fulham power stations and the average operating, maintenance and capital cost of these processes are shown in Table 4.2.

Table 4.2: Actual costs of the flue-gas treatment plants at Battersea and Fulham.

Costs	Battersea 'A' (1934-39)	Fulham (1938-39)
Operating cost, d./kWh sent out	0.0016	0.0060
Maintenance cost, d./kWh sent out	0.0026	0.0047
Capital cost, £ per kW installed	1.45	1.36

Source: MOSI, A1989.338/17/2, BEA, 'A short account of the London Flue gas washing processes', 1949, adapted from Table 6.

Note the operating and maintenance costs varied from year to year, the costs quoted are the mean over the years shown.

The data in Table 4.2 demonstrates the significant operational and maintenance cost advantages of the Battersea process, albeit at a slightly higher capital cost. Before any decision was taken the BEA undertook a practical evaluation. A pilot plant was installed at Bankside 'A' to prove the efficacy of both processes using a high-sulphur oil. Plant trials were undertaken during 1949-50 and appeared to have worked satisfactorily. The BEA confirmed that the outlet temperature of the flue-gases was low, and said that they 'do not, therefore, rise from the chimneys like the gas from a station where no washing is in progress'.[76] After the pilot plant test the BEA concluded that there was little difference in the effectiveness of either type of plant but the capital and operating cost of the Howden-ICI process was significantly higher as shown in Table 4.3.

[76] TNA, POWE 14/141, Letter from C.J. Hornsby (BEA) to the Ministry of Fuel and Power, dated 16 November 1949.

Table 4.3: Estimated cost of the flue-gas treatment plant at Bankside.

Costs	Type of flue-gas treatment:	
	'Battersea' plant	'Howden-ICI' plant
Capital cost for complete station	£550,000	£956,200
Annual operating costs excluding repairs and maintenance	£40,058	£106,610
Average annual energy cost as a percentage of units sent out	0.57	0.69

Source: Adapted from TNA, POWE 14/141, Ministry of Fuel and Power, Bankside Generating Station flue gas washing plant, letter from C.J. Hornsby (BEA) to the Ministry of Fuel and Power, dated 16 November 1949.

Note the additional annual operating cost for the ICI-Howden process are for additional chemicals (£27,000) and disposal of sludge (£25,000).

The BEA concluded that a modified form of the Battersea process should be installed at Bankside. (See Appendix A for a description of the operation of the Bankside 'B' FGD plant). The final capital cost of the flue-gas washing plant at Bankside 'B' was actually less than the above estimates, and the efficiency of sulphur removal was higher.[77] The analysis undertaken by the BEA demonstrates that the selection process was rigorous and addressed financial, technical, and operational factors. The envisaged benefit of pollution-free emissions – Bankside's 'smokeless shimmer of vapour' – was not completely realised since the technology itself led to occasional local nuisances from 'plume droop'. In Chapter 5 – Bankside in Operation, I show that flue-gas washing was ultimately a dead-end technology. No further full scale FGD systems were installed in British power station until the 1980s.

[77] Museum of Science and Industry (MOSI), A1989.338/17/2, BEA, 'Bankside Gas Washing Plant Cost', dated 14 January 1953. Civil works for the flue-gas plant were estimated at £290,000, the associated plant £84,000 and the electrical plant £17,000, a total of £391,000 for the first half of the station. The estimate for the complete station was £430,000 against the original estimate of £550,000 shown in Table 4.3.

The location of Bankside 'B' power station, upwind of St Paul's cathedral and the City of London, was the main reason for the use of this technology. The issue of location and air pollution was significant for other London power stations in the late 1940s. Brunswick Wharf power station in Poplar was developed at the same time as Bankside. The Electricity Commissioners argued that the necessity for gas washing:

> with the heavy additional cost it involved, had not been proved and that the incorporation of high chimneys would result in the diffusion of the flue-gases and prevent high local concentration of sulphur compounds.[78]

This was accepted by Poplar Borough Council which, as the pre-nationalisation electricity undertaking, would have received the projected revenue of £40,000 per annum from the station. FGD would have added to the cost of generating electricity and reduced this revenue. The issue of location is significant in this case: Brunswick Wharf was in the East India dock, upwind of the relatively poor industrial districts of Poplar, Canning Town and West Ham. Whereas Battersea, Fulham and Bankside power stations were upwind of Westminster, Fulham, Chelsea and the City of London – all comparatively wealthy and less industrialised districts, and whose councils had opposed the power stations. There appears to have been little local opposition to the development of Brunswick Wharf. The Electricity Commissioner's consent in November 1946, six months before Bankside 'B', included a clause that space was to be provided for flue-gas washing equipment if it was ever required in future, but none was ever fitted.[79] The adverse effects of air pollution on a locality can be contrasted

[78] The Ministry of Health, the Ministry of Works and the Government Chemist concurred with the view of the Electricity Commissioners that in the case of Brunswick Wharf that no gas washing plant need be installed.LMA, LCC/PC/GEN/01/052, Electricity Generating Stations, File note of a meeting between the LCC, the Ministry of Health and others entitled 'Sulphur emissions from power stations' n.d. but *c.* late 1947.

[79] TNA, POWE 12/702, Ministry of Fuel and Power, Power Stations and Generating Plant: Poplar, Brunswick Wharf, 1940-1949, Letter from the Electricity Commissioners to Poplar Borough Council, dated 6 November 1946.

with the potential benefit that a power station could provide as a source of space heating for neighbouring properties.

During the period 1949-52 the issue of using Bankside ‘B’ to supply a district heating scheme was raised again. There was an increased interest in such schemes from local authorities and private companies in this period because of the technically successful development of the Pimlico heating scheme.[80] In the late 1940s Westminster City Council had planned to rebuild an area of 31 acres with modern centrally-heated blocks of flats at the Churchill Gardens estate in Pimlico. The presence of Battersea power station directly across the Thames provided the opportunity to use heat from Battersea to warm the flats. Work was started in 1949 and the first heat was supplied to a block of flats in February 1951 and was eventually extended to 3200 homes.[81] Hot water was piped from Battersea power station to an accumulator tower in Pimlico and thence to residential buildings.[82] The scheme was estimated to have saved 13,694 tons of coal over a five year period or a 29.2 per cent fuel saving compared to conventional boiler plants. Several other advantages of the scheme were noted: there was less pollution as the flue-gases from Battersea were treated; there were no street deliveries of coal or collection of ashes; there was a reduction in domestic work associated with coal fires; living conditions were cleaner;

[80] See for example: A. Stubbs, ‘District heating’, *Proceedings of the Institution of Mechanical Engineers*, 160 (1949), pp.1-21. Stubbs was the manager of the Mechanical Department of Metropolitan Vickers Ltd. His scheme was for industrial, commercial, community and domestic users in a hypothetical town with a population of 250,000. The scheme gives estimates of the heat loads and costs and includes details such as the arrangements for underground distribution ducts.

[81] The agreement with the BEA was to supply a maximum of 448 therms per hour of heat (13.1 MW) and a maximum annual supply of 1,766,000 therms (51.7 GWh per annum). TNA, POWE 14/1121, Ministry of Power, CEA, ‘Final Report on the operation of the Pimlico District Heating Scheme’, dated April 1958, p.iv.

[82] The accumulator tower, still extant today, is 38 metres tall and 8.8 metres in diameter and was used to balance the heat load on the system.

and there was a reduction in labour associated with numerous boiler plants.[83] The heating scheme therefore appeared to provide a significant amenity advantage. However, the historian of technology Stewart Russell claims that Pimlico was a ‘headache for the BEA and its successor, committed as it was to a thirty-year supply’ and claims that neither the BEA nor Westminster City Council provided operating costs or ‘otherwise discuss its merits in public’.[84]

Other schemes proposed in London included those for the City of London and the South Bank. The requirements for district heating in the City were considered by the Ministry of Fuel and Power in 1949; it was noted that the completed power station at Bankside would have sufficient reject heat to support the whole of a City of London district heating scheme.[85] Elsewhere the LCC intended to redevelop the South Bank with government offices, a national theatre and public buildings, including a concert hall which was to become the Royal Festival Hall. Detailed estimates of the likely heat requirement of these buildings were calculated, and it was proposed to use heat from either Bankside or Battersea power station.[86] Yet none of these proposals, other than the Pimlico scheme, developed beyond the planning stage. This was primarily a question of economics: there were only marginal cost advantages to district heating schemes. This reflects Stewart Russell’s comment on the secrecy surrounding financial operating data for the Pimlico scheme.

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[83] TNA, POWE 14/1121, Final Report, p.24.
[84] Russell, ‘Writing Energy History’, p.41.
[85] This scheme had a projected requirement of 27 million therms per annum (791 GWh per annum) by 1977, TNA, POWE 14/202, file note by C. H. Secord (Chief Scientist’s Division of the Ministry of Fuel and Power) to Dr H. Roxbee Cox, dated 10 February 1949. This was about 15 times the size of the Pimlico scheme.
[86] TNA, POWE 14/265, file note ‘District Heating’ dated 2.12.1947, and Letter from the Chief Engineer of the LCC to the Ministry of Fuel and Power, dated 20 October 1948. Users would have included Government offices, a Concert Hall, a theatre, a hotel, County Hall and ‘shops, offices and flats’ in York Road.

District heating was supported by post-war legislation. Under the Electricity Act 1947, which nationalised the electricity industry, a statutory duty was placed on the newly constituted BEA 'to investigate methods by which heat obtained from or in connection with the generation of electricity may be used for heating of buildings in neighbouring localities'.[87] The use of heat in this way was a novel approach as hitherto the supply of heat – other than electric heating – had not been one of the functions of electricity undertakings. This new approach to heating was therefore enabled by the national body, the BEA, which now owned most British power stations. However, the statutory duty was 'to investigate methods' there was no compulsion to provide a system. The timing of the introduction of these powers did little to assist the development of district heating schemes associated with new power stations. From the 1950s much larger, non-urban, power stations were being planned. They were developed in the optimum location for fuel supplies and, as the Ministry of Power later noted, may 'well not be the places with very large concentrations of houses' that could take advantage of the waste heat.[88] The 1947 Section 50 legislation was therefore introduced at an unfortunate time in the development of the British ESI, just when the urban power station was in decline. Despite the unsuccessful proposals associated with Bankside power station, one small-scale space-heating scheme was deployed at Bankside in the 1950s. The auxiliary boilers were used to provide heat and hot water services to the power station itself and the adjacent offices of the BEA at Bankside House.[89]

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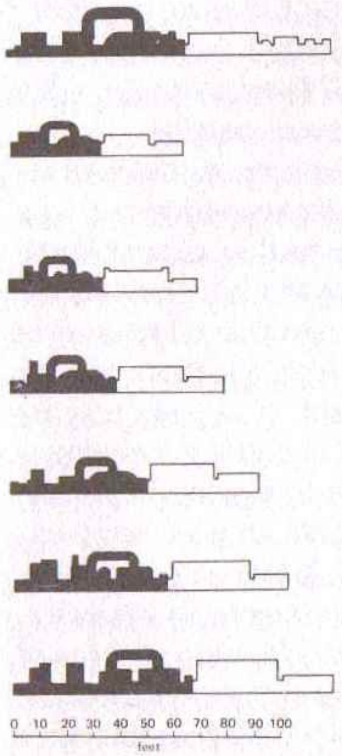
87 Electricity Act 1947, Section 50, London, HMSO.
88 TNA, POWE 14/1591, Ministry of Power, District Heating schemes: role of power stations, 1963-69, file note by A. Struthers dated 12 December 1963.
89 Pugh, 'The Generation of Electricity', p.488.

In summary, the period 1949-52 was the time when the design of Bankside 'B' was being refined, and the station was being built and commissioned. Several ideas about novel technologies that might be used at Bankside were proposed and considered. Bankside was valued by parts of the scientific community as a potential test site for new technologies. Most of these ideas were not developed beyond an initial assessment, although considerable efforts were made to evaluate some of the proposals. New technologies such as gas-turbines and district heating and alternative fuels such as town gas and creosote-pitch were evaluated. The issues of immature technological development, cost and supply counted against these proposals. Several of the technological suggestions in this period were made by the Ministry of Fuel and Power which was responsible for national energy policy, rather than the BEA who, at that stage, were reluctant to change the design of Bankside 'B' as it may have delayed commissioning. One successfully adopted technology was FGD which had undergone a rigorous technical, economic and practical evaluation. But which was ultimately to prove a dead-end technology. Developments in technology over the following decade had an impact on Bankside and significant effects on the wider ESI.

Technological change: size, efficiency and location, 1957-63

The first half of Bankside 'B' power station was commissioned in late 1952 and operated successfully, generating electricity for the London area, see Chapter 5 – Bankside in Operation. The next significant moment for the technological development of Bankside 'B' was the period from 1957-63 when the second half of the station was planned, built and brought into operation, and when the station was completed. The 1950s was a time of significant technological change in the ESI, and these changes had a direct impact on the second half of Bankside 'B'.



Size and steam conditions	First installed	Station cost per kW installed (1957 prices)	Average annual thermal efficiency (1957 estimates)
105MW 600 psi 850°	1935	n.a.	27.5%†
30MW 600 psi 850°F	1929 (first post-war 1948)	£75.5	25.5%
60MW 900 psi 900°F	1950	£61.9	28.0%*
100MW 1500 psi 1050°F	1956	£57.9	30.5%
120MW Re-heat 1500 psi 1000°F/1000°F	1958	£54.7	31.0%
200MW Re-heat 2350 psi 1050°/1000°F	1959	£54.2	32.0%
275MW Re-heat 2300 psi 1050°F/1050°F	1962	£50.0	33.5%

Source: *Proceedings of the British Electrical Power Convention 1957*, pp. 50, 109.

* Some of the later, non-standard 60MW sets, incorporating more advanced steam conditions and re-heat, achieved higher thermal efficiencies around 30 per cent.
† Estimated.
n.a. Not available.

Figure 4.6: Developments in turbo-alternators, 1929-62.[90]

Source: L. Hannah, *Engineers, managers and politicians: the first fifteen years of nationalised electricity supply in Britain* (London, 1982), Figure 9.1. Reproduced with permission of Palgrave Macmillan. This material may not be copied or reproduced without permission from Palgrave Macmillan.

[90] There are several, but different, figures for average capital costs for new power stations, for example Harlow gives a value of £58.5/kW in 1950 and £54.5/kW in 1959, Harlow, *Innovation and Productivity*, p.62. At the public inquiry Sir Leonard Pearce had said that the cost of the coal-fired Bankside 'B' would be £53.55 per kW, see TNA, POWE 12/798, public inquiry, day 1, p.37.

The most significant change during the 1950s and 1960s was the growth in both the size of power stations and their equipment. The business historian Leslie Hannah has charted the development in turbo-alternators that occurred over the period 1929 to 1962, this is outlined in Figure 4.6.[91] Most notable is the nearly ten-fold increase in turbo-alternator ratings from 30 MW to 275 MW. This change was mainly driven by economic considerations of increased efficiency and was facilitated by technological developments in construction, metallurgy and welding techniques to withstand the more intense conditions at which the larger machines operated.[92]

This technological change is demonstrated in the specification of the turbo-alternators at Bankside 'B'. The first half of the station had two 60 MW machines, it was envisaged that the second half of the station would be identical. When the second half was designed in 1957-59 the new 'standard' turbo-alternator size was 120 MW. At Bankside an English Electric 120 MW turbo-alternator set was installed (see Figure 4.7), together with its dedicated 'unit' boiler. The unit boiler was another innovation introduced in the 1950s from American boiler house practice. The unit boiler was dedicated to a turbo-alternator, rather than having a range of boilers shared amongst several turbo-alternators as provided in the first half of Bankside. See Table A.1 in Appendix A for details of the specification of the boilers and the higher operating conditions of the 1963 unit boiler.

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[91] Hannah, *Engineers,* pp.111-16. Hannah's Figure 9 extends a sequence demonstrating the earlier growth (1895-1940) of turbo-alternator capacities in Pearce, 'Review of Forty Years' Development', Fig.30, p.328. The sequence is extended in tabular form to 1970 in Harlow*, Innovation and Productivity*, Table 3.6, pp.78-81.
[92] Harlow*, Innovation and Productivity*, p.71. A. Sherry, 'The Power Game – The Development of Conventional Power Stations 1948-1983', *Proceedings of the Institution of Mechanical Engineers Part A power and process engineering*, 198:13 (1984), p.262.

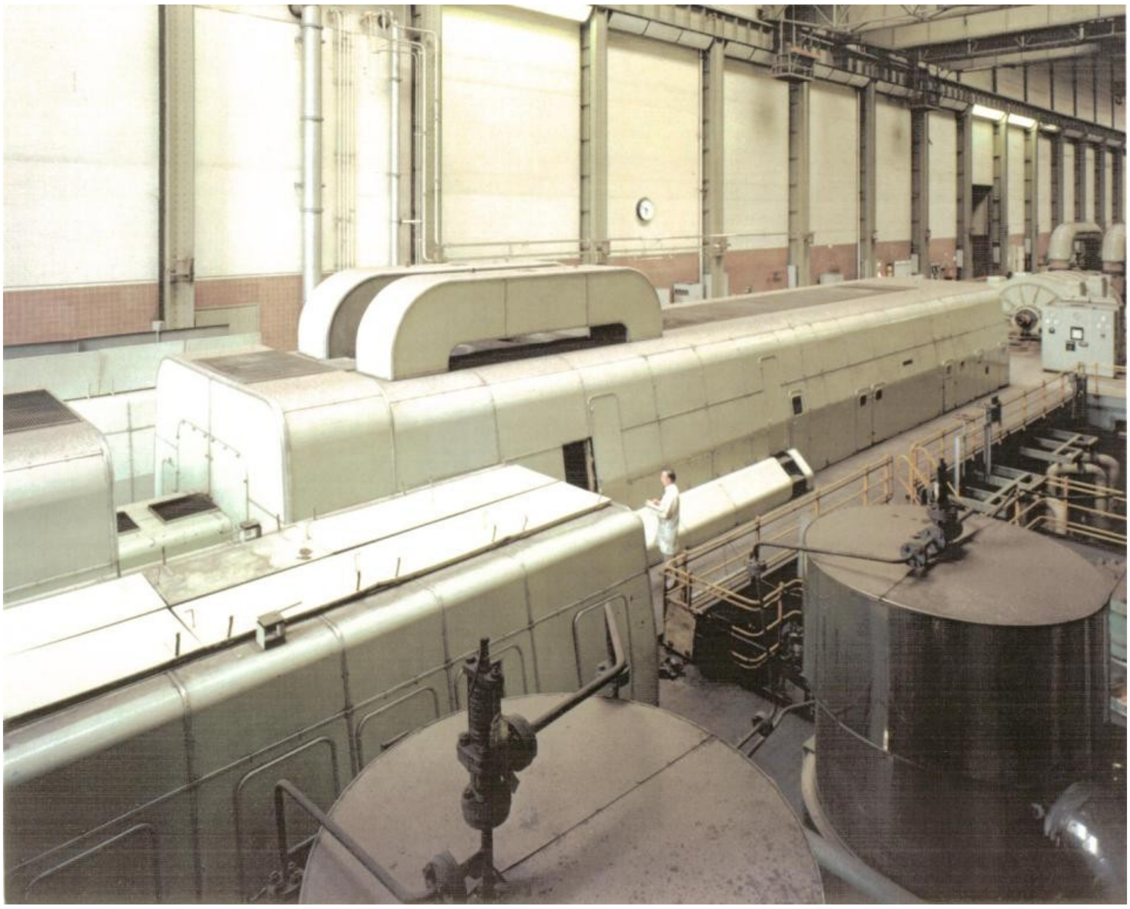

Figure 4.7: Techno-modernity: the 120 MW turbo-alternator at Bankside.

Source: G.B. Marshall, 'Tate Modern Its Industrial History', unpublished (2004), Southwark Local History Library, Illustration 23 (CEGB photo library).

Note the bright, clean, modern design and a white-coated technician.

The 120 MW machine was only slightly larger than the original 60 MW sets, so there was sufficient space within the turbine hall for a third 60 MW machine.[93] This was planned for installation in 1965, but in 1960 the CEGB noted that 'it now appears that capital expenditure on transmission into central London can be saved if the set is installed as soon as possible'.[94] This shows that the CEGB were able to take advantage of the central London location of Bankside power station to increase electricity supplies in the capital. The new set would provide extra generating capacity at

[93] 'Bankside LEB: Seventy Years at Bankside' *The Borough* (November 1961), p.23.
[94] TNA, POWE 14/1116, file note f.36 dated 19 October 1960.

relatively low capital cost because no further electricity transmission cables would be required and no new buildings or boilers would be needed. Bankside's original four boilers were found to be over-sized, perhaps conservatively designed because of the novel oil fuel. They were capable of delivering more steam than their maximum rating. This overcapacity enabled the four boilers to provide sufficient steam to the two original and the one new 60 MW turbo-alternator.[95] The installation of this final set was therefore brought forward to 1962 and it was commissioned before the 120 MW set. The final total output capacity of Bankside 'B' was therefore 300 MW.[96]

Associated with the growth in the capacity of power station equipment were changes in the size and location of power stations. From the 1950s many power stations were built near the coal-fields of the Midlands and Yorkshire where their requirements for the storage and handling of large quantities of coal and their cooling towers and tall chimneys could be more easily, and acceptably, accommodated than in urban locations.[97] Furthermore, for safety reasons nuclear power stations were built in sparsely populated areas around the coast. This locational change was enabled by the development of the electricity super-grid during the 1950s, the considerably lower electrical losses allowed electricity to be transmitted in bulk over long distances.[98]

As well as location, the form of power stations was also undergoing a transformation. The architectural historian Robert Furneuax Jordan, was critical of the brick cathedral power station which he considered was the 'largest, last and worst

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[95] Ibid., Letters from the CEGB to the Ministry of Power, dated 17 June 1960 and 15 September 1960.
[96] The final configuration at Bankside 'B' was: four original boilers supplying three 60 MW turbo-alternators and a single 'unit' boiler supplying the 120 MW machine, a total capacity of 300 MW.
[97] This is not to say that the non-urban station were uncontroversial; the CEGB made considerable efforts to reduce the amenity impact, see for example S. Crowe, *The Landscape of Power* (London, 1958); Sheail, *Power in Trust*, pp.138-66; CEGB, *Electricity Supply and the Environment*.
[98] See Hannah, *Engineers*, pp.102-04 and pp.252-53; Sheail, *Power in Trus*t, pp.127-33.

manifestation of the disastrous process that began at the Renaissance with the divorce of structure and 'design''.[99] His sentiment echoes the Royal Fine Art Commission's concerns about cathedral-like power stations, discussed above. However, Jordan's favoured style of the 'generating station as a machine' (see Figure 4.8), would not have been any more acceptable on the Bankside site than Scott's brick cathedral.

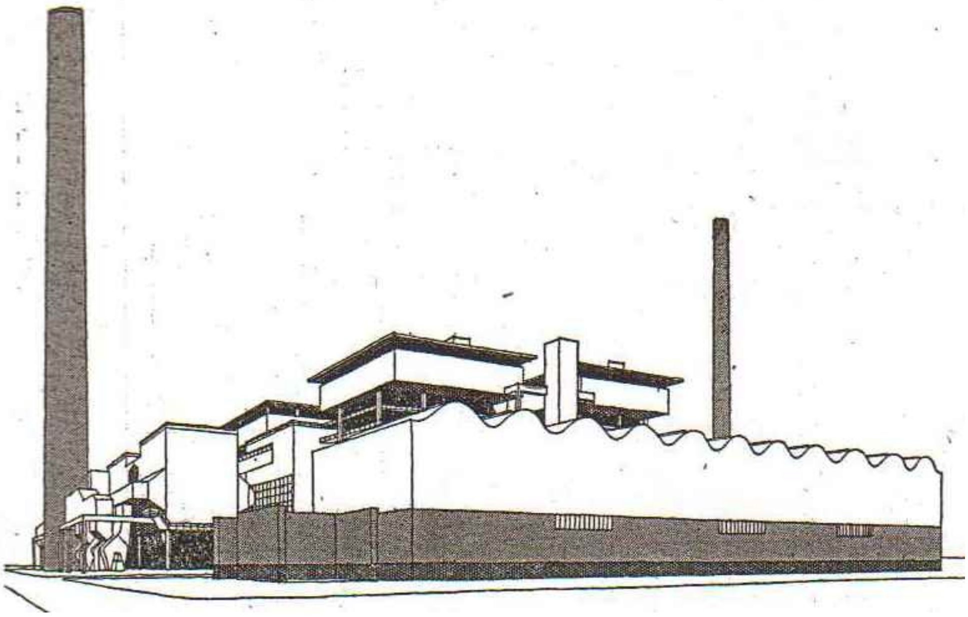

Figure 4.8: The power station as a machine.

Source: R.F. Jordan, 'Power Stations', *The Architectural Review*, 113:676 (April 1953), Figure 14, p.324. Reproduced with permission. *The Architectural Review.*

Nevertheless, the 'machine' style was adopted by many non-urban power stations from the 1950s. West Burton power station in Nottinghamshire won a Civic Trust Award, the citation said it was 'an immense engineering work of great style'.[100] Bankside 'B' was completed to Scott's original design, and later became admired as an 'an original and pure monumental expression of industrial and electric power'.[101] Although Jordan's conception may have been inappropriate for the central London location of

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[99] Jordan, 'Power Stations', p.230.
[100] A.J. Clarke, *Electricity Supply and the Environment* (London, 1979), p.8.
[101] G. Stamp and G.B. Harte, *Temples of Power: Architecture of Electricity in London* (Burford, 1979).

Bankside power station, the location enabled the possibility of district heating to be revisited.

When the CEA (the 1955 successor to the BEA) was planning the completion of Bankside in 1957 they re-examined the possibility of a district heating scheme for the City of London and developed a detailed proposal.[102] The CEA estimated that the completed station would be capable of supplying two-thirds of the total heat load in the City.[103] This was an ambitious, I would argue over-ambitious, scheme with an output about 30 times that of the Pimlico development. The CEA / CEGB's proposal was to be developed in four stages over the period 1962 to 1971.[104] The total capital cost was estimated at £12 million of which £10 million was to be borne by the Corporation of London and £2 million by the CEGB. The advantages of the scheme were the high heat load density in the City and the high standards of heating required for commercial firms and public buildings. This reflects the density and intensity of electricity use that I have suggested accounts for the success of the CLELC in the first half of the twentieth century. Bankside was well placed for supplying both electricity and heat to the City. In 1957 there was a new dimension to the argument in favour of district heating. Such as scheme in the City would aid compliance with the smoke control requirements which would otherwise entail the expense of converting boilers and purchasing smokeless fuel. The timing of the district heating proposal was topical and

[102] The BEA was reformed as the Central Electricity Authority (CEA) in 1955 after the independent South of Scotland Electricity Board had been established. From January 1958 the Central Electricity Generating Board (CEGB) took over from the CEA the duties of generation and transmission. Electricity Council, *Electricity Supply*, p.71 and p.73. The Electricity Act Section 50 legislative requirement to examine waste heat from power stations was still in force.

[103] The heat load to be supplied from Bankside was 13,330 therms per hour or 395 MW. TNA, POWE 14/265, City of London District Heating Scheme, Letter from the CEA to the Ministry of Power, dated 17 October 1957.

[104] Ibid., CEGB, Report: 'Proposed City of London District heating Scheme' n.d. but *c*.1958, p.2. The CEGB was established on 1 January 1958 taking over the role of electricity generation and distribution from the CEA.

coincided with the introduction of Smoke Control Areas under the Clean Air Act 1956. This had been enacted in response to the issue of urban smog, particularly the 'killer smog' episode of December 1952.[105] The district heating system would therefore not only save energy but, it was claimed, also reduce air pollution, and ensure compliance with legislation.

The district heating scheme would also have had an impact on the local built environment. Steam from the 120 MW turbine would be used to heat circulating water. This would be stored in five large accumulators, each 175 ft high and 50 ft in diameter on the corner of Sumner Street and Park Street south of the power station. These would have been a significant addition to the urban skyline at over twice the height of Bankside's main building and more than half the height of the chimney. The accumulators would have provided a supply when the power station was not operating and their height would determine the level to which users in the city could be supplied. Superheated water at 250°F would be sent in mains under the river to four distribution points in the City (see Figure 4.9).

The scheme appeared to offer some economic benefits over conventional heating.[106] The proposal was considered by the Corporation of London's policy committee who indicated they were unable to recommend its adoption to the Court of Common Council. They noted that while their decision was based on several factors

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[105] Ashby and Anderson, *The Politics of Clean Air*, p.104 and pp.111-16. Some commentators have claimed that the December 1952 smog episode had a much greater impact on public health than had previously been suggested, see M.L. Bell, D.L. Davis and T. Fletcher, 'A Retrospective Assessment of Mortality from the London Smog Episode of 1952: The Role of Influenza and Pollution', *Environmental Health Perspectives*, 12:1, Jan 2004, pp.6-8.

[106] The total cost per therm sold in the proposed scheme was 13.86d. for stage 1, falling to 12.64d., 12.19d. and 11.94d. in stages 2, 3 and 4. The estimated cost for a conventional oil-fired central heating plant was estimated as 13.8 to 15.5d. per therm. TNA, POWE 14/265, 'Proposed City of London District Heating Scheme', Table 2.

'the question of finance was largely in their mind' particularly the narrow margin between the cost of the supply of heat from the proposed scheme and more traditional methods.[107]

Figure 4.9: District heating distribution for part of the City of London, 1957.

Source: TNA, POWE 14/265, Ministry of Power, CEGB Report: 'Proposed City of London District heating Scheme'. Reproduced with permission. The National Archives.

Note the networked nature of the district heating supply system reflects the electricity supply network for the City shown in Figure 2.2.

Thus the opportunity provided by the completion of Bankside 'B' power station enabled a detailed technical and economic plan for a district heating scheme for the City to be developed by the CEA / CEGB. The marginal economic benefits counted against the scheme. The benefits of reducing air pollution were outlined in the proposal, but these advantages were not financially quantified. The environmental and economic tools for doing so were not available until the 1980s. Such an analysis would

[107] Ibid., Letter from the CEGB to the Ministry of Power, dated 2 July 1958.

have weighed the argument further in favour of the development of the district heating scheme.

District heating: fourth time unlucky - the primacy of economics, 1972-75

Although the 1957 scheme for the City of London was not adopted, the issue of district heating continued to be of interest to urban planners and the Ministry of Power during the 1960s. In 1964 a study was undertaken by the County Architect for a new town in North Buckinghamshire with a population of 250,000 in the form of 50 high-density housing areas, linked by a monorail system. There was to be a central commercial and shopping area with traffic and pedestrian segregation and pedestrian walkways. The Ministry of Power, in reviewing the proposal, noted that the development would be advantageous for district heating since the heat transmission mains could be accommodated within the monorail supporting structure, thus saving the cost of some 40 miles of underground pipe ducts, and that the distribution mains could be incorporated within the pedestrian walkways.[108]

The issue of district heating was raised again at Bankside in the early 1970s. On this occasion the proposal was developed as far as the installation of the physical infrastructure, but the timing was unfortunate, and the scheme was undermined by political-economic events and policy changes. The incentive for the scheme on this occasion was the redevelopment of the South Bank. Following deindustrialisation and the relocation of shipping and associated facilities to further down-river, the London Borough of Southwark prepared plans for the redevelopment of the increasingly derelict area of the South Bank. The plans included five million square feet of offices,

[108] TNA, POWE 14/1591, Ministry of Power, District heating schemes: role of power stations, file note by F.C. Lant dated 11 June 1964.

hotels with up to 10,000 beds, and homes for 7000 people. The CEGB and the London Electricity Board (LEB) contributed to the Council's plans and proposed to heat most of the development from hot water obtained from Bankside power station.[109] The ultimate area of supply was to be 70 hectares from Waterloo Bridge to downstream of Tower Bridge (see Figure 4.10).

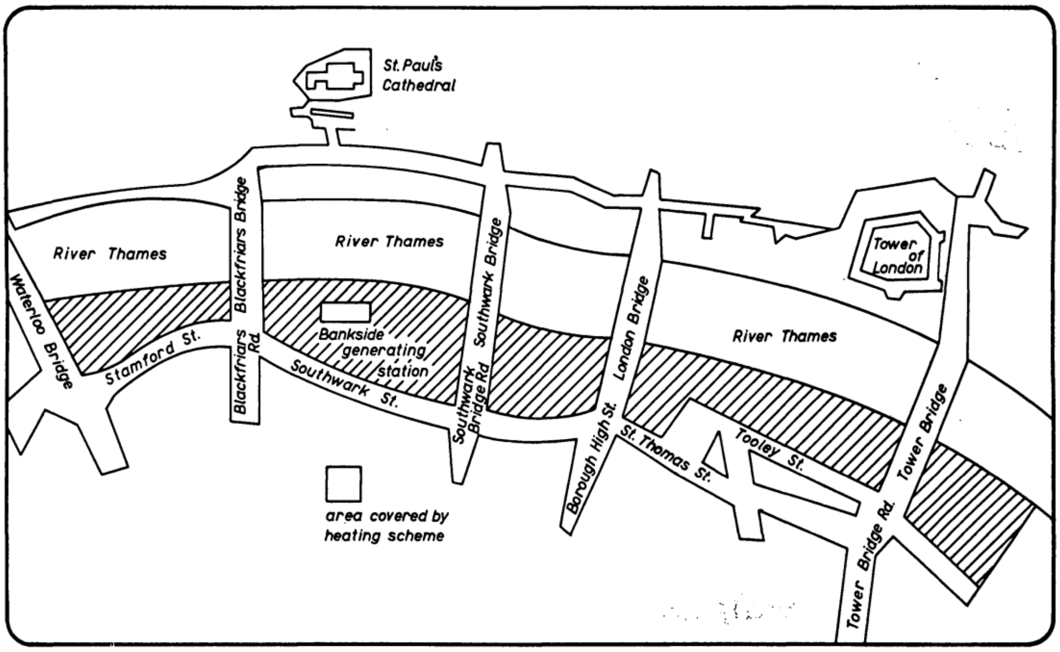

Figure 4.10: Extent of the LEB South Bank district heating scheme, 1972.

Source: J.J. Crawford, 'Total energy a realistic answer to fuel conservation', *Electronics & Power*, 19:10 (31 May 1973), Figure 4, p.212. Reproduced with permission. Institution of Engineering and Technology.

The LEB were given statutory authority to develop the scheme in 1971.[110] The heating load was initially expected to be about 50 MW, this was later increased to 63.5 MW and the ultimate heat load was envisaged to be 100 MW.[111] These heat loads were greater than the Pimlico scheme at 13.1 MW, but less than the over-ambitious 1957

[109] 'Heat from Power Station', *Financial Times*, 1 October 1971, p.10.
[110] The London Electricity Board Heating Scheme Order 1971 (Statutory Instrument 1971 No. 152) made under section 50(3) of the Electricity Act 1947. The order came into effect on 8 February 1972 and approved a scheme submitted by the LEB to use heat from the CEGB's Bankside power station to heat buildings in the locality.
[111] TNA, EG 2/1627, Department of Energy, Sizewell 'B' public inquiry, Note of a meeting between representatives of the GLC and the LEB on 28 June 1983.

City of London scheme at 395 MW. This suggests that the scheme was realistic, viable and practicable. The system was to include independent boilers in the power station. Steam from Bankside's boilers would be used to provide the heat when excess was available, and the independent boiler house was to be used to provide heat when all the steam was required for electricity generation or when the station was not operating. The independent boilers were to use the power station's fuel oil and would thus be independent of the electricity generating system. The LEB constructed a separate boiler house in the north face of the power station at the base of the chimney, installed some of the boilers, and laid underground distribution pipes in Tooley Street.[112]

Despite some of the physical infrastructure being installed, political and economic factors came into play to undermine the scheme. In September 1973 the new socialist Labour GLC administration asked the Borough of Southwark to reconsider its plans and to reduce the amount of office development and to give a greater emphasis to housing. The LEB said this change of policy was the principal reason for the failure of the scheme. However, a parliamentary report in 1974 noted that the scheme was in real difficulty because potential customers 'do not seem as keen as they appeared to be in the early discussion stages of the project'.[113] One potential user was the Ministry of Transport offices at St Christopher's House in Southwark Street, however, the Ministry of Building and Works which was responsible for implementing this development was said to have 'showed little interest'.[114] The original cost estimates for the scheme had

[112] Barry Kett (personal interview, November 2011) believes that three boilers were installed, these had been made in Sweden and brought to the power station by barge. The boilers were delivered to Bankside in January 1974, see 'Town's Heating', *South London Press*, 15 January 1974, p.1. G.T. Shepherd states that that the CEGB allowed to LEB to use the existing power station chimney for engine exhausts, G.T Shepherd, 'Waste Not, Want Not', *IEE Proceedings*, 134 A1 (1987), p.1.
[113] UK Parliament, Evidence given by Mr A.E. Hawkins at the Select Committee on Science and Technology, Energy resources, session 1974, 127-I. Minutes of Evidence taken 18 July 1974, p.164.
[114] TNA, EG 2/1627, Meeting of the GLC and the LEB on 28 June 1983.

been undertaken in 1971-72, but the Middle East oil crisis of 1973-74 had significantly increased the price of oil thus undermining its financial viability.[115] The LEB abandoned the project in May 1975 with large losses, including expenditure of £1.25 million on plant and equipment.[116]

Although district heating had been stimulated by the urban location of Bankside 'B' power station none of the proposed schemes from 1947 to 1974 were fully developed. This was due to financial and commercial, rather than technological reasons. The technology had been used successfully elsewhere and some physical infrastructure had been put in place at Bankside. Combined heat and power and district heating schemes (CHP-DH) continued to be proposed, such as one for Leicester in 1986 using heat from Ratcliffe power station or the gas-turbines at Leicester's Freeman's Meadow power station.[117] The issues were similar to those at Bankside. A member of the Leicester Combined Heat and Power consortium noted that financing of the project became 'far more critical than the technical problems'. The 1986 Leicester scheme failed to secure a supply contract, this had also been blamed on liberalisation of the electricity industry which 'shifted negotiating power away from CHP-DH

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[115] In 1970 Arabian light crude was less then $2 per barrel, on 1 January 1974 it was $11.65 per barrel, see C. More, *Black Gold: Britain and Oil in the Twentieth Century* (London, 2009), pp.146-47.

[116] Russell, 'Writing Energy History', p.44. 'Huge District Heat Plan Founders for Lack of Buildings to Warm', *South London Press*, 13 May 1975; the capital cost was estimated at £1.25 million at 1972 prices. UK Parliament, Evidence of Select Committee on Energy Session 1981-2, Combined heat and power, HC 60-vii, p.303. A note in the Sixth Report from the Energy Committee Session 1985-6 states that the property development did not go ahead because of 'a change in local Council and planning requirements', 1985/86 HC 488, note 58 p.xvi.

[117] I. Jarvis, 'Can a Successful City-Wide CHP Scheme be Launched in the UK?', *Energy Policy*, 14:2 (1986), pp.160-63.

schemes to larger centralised power plants'.[118] But proposals and developments continue, a district heating scheme has recently been commissioned in Leicester.[119]

Conclusion

This chapter addresses the technologies that were considered, examined, assessed and deployed in a somewhat atypical mid-twentieth century urban power station. The chapter illustrates how technological decision-making by the designers and owners of Bankside and by the Ministry of Fuel and Power operated in practice. A number of technological possibilities were considered but political imperatives, social issues and economic factors influenced the choices that were assessed and the decisions that were made. The historian of science and technology Stewart Russell has argued that the history of technology tends to ignore alternative technologies which remained undeveloped.[120] This chapter redresses this perception through the examination of several undeveloped and alternative technologies associated with Bankside and addresses why they were not developed.

This chapter is framed as a series of historical moments of significance and change for the power station. These moments demonstrate how Bankside and its technologies were viewed by its engineers and the wider scientific community and how these views and issues shifted over time. Bankside was initially intended to be a conventional coal-fired 'brick cathedral' power station but one which incorporated several technologies to mitigate its impact on the locality. The amenity value was

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[118] S. Kelly and M. Pollitt, 'An Assessment of the Present and Future Opportunities for Combined Heat and Power with District Heating (CHP-DH) in the United Kingdom', *Energy Policy*, (2010); doi:10.1016/j.enpol.2010.07.010, p.4.
[119] Cofely GDF Suez, 'Leicester District Energy', http://www.cofely-gdfsuez.co.uk/solutions/district-energy/district-energy-schemes/leicester-district-energy/ [accessed March 2013].
[120] Russell, 'Writing Energy History', p.34.

enhanced, as intended, by the imposed political condition to make the power station oil-fired. This had significant additional benefits as it reduced the capital cost of the station and enabled the height of the building to be lowered. During the time when Bankside 'B' was being constructed it was seen as a potential test site for new and innovative technologies by some in the scientific community. These ideas were evaluated but most were not deployed because of the state of technological development or unfavourable economic conditions. In the context of a significant shortfall in electricity supply capacity in the late 1940s and early 1950s the generation of electricity was seen as a priority and became a justification to dismiss some of the proposals. The flue-gas washing plant underwent a rigorous scientific and economic evaluation drawing on the pre-war experience from Battersea and Fulham and on the results from pilot-plant tests. The flue-gas washing plant was the best available technological solution to the problem of sulphur fumes despite the evidence and the argument from some engineers that its benefits were illusory. The evolutionary nature of technological developments in the wider ESI during the 1950s are reflected in the second half of Bankside 'B'. The issue of district heating has cross-cut the moments of significance identified in this chapter. The technology itself was practicable, as demonstrated in the Battersea / Pimlico scheme, but throughout the period from 1947 to 1975 its financial viability was undermined because of the marginal cost benefits, the inability to attract sufficient customers, or political planning decisions concerning office and housing developments. The next chapter examines how the technologies that were deployed at Bankside 'B' operated in practice. This includes an analysis of the extent to which the technologies installed at Bankside achieved their intended aim, and the changing externalities that influenced and affected the results that had been envisaged.

Chapter 5 – Bankside in Operation: effectiveness in changing environments

This chapter examines the operational history of Bankside ‘B’ power station from 1952 when it first generated electricity to 1981 when it was decommissioned. As noted in the literature review in Chapter 1 there are few histories of British power stations and it has been claimed that objective facts about elements of the operation a power station can never be fully recovered or reconstructed. The absence of the CEGB records makes this especially problematic. Nevertheless, this chapter aims to undertake a reconstruction of some aspects of the operation of Bankside based on the available information. The operational analysis in this chapter is therefore a significant addition to a sparse field of study. The focus on Bankside reveals how the power station functioned in its urban setting and demonstrates the impact and influence of the changing social, economic and political environments in which it operated.

Chapter 4 examines the technologies that were deployed at Bankside; this chapter address the effectiveness of these technologies and the extent to which the power station met its dual design intent of efficiently generating electricity while minimising the impact on its surroundings. This is conceptualised as a normal or ideal model of operation. As Britain’s first entirely oil-fired power station, and thus independent of the availability of coal, Bankside ‘B’ became a model for several other power stations. In the mid-1950s Bankside was also held up as a model power station by the Beaver committee inquiring into urban air pollution because of its flue-gas cleaning process.

The chapter also examines government strategy and electricity industry policy concerning coal-fired and oil-fired power stations and how this was related to the availability and costs of these fuels. The utilisation of Bankside and other oil-fired stations shifted in the changing political and economic contexts. The ideal model of Bankside occasionally broke down as a result of internal factors such as un-envisaged operating modes or as an unforeseen consequence of the technologies that had been deployed. In Bankside's later working life the ideal model was compromised by economic and environmental externalities. Its economic operation was seriously affected by the increase in oil prices following the Middle East crisis of 1973-74. There was also a shift in the physical environment of London, particularly improvements in air quality and the condition of the river Thames. The air and water pollution produced by Bankside 'B', which had been tolerable or at least tolerated, in the 1950s became increasingly unacceptable by the end of the power station's working life.

A model power station: efficient and effective operation

In 1952, as a new and efficient power station, Bankside 'B' was well placed to meet its primary function of generating and supplying electricity to the London area. The station first started generating electricity on 5 November 1952. The effectiveness and efficiency of Bankside is demonstrated in the performance data for the new station over its first few years, this is summarised in Table 5.1, data for Bankside 'A' and Battersea are included for comparison.

Table 5.1: Performance of Bankside and Battersea power stations.

Year	Bankside 'A'			Bankside 'B'			Battersea 'A'			Battersea 'B'		
	Hours run	Annual Output (GWh)	Thermal efficiency (%)	Hours run	Annual Output (GWh)	Thermal efficiency (%)	Hours run	Annual Output (GWh)	Thermal efficiency (%)	Hours run	Annual Output (GWh)	Thermal efficiency (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1952/53	3150	82.71	13.98	649	17.90	20.55	8760	1029.84	25.15	7893	529.32	28.62
1953/54	1939	38.74	11.42	2973	118.85	24.20	8760	1037.58	24.74	7389	783.52	28.16
1954/55	2360	34.24	12.17	5112	321.56	25.72	8760	897.13	24.54	8709	1090.62	27.71
1955/56	1323	16.41	10.87	5808	354.23	26.14	8784	958.72	23.39	8784	1342.41	28.07
1956/57	1535	20.19	12.57	2730	164.20	25.06	8760	858.65	22.96	8760	1452.38	28.33
1957/58	1177	22.43	12.97	4575	210.35	26.28	8760	898.23	23.49	8645	1106.53	29.32
1958/59	–	–	–	7732	657.73	28.11	7118	414.36	20.62	8760	1122.18	28.20

Source: *Garcke's Manual of Electricity Supply*, Vol. 55 (1958), p.A-113 and Vol. 57 (1960), p.A-107.

Note: 8760 hours equals one year corresponding to continuous or base-load operation. Bankside's second 60 MW turbo-alternator was commissioned in June 1953, the third 60 MW set by March 1963 and the 120 MW set on 1 December 1963.

The data demonstrates how the number of running hours and the electrical output of Bankside 'B' generally increased during the 1950s. In its first full year of operation in 1954/55 Bankside 'B' contributed 5.1 per cent of the total electricity usage in London, this was commensurate with the station's nominal generating capacity (113 MW) which was 6.4 per cent of the generating capacity in London.[1] The high thermal efficiency (Table 5.1, column 7) of the new power station was a significant advantage. The efficiency was more than double that of the old Bankside 'A' (column 4), i.e. the new station generated more than twice the amount of electricity for the same equivalent amount of fuel. The efficiency of Bankside 'B' also compared favourably with other power stations in the London area. The thermal efficiency of 28.11 per cent achieved in 1958/59 corresponds to the average annual thermal efficiency of 60 MW turbo-alternators shown in Figure 4.6.

Bankside had been designed as a 'two-shift' station, that is one that would operate from about 7 a.m. to 8 p.m.[2] It supplied the main daytime electricity load and was shut-down during the night when electricity demand was lower.[3] The two-shift operation was because the cost of oil made the electricity generated at Bankside about ten per cent more expensive than at a coal-fired station (at 1947 prices). This is reflected in the higher outputs of Battersea power station (Table 5.1, columns 9 & 12). Although Bankside had a high thermal efficiency, it was not high in the economic

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[1] The amount of electricity purchased in the London area in 1954/55 was 6285.2 GWh, Bankside supplied 321.56 GWh which represents 5.1 per cent, the generating capacity of Bankside was 113 MW compared to a London-wide maximum load of 1775.9 MW, i.e. 6.4 per cent. LCC, *London Statistics*, Vol.1 new series (London, 1957), p.192.

[2] TNA, POWE 12/798, Evidence of Sir Leonard Pearce at the public inquiry, day 1, p.47. There were three working shifts from 8 a.m. to 4 p.m., noon to 8 p.m. and 8 p.m. to 8 a.m., see Norma Clarke, 'Generation. Generate', *Critical Quarterly* 43:3 (2004), p.21. In an interview Norma Clarke says the morning shift was from around 7 or 7:30 a.m. until 3:30 p.m. and the night shift from 8 p.m. to 7 a.m. (interview with Norma Clarke, August 2011).

[3] As discussed in Chapter 2 Bankside 'A' supplied electricity to the printing presses of Fleet Street, this was a useful night-time load for the CLELC. By the time Bankside 'B' was operational Fleet Street could draw supplies from the national grid.

'merit order' of BEA power stations because of the higher cost of oil.[4] In the period 1959-61 the availability and low cost of fuel oil meant Bankside 'B' was operated as a base-load station – running 24 hours a day.[5] Its cost of producing electricity was then amongst the lowest of all power stations in south-east England. This is demonstrated in the operating data which shows the increased electricity output. The station contributed 8.4 per cent of the total electricity usage in London in 1958/59 whereas its generating capacity was only 4.9 per cent of the total capacity in London. It therefore delivered nearly twice as much electricity in proportion to its size, showing the intensity with which it was operated.[6]

The national shortage of electricity generating plant in the 1950s, and the necessity of meeting the peak winter electricity load, meant that older, less efficient plant had to remain available longer than envisaged. The intention had been to demolish the old Bankside 'A' power station shortly after the new one became operational in 1952, but closure was delayed until 1959. The old station was gradually run down. In 1954/55 the output was only one-tenth of the new station (see Table 5.1, column 3), and was even less in the following years. Bankside 'A' was closed on 23 March 1959 which enabled the second half of the Bankside 'B' to be built on its site.[7]

[4] The merit order was a measure of the economic efficiency of power stations, the most efficient ones, generally large coal-fired stations, were high in the merit order. The merit order was the criteria used by the BEA / CEA / CEGB to select which power stations were to operate. As demand increased stations lower in the merit order were brought into operation. In the mid-1980s the CEGB merit order from highest to lowest cost was: gas turbines; small oil (less than 120 MW); small coal; large oil (550/660 MW); medium coal (200/350 MW); large coal (500/660 MW); nuclear. See Department of Energy, *Sizewell B Public Inquiry*, Chapter C53 (London, 1986), p.5. See also Monopolies and Mergers Commission, *Central Electricity Generating Board*, HC 315 (London, 1981), pp.123-26.

[5] 'Bankside', *The Borough*, 1961, p.23. In 1960 oil accounted for 25 per cent of the primary fuel consumption in Britain, J.R. James, S.F. Scott and E.C. Willatts, 'Land Use and the Changing Power Industry in England and Wales', *Geographical Journal*, 127:3 (1961), p.286.

[6] The amount of electricity purchased in the London area in 1958/59 was 7838.6 GWh Bankside supplied 657.73 GWh which represents 8.4 per cent, the generating capacity of Bankside was 113 MW compared to a London-wide maximum load of 2310 MW, i.e. 4.9 per cent. GLC, *London Statistics*, Vol. VII (London, 1968), p.195.

[7] 'Bankside', *The Borough*, p.23.

In 1947 it had been envisaged that Bankside 'B' would be commissioned in 1950 and the second half 'a year or two years or so after that'.[8] The necessity of meeting electricity demand therefore meant that the 'B' station only became fully operational in 1963, a decade later than had been envisaged. This provided an advantage for the CEGB as demonstrated in Chapter 4. The final 300 MW output capacity of the station was higher than the planned 240 MW because of the technological developments in generating plant that had taken place during the 1950s, especially the development of the 120 MW turbo-alternator which was installed at Bankside.

In 1969 Bankside was again high in the merit order, particularly the 120 MW set which was said to be 'among the first twenty most efficient sets in the country'. The CEGB noted that Bankside was playing an important part in the generation of electricity in the London area.[9] The amount of electricity generated by Bankside 'B' and the intensity of the utilisation of the power station over its operational life is shown in Figure 5.1. The high utilisation in the late 1950s due to the low price of oil has already been mentioned; these conditions were repeated in the late 1960s and this is also apparent from Figure 5.1. Although the output from Bankside in the late 1950s was less than in the late 1960s (the red bars), the intensity with which the power station was used was higher in the late 1950s and early 1960s (the blue line).

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[8] TNA, POWE 12/798, Evidence of J. Hacking, public inquiry, day 3, p.4.

[9] CEGB South Eastern Region, *Bankside Power Station*, n.d. but *c*.1969. The high pressure side of Bankside 'B' (the 120 MW turbo-alternator) was in the list of the top 20 power stations with the highest thermal efficiencies in 1963/64, 1964/65, 1965/66, 1969/70, 1970/71, 1971/72 and 1972/73, with a thermal efficiency of 31.3-32.2 per cent. CEGB, *Statistical Yearbooks*, various editions, 1964-72.

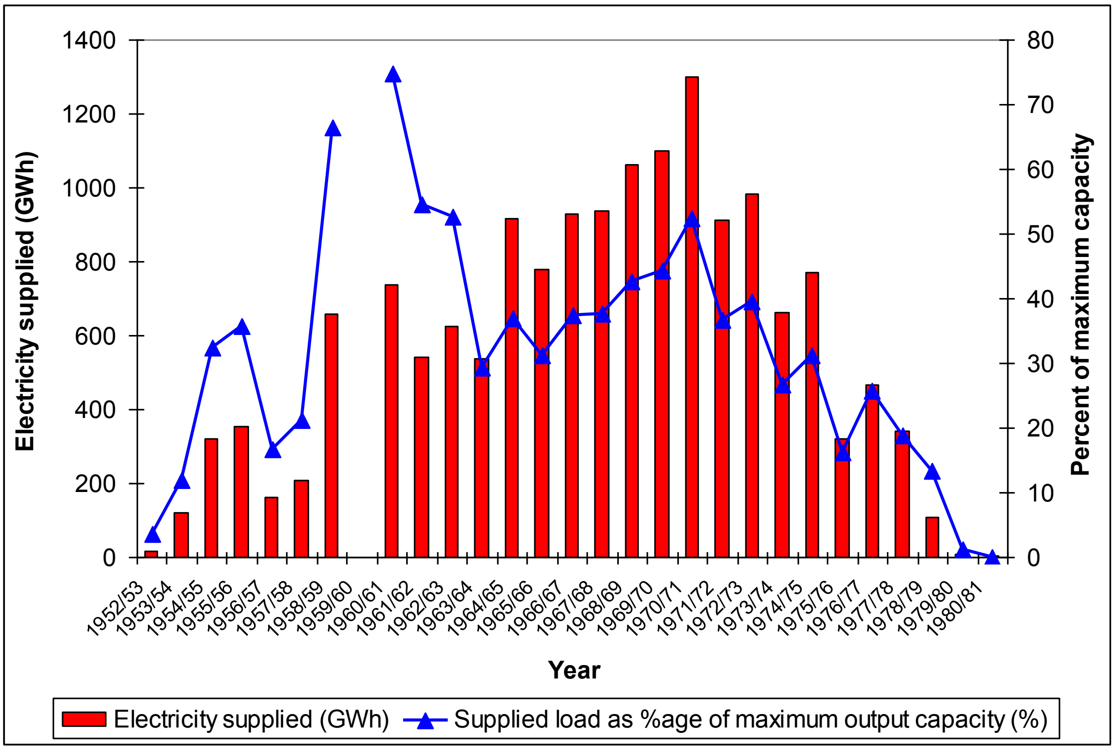

Figure 5.1: Output from Bankside 'B' power station, 1952-81.

Source: Adapted from: *Garcke's Manual of Electricity Supply*, Vol.55 (1958), p.A-113 and Vol.57 (1960), p.A-107; CEGB, *Annual Report and Accounts 1960/61, 1961/62, 1962/63* (London, 1961-63); CEGB, *Statistical Yearbooks, 1964-82*.

Note: No operating data has been found for 1959/60. The blue triangles and blue line represent the intensity with which Bankside was utilised.

It was recognised in 1947 that having an oil-fired power station on the Thames was a benefit as it provided for a diversity of fuel supplies, especially in the period of post-war coal shortages.[10] This diversity became a feature of the British ESI over the following decades but this was as much a product of government policy towards the coal industry as it was a deliberate strategy of the BEA / CEA / CEGB to provide for a diversity of fuel sources for electricity generation. Government policy switched between coal- and oil-fired power stations based on predictions of the availability and the relative cost of fuels and of attempts to support the coal industry. The debate about

[10] TNA, CAB 128/9, Cabinet Meeting 49(47), 22 May 1947, f.49 Item 2.

fuel supplies for electricity generation and national policy has been a recurring theme for the ESI, and remains so.[11]

The decision to specify Bankside 'B' for oil-firing had ostensibly been taken for amenity advantages although, as I have demonstrated, the decision was influenced by coal shortages and the fuel crisis of early 1947. The national coal shortage in the immediate post-war period had led the Government to introduce in 1946 a coal-to-oil conversion programme for commercial and industrial boilers to take advantage of the plentiful supplies of fuel oil. In February 1947 the Ministry of Fuel and Power estimated that for power stations near the sea, oil would cost about 95/- a ton, compared with coal at about 50/- a ton. Allowing for its greater calorific value, oil would therefore be about ten per cent more expensive than coal.[12] However, by June 1947, just after Bankside 'B' had been approved, the oil supply position was less certain and the Ministry decided that no more coal-to-oil boiler conversions should take place.[13] By November 1949 the Ministry observed that if the British refinery expansion programme went ahead as planned 'we will have in 1952 more than sufficient fuel oil from U.K. refineries to meet U.K. requirements'.[14] Expanding refinery capacity was an important part of dollar savings. The programme helped to reduce the dollar expenditure on purchasing refined oil products on the world market, and refinery expansion became a planning priority. UK oil refining capacity increased six-fold over the decade from 1949 thus improving the availability of refined fuel oil

[11] See, for example, G. England (CEGB), *Planning for Uncertainty* (London, 1981). Ensuring the security and diversity of energy supplies is a current policy of the UK Government, see for example 'Maintaining UK energy security', www.gov.uk/government /policies/maintaining-uk-energy-security--2 [accessed April 2013].
[12] TNA, POWE 14/494, CEB: conversion of power station boilers from coal to oil firing 1946-48, Memorandum 'Conversion of power stations to oil-firing', dated 27 February 1947, Item 6.
[13] American consumption of oil had increased significantly and the world shortage of oil had become acute; see for example *Hansard*, House of Commons debates, 6 May 1948, Vol.450 cc.1419-20.
[14] TNA, POWE 14/202, Ministry of Fuel and Power, Minute from J.W. Farrell to Mr. Quirk, dated 25 November 1949.

and reducing its price.[15] As the journalist Andy Beckett observed 'cheap and plentiful oil from the Middle East had been one of the foundations of Western prosperity since before the Second World War'.[16]

A Government review of fuel and power resources led to the Ridley report of 1952. This identified that the National Coal Board (NCB) was in a position to meet the increasing UK demand for energy and at prices that would remain competitive with oil.[17] However, there was criticism from the BEA that the committee had under-estimated the ESI's demand for coal. The BEA projected that, by 1960, the ESI would need substantially more than the Ridley committee's estimate of 45 million tons. The BEA's estimate was for 50 million tons per year by 1960 and 60 million tons by 1965.[18] In conjunction with the Ministry of Fuel and Power, the BEA considered alternative fuels. These deliberations were one of the factors that led to the 1955 White Paper on nuclear power, and the subsequent development of Britain's civil nuclear power station programme.[19] In 1954 the Minister of Fuel and Power, Geoffrey Lloyd, insisted that the BEA should increase their dual- and oil-firing capability with the aim of saving eight million tons of coal annually by 1958, in response the BEA introduced an oil-fired power station programme.[20] For example, a contract was signed with Esso

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[15] Refinery output increased from 6.04 million tons in 1949, to 16.13 million tons in 1951, to 38.35 million tons in 1959 and continued to increase thereafter, Stone and Wigley, *The Demand for Fuel*, Table A.4, pp.102-03.

[16] Beckett, *When the Lights Went Out*, p.128.

[17] Hannah, *Engineers*, pp.168-69.

[18] In 1965/66 the CEGB consumed 64.2 million tons of coal, somewhat more than the 1953 estimate, see The Electricity Council, *Handbook of Electricity Supply Statistics 1989* (London, 1990), Table 14, p.24.

[19] The 'Nuclear' White Paper of February 1955 envisaged a 10-year programme of 1500-2000 MW of nuclear power stations. Nuclear power stations had been ordered with 'rash optimism' following the Suez crisis which had raised the possibility of an imminent oil shortage, L. Hannah, 'A Failed Experiment: The State Ownership of Industry' in R. Floud and P. Johnson (eds), *The Cambridge Economic History of Modern Britain: Vol. 3 Structural Change and Growth, 1839-2000* (Cambridge, 2004), p.100.

[20] TNA, POWE 14/727, Ministry of Power, File note dated 7 April 1955, f.4. The CEA estimated that in mid-1955 37 million tons of coal were being used annually in power stations and this was projected to increase to 50 million tons by 1960. See M. Chick, 'The marginalist approach and the making of fuel

for cheap oil supplies from the Fawley refinery to the nearby Marchwood power station on Southampton Water, and seven other stations were scheduled for oil-firing in 1955.[21]

The relative prices of oil and coal over the period 1946-72 are shown in Figure 5.2, these figures have been normalised to the cost of energy (p/kWh), rather than the cost per ton; this compensates for the different calorific values of coal and oil. Oil was consistently more expensive than coal, but the margin between the costs narrowed considerably over the period 1957-72. Whilst there was a three-fold increase in the price of coal over the period 1946-72 the price of fuel oil, despite yearly variations, was the same in 1972 as it had been in 1951. The data in Figure 5.2 are the actual prices; allowing for inflation the price of oil steadily fell during the 1950s and 1960s.[22] By the late 1950s oil was considered to be the 'cheapest fuel option in many southern locations away from the coalfields'.[23] This was the case for Bankside 'B' which, as discussed above, was run as a base-load station in the late 1950s and early 1960s. Seventeen power stations were planned to be capable of burning up to 5.67 million tons per year of oil by 1960/61, thus saving the equivalent of nine million tons of coal.[24] The oil-burning programme was however affected by external events.

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policy in France and Britain, 1945-72', *Economic History Review*, 59:1, p.156. Electricity Council, *Electricity Supply*, p.68.

[21] The seven stations scheduled were Littlebrook, Tilbury, Barking, Brunswick Wharf all on the Thames and Poole, Plymouth and Portishead, see TNA, POWE 14/727, CEA Press Release (P.R.10), dated 23 June 1955. Not all the stations were converted: Brunswick Wharf remained coal-fired until 1970, Tilbury and Barking 'C' was dual fired, Littlebrook 'A' and 'B' remained coal-fired and only 'C' was oil-fired. CEGB, *Statistical Yearbook*, various editions 1964-66.

[22] Beckett, *When the Lights Went Out*, pp.128-29.

[23] Hannah, *Engineers*, p.233.

[24] The stations in the London area purported to be using oil included Bankside, Barking 'C', Belvedere, Brunswick Wharf, Littlebrook 'B'&'C', Northfleet, Tilbury and West Thurrock, CEA, *Eighth Report and Statement of Accounts for the year ended 31 March 1956*, p.20. However the CEGB *Statistical Yearbooks* identify Brunswick Wharf as being fired by pulverised coal until 1970.

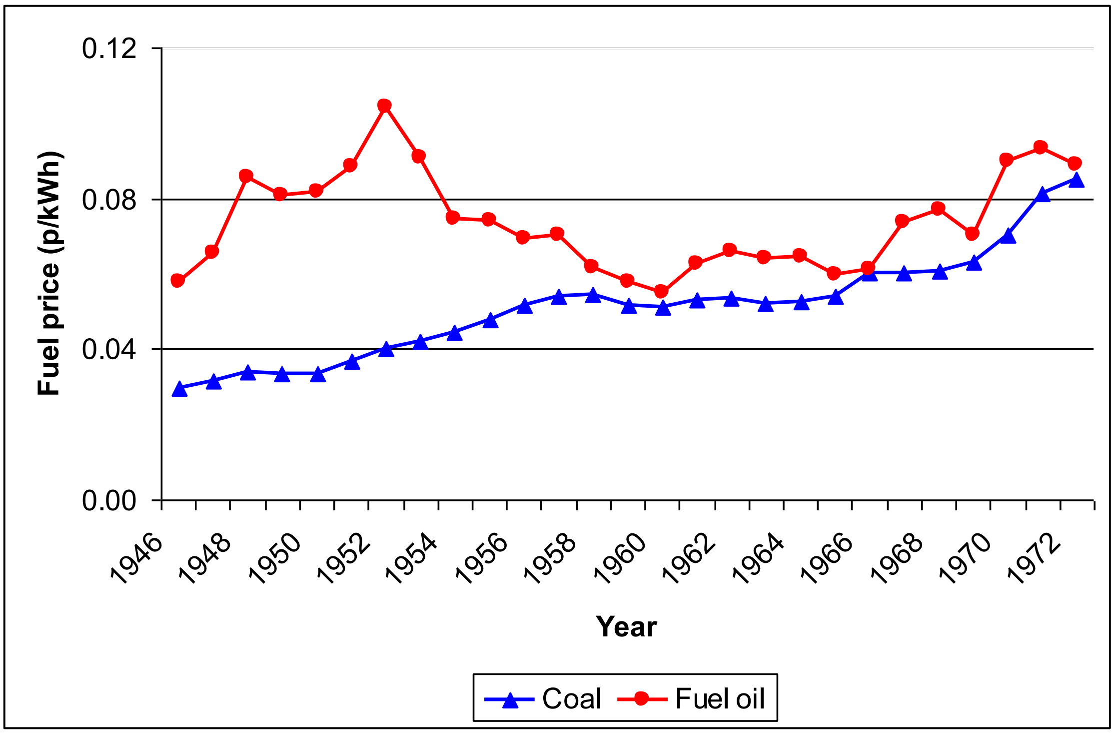

Figure 5.2: Fuel prices for electricity generation, 1946-72.[25]

Source: Adapted from Ministry of Power, *Statistical Digest 1963* (HMSO, 1964), Table 77; and Department of Energy, *Digest of UK Energy Statistics 1975* (HMSO, 1975), Table 77.

The Suez crisis of 1956, and the resultant shortage of oil, led the CEA to reduce their consumption of oil by about ten per cent and led to a delay in implementing, and a partial reversal, of the oil-burning programme.[26] The contingency plans for a potential Middle East crisis envisaged that Bankside power station would be closed down, although this provision was not enacted.[27] The effects of the Suez crisis were short-

[25] The data in Stone and Wigley are purchaser's prices for coal sales to the electricity and purchaser's fuel oil prices, both in pounds sterling per ton (£/ton). These have been converted to price per unit of energy, pence per kilowatt- hour (p/kWh), assuming a calorific value of coal of 12,241 Btu/lb and fuel oil of 18,205 Btu/lb based on the mean calorific value of supplies to Bankside 'A' and Bankside 'B' over the period 1953-59 from *Garcke's Manual of Electricity Supply*, various volumes, 1953-59.
[26] As a result of the Suez crisis and the coal supply position in 1957 the oil programme was reduced by 1½ to 2 million tons of oil (equivalent to 2½ to 3 million tons of coal). This was done by specifying coal instead of oil-firing at Northfleet and West Thurrock stations then under construction. TNA, POWE 14/841, undated note (document 55) on 'oil firing'.
[27] TNA, POWE 14/916, Ministry of Power, File note 'Reducing Petroleum Consumption in the event of a Middle East Crisis', dated April 1955, paragraph 10.

lived and the oil-burning programme was resumed again in 1957.[28] The oil price was affected by other factors such the duty of 2d. per gallon imposed by the Government on fuel oil in April 1961 in an effort to protect the British coal industry against rising mining costs and falling oil prices – the oil duty increase can be seen in Figure 5.2.[29]

In the late 1950s it was recognised that the use of oil was essential in ‘maintaining an adequate power supply to support expanding economies’, and while nuclear power was seen as a long term solution, contemporary economic commentators on the UK energy industries observed that oil ‘must continue to underly [sic] much of the expansion of industry over the next 15 to 20 years’.[30] During a parliamentary debate in 1960 the Paymaster General noted that ‘fuel oil has been getting cheaper’ and that the CEA had, when they drafted their oil supply contracts in 1955, insisted on a clause which allowed for ‘adjustment in price with the level of world prices, coal cost and so on’, as a result it was stated that the CEGB had been getting steadily lower prices for oil.[31]

As the economic historian Martin Chick has argued the surplus of NCB coal from 1962 prompted the Ministry of Power to reverse the oil policy. The CEGB was encouraged to increase their coal burn and had to pay a surcharge if they burnt too little coal.[32] This accounts for the reduced utilisation of Bankside ‘B’ in the early 1960s that is evident from Figure 5.1. By the mid-1960s oil was again being

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[28] Ibid., Letter entitled ‘Economies in Oil Consumption’ from the Ministry of Fuel and Power to industrial and commercial oil consumers, dated 7 November 1956.
[29] Chick, ‘The Marginalist Approach’, p.157, see also Chick, *Electricity and Energy Policy*, pp.9-10.
[30] R.C. Estall, ‘The Problem of Power in the United Kingdom’, *Economic Geography*, 31:1 (1958), p.80 and p.89.
[31] *Hansard*, House of Lords debates, 26 October 1960, Vol.225 c.1141. Note that the CEA was reformed as the CEGB in 1958.
[32] Chick, ‘The Marginalist Approach’, p.156.

considered as the cheapest fuel for southern power stations remote from the coal-fields and close to ports or refineries. On this basis the CEGB began construction of further oil-fired and dual-fired power stations.[33] In the early 1970s the CEGB was set to 'exploit the cheap residual fuel oil then available' and commissioned three large oil-fired power stations.[34] Although primarily driven by economic considerations the diversity of fuel sources proved to be useful for the CEGB, and politically advantageous for the Government. Oil-fired power stations helped to maintain electricity supplies when the availability of coal was restricted during the miners' strikes of 1972 and 1973-74. Indeed, the benefits of oil-fired plant, including Bankside, during 1972 miners' strike led the CEGB to formulate a specific policy for reducing dependence on coal for power generation.[35]

In the early 1970s the CEGB still viewed Bankside 'B' as a valuable power station. Although the technology had been largely fixed when it was designed, the CEGB wished – and indeed had a statutory duty – to get the most from their generating infrastructure. The technical staff of the CEGB's scientific services department made adjustments to Bankside's 120 MW turbo-alternator set in 1970 to improve its output.[36] As a result it was again operated as a base-load station and it broke its output

[33] The 2000 MW Fawley and Pembroke oil-fired power stations, both located adjacent to oil refineries, were part of this programme.
[34] The oil-fired stations were Grain, Ince 'B' and Littlebrook 'D', CEGB, *Advances in Power Station Construction*, p.6.
[35] See R. Eden and N. Evans, *Electricity's Contribution to UK Self-Sufficiency* (London, 1984), p.9. A feature of the miners' strikes was the picketing and blockading of power stations to prevent the delivery of coal, see Beckett, *When the Lights Went Out*, pp.64-65. There is no evidence in the local press that Bankside power station was picketed. The National Union of Miners had a picket boat operating on the Thames and this was deployed at Battersea power station, see Ledger and Sallis, *Crisis Management*, Plate 6. Some power stations such as Marchwood, Plymouth, Bromborough and Ince were supplied by pipeline and would therefore have been difficult to picket. CEGB, *Modern Power Station Practice*, Vol.5 (Oxford, 1971), Table 27, p.91.
[36] Operational research had been introduced by the CEA in 1954 to focus on problems connected with power stations and their operation. W.L. Parkinson and D. Taylor, 'Operational Research in the Central Electricity Generating Board', *Operational Research*, 16:2 (1965), p.133.

records on two occasions with a load factor of over 80 per cent.[37] In 1973 the CEGB planned to undertake a programme of modernisation at Bankside to increase the power station's efficiency and to 'ensure that this historic site continues to play an important part in the generation of electricity well into the 80's'.[38] This is another facet of the technological decision-making process examined in Chapter 4. Rather than the selection of technology this example shows how the life of the technology was to be extended and its efficiency improved. The timing of this announcement coincided with the Middle East crisis which increased the price of oil significantly, and the modernisation plans were abandoned. This is discussed below as an example of the breakdown of the ideal model.

The other significant technological system at Bankside 'B' was the flue-gas washing plant. Controversy had arisen over this plant when the new station was being commissioned and it would continue to be problematic throughout the operational life of the power station. When Bankside 'B' had first started generating electricity in November 1952 the flue-gas washing plant was incomplete because of supply problems with some of its components. It was envisaged that it would not be available until the spring of 1953. Because flue-gas treatment had been one of the operating consent conditions, the BEA discussed the supply difficulties with the Ministry of Fuel and Power. The Ministry took a pragmatic view and agreed that a three or four month delay would not present any difficulties, but cautioned that a longer period would be unacceptable. In view of the expected heavy demand for electricity over the winter

[37] Load factor is the actual output of the station compared to the output that would have resulted if the peak demand had been supplied throughout the year, see Hannah, *Engineers*, p.90. On 30 September 1970 the station had sent out 5,876,246 units (kWh) over a continuous 24 hour period and on 8 October it produced 6,004,364 kWh. Southwark Local History Library 'Bankside' file, CEGB, 'Power Output Records Get a Double Smash!', *South Eastern Power*, November 1970.
[38] CEGB, *South Eastern Power*, October 1973.

period the BEA intended to operate Bankside 'B' during peak hours without the flue-gas plant; they issued a press notice to this effect in December 1952.[39] The Ministry was clearly sensitive about being seen to sanction the operation. They wanted the BEA to take, and be seen to take, responsibility for the decision. An early draft of the BEA's press release had included the phrase 'with the approval of the Minister of Fuel and Power', the Ministry requested that this should be deleted from the press release.[40] Despite the wish to distance themselves from the decision, the Ministry became involved once the details of the start-up of Bankside 'B' were made public.

Following publication of the Press Notice, the Borough of Southwark expressed their concerns about the operation of Bankside 'B' without the flue-gas plant in a letter to George Isaacs, the local MP. They raised several points to support their argument against the BEA's proposal.[41] These included the views of the public health committee who noted that several complaints had already been received about black smoke from the boiler tests. They said that in view of the assurances given at the public inquiry the operation of the station without the flue-gas washing plant 'amounts to a breach of faith'. The Borough noted that the local Medical Officer of Health had reported that, during the smoggy weather of early December, there had been an increased incidence of respiratory illness and mortality – the local Registrar had reported 44 such deaths – and that the number of National Insurance claims in the Borough, associated with these health conditions, had doubled from about 300 to 600. Given these concerns, and the MP's long-standing opposition to the pollution from Bankside, Isaacs forwarded the Council's letter to the Minister, Geoffrey Lloyd. In a

[39] TNA, POWE 14/141, Ministry of Fuel and Power, BEA Press Notice, dated 15 December 1952.
[40] Ibid., Letter from the BEA to the Ministry of Fuel and Power, dated 10 December 1952.
[41] Ibid., Letter from the Town Clerk Borough of Southwark to G.A. Isaacs, dated 5 January 1953.

covering note Isaacs asked him to prohibit the operation of Bankside without the gas-washing plant. The imperative of providing electricity supplies was the foremost consideration of the Minister, or his advisors. Lloyd replied that the ‘continuing shortage of generating plant makes it absolutely necessary that this plant should be run’. He said that he fully sympathised with the people in Southwark but indicated that there were many other sources of pollution in the neighbourhood such as ordinary houses.[42] Operation of Bankside ‘B’ therefore commenced without the flue-gas plant. This was finally ready for commissioning in July 1953, longer that the envisaged three or four month delay. The flue-gas plant was itself the source of many complaints about fumes from the power station.[43]

The consent condition for Bankside ‘B’ was a qualitative one for ‘the prevention of the discharge of sulphur and its compounds into the atmosphere’.[44] The expected performance of the flue-gas washing plant had not been quantified. The plant at Battersea had achieved a sulphur removal efficiency of 90 per cent.[45] Given the greater sulphur content of the fuel oil at Bankside a higher performance standard was desirable. The Government Chemist’s Committee recommendation was that ‘each cubic foot of escaping gas should contain not more than 0.05 grain of sulphur oxides, calculated as sulphur’, but they took a pragmatic approach and said that ‘no objection should be taken to a higher concentration if the efficiency of the gas washing was not

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[42] Ibid., Letter from Geoffrey Lloyd to G.A. Isaacs, dated 3 February 1953.
[43] In September 1954 there was correspondence between the LCC Public Control Department and the Borough of Southwark about ‘emissions of smoke from the new shaft’ at Bankside, LMA, LCC/PC/GEN/01/052, Letter from the Borough of Southwark to the LCC Public Control Department, dated 6 September 1954.
[44] TNA, POWE 14/496, Commissioners Consent dated 23 May 1947.
[45] Bettelheim *et al*, ‘Fifty Years’ Experience of Flue Gas Desulphurisation’, p.276.

less than 95%'.[46] This performance condition was considerably more onerous than at Battersea given that the sulphur content of the fuel was up to four times that at Battersea and that the allowable concentration of sulphur in the emitted gases was to be half that at Battersea, i.e. no more five per cent sulphur in the gases rather than ten per cent.

To determine the performance of the flue-gas plant routine tests were carried out by the power station chemist, but the performance was also of wider interest. The Chief Alkali Inspector wished to assure himself of the 'functioning of the gas washing plant' and made unannounced quarterly visits to the power station.[47] Given the opposition of the LCC to the power station and their concerns about pollution an agreement was reached that the LCC's Chemist-in-Chief could accompany the Alkali Inspector on these visits.[48] The first visit was undertaken on 27 October 1953, the Chief Alkali Inspector tested the discharged gases and reviewed the results of the past quarter. It was noted that the washing plant had been achieving a high overall efficiency of 97.2 per cent. The Inspector observed that 'the white plume from the chimney was rising and dispersing quite well despite unfavourable climatic conditions' (see Figure 5.3). This was the first of several observations about Bankside's chimney plume.[49]

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[46] TNA, POWE 14/141, Government Chemist's Committee, 'Report on proposed gas washing plant for Bankside Generating Station', by G. M. Bennett dated 10 October 1949.
[47] Electricity generating stations had only formally been 'scheduled' under the Alkali Acts, and therefore subject to the inspectorate's jurisdiction, in 1958, see Ireland, 'Cleaning the Air', p.37.
[48] LMA, LCC/PC/GEN/01/052, letter from R.C. Adams of the Ministry of Housing and Local Government to the Clerk of the LCC, dated 18 December 1952.
[49] Ibid., Memorandum of the Chief Alkali Inspector dated 4 November 1953, the gas washing plant at Bankside started operating on 16 July 1953. Giles Gilbert Scott had insisted the power station would emit a 'smokeless shimmer of vapour'; others have remarked of Bankside that 'its most remarkable feature is the tall, square chimney stack, from which ceaselessly bubbles pure-white fleecy exhaust', R.A.S. Hennessey, *The Electric Revolution* (Newcastle, 1972), p.146 and note 8 on p.155. Elsewhere it was noted: 'the tall chimney vomiting black smoke', A. Saunders, *The Art and Architecture of London:*

Figure 5.3: Bankside in operation, 1975: 'the white plume from the chimney was rising and dispersing'.

Source: Bankside power station and St George the Martyr church - geograph.org.uk - 1607688.jpg [accessed June 2012]. © Robin Webster, 1975. Reused under the Creative Commons Attribution-ShareAlike 2.0 licence.

Periodic visits by the Alkali Inspectorate were made throughout the operational life of the power station. The performance for years where annual data are available is shown in Table 5.2. The results demonstrate the consistent effectiveness of the flue-gas washing plant at achieving both the Government Chemist's requirement (column 3), and for the efficiency of the washing plant (column 4). The Chief Alkali Inspector reported in 1955 that visits had been made to the gas washing plants at both Battersea and Bankside power stations and that while the 'position at Bankside was most

An Illustrated Guide (Oxford, 1984), p.413, this is a questionable observation as Bankside only emitted white or light grey vapour.

satisfactory; the problem at Battersea is more difficult'.[50] At Battersea, fly ash from the boilers was carried over into the gas washing plant and affected its operation but this was not an issue for the oil-fired Bankside.

Table 5.2: Performance of the Bankside 'B' flue-gas washing plant.

Year	Total fuel burnt (tons)	Sulphur content of emitted gases (grain/cu ft)[51]	Efficiency of Sulphur removal (%)	Total sulphur discharged to:	
				atmosphere (tons)	river (tons)
(1)	(2)	(3)	(4)	(5)	(6)
1955	106,577	0.025	97.3	98	3526
1957	45,291	0.016	98.2	26	1437
1958	156,146	0.026	97.2	144	5009
1960	213,535	0.038	96.2	297	7530
1961	166,377	0.034	96.7	203	5953
1962	177,551	0.031	97.0	193	6447
–					
1975	–	0.011	98.7	–	–
1976	–	0.014	98.2	–	–
1977	–	0.016	97.9	–	–
1978	–	0.016	97.9	–	–
1979	–	0.011	98.7	–	–

Sources: TNA, POWE 14/141, Electricity Division, Gas washing plant Battersea: Bankside, 1947-63, District Inspectors reports under the Alkali &c Works Regulation Act; LMA, LCC/PC/GEN/01/052, Electricity Generating Stations 1910-63, Ministry of Power, District Inspectors reports; Health and Safety Executive, *Industrial Air Pollution 1975* (London, 1976) and later annual editions.

Notes: No annual data identified for 1956, 1959 and 1963-74. One ton of sulphur is equivalent to 2.0 tons of sulphur dioxide discharged to the air and to 4.25 tons of calcium sulphate discharged to the river.

[50] 'Inspection of Industrial Pollution in Britain', *Nature*, 178:4540, 3 November 1956, p.970.
[51] A three per cent sulphur oil gives a sulphur dioxide concentration in untreated flue gases of 0.83 grains/cu ft (*c.*1600 parts per million), LMA, LCC/PC/GEN/01/052, Chief Alkali Inspector report on Bankside power station test dated 19 April 1956. The Chief Chemist's requirement was for a sulphur dioxide content not exceeding 0.05 grain per cubic foot in the discharged gases.

In summary, the operation of Bankside ‘B’ over its first two decades has been framed as a story of success: an ideal model of an urban power station. Bankside made an important contribution to electricity supplies in London, and the flue-gas washing plant had operated effectively. The BEA / CEA / CEGB were able to use Bankside to exploit the low price of fuel oil in the late 1950s and the 1960s to generate electricity cheaply. As Britain’s first entirely oil-fired power station, Bankside was a pioneering model for later stations. The varying prices and availability of oil and coal influenced Government policy on the provision of coal-fired and oil-fired power stations from the 1950s to the 1970s. The increase in the price of oil from 1973 had a dramatic effect on the operation of Bankside. Despite the generally efficient and effective operation of Bankside ‘B’ throughout the 1950s and 1960s there were several occasions and periods when local problems manifested themselves and led to a breakdown of the ideal model.

Breakdown of the model: local problems at Bankside ‘B’

This section addresses how the ideal mode of operation of Bankside ‘B’ broke down (sometimes literally), and examines the effects both within the power station and on the local area. In addition to the economic implications, the pioneering use of fuel oil at Bankside had several un-envisaged technological consequences. A number of incidents demonstrate how Bankside’s owners, the BEA / CEA / CEGB, had to use innovative scientific and technical solutions to address some unexpected problems. Furthermore, some of these problems were the result of decisions made to enable Bankside ‘B’ to generate electricity as soon as possible at a time when there was a national shortage of generating capacity, or to operate continuously to take advantage of low fuel oil prices.

During the operational life of Bankside 'B' the provision of, and dependence on, electricity supplies in the London area became increasingly significant as shown in Table 5.3.

Table 5.3: Electricity sales by the London Electricity Board, 1948-80.

Year	1948/49	1955/56	1960/61	1965/66	1970/71	1975/76	1980/81
Electricity sales (GWh)	3,655	6,005	8,379	11,508	13,150	14,225	14,541

Source: The Electricity Council, *Handbook of Electricity Supply Statistics 1989* (London, 1990), Table 36, p.56.

There was a three-fold increase in the consumption of electricity in the LEB area over the period 1948 to 1975. The 'flattening' of demand in the 1970s associated with the economic downturn is also evident in Table 5.3.

The City of London and its financial organisations became increasingly dependent on electricity for lighting, transport and for the operation of their businesses. An incident in June 1961 illustrates both this dependency and issues about the security of electricity supplies. One of the transformers at Bankside 'fused' one weekday morning and led to a power cut in the City. Transport was affected with traffic lights, lifts and the travellator at Bank station out of action and trains at London Bridge station were delayed. A range of office equipment was reported to have been affected including calculating and accounting machines, telexes, teleprinters, electric typewriters and some internal telephone exchanges, and one American bank was reported to be virtually cut off from the foreign exchange market. As the City editor of *The Times* noted, as the City of London:

> becomes more equipped with electric and electronic devices – and becomes progressively less able to deal by hand with the great mass of

> clerical and other work – so the effect of even a small cut in power supplies becomes more serious.[52]

The potential unreliability of public supplies and the recognition by organisations that they needed to have an assured electricity supply is illustrated in the report that some companies had brought their own emergency supplies into operation, and it was noted that the Bank of England always used power provided by its own generators. The supply to the City radiated from Bankside power station; this arrangement had been established in 1891 and was one of the arguments to justify the retention of the power station on the Bankside site during the 1945-47 planning process.[53] As a consequence any failure at Bankside, such as the 1961 incident, made the City vulnerable to power cuts. The range of uses of, and dependency upon, electricity increased over the operating life of Bankside. For example, in 1971 an economic study of the City noted that 'air conditioning is essential for computer users and most international (especially American) companies'.[54]

Chapter 4 argued that technological decision-making was a rigorous process which aimed to find the optimum technical solution to address a problem or issue. The imperative of providing electricity supplies also entailed technological decision-making. Another incident demonstrates how the CEGB were prepared to compromise the integrity of the plant in their efforts to 'keep the lights on'.[55] In December 1964 an 'earth fault' developed in one of the alternators at Bankside. The manufacturers, English Electric Co. Ltd., advised that if the alternator were to continue to be operated

[52] City Editor, 'Power Cut Stops Office Machines', *The Times*, 2 June 1961, p.9.
[53] TNA, HLG 79/918, public inquiry, inspector's report, p.4.
[54] Dunning and Morgan, *Economic Study of the City of London*, pp.190-91.
[55] One former CEGB employee observed that 'keeping the lights on', i.e. maintaining electricity supplies, was an imperative for the CEGB (Barry Henniker, personal interview, November 2013).

without a repair then there was a danger that further damage would be done.[56] The necessity of meeting electricity requirements over the winter period was an over-riding consideration for the CEGB and the station continued to use the machine. A more serious fault developed in the following March which necessitated the rotor being returned to English Electric for a major repair.[57] A similar incident arose during the miners' strike of 1984-85 when the oil-fired Littlebrook 'D' power station was operated 'aggressively' to maintain electricity supplies during the coal shortage.[58] One of units at Littlebrook was severely damaged and was permanently decommissioned. The imperative of maintaining electricity supplies therefore sometimes compromised the prudent operation of power station plant.

Technological solutions to unforeseen problems were a characteristic of the operation of the power station. There were several problems and incidents associated with corrosion and erosion caused by the acidic nature of the flue-gases and the waste wash-water. It was known that flue-gases with a high concentration of sulphur dioxide could cause corrosion. Cast iron had been selected as a construction material as it was thought to be more resistant. However, soon after commissioning it was found that corrosion was occurring in the boiler air heaters.[59] The BEA addressed the issue using a combination of scientific and technological solutions. A small quantity of ammonia was injected into the flue-gas ducts to neutralise the acid and the combustion in the boilers was adjusted to reduce the sooty deposits. Sooty deposits were a known problem for oil-fired boilers and provision had been built into the design for these

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[56] MOSI, A1989.338/80/3, Report of Visit to English Electric Co Ltd Stafford Work on 16 March 1965, Letter from English Electric to the CEGB, dated 29 April 1965

[57] Ibid., Investigation revealed that a high current electric arc had melted some of the copper coils.

[58] Anon, *Power Stations in England* (Memphis TN, 2010), p.310.

[59] CEGB, *Bankside Power Station* (n.d. but *c.*1969), p.2. Bankside's primary air heaters had been specified to be 'of gilled cast iron to resists corrosion', 'Bankside Power Station', *The Engineer*, 30 January 1953, p.167.

deposits to be removed by water-washing. This could only be done when the boilers were shutdown and was undertaken during the night when Bankside 'B' was operated as a two-shift station. However, the un-envisaged continuous operation of Bankside as a base-load station from the late 1950s meant that the water-washing could not be undertaken, this led to inefficient operation and further corrosion. The BEA engineers developed the simple and effective technological solution to drop 'a rain of small cast iron shot' onto the heaters once every three hours to remove the deposits, this procedure could be done with the boilers in operation.[60]

There were also corrosion problems with the chimney linings. At Battersea power station the reinforced concrete chimneys had been lined with acid-resistant tiles set in a rubber mortar.[61] However at Bankside the imperative of providing electricity supplies at a time of a national shortage led to a simpler design being adopted. The four flues within the chimney were constructed from plates of cast iron in an octagonal arrangement which had enabled them to be constructed quickly.[62] The flue-gas washing process meant that the flues operated at about 20-30°C which led to the formation of a film of acidic liquid on the inside of the flues which gradually corroded them. By 1969 the corrosion had become severe and the flues were replaced with stainless steel ones which proved to be effective at preventing further corrosion.[63] These examples of problems and solutions demonstrate how the engineers and scientists in the BEA / CEA / CEGB were able to address and resolve both known and unexpected issues at Bankside 'B'.

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[60] CEGB, *Bankside Power Station*, p.2.
[61] Bettelheim *et al*, 'Fifty Years' Experience of Flue Gas Desulphurisation', p.276.
[62] Like the boiler air heaters 'cast iron was used for the flues because of its resistance to corrosion', Anon, 'The reconstruction of Bankside Power Station', *Civil Engineering and Public Works Review*, 48:561, March 1953, p.244.
[63] Anon, *Electrical Review*, 19 Sept 1969, p.409. Anon, 'Chimney is Given Stainless Steel Lining', *Power News*, July 1969.

The history of technology includes other examples of the unexpected and unpredicted consequence of technological decision-making. The oil-firing decision led to a lengthy shutdown of Bankside 'B' in 1956-57 and to a fatal accident. The treated water effluent from the flue-gas washing plant was mixing with the cooling water returning to the river. In 1956 the acidic effluent eroded the lining of the discharge tunnel and 'scooped out a large cavity beneath – in fact, 100 tons of debris had been washed into the effluent system'.[64] The CEA assured the public that the closure of the station would not lead to power cuts and that 'engineers have worked day and night to make emergency repairs'.[65] However, the damage was more extensive than first thought and it was necessary to empty the discharge tunnel.[66] To do this the far end of the tunnel on the river bed was sealed with a temporary caisson. Unknown to the CEA, or to the men working there, the organic matter in the silt had generated flammable methane gas which had accumulated in the roof of the tunnel. As the tunnel was being pumped-out this gas migrated to the caisson where three men were working. When one struck a match there was 'a huge blue flash and an explosion [...] followed by two or three more in a matter of a second'.[67] One of the men was blown out of the caisson into the river and sustained fatal injuries, and the others were badly burned.[68] The incident was noteworthy enough to be reported in the national and the scientific press, and the death was the subject of a Coroner's Inquest.[69] The power station remained out of commission for several months over the winter period while repairs were carried out;

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[64] See Anon, *New Scientist*, No.6 (1956), p.19; and *CEA Annual Report and accounts* (1957), p.27.
[65] 'Leak Puts Power Station Out of Action', *The Times*, 10 Aug 1956, p.11.
[66] The tunnel was 1200 ft long, 10 ft in diameter and located 34 ft below the river bed, its construction was similar to the access tunnel shown in Figure 4.4.
[67] LMA, CLA/041/IQ/05/027, City of London Coroner's Inquest, Witness Statement by John Douds dated 7 January 1957.
[68] This incident also demonstrates that lessons from the causes of industrial accidents are often forgotten. A similar methane explosion from stagnant water occurred at Abbeystead pumping station in Lancashire in 1984 where 16 people were killed, see Health and Safety Executive, *The Abbeystead Explosion* (London, 1985).
[69] Anon, 'Man Killed in Thames Explosion - Blown Out of Caisson', *The Times*, 01 October 1956, p.8; 'What Happened at Bankside', *New Scientist*, No.6, 27 December 1956, p.19.

the reduction in the output of Bankside 'B' in 1956-57 is evident in Table 5.1 (columns 5 & 6). As well as the unexpected consequences of technological choices, some adverse effects were a result of the limitations of the available technology. The flue-gas washing plant is an example.

Despite the efficacy of the flue-gas washing plant, demonstrated in Table 5.2, it did not solve the problem of air pollution. The plant was not deployed elsewhere, although it was held up by those with an interest in the issue of pollution as an ideal model for urban power stations. Flue-gas washing was a vexed issue within the BEA, as it had been for the pre-nationalisation CEB. An article in the *News Chronicle* in January 1953 reported the initial operation of Bankside. A senior member of the BEA staff was quoted as saying that gas washing was a 'sore point' and that 'we don't think it is necessary, or that it does what its originators intended'.[70] The Minister of Fuel and Power, Geoffrey Lloyd, saw this article and asked the BEA whether they 'really consider that the gas washing plant is unnecessary and ineffective'.[71] The BEA responded to Lloyd that the remarks were not a formal expression of the Authority's opinion and that this 'must be taken as an extremely tactless and injudicious expression of his own view', but then added 'in fact he is probably correct and expert opinion has been moving more and more in this direction recently'.[72] In another example J.D. Peattie another senior member of the BEA staff said of Bankside 'it is debateable whether better results would not have been obtained without flue-gas washing'.[73]

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[70] This was Harold Pugh the controller of the London Division of the BEA. 'Planners Blamed for Dear Power', *News Chronicle*, 21 January 1953.
[71] TNA, POWE 14/141, Minute by M. Fletcher, dated 21 January 1953.
[72] Ibid., Minute by A.G.F. Farquhar, dated 22 January 1953. A handwritten note on this document observes that 'gas washing at Battersea was required partly because of fears for Buckingham Palace amenities'.
[73] Peattie's address as Chairman of the Supply Section of the Institution of Electrical Engineers. J.D. Peattie, Chairman's Address, *Proceedings of the IEE*, 102:1 (1955), p.14.

These views were supported by scientific evidence from the DSIR. In a report on the treatment of flue-gases, they noted that power stations were generally provided with high chimneys of 300 ft (Bankside's chimney was 325 ft) which aided the dispersion of gases into the upper atmosphere whereas domestic chimneys were closer to ground at 30 to 60 ft. They made the point that flue-gas washing cooled the gases so they did not rise and disperse, as a result if only part of the sulphur dioxide was removed the concentration at ground level might be greater than if no sulphur were removed and the hot gases were allowed to disperse naturally. The DSIR also mentioned the financial cost of flue-gas washing, which increased the cost of electricity.[74] Although neither the BEA or the DSIR were convinced of the benefits, a Government report recommended that it should be more widely installed following the London smog episode of 1952. The social and environmental changes that came about as a result of the 1952 pollution episode had an indirect but significant impact on Bankside power station.

The 'killer smog' of 5-9 December 1952 is a widely reported instance of the adverse effects of air pollution.[75] It was estimated to have caused at least 4000 additional deaths in London and the local effects in Southwark are described above.[76] A committee chaired by the civil engineer Sir Hugh Beaver was appointed to investigate the issues. It reported in 1954 on the social and economic costs of air pollution and suggested that clean air was then as important as clean water had been in the mid-nineteenth century. The committee proposed that domestic coal should be

[74] TNA, POWE 14/141, Memorandum by the Director of Fuel Research DSIR on 'Removal of sulphur compounds from the flue gases of Electricity Generating stations', dated August 1952.
[75] See, for example, Sheail, *An Environmental History*, pp.247-48; L.E.J. Roberts, P.S. Liss and P.A.H. Saunders*, Power Generation and the Environment* (Oxford, 1990), p.69; Sheail, *Power in Trust*, pp.58-59; Clapp, *An Environmental History*, pp.44-45; Ashby and Anderson, *The Politics of Clean Air,* pp.104-16. The issue was not new: over a smoggy fortnight in December 1891-January 1892 it was estimated that 829 people had died. Anthony Wohl suggests that a dense fog 'could carry off some 500 to 700 people in a week in London', Wohl, *Endangered Lives*, pp.212-13.
[76] Bell *et al* suggest that this episode had a much larger impact on health than previously reported, see Bell *et al*, 'A Retrospective Assessment of Mortality', pp.6-8.

replaced by coke, and that greater reliance should be placed on other 'smokeless' fuels such as electricity and gas. Yet each of the industries that produced smokeless fuels: coke and gas works and electricity generating stations burned coal to produce the 'smokeless' fuel.[77] This was an example of the transfer of pollution from the consumer to the producer and is discussed further below.

The Beaver committee used the example of Bankside to recommend the widespread adoption of flue-gas desulphurisation (FGD) for all new power stations in urban areas.[78] They claimed that this would be practicable and cost effective if it added no more than 0.06d. to 0.07d. to the cost of a unit of electricity (1 kWh).[79] The BEA remained sceptical about the benefits of FGD and they challenged the draft report's recommendations and stated that this 'strikes a damaging blow against the economy of electricity development in this country' and that its financial implication 'are potentially more serious than those of any previous restrictions or control imposed upon the Authority's activities'. The BEA claimed that installing plant in all power station would entail an annual capital investment of £10 million and would increase the cost of electricity by 0.1d. per kWh and therefore exceeded the cost-effectiveness criterion suggested in the Beaver report.[80] The issue was technical and environmental as well as economic. The BEA noted that the process used at Bankside was within

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[77] The six million tons of coal a year that were converted to coke in North-East England in the late nineteenth century emitted some two million tons of volatile matter such as carbonic and sulphurous acid. Wohl, *Endangered Lives*, p.214.

[78] The Beaver report recommended that 'the most efficient practicable methods of removing sulphur from flue gases should be adopted at all new power stations in or near populated areas', *Committee on Air Pollution Report,* Cmd. 9322 (London, 1954), paragraph 122(6).

[79] *Committee on Air Pollution Report,* paragraph 55, the revenue to the BEA of the electricity sold depended on the type of customer, in 1954/55 the domestic rate was 1.52d. per kWh, the commercial rate was 1.92d. per kWh and the industrial rate was 1.14d. per kWh, Electricity Council, *Handbook 1989*, Table 41, pp.64-65, converted from pence (p.) to old pence (d.). On these figures the Beaver report argued that sulphur removal should not increase the cost of electricity by more than 3 to 6 per cent.

[80] MOSI, A1989.338/17/4, BEA, 'Report of the Committee on Air Pollution, Preliminary comments on the more important recommendations', p.5.

their criteria of efficiency and cost, but that it could only be used on power stations 'near a very large river (which is not a fishing river) or near the sea'. The point was that the liquid effluent from the plant would be damaging to aquatic life in any river where it was located. The lower Thames in the mid-1950s was considered to be a dead river, so the issue of effluent pollution from power stations was not seen as a major problem.[81] The BEA were also critical that the Beaver committee had made no serious attempt to assess the relative economics of different ways of reducing atmospheric pollution. They claimed that burning coal in modern power station boilers that were equipped with efficient grit collectors and into tall chimneys was 'an extremely efficient method of controlling pollution in terms [...] of capital outlay'.[82] The 'tall chimney' policy remained a tenet of pollution control for the BEA and later the CEGB into the 1980s. Tall chimneys are another example of pollution transfer. Air pollution from power stations was essentially a local problem and technology – tall chimneys – was deployed to reduce the local impact by diluting the smoke in the atmosphere. This transferred the pollutants to further afield albeit in less concentrated form.[83]

Many of the recommendations of the Beaver report were enacted in the 1956 Clean Air Act.[84] The BEA's arguments against the wider adoption of FGD for urban power stations appear to have been convincing since the Act did not include any requirement for FGD to be provided at power stations. The Act prohibited 'dark smoke' from chimneys; required that new furnaces should be smokeless; that grit and dust should be minimised; and significantly also encompassed domestic sources of air

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[81] L.B. Wood, *The Restoration of the Tidal Thames* (Bristol, 1982), pp.51-55.
[82] MOSI, A1989.338/17/4, BEA, 'Report of the Committee on Air Pollution, Preliminary comments on the more important recommendations', p.1.
[83] CEGB, *Acid Rain* (London, 1984); Fisher,'Impact of Power Generation on Air Quality', pp.21-35; F. Pearce, *Acid Rain* (Harmondsworth, 1987).
[84] Clean Air Act 1956, 4 & 5 Eliz 2, Ch.52.

pollution. The Act allowed local authorities to establish Smoke Control Areas (smokeless zones) in which dark smoke from industrial and domestic premises was restricted. In the decade following the Clean Air Act British industry reduced smoke emissions by 74 per cent, by which time the ESI accounted for one fifth of atmospheric smoke.[85] It has been claimed that the Act had little direct impact on the ESI since their tall chimney policy and the provision of electrostatic precipitators in coal-fired power stations meant that the industry did not contribute significantly to local air pollution, rather it spread pollution further afield, including internationally.[86] Both despite and because of the provisions of the Clean Air Act, local concerns about air pollution from Bankside power station continued to be raised.

In 1954 in the House of Lords the Government were asked whether the fumes were 'having any injurious effect on St Paul's Cathedral' in response Lord Mancroft, for the Government, stated that the performance of the gas-washing plant has been 'under constant observation' and that the small amount in the atmosphere had no harmful effect. The point was made that the 10 tons of sulphur fumes per month from the 'B' station (see Table 5.2, column 5) compared favourably to the 150 tons a month from the old 'A' station.[87] The debate was reported in the press partly on the instigation of Lord Silkin who, as the Minister responsible for sanctioning Bankside in 1947, said he had 'been the victim of very savage attacks in a number of newspapers over the effects of these fumes on St Paul's Cathedral' and hoped that Mancroft's reply would receive at least as much publicity as the original attacks had received.[88] In the

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[85] Clapp, *An Environmental History*, p.51.
[86] G. MacKerron, 'Historical Overview' in R.E. Hester and R.M. Harrison, *Environmental Impact of Power Generation* (Cambridge, 1999), p.6.
[87] *Hansard*, House of Lords debates, 30 March 1954, Vol.186 c.778.
[88] 'Power station fumes not endangering St Paul's', *Financial Times*, 31 March 1954, p.7. The issue was raised again in 1977: the Secretary of State for the Environment was asked whether he was aware of the

early 1970s the CEGB co-operated with a study which showed that Bankside 'was not the major source of pollution at the cathedral'.[89] While the physical effects on the built environment were dismissed as negligible, the social effects on health and amenity remained an issue.

During the 1950s George Isaacs continued to raise the issue of fumes from Bankside in the House of Commons. In one debate he spoke of the 'insufferable nuisance' and observed that a great deal of fuss was made about damage to St Paul's but not about 'possible damage to the health, comfort and temper of those who lived in the immediate vicinity of the power station itself'.[90] In September 1954 the problem of 'plume droop' from Bankside was experienced when fumes from the chimney descended to 'pour through the windows of City offices'. A spokesman for the BEA noted that 'in some kinds of weather the effect of gas washing is to cool the gases so that instead of rising into the upper atmosphere they disperse and come down' and the 'amount of vapour coming down on a hot day would probably be more than usual'.[91] An experiment by the CEGB in December 1958 known as Operation Chimney Plume used an aircraft to photograph the extent to which power station plumes penetrated the fog layer over London. The results showed that the cold washed plumes from Battersea and Bankside could not be seen as they had mixed with fog layer, whereas the hot unwashed plumes from Brunswick Wharf power station 'punched' through and rose

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damage caused to the fabric of St Paul's, the reply noted that air pollution levels in the City have fallen significantly in recent years and the Secretary of State was not aware of any evidence linking emissions with damage to St Paul's. Mr. Brook and Mr. Marks, *Hansard*, House of Commons debates, 20 April 1977, Vol.930 cc.101-2W.

[89] Reported in the House of Commons in 1985, Mr. Goodlad (for the Secretary of State for the Environment), *Hansard*, House of Commons debates, 2 April 1985, Vol.76, c.518W.

[90] *Hansard*, House of Commons debates, 10 December 1953, Vol.521 c.281W; Isaacs had spoken in favour of the new power station in 1952 as it 'will relieve the residents in the locality of the nuisance of soot and grit now deposited by the old station', *Hansard*, House of Commons debates, 24 November 1952, Vol.508 c.4. Isaacs also spoke at some length on pollution from Bankside in an adjournment debate in 1955 see *Hansard*, House of Commons debates, 6 April 1955, Vol.539 cc.1303-6.

[91] 'Vapour Clouds over the City', *The Times,* 2 September 1954, p.11.

above the fog layer.[92] In 1959 when the second half of Bankside 'B' was being constructed one correspondent to *The Times* said that under certain conditions:

> smoke and attendant dirt from the existing chimney surrounds one while walking across London Bridge, and must have deleterious effect on the health of many thousands of people.[93]

The nuisance was reported again during another smog episode in London in December 1962. In a Commons debate it was again observed of the fumes that 'in certain weather conditions they come down to ground level rather than being harmlessly dispersed into the upper air'.[94] The problem of plume droop was an issue throughout the operating life of Bankside power station (see Figure 5.4).

Figure 5.4: 'Plume droop' at Bankside, *c*.1973.

Source: Greater London Industrial Archaeological Society, Newsletter, August 2009, www.glias.org.uk/news/243news.html [accessed April 2012]. © Bill Hines. Reproduced with permission.

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[92] Sheail, *Power in Trust*, pp.164-65 and Fig. 14.3.
[93] *The Times*, C.E. Wallis, letters to the editor, 5 October 1959, p.11.
[94] Denzil Freeth, Parliamentary Secretary for Science, *Hansard*, House of Commons debates, 4 Feb 1963, Vol.671 cc.203.

These examples demonstrate the contrast between the technical effectiveness of the flue-gas washing plant in removing sulphur, as part of the ideal model of Bankside 'B', and the adverse and ongoing issues of air pollution from the power station.

The end of the ideal model: challenging operation in changing environments

It has been argued that 1970 was a major turning point for the British ESI.[95] For Bankside the critical year was 1973, for after that Bankside 'B' was no longer an ideal model of an efficient and effective power station. Three factors contributed to the undermining of the ideal model. First, the dramatic and sustained increase in the price of oil from late 1973; secondly, the ongoing impact of the Clean Air Act which had, together with urban deindustrialisation, effected a significant reduction in air pollution in London by the 1970s; and thirdly, the concerted efforts that were made from the 1960s to reduce pollution in the river Thames. The significance of these factors for Bankside 'B' and the wider ESI are addressed in turn.

In October 1973, as a consequence of the Arab-Israeli war, the Arab states began to cut oil production and to embargo supplies to the West. The price of oil increased from \$2 per barrel in 1970 to \$5 per barrel in 1973, and by January 1974 the price had doubled again to \$11.[96] The price continued to increase throughout the 1970s and rose further as a result of the Iranian revolution in 1979.[97] The effect can be seen in the price that the CEGB paid of fuel, illustrated in Figure 5.5.

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[95] Eden and Evans, *Electricity's Contribution*, pp.34-35.
[96] More, *Black Gold*, pp.139-40.
[97] The price of crude oil rose from \$13 to \$34 per barrel between1979 and 1981. Chick, *Electricity and Energy Policy*, p.139.

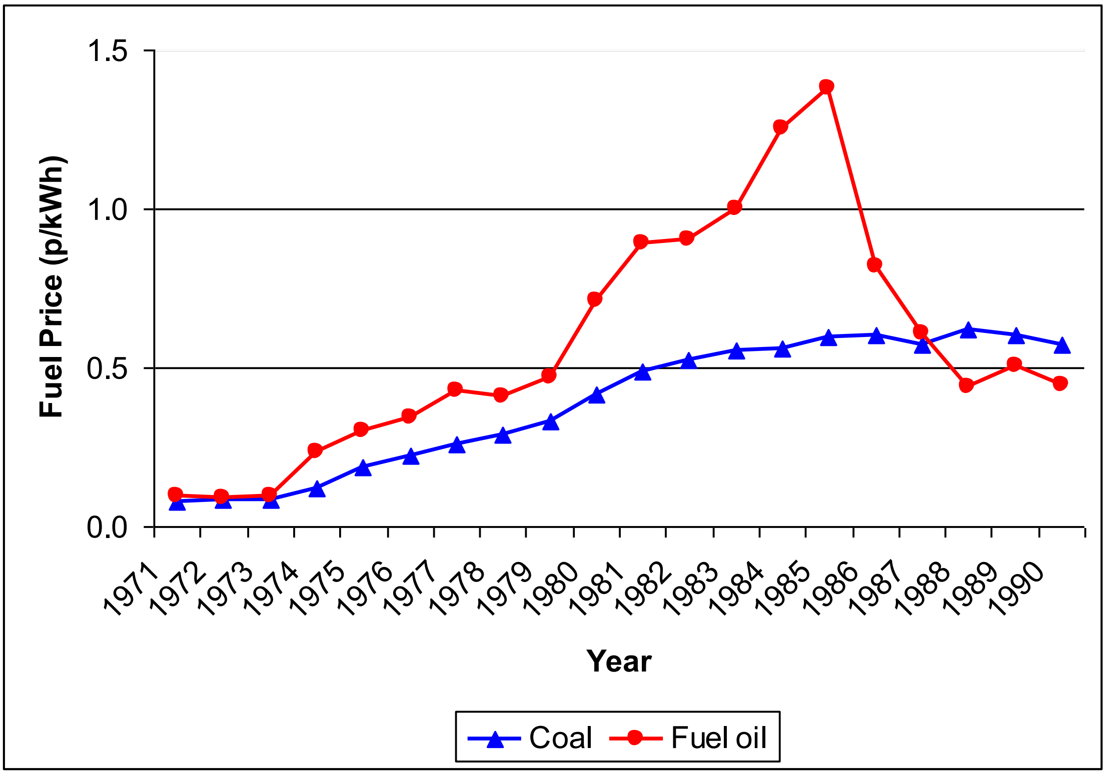

Figure 5.5: Fuel prices for electricity generation, 1971-90.

Source: Adapted from Department of Energy, *Digest of UK Energy Statistics 1975*, Table 77; *1982*, Table 70; and *1990*, Table 69 (HMSO, 1975, 1982, 1990).

There was a trend of increasing coal and oil prices from 1973 but oil became significantly more expensive than coal, reaching a peak in 1985. This is in marked contrast to the marginal difference between the cost of oil and coal up to 1972 shown in Figure 5.2.

The impact of the 1973 crisis was to make oil-fired electricity generation significantly less economically attractive for the CEGB. The operational consequences for Bankside were far-reaching. Instead of the programme of modernisation that had been proposed early in 1973, no further improvement work was undertaken at Bankside. Although the station was used during the rest of the decade its position, and that of other oil-fired power stations, fell in the merit order. The rise in oil prices had also compromised the economic viability of the 1972 district heating scheme at Bankside (see Chapter 4). In evidence to a Select Committee on Energy Resources in 1974 it was stated that the cost of oil at Bankside 'for heating was a certain figure and it is now three times as high'.[98]

By the mid-1970s oil was the most expensive fuel used by the CEGB and as a consequence the amount used fell from 26 per cent of all fossil fuel burned in 1972/73 to six per cent in 1983.[99] This was despite nearly 6000 MW of new oil-fired and dual-fuelled power stations being commissioned in the late 1970s. The consumption of fuel oil in British power stations is shown in Figure 5.6.

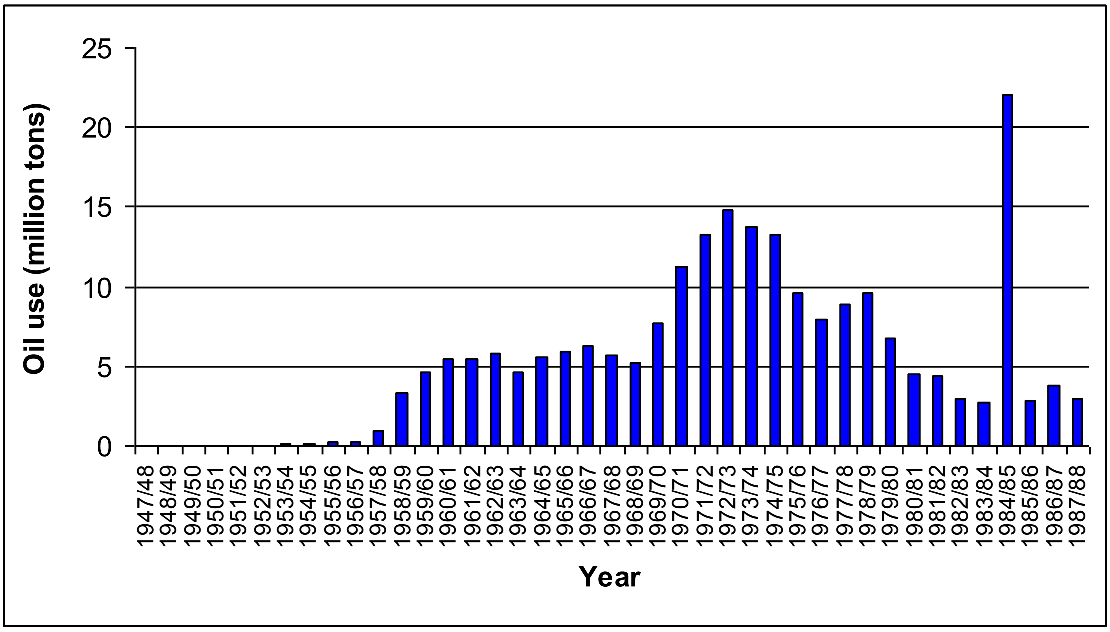

Figure 5.6: Consumption of fuel oil in British power stations, 1947-87.

Source: The Electricity Council, *Handbook of Electricity Supply Statistics 1989* (London, 1990), Table 15, pp.26-27.

[98] House of Commons Parliamentary papers, session 1974, The Select Committee on Science and Technology, Energy Resources, Evidence of A.E. Hawkins dated 18 July 1974, p.164.
[99] The Electricity Council, *Handbook of Electricity Supply Statistics 1989* (London, 1990), Table 15, pp.26-27.

This illustrates the increased use of oil during the 'oil-firing' programmes of the late 1950s to the early 1970s and the decline associated with the rise in oil prices from 1973.[100] The high usage of oil in 1984/85 was a consequence of the year-long miners' strike, when oil-fired power stations – although not the closed Bankside – were used to maintain electricity supplies.

From 1974 the CEGB began a process of mothballing and decommissioning at Bankside power station. One of the 60 MW turbo-alternators was decommissioned in 1976 followed by the other two 60 MW sets in 1978.[101] By 1979 Bankside was only used to meet the peak winter load using its 120 MW generator which was down-rated to 100 MW, in 1980 the station did not operate all year. Bankside was one of 16 power stations closed in October 1981 as part of a wider closure programme.[102] The closures were partly due to the economics of oil but also because several large and more efficient power stations had been commissioned in the late 1970s. The long lead-time for power station planning, design and construction, and uncertainties in the prediction of future demand, meant that this increased capacity became available at a period of static or declining demand. As a result there was a significant national surplus of generating capacity in 1980.[103]

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[100] The oil or dual-fuel stations commissioned in the early 1960s included Padiham, Richborough and West Thurrock; larger stations (greater than 1500 MW) were built from 1968 and included Tilbury, Fawley, Kingsnorth and Pembroke and from 1979 Grain, Ince 'B' and Littlebrook 'D'.

[101] The depreciation period for plant at Bankside was 20 years and the buildings 30 and 40 years, see TNA, HLG 79/918, Report on public inquiry Appendix B. In 1973 the turbo-alternators were close to, or just over, their 20 year discounting period. Decommissioning data from Bettelheim *et al*, 'Fifty Years' Experience', p.276.

[102] Health and Safety Executive, *Industrial Air Pollution 1979* (London, 1981), p.24, and *Industrial Air Pollution 1980* (London, 1982), p.18. The CEGB's the closure programme entailed 2082 MW of generating capacity in 16 stations, Electricity Council, *Electricity Supply,* p.142.

[103] In 1980 the maximum potential national load was 48,284 MW compared to a generating output capacity of 66,541 MW, thus there was a surplus generating capacity of 27.4 per cent, data from Hannah, *Engineers*, Table A.1, p.291.

The second factor that led to the undermining of the ideal model of Bankside was improvements in air pollution. The environmental history of London has been addressed by several commentators and the immediate effects and issues around smog and the 1956 Clean Air Act are discussed above.[104] The indirect effects at Bankside constitute a case study which extends the current historiography. The envisaged benefit of pollution-free emissions, Bankside's 'smokeless shimmer of vapour', was not realised as the technology itself led to occasional local nuisances from 'plume droop', as already discussed. Air pollution from Bankside, and its effects, continued to be reported in the press and noted in official publications. In 1972 as 'thick smoke belched from Bankside power station', two hundred children launched balloons across the Thames at the Mermaid Theatre as part of a survey of air pollution in London.[105] In 1975 the Alkali and Clean Air Inspectorate noted that there was 'considerable complaint against this station during the year on account of the grounding of the washed plumes'.[106] On this occasion the problem was traced to poor combustion in some of the boilers, a full overhaul led to improved conditions but the problem of plume droop remained. The inspectorate discussed the long-term options with the CEGB such as fitting bypasses across the washer to give extra heat to the gases during adverse conditions, but noted that this was a major exercise and in the context of the country's economic situation in the mid-1970s 'the financial climate is not yet right'.[107] This position echoes the technological solution of grit arresters at Bankside 'A' that had been proposed in 1952 which had also been ruled out on economic grounds (see Chapter 2). So although technological solutions were available to address the air pollution amenity problems at Bankside, the cost of these solutions made them

[104] See for example Ashby and Anderson, *The Politics of Clean Air*, pp.104-16; Brimblecombe, *The Big Smoke*, pp.165-72; Sheail, *An Environmental History of Twentieth-Century Britain*, pp.247-50.
[105] Anon, 'Children to Survey Pollution', *The Times*, 19 June 1972, p.14.
[106] Health and Safety Executive, *Industrial Air Pollution 1975* (London, 1976), p.33.
[107] Health and Safety Executive, *Industrial Air Pollution 1981* (London, 1982), pp.6-7.

economically unattractive. After the station closed in 1981 the Alkali and Clean Air Inspectorate noted that it was the longest operating and the 'most successful flue-gas desulphurising system in the world' achieving an overall efficiency of sulphur removal averaging 97.2 per cent over its operational life (see Table 5.2). Although it was very efficient at removing sulphur dioxide the technology itself, by cooling the flue-gases, gave rise to local air pollution.

Flue-gas washing was a dead-end technology as John Sheail contends.[108] Bankside 'B' was at the limit of what was possible with this technology, it was the last British power station to be provided with FGD until the 1980s. Larger power station fitted with flue-gas washing systems would have required much greater volumes of water and would have produced large volumes of effluent. This would not have been possible or acceptable on any British river or even in coastal waters. Instead of treating the flue-gases the CEGB had built chimneys of up to 850 ft high to disperse flue-gases into the atmosphere.[109] In the early 1980s the CEGB resisted the wider application of FGD to power stations just as the BEA had done in the 1950s. The CEGB estimated that the cost of FGD would increase the price of electricity to the consumer by about five per cent.[110] FGD, using a different technology, began to be installed in British power stations in the late 1980s after the issue of trans-national air pollution and acid rain became a political issue. Acid rain is another example of pollution transfer whereby sulphur pollutants in the air are transferred to droplets of water and cause damage to stonework, lakes and vegetation. Acid rain also entails a locational transfer;

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[108] Sheail, *Power in Trust*, p.176.
[109] F.E. Gartrell 'Power Generation' in A.C. Stern (ed.), *Air Pollution, Volume 1V Engineering Control of Air Pollution* (London, 1977), Table III, p.485; Anon, *Power Stations in England,* p.395.
[110] CEGB, *Acid Rain* (London, 1984), p.14.

sulphur from the chimneys of British power stations are transferred to the lakes and forests of Scandinavia and continental Europe.[111]

The technical and economic implications for the ESI of the Beaver report and the 1956 Clean Air Act are discussed above. The social and environmental effects of this legislation had a significant impact on Bankside power station. One immediate effect of the Clean Air Act was a major reduction in the amount of domestically generated smoke in London as a consequence of the adoption of Smoke Control Areas. The traditional domestic coal fire was also in decline, partly because coal was rationed until 1958, but principally because central heating, virtually unknown in British homes before the 1950s, became widespread.[112] Some central heating systems used solid fuel such as anthracite or coke, but the convenience and reduced mess and labour of oil and gas were attractive. The economic historian Brian Clapp notes that 'fireplaces and chimney's were often omitted from the design of new houses and especially new flats in the 1960s' and that 'ripping out old fireplaces became second nature to the do-it-yourself enthusiast intent on modernising his home'.[113] In place of coal, the use of gas and electricity for heating increased significantly. This entailed an interplay of social, technological and economic forces. Both the gas industry and the electricity industry promoted the use of their products. From 1962 'High Speed Gas' was promoted and a wide range of gas heaters became available.[114] The electricity industry promoted the use of electric night-storage heaters which took advantage of cheap off-peak 'white meter' electricity, thus utilising the spare night-time generating capacity of power

[111] B.E.A. Fisher, 'Impact of Power Generation on Air Quality' in R.E. Hester and R.M. Harrison, *Environmental Impact of Power Generation* (Cambridge, 1999), pp.26-30.
[112] Kelf-Cohen, *Twenty Years of Nationalisation*, p.106.
[113] Clapp, *An Environmental History*, p.53.
[114] H. Barty-King, *New Flame: How Gas Changed the Commercial Domestic and Industrial Life of Britain between 1913 and 1984* (Tavistock, 1984), pp.236-38;

stations. This was supported by fiscal measures such as the removal of purchase tax on electric storage heaters in 1963.[115] Therefore, one of the effects of the Clean Air Act was to increase the use of electricity. The shift to electricity was aided by an increasing differential between the price of gas and electricity. Over the period 1950 to 1960 the price of gas rose by 73 per cent whereas electricity rose only by 23 per cent.[116] By the mid-1970s when oil had become costly, gas-fired central heating came to the fore using increasingly available natural gas.[117] Unlike town gas, the production of natural gas did not add significantly to local air pollution. Gas works were closed down thereby further reducing urban air pollution.[118] The improvement of air quality in inner London is illustrated in Figure 5.7 which shows the steady decrease in the amount of smoke and sulphur dioxide over the period 1955 to 1980 which broadly corresponds to the operating life of Bankside 'B'. In this significantly cleaner environment the air pollution from Bankside became increasingly intolerable.

[115] In 1966 2.3 per cent of domestic customers had an electric storage heater, this rose to 7.6 per cent by 1978, Electricity Council, *Handbook 1989*, Table 50, p.84. For the ESI the night-storage load in 1963 was 1100 MW, by 1970 it was 9400 MW, see Bowers, 'Electricity', p.292. There was also a three fold increase in electric water heating from 20.6 per cent of customers in 1955 to 66.6 per cent in 1978 (see Chapter 3 Table 3.1), Electricity Council, *Handbook 1989*, Table 50, p.84. The LEB sold about 26,000 storage heaters per annum in the early 1970s but the market had collapsed by 1976/77 to about 2000 to 3000 units, Monopolies and Mergers Commission, *London Electricity Board Retailing of Domestic Goods*, Cmnd. 8812 (London, 1983), p.9. A parliamentary Select Committee had recommended that purchase tax on domestic storage heaters should be removed, *First Special Report of the Select Committee on Nationalised Industries* (London, 1964), p.4.

[116] Falkus, *Always under Pressure*, Table 3.4, p.48. Malcolm Falkus identifies several reasons for this increase: a general rise in the price of coal; a reduced availability of carbonising coal for use in gas works; and a differential pricing scheme by the National Coal Board which disfavoured the gas industry, Falkus, pp.46-48.

[117] Between 1966 and 1977 the proportion of domestic heat supplied by solid fuel fell from 64 per cent to 26 per cent and the proportion supplied by gas rose from 15 per cent to 43 per cent. F. Tombs, *The Pattern of Domestic Energy Consumption and the Growth of Prices in Relation to Consumers' Income and Expenditure 1966-1977*, Energy Commission Paper Number 21 (London, 1978), p.4.

[118] T.I. Williams, *A History of the British Gas Industry* (Oxford, 1981), pp.180-203.

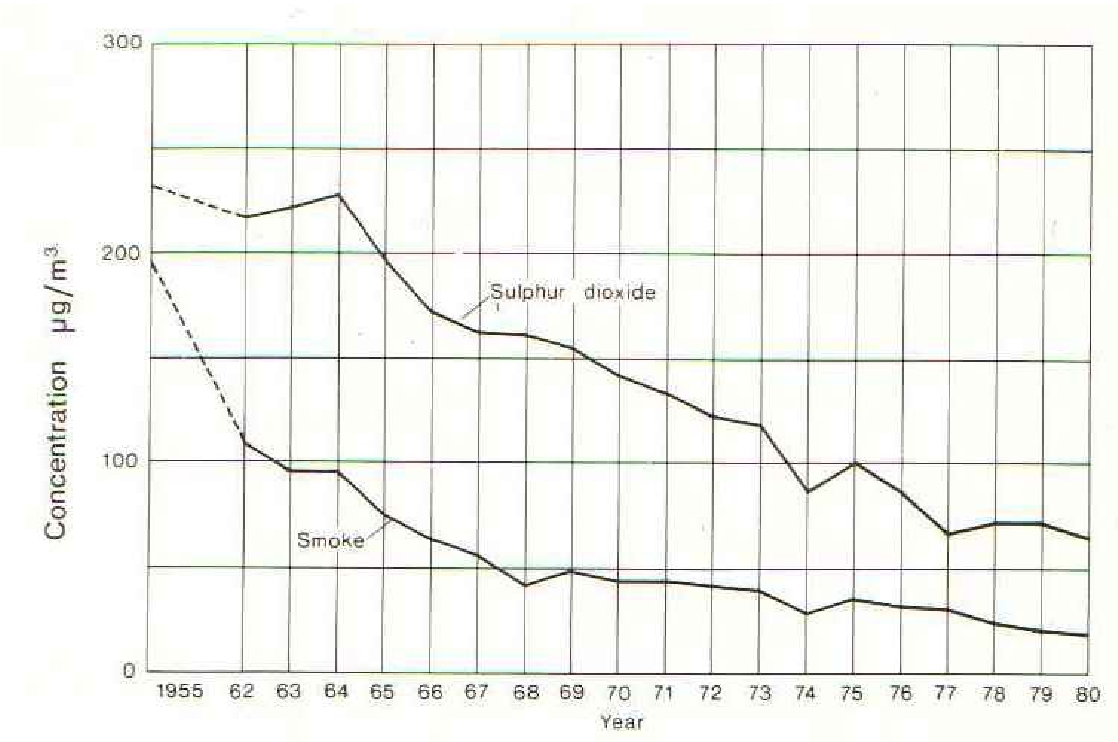

Figure 5.7: Air pollution in inner London, 1955-80.

Source: M.J.R. Schwar and D.J. Ball, *Thirty Years On: A Review of Air Pollution in London* (London, 1983), Figure 6. Reproduced with permission. London Metropolitan Archives.

The third factor that led to the decline of Bankside 'B' as an ideal model was the issue of water pollution in the Thames. One of the effects of the flue-gas washing process at Bankside was to add effluent to the river. The concept of pollution transfer has already been discussed: pollution at one location, or in one medium, was reduced but was increased elsewhere. The flue-gas washing process used at Battersea and Bankside was recognised as an 'effluent' process; it removed sulphur compounds for the flue-gases but discharged large quantities of calcium sulphate effluent into the Thames. The BEA estimated that Battersea and Bankside would respectively discharge 3200 and 3000 tons per month of calcium sulphate into the Thames.[119] The amount of

[119] MOSI, A.1989.338/17/2, Memo from the CEA Chief Engineer's Department to the Ministry of Local Planning dated 17 August 1951; this would give 40 parts per million of calcium sulphate in winter and about 250 parts per million in summer.

sulphur discharged to the river from Bankside ‘B’ is shown in Table 5.2 (column 6).[120] Appendix A explains how this effluent was treated. The effluent had the effect of depleting the oxygen content of the river.[121] Dissolved oxygen is a measure of the health of a river. Concerted efforts had been made to improve the condition of the Thames, principally by modifications to the sewage works discharging into the river.[122] The improvement in the condition of the Thames in London from the mid-1960s is demonstrated by the notable increase in the oxygen saturation of the river shown in Figure 5.8. The issue of oxygen depletion caused by the effluents from Battersea and Bankside was less significant for the ‘dead’ river in the 1950s but, as the Pollution Inspectorate noted, in the early 1980s their effect on river water quality ‘was retarding the remarkable rate of improvement of the River Thames generally’.[123]

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[120] Every one ton of sulphur in Table 5.2 column 6 corresponds to 3.75 tons of calcium sulphate ($CaSO_4$) discharged to the river.

[121] Oxygen was consumed in oxidising the effluent, therefore less was available to support the river’s aquatic life. The oxygen load on the river from Bankside power station was 1.2 tonnes/day in 1952 and 2.0 tonnes/day in 1962. This is notably lower than that the corresponding demand imposed by Battersea of 3.0 tonnes/day in 1952 and 6.0 tonnes/day in 1962 and demonstrates the effectiveness of the improved waste water treatment process at Bankside, data from Wood, *The Restoration*, p.71.

[122] Wood, *The Restoration*, pp.101-12.

[123] Health and Safety Executive, *Industrial Air Pollution 1981* (London, 1982) pp.6-7.

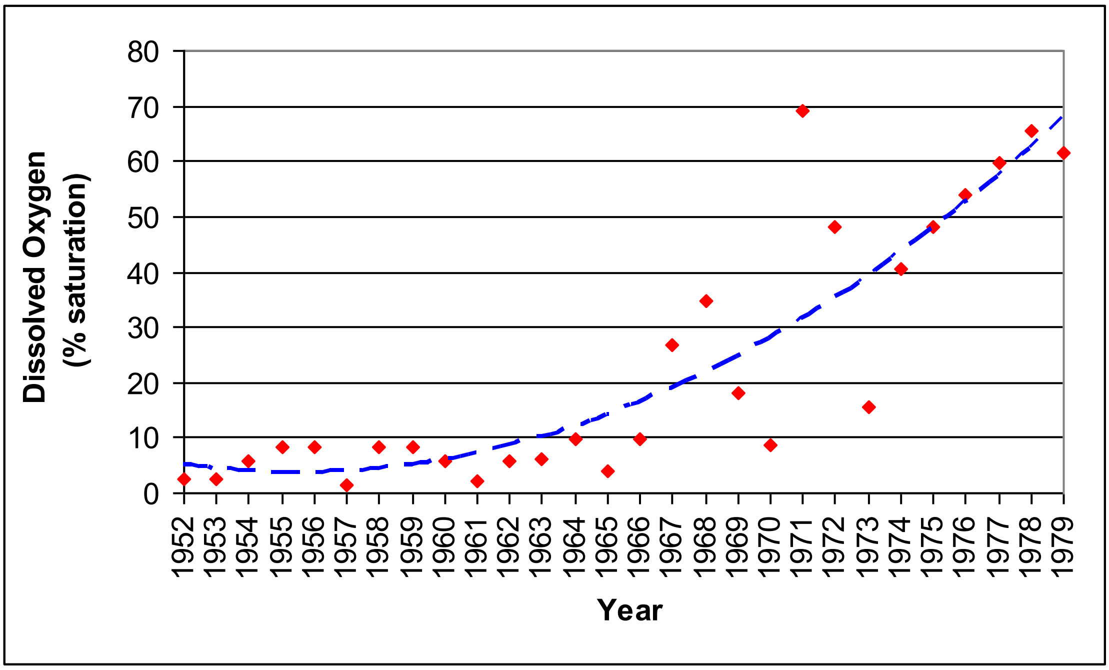

Figure 5.8: Oxygen in the river Thames at London bridge, 1952-79.

Source: Adapted from L.B. Wood, *The Restoration of the Tidal Thames* (Bristol, 1982), Figure 81, pp.116-17.

Note the red diamonds are the annual ‘third quarter’ average measurements, the broken blue line the overall trend.

In addition to the chemical pollution of the river a related issue was thermal pollution. The visual amenity advantages of direct water cooling, whereby cooling towers were unnecessary, is discussed in Appendix A. However, direct cooling meant that a large amount of heat from the power station was added to the river. It was estimated that in 1980 the Thames just downriver from London Bridge was about 3°C warmer than its ‘natural’ temperature due to the effect of London power stations.[124] Locally the river temperature may have been higher due to thermal plumes from individual stations. For example, the cooling water used at Bankside was returned to the river about 8°C warmer than the abstraction temperature. The increased temperature made the river ‘unsuitable for sensitive organisms such as migrating fish’,

[124] The 3°C rise reduced the saturation of oxygen by about 5.4 per cent, Wood, *The Restoration*, p.73.

but also reduced the concentration of dissolved oxygen in the river. The Ministry of Housing and Local Government raised the issue of thermal pollution in 1960 in commenting on the proposed extensions to Bankside, Tilbury 'B' and West Thurrock and the effects these power station extensions would have on the Thames. They stated that they were concerned about the quantity of heat to be discharged into the Thames 'as the increase in river temperature in the reaches deoxygenated by pollution has a bad effect in that it accelerates the formation of hydrogen sulphide'.[125] This is an example of one form of pollution aggravating the effects of another. However, the Ministry's reservation did not prohibit the building of these extensions.[126] The necessity of providing electricity supplies was again the over-riding consideration.

The issue of river pollution from Bankside had a less visible impact than air pollution. There are similarities and parallels between the two cases. Both London's air and water had become significantly cleaner over the operational life of Bankside power station. This was driven by social and amenity concerns and the political will to address them. The improvements serve to highlight the increasingly adverse, and unacceptable, environmental effects of Bankside power station. Although air and river pollution were not themselves decisive factors in the closure of Bankside, the environmental context in which the power station was being operated at the end of its working life was significantly different to smoggy London and the dead Thames of 1952. The urban power station, exemplified by Bankside 'B', was no longer the ideal model. Even when it was conceived Bankside 'B' was at the physical size limit of

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[125] The LCC raised the issue of thermal pollution when Brunswick Wharf power station was being planned in 1946 and the impact this might have on the badly polluted river at this point. TNA, POWE 12/702, Ministry of Fuel and Power, Brunswick Wharf, Letter from the Deputy Clerk of the LCC to the Electricity Commission dated 21 February 1946, f.2.

[126] TNA, POWE 14/1116, letter from the Ministry of Housing and Local Government to H.J. Gummer at the Ministry of Power, dated 26 September 1960.

what was possible, desirable or permissible to construct in an urban setting. By the early 1980s the deindustrialisation and environmental improvement of London had made Bankside a relic of an earlier age, a form of industrial urban infrastructure that would have been inconceivable to build anew. Bankside is an example of an industrial structure rendered redundant by technological progress, economic change and environmental improvements.

Conclusion

This chapter reconstructs aspects of the operation of Bankside power station. It extends the history of technology examined in Chapter 4 into the operational phase of the power station. It addresses several of the practical issues and concerns that arose throughout Bankside's operational life and examines how these were dealt with by the power station's owners and operators. The study demonstrates that operational and technological decision-making were processes that were influenced by significant externalities such as the economics of oil supply, the necessity of maintaining electricity supplies, and environmental issues.

The chapter shows that for much of its life Bankside was a model power station. It was recognised by the BEA / CEA / CEGB as an efficient and valuable station to provide electricity supplies to London throughout the 1950s and 1960s. As an oil-fired power station it had a significant amenity advantage on its sensitive riverfront location. The station had a high thermal efficiency and was operated extensively, and often intensively, in its first two decades to take advantage of relatively cheap fuel oil. The washing plant operated effectively to remove sulphur compounds from the flue-gases; this plant was significantly more efficient than had originally been envisaged and was more effective than the one at Battersea power station. The model power station therefore met or exceeded the expectation of its designers to provide electricity efficiently; to remove pollutants from its flue gases; and to minimise the amenity impact on its surroundings.

Bankside, in its pioneering use of fuel oil, was also a model for later power stations. Oil was an important fuel source for British power stations until 1973 and again during the miners' strike in 1984-85. This encouraged and allowed the ESI to build several phases of oil-fired power stations. On several occasions the plant at Bankside was rated as one of the most efficient in the country and there were plans in 1973 to extend the operational life of Bankside well into the 1980s. Nationally, a four-fold increase in the use of electricity, to which Bankside contributed, reflects the growth of the British economy over the operational life of the power station.[127] The chapter demonstrates the increasing dependence of businesses in the City on electricity. The security and reliability of electricity supplies was an important issue for the industry: the CEGB were prepared to jeopardise the integrity of the plant at Bankside to 'keep the lights on'.

The ideal model was subject to some perturbations; the operation and output of Bankside was affected by both internal and external factors. Bankside was operated as a base-load station when oil prices were low, but this led to some unexpected technical and operational consequences. Problems were experienced with the novel use of oil and with the flue-gas washing system. The study has shown that Bankside's engineers

[127] The amount of electricity generated by the BEA / CEGB increased from 51,859 GWh in 1950/51 to 226,761 GWh in 1981/82, Electricity Council, *Handbook of Electricity Supply Statistics 1989*, Table 12, pp.20-21. Electricity's share of the final energy market doubled during the first 15 years of nationalisation from 14 per cent in 1948 to 29 per cent in 1963, Hannah, *Engineers*, p.280.

were able to apply scientific and technical solutions to resolve these problems. The incidents examined in this chapter illustrate both the predictable and the often unexpected consequences of earlier design and operational decisions.

This chapter contributes to the urban environmental history of London. It extends the existing historiography on the 'killer smog' of 1952 and the subsequent Clean Air Act, by providing specific examples from Bankside power station and its locality.[128] The research examines the local effects of air pollution in Southwark; the discussions around the commissioning of Bankside in 1952; and the long-term improvements in air quality and the influence on the perception of the power station. The amenity impact of Bankside had been a major consideration during the planning phase. Yet both despite, and because of, the abatement technology the adverse environmental impacts of the power station were an issue throughout its operational life. The BEA was ambivalent about flue-gas desulphurisation and successfully resisted calls by the Beaver committee on air pollution for the universal deployment of this 'model' technology in other urban power stations, principally on economic grounds. The flue-gas washing process was not an ideal model for flue-gas desulphurisation because under certain atmospheric conditions it gave rise to local air pollution. It was a dead-end technology because of the scale of the plant necessary for larger power station: flue-gas washing was not adopted elsewhere.[129] The air and water pollution generated by Bankside were accentuated in the 1970s as the efforts to reduce urban air pollution and to clean-up the Thames yielded positive results.

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[128] Ashby and Anderson, *The Politics of Clean Air*, pp.104-16; Brimblecombe, *The Big Smoke*, pp.165-72; Sheail, *An Environmental History of Twentieth-Century Britain*, pp.247-50; Clapp, *An Environmental History of Britain since the Industrial Revolution*, p.51.

[129] This supports John Sheail's contention that this technology was a blind alley, see J. Sheail, *Power in Trust*, p.176.

This study has identified and examined several examples of the phenomenon of pollution transfer. The literature on this topic is not extensive although there are some examples for the United States, this research therefore extends the field by providing a number of British examples.[130] The research demonstrates how the wider context of the ultimate sink of the environment must be considered in examining the fate and effects of pollutants. Examples include the transfer of the sulphur pollutants from Bankside's flue-gases into the river Thames; the shifting use of coal, coke, gas, oil and electricity for domestic heating; the proposal to use town gas at Bankside; the tall chimneys of British power station built from the 1950s; and district heating schemes which aimed to eliminate the local use of coal or gas.

A turning point for Bankside was 1973 when the 'ideal model' was fatally undermined. Substantial oil price increases made oil-fired electricity generation expensive, and the use of oil by the CEGB fell significantly. In the wider economy the stagnation of electricity demand in the 1970s and a national overcapacity of generating plant made the then less efficient Bankside increasingly uneconomic. It was partly decommissioned in the late 1970s before it closed in October 1981. During the following decade Bankside stood derelict, a 'gloomy presence' on the South Bank. The next chapter examines the post-industrial history of the building and the locality.

[130] It has often been said that electric lighting improved the conditions in domestic living rooms, offices and inside public buildings compared to gas or earlier oil lamps, See for example Otter, *The Victorian Eye*, pp. 206-08, and Weightman, *Children of Light*, p.129. However, the supply of electricity entailed the construction of power stations whose smoke and fumes added to urban air pollution. This is another example of pollution transfer.

Chapter 6 – Transforming Bankside: industrial dereliction to cultural consumerism

During the evening of Thursday 11 May 2000 two-and-a-half-thousand bottles of champagne were consumed at a party in Southwark; tickets for the 4000 guests reputedly changed hands for £1000. The occasion was the gala opening of Tate Modern, London's first museum of modern art.[1] Tate Modern was more than a museum; as the art historian Sir Roy Strong said the following day:

> It is a London landmark, a new destination. It signals the renaissance both of the river and of the South Bank and continues the eastward thrust of new London that began with the Thatcherite redevelopment of the Docklands.[2]

The conversion of Bankside power station to Tate Modern was a remarkable transformation; but one that may never have happened. After its operational life ended in 1981 the power station was derelict for over a decade and there were several proposals for its demolition. There were also plans for redevelopment although none were financially viable until the Tate Gallery acquired the building. In its transformed state it has brought about, as Roy Strong remarked, a renaissance of this part of the South Bank. The location was a key aspect to the success of Tate Modern, yet the juxtaposition with the City and St Paul's cathedral had been decried in the late 1940s.

This chapter examines the post-closure history of Bankside power station together with an analysis of the changes that took place in the immediate area over the operational life of the power station and up to the present day. Bankside power station, as a private industrial place, had largely stood apart from its surroundings. By 2000 the building had been transformed into a new public space that was being integrated into

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[1] A. Hamilton and A. O'Connell, 'Tete-a-Tate Shows the Art of Partying', *The Times* (12 May 2000), p.1.

[2] R. Strong, 'From Power Station to Masterpiece', *Daily Mail* (12 May 2000), p.44.

the material, social and cultural fabric of the neighbourhood and of London.[3] The Bankside area evolved from a run-down post-industrial locality with dreary office buildings and derelict property to a popular cultural centre with new – but not uncontroversial – office, commercial and residential developments and improved transport connections.

The chapter uses a framework of potential and realised changes and transformations to examine the interplay of social and cultural issues, political positions and economic forces that are an overarching theme of this thesis.[4] The redevelopment of the Bankside area during the second half of the twentieth century was manifest in piecemeal, individual development of specific sites. The changes reflected wider forces and influences such as the decline of riverside industry and commerce; a period of speculative office building; and access, or otherwise, to appropriate financing. The transformation of Bankside to Tate Modern was crucially dependent both on its location and of the timing of the redevelopment. Several contingent factors made the transformation viable, including concerted efforts to sell the site by the newly privatised electricity industry; the needs of the Tate Gallery; and the availability of public and private financing. The redevelopment of Bankside – both the power station and the locality – is contrasted with the post-industrial fates of two other Thames-side power stations whose operational lives had paralleled Bankside. Location, timing, finance and aesthetics were key factors in the fate of Battersea and Brunswick Wharf power stations. This chapter shows how Tate Modern, together with

[3] The integration into the social fabric was one of the intentions of the design brief for the new gallery. London Metropolitan Archives, LMA/4441/01/4842, *Tate Gallery of Modern Art: Competition to Select an Architect* (1994), pp.10-12.
[4] The term 'Bankside' has itself undergone several transformations: originally – and still – referring to the riverside road; it also referred to Bankside power station; and since the opening of Tate Modern it refers to the locality, broadly the quadrilateral of the 1947 public inquiry. The London Borough of Southwark has defined the Bankside Regeneration Area as a considerably larger locality, see Figure 6.2.

the Globe Theatre, has repositioned Bankside as a major visitor and tourist location which, in turn, has driven the regeneration and transformation of the area. The success of the gallery – with four million visitors a year – has given rise to another transformation: the on-going redevelopment of Tate Modern through the addition of a major extension.[5]

Evolution of the Bankside area, 1947-81

Chapter 5 examines the operational life of Bankside power station from its commissioning in 1952 to its closure in 1981, together with the changing economic and environmental conditions in which it functioned. This section addresses the changes that occurred in the built environment of the Bankside area over this period. This analysis provides detailed evidence for some of the planning strategies that local authorities put in place and demonstrates the reality of planning as it was manifest in this area of London.[6] It also complements and extends the scope of some popular accounts of the history of the Bankside area.[7] I suggest that the changes on Bankside in this period were evolutionary rather than radical. Despite specific plans and zoning of the area, the developments that took place were piecemeal and were the result of commercial and other economic forces. The presence of the working power station had little impact, adverse or otherwise, on the developments that took place, contrary to what had been feared during the 1945-47 planning process.

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[5] In its first year there were 5¼ million visitors, M. Kennedy, 'Tate Modern: This is the favourite exhibit in the world's favourite museum of modern art', *Guardian* (12 May 2001), p.3. The popularity was sustained with nearly 22 million visitors in its first five years, see A. Searle, 'Happy Birthday, Tate Modern', *Guardian Arts* (5 May 2005), p.14.

[6] Brindley *et al*, *Remaking Planning*; McCarthy, 'The Evolution of Planning Approaches', pp.149-50.

[7] Golden, *Old Bankside*; Reilly and Marshall, *The Story of Bankside* and G. Tindall, *The House by the Thames* (London, 2007).

Following the approval of the new power station in May 1947 the LCC reconsidered the zoning of the Bankside area. They proposed that this should be consistent with the power station 'yet which aims at preserving, to some degree, the character of the original proposals for the area', i.e. the *County of London Plan*.[8] The bomb-damaged Bankside area (see Figures 3.2 & 3.3) was zoned for business; riverfront open space; residential areas; offices; and 'technical institutions, including the Bankside Generating Station'. The word 'industry' was not used but the reality was that Bankside 'B', a very large industrial building, was intermixed with residential and commercial premises against the principles of the *County of London Plan*. One proposal by the LCC's architect in 1947 was that the area adjacent to the station could be developed as an electricity centre for London with offices for a regional headquarters and electricity showrooms.[9] This idea was taken up by the BEA which built Bankside House on a vacant plot south of the power station. This became the BEA's headquarters and, from 1964, the CEGB's South Eastern regional headquarters. The national grid control centre was also based there from 1962 until 1971.[10] There was also an 'Electricity Meter Testing Station' at No.95 Park Street, and the offices of the old Bankside 'A' power station remained at No.64 Bankside until both the station and the property were demolished in 1959.[11] The area's connection with electricity persisted: in 1971 the national grid control centre was relocated to a building on the corner of Park Street and Sumner Street and remained there until 1996, long after

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[8] LMA, LCC/PC/GEN/01/052, LCC Town Planning Committee, Report on Bankside generating station – re-planning of surrounding area, dated 20.11.47 (T.P. 939), f.1.
[9] Ibid., f.2.
[10] Bankside House was built at the same time as the western half of the power station and used steam from the power station for heat and hot water services, Pugh, 'The Generation of Electricity', p.488. H.F.R. Taylor, 'New National Control Centre', *Electrical Review,* 170 (30 March 1962), pp.541-43.
[11] *Post Office Street Directory London, 1950* and *1957.*

Bankside power station had closed.[12] The persistence of the connection with electricity is an aspect of 'the momentum of place' that the site had acquired when the first power station had been established in 1891; this connection with electricity continues to the present day as discussed below.

The LCC's zoning for business was manifest in a number of office blocks that were built in the area during the 1950s and 1960s (see Figure 6.1).

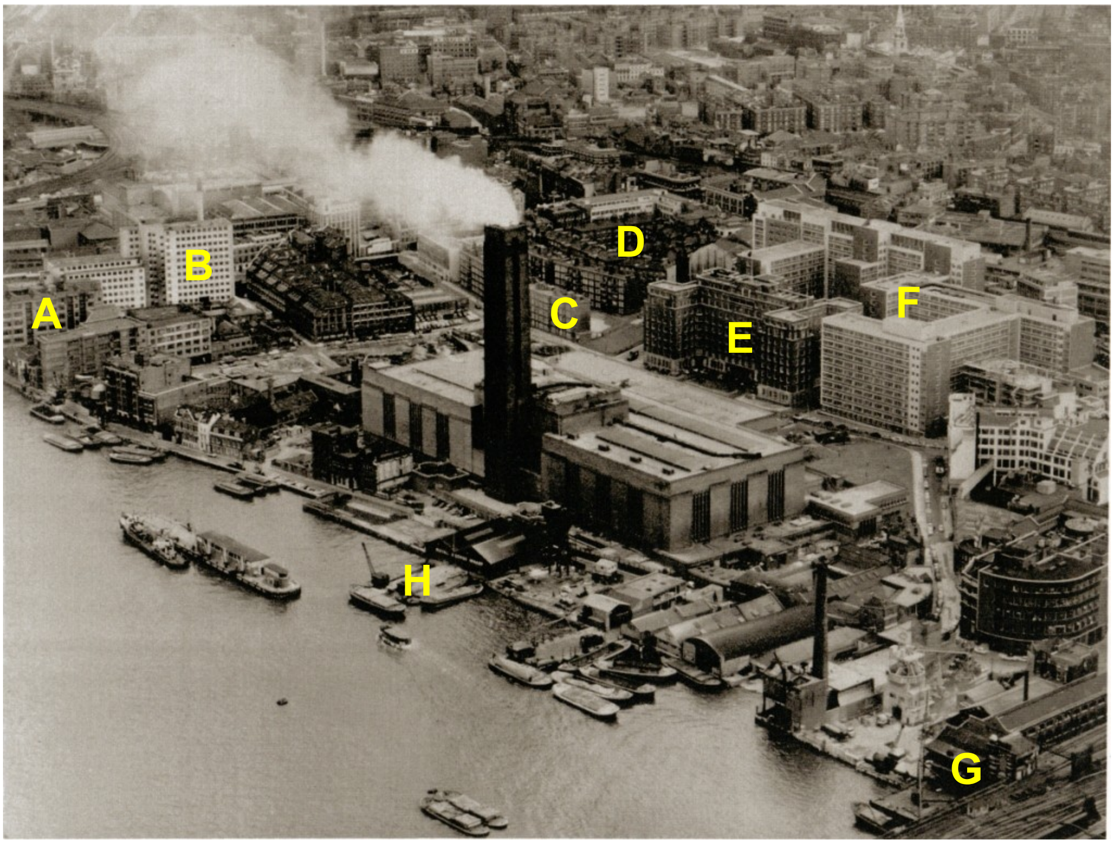

Figure 6.1: Bankside and surroundings, *c*.1963.

Source: G.B. Marshall, 'Tate Modern Its Industrial History', unpublished (2004), Southwark Local History Library, Illustration 19 (CEGB photo-library).

Key: A=Universal House, B=Southbridge House, C=Sumner Buildings, D=Peabody Buildings, E=Bankside House, F=St Christopher House, G=Falcon Wharf, H=Royal George Wharf.

[12] Southwark Local History Library, 'Bankside file', CEGB, 'Most Modern Control Centre in the World', *South Eastern Power*, No.58, October 1971.

As the cultural historian Frank Mort has argued, the lifting of building controls by the Conservative Government in 1954 was the starting gun for a property boom that lasted for a decade.[13] The County of London Development Plan, adopted in 1955, included plans for the development of the South Bank with priority given to new government offices.[14] Southbridge House was built on Southwark Bridge in 1957 and was occupied by Ministry of Public Building and Works. St Christopher House on Southwark Street was built in 1959 and occupied most of the site to the south and west of Bankside House. This office development – reputedly the largest in the country – was occupied by several government departments.[15] The presence of Bankside power station was not a disincentive to these developments. However, the offices were not occupied by 'good class businesses' from the City, as Patrick Abercrombie had suggested during the 1947 public inquiry, but by civil servants.[16]

The riverfront at Bankside also underwent a significant, but unplanned, transformation. Prior to the Second World War the riverside was an area of wharves, warehouse and associated trades and industry (see Figure 3.3). At the 1947 public inquiry Counsel for the City of London Corporation had said that 'the treatment of the river frontage there should retain the wharfingers'.[17] The Borough of Southwark also noted that the wharfingers along the riverside would keep their properties for a number

[13] Mort, 'Fantasies of Metropolitan Life', p.122. Peter Scott also maintains that property development was probably the most prosperous sector of the British economy during the 1950s and early 1960s, Scott, 'The Evolution', p.518. The office building boom was brought to an end by Harold Wilson's incoming Labour Government in 1964. A ban on further office building in London and the surrounding region was imposed from 4 November 1964. P. Hall, *Urban and Regional Planning* (Newton Abbot, 1975), p.144.
[14] E.V. Marmaras, 'Central London Under Reconstruction Policy and Planning, 1940-59' unpublished PhD thesis, University of Leicester, 1992, p.221.
[15] St Christopher House was occupied by the Ministry of Transport and Civil Aviation; the Ministry of Defence; the National Road Safety Advisory Council; and, in an annex, the Central Office of Information. Southbridge House was occupied by the Ministry of Works; the Ministry of Transport; and the Ministry of Pensions and National Insurance. *Post Office Street Directory London, 1960* and *1967.*
[16] TNA, POWE 12/798, evidence of Sir Patrick Abercrombie at the public inquiry, day 3, p.33
[17] Ibid., public inquiry, day 4, p.25.

of years and these should be zoned for eventual incorporation into the riverside open space as envisaged in the *Plan*.[18] The general wharfingers Beck & Pollitzer Limited had a long association with Bankside from the turn of the century and before the war they had occupied six wharves along Bankside.[19] The company expanded during the 1950s when they occupied nine wharves together with their offices in Universal House on Southwark Bridge.[20] London's riverside trade was still significant enough in 1954 for a directory of wharves to be compiled. But the decline of riverside commerce is apparent: of the 22 wharves along Bankside between Southwark Bridge and Blackfriars Bridge, seven were identified as being destroyed or not in use. The wharves handled a variety of goods: building materials; newsprint; general cargo; canned goods and dried fruit; and house refuse.[21] Some of the wharves are shown in Figure 6.1. By 1967 Beck & Pollitzer Ltd. were no longer operating in the area and only four of Bankside's wharves had an occupier. Commercial decline, led to the gradual disappearance of the wharves on Bankside and by the late-1970s they had all closed.[22] The deindustrialisation of Bankside was not a result of strategic planning by the local authorities but rather the result of the economic decline of riverside wharfage due to the eastward shift of the Port of London and the associated decline in upriver commerce and industry.

The piecemeal nature of the development of the Bankside area is also demonstrated in several building schemes that were proposed or built during the 1970s.

[18] Southwark Local History Library, Southwark Borough Council, Council resolutions 'Bankside Generating Station – Re-planning of surrounding area', item 268/2/48, February 1948.

[19] Beck & Pollitzer appear in photograph of Universal Wharf, Bankside taken from Southwark Bridge in 1898, MOSI, A1989.338/2,4,5.

[20] Universal House had been opened in 1933, it is mentioned in an article in *The Architects' Journal,* in the same edition Battersea power station is first described as a modernist cathedral, C.H. Reilly, 'The Years' Work at Home', *Architects' Journal* (January 1934), p.65.

[21] J.G. Eves and R.F. Hazell (eds), *River Thames Wharf Directory* (London, 1954), pp.81-85.

[22] In 1971 there were five operational wharves in the City of London which still handled goods, see Dunning and Morgan, *An Economic Study of the City of London*, p.373.

In 1971 Southwark Borough Council adopted a strategic plan for a mixed-use development of the area. This was to entail the large-scale redevelopment of the riverside with offices, hotels and houses all heated by a district heating system based at Bankside power station.[23] The town planning geographer John McCarthy has called the period from 1971-82 in north Southwark the era of 'trend planning'.[24] He identifies characteristics such as a falling population; declining traditional industry; and rising land values that led to land speculation.[25] Concerned that their traditional jobs and homes were being lost community groups began taking an active role in the local planning process in the early 1970s.[26] The planning authorities had also begun to consult more extensively with residents from the late 1960s.[27] One organisation was the North Southwark Community Development Group, established in 1972. The Group were critical of the Southwark's planners acquiescing to the demands of commercial developers at the expense of jobs and homes for the area's working class population.[28] One of their representatives said of some of the proposed riverfront developments on Bankside in 1972 'what they mean is shag-pads for bloody millionaires'.[29] The subsequent economic downturn of the 1970s and the GLC's post-1973 policy of reducing office development, left the Borough of Southwark's development plans largely unfulfilled. The only residential development in the Bankside area was the 110 council flats at Falcon Point – recalling the demolished Falcon Wharf – constructed in

[23] M. Walker, 'A Kick Up the Bankside', *Guardian* (30 August 1972), p.12; 'Heat from a Power Station', *Financial Times*, 1 October 1971, p.10.
[24] Trend planning was characteristic of buoyant areas with only minor problems and a market-led approach to market processes see Brindley *et al*, *Remaking Planning*, Table 2.1, p.9.
[25] McCarthy, 'The Evolution of Planning Approaches', pp.149-50.
[26] Brindley, 'Community Roles', p.368.
[27] See, for example, Brindley *et al*, *Remaking Planning*, pp.17-20.
[28] Harris, 'From London to Mumbai and Back Again', p.2414.
[29] Walker, 'A Kick Up the Bankside', p.12.

1978. This project was aided by a financial contribution from the Lloyds Bank computer centre development adjacent to Blackfriars Bridge.[30]

Another development on Bankside was the Globe Theatre, the seminal precursor to the later cultural repositioning of area. In 1970 Sam Wanamaker had established a temporary Globe Theatre at Skin Market Place. One critic at the theatre's first season in 1972 was less than impressed with the production, the theatre, or the locality. The comments are revealing of the Bankside area at this time: a 'plastic theatre open on all sides to grim warehouses and smoking chimneys […] the youth of Southwark bawling misquotations from *Hamlet* through the back wall'.[31] In 1977 the riverside walk in front of the power station was designated a part of London's Silver Jubilee Walkway together with green spaces and gardens that had been envisaged in both the *County of London Plan* and the 1947 zoning. Despite these developments much of the area behind the riverfront remained derelict and run-down, the redundant Bankside power station adding to the sense of dereliction in 1981.

Thus the transformation, or rather the evolution, of the Bankside area over the period 1947-81 was a gradual, piecemeal process that only partly conformed to the strategic plans and the intended zoning for the area. The changes reflect the wider developments in the economy such as the decline of riverside trade and the office building boom of the 1950s. The next section addresses the post-closure plans for, and changing attitudes to, the derelict power station and its relationship with the surroundings.

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[30] T. Aldous, 'The Changing Face of the Thames', *Illustrated London News* (31 October 1981), p.35.
[31] I. Wardle, 'Putting Bankside Myth to the Test', *The Times*, 4 July 1972, p.9.

Plans, protection and uncertainty, 1982-93

Bankside power station stood derelict for over a decade following its closure in October 1981, although the power station offices continued to be occupied by CEGB staff until privatisation.[32] The available sources demonstrate that several private sector redevelopment plans were proposed but none proved to be financially viable. During the 1980s the architectural and industrial archaeological value of the building began to be acknowledged. Formal listing was refused because the building and its site were seen by Margaret Thatcher's Conservative Government as an asset to exploit.

It was recognised by several contemporary commentators that the imposing Bankside power station and its location opposite the City of London offered either a 'rare site for redevelopment or a challenge to designers of schemes for the re-use of the Giles Gilbert Scott turbine halls'.[33] Proposals for the power station and the site centred on two broad options: the retention and redevelopment of the building as a museum, exhibition, entertainment or leisure centre, or its demolition and the reuse of the site for housing or offices. The campaigning group SAVE Britain's Heritage visited Bankside in May 1980 and produced a report on potential future uses.[34] They noted that 'Bankside was superbly built and is very well maintained […] it has none of the structural problems of Battersea power station'.[35] The report prophetically suggested that the turbine hall was suitable for an exhibition space and acknowledged the economic value of the site by noting that the Borough of Southwark would be looking

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32 Interview with Barry Henniker, November 2013.
33 Aldous, 'The Changing Face of the Thames'.
34 SAVE Britain's Heritage was founded in 1975 by a group of architectural historians, see J.N. Tarn, 'Urban Regeneration: The Conservation Dimension', *The Town Planning Review*, 56:2 (1985), p.253.
35 Tate Archives, TG 12/1/1/7, SAVE Britain's Heritage Report by M. Binney and B. Mazur, *Bankside Power Station: The Possibility of Alternative Use* (London, 1980). The structural problems at Battersea were in the washing towers just below the chimneys where chemicals associated with the flue-gas washing process had leaked out and damaged the brickwork, M. Binney, *The Colossus of Battersea: A Report by SAVE Britain's Heritage* (London, 1981).

for a use capable of producing 'a considerable rateable income'. The CEGB intended to sell the redundant power station and its site by competitive tender in 1982, although they recognised that removing the plant and machinery and converting it to another use would be costly to any developer.[36] Despite the potential cost a number of notable architects and developers, for example Terry Farrell, Theo Crosby and Pentagram, were interested in the site and put forward ambitious proposals over the following decade. The difficulty of financing prevented the realisation of any of these plans.

One early proposal was that the building and its machinery could be preserved as an industrial museum. The GLC Councillor for Bermondsey, George Nicholson, opposed the suggestion and said that there were enough museums in London and that Battersea Power Station was going to be used as an extension to the Science Museum and therefore such a use would be an inappropriate for Bankside.[37] Nicholson observed that 'some people would like to see it knocked down and houses put on the site' but recognised there was also potential for the building to be used for recreational facilities. A response to his comments in the local press noted that there were few museums of engineering in London and that such a museum at Bankside would provide employment opportunities for local people.[38] At a time of high unemployment, many developers made a point of highlighting the job opportunities that their schemes would provide. One proposal for Bankside in 1982 by the developer and accountant Len Castle was a 'Las Vegas-style' entertainment hall with seating for 2000 diners.

[36] The location of the CEGB archives is unknown, therefore the position of the CEGB is inferred from attributed quotes in press reports, e.g. P. Silva, 'Lights go down on a faded star', *South London Press*, 30 October 1981, pp.40-41.
[37] George Nicholson quoted in Silva 'Lights go down', p.41; Binney, *The Colossus*, the use of Battersea as an extension of the Science Museum is mentioned in G. Stamp, 'What Shall We Do With This Cathedral of Power?', *The Times*, 16 April 1983, p.6.
[38] 'Keep Power Station as a Museum', letter to the editor from P. Gibbons, *South London Press*, 17 November 1981.

The developer claimed this would provide 1400 new jobs including 900 unskilled ones. The £65 million development would also include a sports complex, tennis and squash courts and a gallery for local artists. The promoters said that banks and pension funds were interested in financing the proposals; the reality was that funding, in the economic downturn of the early 1980s, was not available and nothing came of these plans.[39]

As well as private developers, the local authority was interested in the site. In 1984 the Borough of Southwark suggested that they might buy the site, demolish the power station and encourage the construction of a large office development together with shops, a theatre, and a small amount of housing and an improved riverside walkway. But like the other proposals this scheme remained unfulfilled.[40] The Council's plans were typical of many schemes for the mixed use of the site. In 1989 there was a proposal from Theo Crosby of the design group Pentagram (the architects of the Globe Theatre) for an opera house which would have entailed demolition of the power station and was to include flats, 'high-value' offices, shops, a hotel and conference centre and a pedestrian bridge to link the scheme to St Paul's cathedral.[41] In the early 1990s the Location of Industry Bureau recognised that, given the state of the property market, neither large quantities of new offices, nor shops, or residential properties would be profitable and proposed a development that would retain the building and convert it into an exhibition and conference centre together with a

[39] Anon, 'Las Vegas Style May Hit London', *South London Press*, 2 April 1982.
[40] Anon, 'Bankside to be Demolished', *Evening Standard*, 5 September 1984, p.5. These plans included new offices despite the 70,000 square metres of empty office space in north Southwark in 1983, Teedon, 'Designing a Place called Bankside', p.464.
[41] H. Pearman, 'Opera Plan for Power Station', *Sunday Times*, 12 Feb 1989, p.9.

museum of British industrial achievement and a 200 room hotel.[42] The Bureau had been in negotiations for a long lease on the building but Nuclear Electric, Bankside's post-privatisation owners, indicated they were 'taking advice from certain developers' and would be seeking planning permission to redevelop and then sell the Bankside site.

A significant problem for the developers was that the site was not a 'blank slate' for redevelopment. The distribution and supply of electricity, although not its generation, remains a function of the Bankside site. The electricity switch-house to the south of the building had to remain to continue to distribute electricity to the City of London and the local area from supplies from the national grid. This distribution function dated from the original 1891 power station and had been one of the key arguments for retaining a power station at Bankside during the 1947 public inquiry.[43] The switch-house and the underground electricity cables across the site constrained potential redevelopment. As one former worker observed 'Bankside remained in existence well after its sell by date because of the copper in the ground'.[44] In 1985 the CEGB objected to the site being zoned for housing by the Borough of Southwark. They argued that the switch-house would 'cast a shadow over part of the site' making it unsuitable for housing. A community bulletin suggests that the CEGB's real concern was that if planning permission for housing was granted then the value of the site would be lower than if it were zoned for office development.[45] The switch-house would later be an issue for the Tate as it constrained their plans for the site. After Tate Modern opened the transformers in the switch-house generated an annoying hum

[42] LMA, LMA/4441/01/4842, Letter from the Location of Industry Bureaux to English Heritage, dated 4 January 1993.
[43] TNA, HLG 79/918, Inspector's report on public inquiry, p.4.
[44] Interview with Barry Kett, November 2011.
[45] Southwark Local History Library 'Bankside File', 'The Bankside Battle', *Through the Roof; The Bulletin of the Campaign for Housing in Central London,* No.2 (1985).

throughout the building.[46] The electricity distribution function continues and recent modernisation of the electrical equipment has allowed more of the site to be relinquished and has provided Tate Modern with an opportunity to further develop the site. The persistence of the electricity distribution function is another aspect of the momentum of place that the Bankside site had acquired.

Although the 1980s development schemes had focussed on the power station site there was a wider context: the regeneration of the locality. In the 1980s the Borough of Southwark developed a regeneration policy for the area and zoned the Bankside site for housing in response to a chronic shortage and a waiting list of 4000 families in north Southwark.[47] John McCarthy has called the period of 1982-87 in Southwark the era of 'popular planning' which promoted the interests of the local community over the private sector developers.[48] In these circumstances the North Southwark Community Development Group supported the redevelopment of the power station site with low-cost public housing. However, the rate-capping measures of the late-1980s made the implementation of the Council's popular planning policy difficult to achieve in practice and the 'need for effective partnership with the private sector was becoming increasingly urgent'.[49] Following the abolition of the GLC in 1986, the London Borough of Southwark developed a Unitary Development Plan and designated the Bankside Regeneration Area (see Figure 6.2). In view of housing shortage the Borough's focus was on housing and not on cultural redevelopment; an idea that they

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[46] Sabbagh, *Power into Art*, pp.10-11.
[47] 'The Bankside Battle', *Through the Roof*.
[48] McCarthy, 'The Evolution of Planning Approaches', pp.149-50. Popular planning according to the typology of Brindley *et al*, *Remaking planning*, Table 2.1, p.9, is characterised as appropriate to a marginal area with pockets of urban problems with a market-critical approach to market processes.
[49] Ibid., p.150; McCarthy identifies the period 1987-94 as 'leverage planning' referring to partnerships with the private sector and financial gearing or 'leverage' i.e. the ratio of public-to-private sector investment within the area. It is characteristic of marginal areas with a market-led approach.

were reluctant to accept until the early 1990s.[50] The area was identified as one of deprivation in which the Council would 'seek to stimulate and direct private investment to assist the local economy, improve the environment and meet community need'.[51]

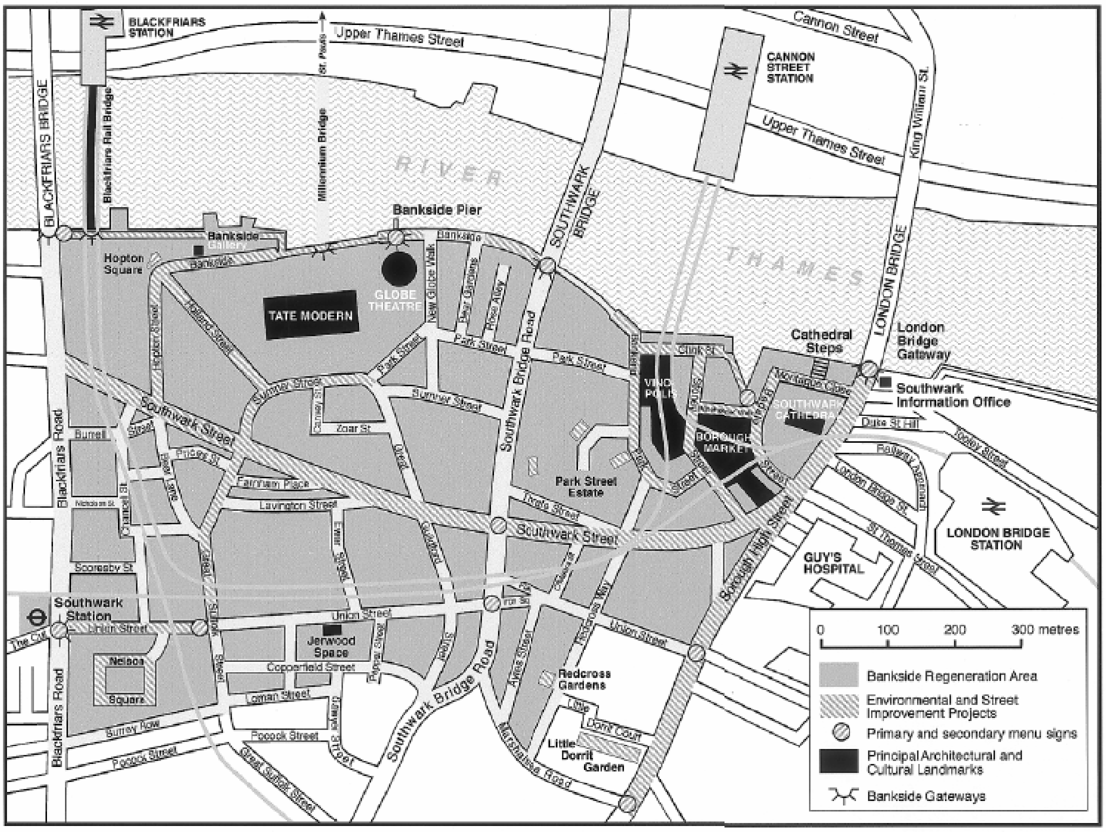

Figure 6.2: The Bankside Regeneration Area.

Source: P. Teedon, 'Designing a Place Called Bankside: On Defining an Unknown Space in London', *European Planning Studies*, 9:4 (2001), Figure 2, p.463. Reproduced with permission. http://www.tandfonline.com.

The Regeneration Area status was later used by Nuclear Electric as an argument against the formal listing of the power station; they argued that listing would 'prejudice

[50] P. Teedon, 'New Urban Spaces: Regenerating a Design Ethos' in J. Rugg and D. Hinchcliffe (eds), *Recoveries and Reclamations Advances in Art and Urban Futures, Vol.2* (Bristol, 2002), p.50. Newman and Smith suggest that in the period 1980-92 there was a resistance to 'high cultural production' on the South Bank. P. Newman and I. Smith, 'Cultural Production, Place and Politics on the South Bank of the Thames', *International Journal of Urban and Regional Research*, 24.1 (2000), pp.16-18.
[51] McCarthy, 'The Evolution of Planning Approaches', p.150.

the implementation of the Council's objectives for the regeneration of the area'.[52] As I demonstrate below, the principal reason that Nuclear Electric were concerned about listing was that it would have constrained the sale and development potential of the Bankside site. Therefore, in a curious twist, the site's original owner, the CEGB, lost the argument against zoning of the Bankside site for housing, but the new owner Nuclear Electric used the zoning status in their argument against listing.

The redevelopment schemes and regeneration policies had seen the Bankside site as an asset that could be exploited for redevelopment and had not viewed the former power station as having a significant aesthetic, architectural or industrial archaeological value. There were several contingent factors in the 1980s that influenced how the building was perceived and which in turn affected how it might be redeveloped. Throughout its operational life the power station itself, although not its pollution effects, attracted little comment, despite the 1947 controversy about its looming bulk opposite St Paul's.[53] From the early 1970s there was a growing interest in conservation and industrial archaeology, and a willingness by interested groups to oppose redevelopment and destruction of historic buildings. A *cause célèbre* in London in the 1970s was the battle over the plans for the redevelopment of Covent

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[52] LMA, LMA/4441/01/4842, London Borough of Southwark, *Unitary Development Plan*, Policy R.2 and R.2.1 quoted in a letter from Hillier Parker to the Department of National Heritage, dated 2 October 1992, f.3.

[53] The visual conflict with St Paul's had been a significant fear when Bankside was being planned, but it was noted in 1995 that 'although this chimney is of considerable height the architect has succeeded in keeping the rest of the huge mass of the building fairly low and on one horizontal line […] regarding the feared intrusion against the beauty of St Paul's, the tall, slender, vertical form of the tower is so diametrically different to the large circular dome that there is simply no conflict whatsoever on the skyline', Lowe, 'Battersea power station', pp.87-88. Bankside was also called 'a worthy neighbour to St Paul's and the City of London', LMA, LMA/4441/01/4842, English Heritage internal memorandum from Dr M. Cherry to Mrs Bostock and P. Heron, dated 22 December 1992.

Garden which would have entailed the destruction of two-thirds of the buildings.[54] By the early 1980s there was a growing interest in industrial archaeology and in the preservation of Britain's industrial heritage. The historian of technology R. Angus Buchanan claims that industrial archaeology had come of age in 1979 with thriving local societies, a national organisation and a growing academic recognition of the subject.[55] Longman published a series of popular books on industrial archaeology and there was a growing public interest in Britain's industrial heritage and a greater appreciation of industrial buildings.[56] This interest is exemplified in the outcry following the controversial demolition of the façade of the art deco Firestone factory in west London during one weekend in 1980, just before the building was to have been protected by listing.[57]

The preservation of the derelict Bankside power station was of interest to several organisations and individuals. There was an influential champion in English Heritage which, from its inception in 1983, had as a part of its remit the protection of industrial structures. The architectural critic Gavin Stamp was also an early admirer of the building. In his 1979 book *Temples of Power* – a tribute to London's power stations, many of which were soon to be demolished – Stamp described Bankside as

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[54] John Pendlebury notes that the argument in the early 1970s around the Covent Garden development was more about lack of consultation by the GLC and the displacement of the residential population than conservation issues. Pendlebury, *Conservation in an Age of Consensus*, pp.65-66.

[55] See Buchanan, 'The Origins of Industrial Archaeology', p.28. John Pendlebury also states that the 1970s had seen the establishment of industrial archaeology as worthy of serious study, in part related to rapid de-industrialisation of Britain, see Pendlebury, *Conservation in an Age of Consensus*, pp.70-71. The Newcomen Society had first published the *Journal of Industrial Archaeology* in 1964 and the national organisation the Association of Industrial Archaeology had first published *Industrial Archaeology Review* in 1976. Buchanan notes that by 2000 the subject 'has signally failed to achieve the status of an academic discipline which seemed to be within its reach by 1980', p.31.

[56] Longman's industrial archaeology series was published from 1969, it included volumes on transport, the iron and steel industry, etc, but curiously electricity and the other utilities did not feature in the series. There had been a projected volume on Electrical Engineering by C.M. Jarvis (mentioned on the dust jacket of W.A. Campbell, *The Chemical Industry* (London, 1971)) but the electrical volume does not appear to have been published.

[57] M. Binney, *Our Vanishing Heritage* (London, 1984), pp.253-54; J. Witherow, 'No Listing of Hoover Factory', *The Times*, 1 September 1980, p.4.

'an original and pure monumental expression of industrial and electric power – which is also urbane and elegant […] Bankside is a complete masterpiece'.[58] Elsewhere he asserted that it was a much finer building than Battersea and deserved to survive, although he acknowledged that the Bankside site was problematic for redevelopment: it had poor access and was surrounded by urban dereliction and gloomy office blocks; the blocks that had been built in the 1950s and 1960s.[59] The growth of interest in industrial archaeology and support from organisations and individuals changed the view of the derelict Bankside power station: it was seen as a building that was worth preserving. Despite this support, there was no official mechanism for its protection.

The listing and protection of pre-1914 buildings of special architectural or historic interest had become a statutory process under the Town and Country Planning Act 1944. Listing aimed to protect buildings against demolition or alteration without consent, and to ensure that the buildings were taken into account in the planning of an area. Buildings of the inter-war period began to be considered for listing in the late 1960s with the addition of 50 building in 1970. A further 150 buildings, including Battersea power station, were added in 1980.[60] Post-war buildings, such as Bankside, were excluded. In 1987 the Department of the Environment announced that buildings could be considered for listing when they were 30 years old. English Heritage, in their role as Government advisor, prepared a list of 70 buildings including two power stations – Bankside and Marchwood.[61] They noted that Bankside was:

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[58] Stamp and Harte, *Temples of Power*.
[59] G. Stamp, 'Saving the South Bank', *Illustrated London News*, 27 August 1983, pp.312-13; also G. Stamp, 'A Prayer for the Brick Cathedral Facing St Paul's', *Independent*, 11 October 1989, p.19.
[60] M. Binney, *Our Vanishing Heritage* (London, 1984), pp.233-43. In 1980 Battersea 'B' was still an operational power station, it closed in 1983, Battersea 'A' closed in 1975.
[61] E. Harwood, 'Keeping the Past in England: The History of Post-War Listing', *The Journal of Architecture*, 15:5 (2010), p.674.

> one of the most stylish twentieth century industrial buildings and the only work of Giles Gilbert Scott not to be listed; comparison with his other buildings suggest that it is worthy of grade II*.[62]

It is notable that the listing proposal was on the basis of the architectural aspects of the building, its brick shell and outward appearance – the work of Scott – but not on the industrial historical value of the machinery and the redundant functional elements of the interior as a once working power station. This proposal therefore disregarded the industrial archaeological value of the building.

Partly for political reasons few of the post-war recommendations for listing were accepted. In the context of the privatisation of the nationalised industries the Conservative Government wished to maximise the financial return from the disposal of potentially valuable assets. English Heritage had expected perhaps 20 of their 70 post-war recommendations to be rejected, but the Department of the Environment selected only 18 buildings from the list and none of these was an industrial building.[63] The Secretary of State, Nicholas Ridley, said of Bankside and Marchwood that ‘neither of these power stations is of special architectural or historic interest’.[64] Gavin Stamp has noted the political context of the rejection. He said that the refusal to list Bankside was because ‘listed building procedures might impede the full commercial realisation of the site when the electricity industry is privatised’. Elsewhere it was said that ‘the CEGB wants to maximise the value of its land holdings before privatisation next year’.[65] These claims are supported by the speed with which the post-privatisation Nuclear

[62] LMA, LMA/4441/01/4842, English Heritage file note by Elain Harwood, London Division, dated November 1989.
[63] English Heritage, *Conservation Bulletin*, No.16, February 1992. The only grade I buildings to be listed were Coventry Cathedral and the Royal Festival Hall.
[64] This formal response dated 15 April 1988 from the Secretary of State Nicholas Ridley to the proposal for listing by English Heritage is quoted in a letter from Hillier Parker to the Department of National Heritage, dated 2 October 1992 in LMA, LMA/4441/01/4842, f.3.
[65] Stamp, ‘A Prayer’, 1989, p.19; Pearman, ‘Opera Plan for Power Station’, p.9. A more nuanced account of the DoE’s reasoning about the rejection of these buildings awaits the public availability of the Department of the Environment’s case files.

Electric subsequently prepared the derelict Bankside for sale, compared to the decade when little was done under the CEGB's ownership. English Heritage put Bankside forward again for listing in 1992; the then responsible Department of National Heritage stated that:

> Ministers have decided that the building is not of sufficient special interest, either architecturally or historically, to merit listing. We will not therefore be adding this building to the statutory list.[66]

Despite the championing of Bankside, there was not universal appreciation of the building. One architectural guide said that:

> in comparison with Battersea power station and the Guinness Brewery and despite the use of the same monumental brickwork, Scott's design for Bankside is more a municipal building than a cathedral of power.[67]

Even within English Heritage there was not universal support. The architect Trevor Dannath, a member of the post-war listing steering group, opposed grade II* listing on the basis of Bankside's 'bulk and ponderous nature'. The working life of Bankside was sufficiently short, less than 30 years, for Dannath to claim that he had opposed Bankside's construction originally and still regarded it as a 'visual and environmental disaster'.[68] Unsurprisingly, many of those with an interest in the redevelopment of the site itself were also less than sympathetic to the building. For example, a representative of the Southwark Environment Trust, commented that Bankside was:

> remarkable for being at least as depressing as it is handsome – I would say more so. It casts a mighty gloom over a major area of central London […] this grim pile sprawls along 200 meters of the river slap

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[66] LMA, LMA/4441/01/4842, Letter from the Department of National Heritage to the Southwark Environmental Trust, dated 24 September 1992 quoted in a letter from Hillier Parker to the Department of National Heritage, dated 2 October 1992, f.4.
[67] E. Jones and C. Woodward, *A Guide to the Architecture of London* (London, 1983), p.L291.
[68] Tate Archives, TG 12/3/2/1, Papers on the selection of Bankside, letter from Trevor Dannath (Chartered Architect) to Nicholas Serota, dated 28 January 1994.

> opposite St. Paul's, blocking off the river and blighting the prospects for the large area of obsolescence immediately to its rear.[69]

Sam Wanamaker had long been an opponent of the power station, notwithstanding its presence long before he started his Globe Theatre project. When the demolition of Bankside was proposed in 1992 he supported the proposal and argued that 'the stark and unsympathetic lines of the power station' were incompatible with his theatre complex.[70] Later, after the Tate Gallery had announced they would convert the building to a museum of modern art, Wanamaker wrote to the Tate and said he 'would strongly oppose the retention of the Power Station'.[71] Some in the arts community appreciated the decaying splendour of the building: it was the setting for two films released in 1995.[72] In its transformed state Tate Modern has attracted large numbers to the Bankside area and thereby increased potential visitors to the Globe. The increased footfall of such co-location is an advantage for those engaged in commercial and cultural activities, including retailers and the Globe Theatre itself (now Shakespeare's Globe), and such an 'agglomerative advantage' adds to what has been called the South Bank's 'string of pearls' effect.[73]

Upon privatisation of the electricity industry in 1990 the ownership of Bankside power station was transferred to Nuclear Electric and the operational switch house was leased to London Electricity plc (later EDF Energy). The economic

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[69] LMA, LMA/4441/01/4842, Letter from the Southwark Environment Trust to Private Eye, dated 19 May 1993. The letter was in response to an article by 'Piloti' that appeared in *Private Eye,* No.820, May 1993, p.11, praising Bankside and deploring the fact that it was not listed.
[70] R. Allen, 'Final curtain for station?', *South London Press*, 20 November 1992, p.16.
[71] Tate Gallery, TG 12/3/2/1, Letter from Sam Wanamaker to Dennis Stevenson (Tate Gallery), dated 7 October 1993.
[72] The films were the science fiction drama *Judge Dredd* directed by Danny Cannon and Richard Loncraine's 1930s version of Shakespeare's *Richard III*, which also used Battersea as a set. Sabbagh, *Power into Art*, p.11.
[73] The 'string of pearls' concept refers to the uniting of a number of cultural and tourists sites including the South Bank Centre, HMS Belfast, County Hall, the Globe and Tate Modern. Newman and Smith, 'Cultural Production', pp.10, 14, 18 and 21.

historian Martin Chick identifies the issue of ‘stranded assets’, mainly nuclear power stations which the privatised electricity market would not purchase and which were retained in public ownership.[74] The CEGB had made attempts to sell Bankside power station since 1982; it too can therefore be seen as a stranded asset. The new owners quickly developed a strategy to sell Bankside, supporting the contention that it was viewed as an asset to be exploited. Firstly, Nuclear Electric appointed Hillier Parker as estate agents to market the building; they were keen to avoid the debacle over Battersea power station which had been sold in 1984 to be developed as a theme park but had since lain derelict.[75] Secondly, to improve the marketability of the site Nuclear Electric arranged for the asbestos to be removed from the building at a cost of £2.5 million, and for it to be ‘de-planted’, that is all the power station plant to be removed. They proposed to ‘offer the site for sale on the open market within two years’, i.e. by summer 1993.[76] Hillier Parker noted, in an echo of the 1980s proposals, that the Bankside site would be suitable for a range of uses such as housing, offices, retail and leisure.[77] Thirdly, with the ongoing possibility of listing, which would have constrained future development options, Hillier Parker applied to the Department of National Heritage for a Certificate of Immunity from Listing. Bankside’s two previous rejections for listing in 1988 and 1992 were used to support the application. The submission stated that it was ‘the opinion of Nuclear Electric and its architects, RMJM, that the architectural merit of the Power Station is unremarkable’ and furthermore that ‘it is a particularly oppressive neighbour and adds nothing to the potential of an

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[74] The economic historian Martin Chick notes that the Government had used public ownership to absorb the nuclear power stations which the market would not accept, he calls this ‘a stranded asset problem’. Chick, *Electricity and Energy Policy*, p.115.

[75] ‘Regenerating’, *Building Design*, 1089 (July 24/31, 1992), p.1.

[76] LMA, LMA/4441/01/4842, Letter from Nuclear Electric to D. Du Parc Braham, dated 10 July 1991; ‘Power Station May be Sold’, *Financial Times*, 1 June 1993, p.9.

[77] D. Spittles, ‘Playing Power Politics; Sparks Could Fly Over the Bankside Power Station’, *Evening Standard*, 19 July 1993, p.52.

exceptional location'. This demonstrates that the interest was in the value of the site, not the building. Hillier Parker seized upon the above 'municipal building' quotation together with the observation that architectural books referred to the size of the building rather than its 'significance in any architectural or historical sense'.[78] This was a highly selective reading of the literature and disregarded the large number of positive views and opinions about the building.[79] The Borough of Southwark, as part of their regeneration strategy for the area, also had an interest in the redevelopment of the site and supported the immunity application.[80] The application was successful and a formal Certificate of Immunity was issued in February 1993 which prevented the Secretary of State from listing the building for five years.[81] Future developers were therefore free from any constraints concerning the preservation of the building or any of its elements.

Despite Nuclear Electric's disposal strategy and the Certificate of Immunity, support for Bankside continued, although English Heritage acknowledged that there was no further influence they could bring to bear regarding the protection of the building.[82] A proposal to demolish part of the building met with considerable opposition. To implement their aim of de-planting Bankside, Nuclear Electric applied

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78 LMA, LMA/4441/01/4842, Letter from Hillier Parker to the Department of National Heritage, dated 2 October 1992, f.2.

79 For example, the Twentieth Century Society said that Bankside was 'characterised by a monumental simplicity and superb brickwork. It is a great tribute to British craftsmanship and a wholly successfull [sic] attempt to give dignity and grandeur to an industrial building', LMA, LMA/4441/01/4842, Letter from The Twentieth Century Society to the London Borough of Southwark, dated 11 November 1992, f.1.

80 Ibid., Letter from London Borough of Southwark to the Department of National Heritage, dated 12 November 1992.

81 Tate Archives, TG 12/3/2/1, Department of National Heritage, Certificate that a building is not intended to be listed, Bankside Power Station, dated 3 February 1993, the certificate states 'the building is not of sufficient interest to merit inclusion in a list of buildings of special architectural or historic interest'.

82 LMA, LMA/4441/01/4842, Letter from Jocelyn Stevens (English Heritage) to D. du Parc Braham, dated 12 January 1993.

to the Borough of Southwark for planning permission to demolish the west wall of the building to allow the internal plant to be removed.[83] The Twentieth Century Society urged them to refuse consent, they noted that the application did not entail any restoration of the building and that the work would 'utterly compromises the remarkable character of one of London's best loved buildings and one of Sir Giles Gilbert Scott's masterpieces'.[84] A local conservation advisory group was also concerned about the demolition and urged that the walls should be reinstated after de-planting to maintain the building in a weatherproof state. They used the example of Battersea power station as a warning of how Bankside might otherwise deteriorate.[85] Battersea was also invoked by The London Society. In a letter to the Borough of Southwark they argued that it was 'crucially important that the integrity of the building's appearance should be maintained'. While sympathetic to the need to remove redundant equipment they were concerned that 'a state of stark partial demolition as at Battersea Power Station must be avoided'.[86] The demolition of Bankside's west wall and the de-planting proposal were not undertaken since by the spring of 1993 Hillier Parker had reputedly received 'a stream of inquiries' from potential developers that might be expected to take on the de-planting cost themselves.[87] One of those interested in redeveloping Bankside power station was the Tate Gallery.

In summary, the redundant Bankside power station and its site were viewed and valued by a range of interested parties in the decade after its closure. There was some

[83] Ibid., Letter from Hillier Parker to the London Borough of Southwark, dated 17 September 1992.
[84] Ibid., Letter from The Twentieth Century Society to the London Borough of Southwark, dated 11 November 1992. Nuclear Electric's proposal was to replace 'the window panels in the west elevation with metal cladding infill panels and block masonry walls', Ibid., Letter from Hillier Parker to the London Borough of Southwark, dated 17 September 1992.
[85] Ibid., Letter from the Conservation Areas Advisory Group to the London Borough of Southwark to the Department of National Heritage, dated 17 November 1992.
[86] Ibid., Letter from the London Society to London Borough of Southwark's Planning Officer, dated 26 January 1993.
[87] Spittles, 'Playing Power Politics', p.52.

interest from private sector developers for the redevelopment of the site for housing, cultural or leisure uses, but these plans remained unfulfilled primarily because of lack of appropriate financing. The period saw the transformation in attitudes to the derelict power station reflecting the wide and growing interest in industrial archaeology and architecture. Bankside became valued as 'Scott's masterpiece', a building that was worth preserving. However, the attempts to have the building protected by formal listing were rejected by the Government which saw the building as an asset to be exploited. The derelict state of Battersea power station has been mentioned, the next section addresses how this came about and examines the contrasting fates of two London power stations whose working lives closely paralleled Bankside.

Location, location, location: Battersea, Brunswick Wharf and Bankside

Battersea was, and is, an iconic structure, the flagship British power station of the 1930s. It was the direct precursor to Bankside in its form as a brick 'temple of power'; in the controversy during the planning stage; and in some of the technology that was deployed. Battersea continued to supply electricity to west London until 1983. As a coal-fired station it was less affected by the increase in oil prices from the early-1970s, although as shown in Figure 5.5 the price paid by the CEGB for coal continued to increase until the mid-1980s. Even after Battersea 'A' power station closed in 1975, the electricity output of the 'B' station in 1978/79 was nearly twice that produced by Bankside.[88] Like Bankside, there was an interest in potential future uses of the power station. In 1981 SAVE Britain's Heritage published a report that included proposals for a large indoor sports arena with seating for up to 11,500 people in the boiler houses, with an ice skating rink beneath and indoor sports halls and exhibition and museum

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[88] The output of Battersea 'B' in 1978/79 was 192.7 GWh, Bankside was 109.4 GWh. CEGB, *Statistical Yearbook 1978-79* (London, 1979), p.6.

spaces in the turbine halls (see Figure 6.3).[89] The area around the power station would include a swimming pool, a shopping square, studio spaces, a hotel and offices. The report was a redevelopment concept and was not taken up by any developers.

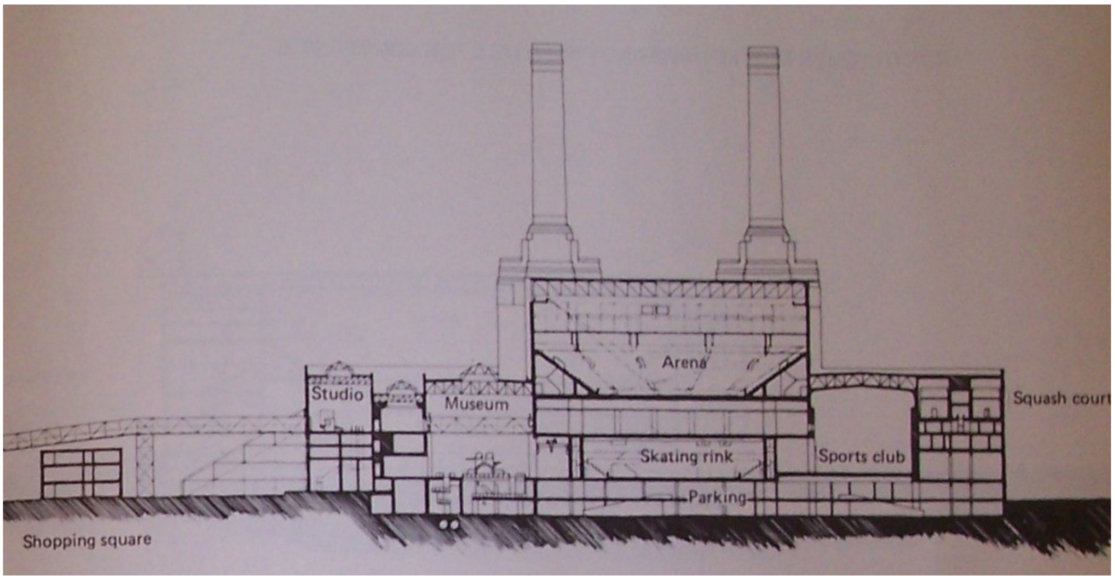

Figure 6.3: Redevelopment proposal for Battersea power station, 1981.

Source: M. Binney, *The Colossus of Battersea: A Report by SAVE Britain's Heritage* (London, 1981). Reproduced with Permission. SAVE Britain's Heritage.

Note the retained turbines in the turbine hall (labelled 'Museum').

There was also a proposal for the continued industrial use of part of the building. In 1982 it was suggested that it could be used to burn refuse using new boilers and the existing, and then still operational, turbines of the 'B' station, but this plan was not developed.[90] Unlike the unrealised outline proposals for Bankside, developers took a more concrete interest in Battersea; the early redevelopment of the power station was promising. In contrast to Bankside there was also support from the local community to retain the building through the Battersea Power Station Community Group. A local survey indicated that 69 per cent of local residents wanted

[89] Binney, *The Colossus*.
[90] K. Garner, 'A well known power station', www.kgarch.co.uk/writing/battersea/battersea.htm [accessed August 2012]; G. Stamp, 'What shall we do with this cathedral of power?', *The Times*, 16 April 1983, p.6.

to save the station and only 25 per cent wanted it demolished.[91] In 1984 the site was purchased by Battersea Leisure, a development group headed by John Broome, the businessman who had built the Alton Towers theme park. Broome's proposal was to turn Battersea into a leisure park which would include spectacular rides, shops and restaurants and which was hoped would attract three million visitors a year when it opened in 1986. The financing of the project, like the proposals for Bankside, proved to be problematic. A larger scheme, including a more lucrative office and hotel development on the adjacent land was then proposed, but this too progressed no further.[92] In 1988 some of the roofs of the power station were removed and the boiler plant and turbines were taken out. Further work was stopped after only a few months when the consortium that had backed Broome became concerned about the escalating costs. In 1991 the accounts of Battersea Leisure showed debts of £91 million.[93] Two years later the architectural commentator Jonathan Glancey observed that Battersea 'stands as a metaphor of the underlying weakness of an economy built on dreams of infinite credit and our ambivalent attitude towards such buildings'.[94] In the following two decades little has changed, despite a succession of ambitious redevelopment plans.

Following the collapse of Battersea Leisure the site was sold in 1993 to Parkview which noted that the cost of repairing Battersea 'may be prohibitive'.[95] The new owners envisaged a mixed-use retail, entertainment and culture complex, but again financing was difficult and little was done to the site over the following decade.[96] In 2001, acknowledging the success of Tate Modern, a new design for the whole site

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[91] Heathorn, 'Aesthetic and Heritage Nostalgia', p.135.
[92] R. Kelly, 'Powerless to Stop the Rot', *The Times*, 25 February 1993, p.16.
[93] Kelly, 'Powerless'.
[94] J. Glancey, 'The Powerhouse for Modern Art?', *Independent*, 10 November 1993, p.22.
[95] Parkview was owned by the Hong Kong based Hwang family, see Kelly, 'Powerless'.
[96] K. Garner, 'Crisis Time for Neglected Landmark Power Station', *Architects Journal*, 199:20, 18 May 1994, pp.13-14; Garner, 'A Well Known Power Station'.

was proposed and it was said that the architect Nicholas Grimshaw would 'take on the station itself'.[97] However, nothing was done to the site, and a succession of other plans followed.[98] The catalogue of unfulfilled schemes mirrors the situation at Bankside during the 1980s, and again the issue was one of financing.

Battersea was sold to an Irish developer in 2006.[99] This was during the period of the 'Celtic tiger' economy, and at a time of rising land values, when developers had only to retain a site, and do nothing, to make a substantial profit. The World Monument Fund was concerned enough to put Battersea on their endangered buildings list and said 'we don't think it's overly pessimistic to predict that history will repeat itself' and that the situation on redevelopment will be the same in five or ten years.[100] So it has proved. Following the economic downturn of 2008 Battersea was seized by creditors who put the site up for sale.[101] There were several high-profile bids including Chelsea Football Club which proposed constructing a 60,000-seat stadium within the building. In June 2012 a Malaysian consortium outbid Chelsea and purchased Battersea for £400 million. The new owners said they would redevelop the 36-acre site with offices, restaurants and about 3700 homes and would keep the power station's art deco façade and the iconic chimney stacks. These new plans are in the context of wider developments in the area including the designation and proposed redevelopment of the whole Vauxhall, Nine Elms and Battersea Opportunity Area, with improved transport

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[97] S. Gardiner, 'More Power to the Riverside Giants', *The Times*, 7 April 2001, p.23.
[98] For example, in July 2005 there was a plan for Battersea to be surrounded by offices, hotels and flats; J. Glancey, 'The Power and the Glory', *Guardian*, 11 July 2005, p.12. In April 2006 it was said that work was about to start to convert the power station into 750 flats, but again nothing happened; 'Eyewitness Battersea, South-West London', *Guardian*, 25 April 2006, pp.18-19.
[99] The Irish developer was Real Estate Opportunities, B. Galilee, 'Battersea Power Station', *ICON* 45 (March 2007).
[100] Galilee, 'Battersea Power Station'.
[101] The creditors were Ireland's National Asset Management Agency and Lloyds Banking group, Anon, 'Abramovich's Battersea Dream is Kicked Into Touch' and R. Lydall, '£400m Deal to Regenerate Battersea', *Evening Standard*, 7 June 2012, p.2 and pp.60-61.

links including an extension of the London Underground.[102] Unless, or until, these ambitious plans have been enacted Battersea power station remains a derelict ruin (see Figure 6.4).

Figure 6.4: Inside Battersea Power Station, 2006.

Source: en.wikipedia.org/wiki/File:Inside_Battersea_Power _Station.jpg [accessed August 2013], Taken by Ian Mansfield, inside Battersea Power Station on 21st October 2006. CC Attribution-Share Alike 3.0 Unported license. Released under the GNU Free Documentation License.

The post-closure history of Brunswick Wharf power station had another outcome: the demolition of the building and the redevelopment of the site as housing. This was a consequence of the strategic planning for the redevelopment of the London docklands in the 1980s. Brunswick Wharf power station was planned at the same time as Bankside, its construction was brought forward when the planning and amenity objections to Bankside had become evident (see Chapter 3). The station was built on a

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[102] The proposal includes a linear park, 16,000 new homes, and a tall buildings strategy, it will create 20,000 to 25,000 new jobs, Greater London Authority,www.london.gov.uk/who-runs-london/mayor/publications/planning/vauxhall-nine-elms-battersea-opportunity-area-planning-framework [accessed August 2012 and May 2013].

19½ acre site in the redundant East India export dock in the east London Borough of Poplar. The station was commissioned over the period 1952-56. It too was a riverside brick cathedral, reminiscent of the original Battersea 'A' in appearance, although not designed by Scott (see Figure 6.5).

Figure 6.5: Brunswick Wharf power station, Poplar, *c*.1983.

Source: Brunswick Wharf/Blackwall Yard, Rogers Stirk Harbour + Partners, 2007, p.2. www.rsh-p.com/work/all_projects/brunswick_wharf _blackwall_yard [accessed July 2012]. Reproduced with Permission. © Rogers Stirk Harbour + Partners.

Note the oil tanks on the riverfront (bottom) and in front of the power station; West Ham power station and its cooling towers at top left.

Although originally coal-fired, Brunswick Wharf station was converted to oil-firing in 1969-70 to take advantage of plentiful and cheap fuel oil in this period.[103] Like Bankside it was a victim of both the 1973 oil price increases and the national generating overcapacity in the late 1970s. As a result, the station was gradually run

[103] H. Hobhouse, 'Brunswick Wharf', S*urvey of London: Volumes 43 and 44: Poplar, Blackwall and Isle of Dogs* (1994), online version [accessed May 2012]. The oil tanks can be seen on the riverside in front of the power station in Figure 6.5.

down. In 1982 there was a proposal, like Battersea, to convert the station to burning refuse, which in this case was to supply a district heating scheme. The site had several advantages for this purpose. It was well placed to receive refuse from the local authority of Tower Hamlets; from south of the river through the adjacent Blackwall tunnel; and by river barge from further afield.[104] It was also sited adjacent to the London Docklands Development Corporation's (LDDC) Private Enterprise Zone where favourable tax and rate allowances and planning conditions had encouraged new large-scale housing and office developments.[105] These developments, it was thought, would ensure 'a rapid build-up of demand for heat' supplied by Brunswick Wharf.[106] Although the docklands area developed extensively in the 1980s, a district heating scheme was not part of the plans. I suggest that as a large industrial building, frequently visited refuse lorries, and with a refuse handling facility on the riverfront, it was incompatible with the vision of the new docklands that developers wished to promote.[107] Brunswick Wharf power station was decommissioned in October 1984.[108]

In 1987 the Brunswick Wharf site was sold for redevelopment. The developer noted that they wished to capitalise on the natural attributes of the site, particularly 'the

[104] LMA, GLC/HE/SW/DD/02/006, Brunswick Wharf CHP, 'Applicability for Conversion to Refuse-Fired Combined Heat and Power', December 1982.
[105] The London Docklands Development Corporation (LDDC) was established in 1982 to manage the redevelopment and regeneration of the docklands. It was directly appointed by central Government and had planning powers to acquire land in anticipation of 'leveraging' private sector input. G. Macleod and C. Johnstone, 'Stetching Urban Renaissance: Privatizing Space, Civilizing Place, Summoning Community'', *International Journal of Urban and Regional Research*, 36.1 (2012), pp.2-5.
[106] The LDDC's strategy was to 'stimulate the market by facilitating the development of offices and private housing', McCarthy, 'The Evolution of Planning', p.149.
[107] The development included 'high density housing, office, retail and leisure activities'. Brunswick Wharf/Blackwall Yard (Brochure), Rogers Stirk Harbour + Partners, 2007.
[108] The LDDC supported the financing, repair and refurbishment of some small-scale historic and industrial buildings within the docklands area, but not the large Brunswick Wharf. Refurbishment included the Limehouse Basin hydraulic accumulator tower, see T.R. Smith, 'The Limehouse Basin Accumulator Tower', *London's Industrial Archaeology* No.11 (London, 2013), pp.37-54. The *Survey of London* states the power station ceased generating electricity in March 1984 and was closed in October 1984. Note that this oil-fired power station was not retained in commission during the 1984-85 miners' strike.

view south along the Greenwich Meridian towards the Royal Observatory and east towards the Royal Docks'.[109] There was no campaign to save or 'list' Brunswick Wharf, it was a largely unknown power station that was located in a run-down dock area, and it had not been designed by a famous architect.[110] Its location at the head of a bend in the river was a desirable site for redevelopment. The power station was demolished in 1988-89 to make way for a new housing developments, although the switch house to the north remained until it too was demolished in 2004-05 and the site was also redeveloped as housing.[111] Today, there is no remaining material evidence of Brunswick Wharf power station.[112]

Despite having much in common as operational power stations, the post-closure histories of Battersea, Brunswick Wharf and Bankside were significantly different. As Rebecca Madgin has observed, the decisions of urban actors:

> whilst reflecting societal and economic preoccupations and political power crucially reveal the reasons why certain buildings are ascribed with a contemporary value manifest through their retention and adaptation while others are devalued and thus demolished.[113]

Battersea power station is a story of failure. Over three decades a succession of developers have attempted to redevelop the former power station and its site to new uses. None of the plans has so far proved to be financially viable. This is in part due to the listed status of the building: developers are constrained in how they can adapt or modify it. But the problem is primarily due to difficulties of financing the wider

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[109] *Brunswick Wharf/Blackwall Yard* Brochure.

[110] The original design had been undertaken by D. Hulbert Lewis of John Bruce & Staff in 1945, Farmer and Dark were called in at the last minute to 'tidy up and make more presentable an already well-advanced project', Hobhouse, 'Brunswick Wharf'.

[111] Abandoned Britain, 'Brunswick Wharf Power Station', www.abandoned-britain.co./PP/brunswick/1.htm [accessed July 2012].

[112] Personal observation, September 2013, the redundant jetty on the river at this point may be the only remaining relic of the power station. The power station is recalled in the names of two of the residential blocks on the site: Elektron House and Switch House. Elektron & Switch House Residents Association, www.elektronresidents.co.uk, [accessed August 2012].

[113] Madgin 'Urban Renaissance', p.3.

redevelopment of the area. In contrast Brunswick Wharf is a story of un-mourned loss. It was not listed; it was not designed by a prominent architect; and was not valued as a building. It was a redundant industrial relic within the docklands redevelopment zone which prioritised new office and residential developments. The post-industrial fate of Bankside is a story of success. The building, although modified, has survived and has a new life as an art gallery. The account of Bankside that follows is conceptualised as three major transformations: that of the building itself from power station to gallery; the consequent transformation of the Bankside area; and the ongoing transformation of Tate Modern.

Transformation 1: power station to Tate Modern, 1993-2000

The acquisition and redevelopment of Bankside by the Tate Gallery has largely preserved the appearance of the former power station and transformed the internal structure of the building for a new role as a major art gallery. The timing of the Tate's interest in Bankside was crucial to the success of the redevelopment as it gave access to the Millennium Fund. Tate Modern, and its public popularity, has provided the major stimulus to the redevelopment and regeneration of the Bankside area.

By the early 1990s the Tate Gallery's art collection had outgrown its Millbank site and the trustees were looking for a new centre to display their modern international collection.[114] The Tate's trustees had considered several sites across London; both existing buildings and vacant sites for a new building.[115] One suggestion was a site in

[114] The Tate Gallery is run by a charitable trust and receives government funding for its responsibility for British art.

[115] Existing buildings included the Department of the Environment's Marsham Street site, there was also a proposal for the new gallery to be the centre-piece of a new park north of Kings Cross, see 'Power Play at the Tate', *Building Design*, 1141, 10 September 1993, p.1., also M. Craig-Martin, 'Towards Tate Modern', in Blazwick and Wilson, *Tate Modern:The Handbook*, p.14.

the dockland's, east of Canary Wharf, and therefore near to the demolished Brunswick Wharf power station. This site was considered to be too isolated and inaccessible.[116] Three sites were short-listed: Bankside power station and two car park sites at Vauxhall Cross and Jubilee Gardens. Both of the latter had better public transport connections than Bankside but would have entailed constructing a new building.[117] The former power station met most of the Tate's requirements for a new gallery: the site was on a large scale; it was centrally located; it was within reach of Millbank; and was available for development.[118] The Tate's trustees believed that the reuse of an existing building would avoid the planning problems and controversy that had often surrounded the construction of large new buildings in London. Although as Madgin has observed it is a generally accepted fact amongst conservationist and planners 'that it is more expensive to restore and re-use existing buildings than to construct a purpose built new structure'.[119] The Tate's position disappointed many architects who saw the project as a chance for a high profile work of contemporary architecture.[120] Another aspect of the Tate's thinking was that 'adapted industrial spaces made more sympathetic and inspiring spaces for exhibiting art than purpose-built new ones'.[121] The Tate already had experience of adapting industrial buildings. They had remodelled the redundant warehouses of Liverpool's Albert Dock and transformed them into Tate

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[116] Craig-Martin, 'Towards Tate Modern', p.14.
[117] The Tate's options were constrained when the Jubilee Gardens site was zoned by Lambeth Council as public open space, M. Ellison, 'Disused Power Station by the Thames Could be Turned into Tate Gallery of Modern Art', *Guardian*, 2 November 1993; M. Binney, 'A Power Base for Modern Art', *The Times*, 7 January 1994, p.29.
[118] Craig-Martin, 'Towards Tate Modern' in Blazwick and Wilson, *Tate Modern: The Handbook*, p.13.
[119] Madgin, 'Urban Renaissance', p.19.
[120] D. Sudjic, 'Tate Wants Power Station as Art Gallery', *Guardian*, 28 April 1994, p.8; see also Craig-Martin 'Towards Tate Modern' in Blazwick and Wilson, *Tate Modern: The Handbook,* p.17; Richard Nightingale states 'if we have any confidence in the worth of our end-of-millennium civilisation should we not have bitten the bullet, pulled the thing down and built something new to celebrate the art of the twentieth century?', R. Nightingale, 'Sacred Cows', *Perspectives on Architecture*, No.29 (June/July 1997), p.96.
[121] R. Ryan, 'Transformation' in Moore and Ryan, *Building Tate Modern*, p.18.

Liverpool. The derelict Bankside power station therefore became the favoured candidate for the new Tate Museum of Modern Art (MOMA).

The timing of the Tate Gallery's decision was crucial to the success of the project. The National Lottery had started in 1994 with the profits being distributed to charities and other causes. One of these was the Millennium Fund which aimed to support a number of projects of national importance to mark the millennium.[122] In 1994 the projected cost to convert Bankside to the Tate MOMA was about £80 million and it was envisaged that about half of this could be obtained from the Millennium Fund with the rest from private donations.[123] By 2000 the redevelopment costs had increased to £134.5 million with 60 per cent from public funding.[124] The redevelopment exemplifies the neo-liberalist agenda of regeneration through public-private partnerships that had started in the early 1980s. Similarly the LDDC (as mentioned above) had aimed to leverage private sector input to transform and rebuild the east London docklands.[125] The Millennium Fund itself is another example based on a partnership of private, public and voluntary sector agencies.[126]

The Tate's board indicated that they intended to make some major interventions into the fabric of Scott's building to open it up for public use. The

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[122] It has been noted that 'the Lottery can make a significant difference to the fortunes of an urban area' the South Bank with Tate Modern, the Globe theatre, the Millennium Bridge, the IMAX cinema and other projects for example; R. Rogers, *Towards and Urban Renaissance: Final Report of the Urban Task Force* (London, 1999), p.292.
[123] J. Glancey, 'A Great Place for a Gallery', *Independent*, 2 March 1994, p.22.
[124] Public funding included a maximum £50 million from the Millennium Commission, £12 million from the regeneration agency English Partnership for the purchase of the Bankside site, £6.2 million from the Arts Council and £1.5 million from the London Borough of Southwark. See Moore and Ryan, *Building Tate Modern*, p.16; A. Harris, 'Livingstone Versus Serota: The High-Rise Battle of Bankside', *The London Journal*, 33:3, p.292.
[125] T. Butler,'Re-Urbanizing London Docklands: Gentrification, Suburbanization or New Urbanism?', *International Journal of Urban and Regional Research*, 31.4 (2007), p.760 and p.765.
[126] Brindley, 'Community Roles', p.370.

Certificate of Immunity allowed considerable freedom for the proposed architectural changes which would otherwise have been constrained had the building been listed. The Tate launched an architectural competition in July 1994 and by November six architectural practices had been short-listed. The winning design by Herzog & de Meuron envisaged making the turbine hall a vast public space, together with multi-level galleries in the boiler house which would be extended upwards by the addition of a two-storey glass 'light beam' structure running the length of the building.[127] As a long-standing champion of the building English Heritage continued to take an interest in the Tate Gallery's plans for Bankside. Their support is evident in a letter to the Tate in which they said 'the news about Bankside is wonderful – we will naturally do all we can to assist, since as you know, the project has our full support in principle'.[128] But they were concerned that the form of the building should be preserved. Acting in an advisory capacity they indicated that any proposed changes at roof level should not compromise the silhouette of the building nor detract from its strong symmetrical composition. They were also concerned about the integrity of the strategic views from across the Thames. Despite these concerns the 'light beam' design (see Figure 1.1) entailed the removal of the flue-gas washing chambers adjacent to the chimney which destroyed the ziggurat silhouette of the building, a change which Gavin Stamp deplored.[129]

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[127] Ryan, 'Transformation' in Moore and Ryan, *Building Tate Modern*, pp.18-19. Harry Gugger, a Herzog and de Meuron partner, noted of the turbine hall that at 150 m long, 27 m wide and 30 m high it 'would not have been possible to design such a room if it hadn't already existed', B. Kuert, *Tate Modern*, DVD, (San Francisco, 2008).

[128] LMA, LMA/4441/01/4842, Draft letter from Jenny Page (English Heritage) to Nicholas Serota (Tate Gallery), n.d. but *c.*June 1994.

[129] Personal comment at The Twentieth Century Society conference 'Battersea Power Station – Conservation and Regeneration' held at the Design Centre, London, on 20 April 2012.

The transformation of the private place of Bankside power station to the public space of Tate Modern entailed other demolition work, including the 12-foot high boundary wall surrounding the site which had set it apart from the surroundings.[130] The un-commissioned 1972 district heating boiler house at the base of the chimney was demolished to make the chimney a more free-standing element; the architects indicated that this would enable the horizontal light beam to get in discourse with the chimney.[131] Despite extensive demolition work, efforts were made to maintain the integrity of Scott's fabric. A survey indicated that the building was in reasonably sound condition although some external brickwork had to be repaired and the glass-and-concrete roof lights over the turbine hall had to be replaced.[132] The contractors found a way to de-plant the station's equipment through an aperture below the west window of the turbine hall, this would later form the main entrance to the building. This solution was considerably less destructive than Nuclear Electric's proposed demolition of the west wall. The process of designing the new building and the reconstruction of Tate Modern has been documented by Karl Sabbagh and elsewhere.[133]

Bankside has been called the last great 'brick cathedral' power station.[134] The expression was coined in the 1930s for Battersea power station because of the imposing monumentality of the building.[135] The term is particularly apt for Bankside

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[130] The single- and two-storey office and service blocks on the west side and north-east corner of the building were also demolished, although the south-east block was retained as offices.
[131] Sabbagh *Power into Art*, p.52.
[132] Ibid., pp.77-80.
[133] The conversion process has been described by Sabbagh in *Power into Art* and by Moore and Ryan in *Building Tate Modern*. Part of the process was also recorded for a TV series the first part of the Channel 4 television series *Power to Art* was screened in November 1996 and as a four-part series *Power into Art: the Battle for the new Tate Gallery* in April 2000 to coincide with the opening of Tate Modern.
[134] Stamp and Harte, *Temples of Power*.
[135] The earliest 'cathedral' reference appears to be by the architect Prof. Charles Reilly. He described the sight of Battersea from the railway in 1934: 'What is this great romantic pile with its long, incised

because of its east-west orientation and the juxtaposition with St Paul's cathedral. Although referring to its outward form, the cathedral metaphor extends to the function and appearance of the inside, in both its guises as a power station and an art gallery. Cathedrals are largely public spaces yet Bankside as an operational power station was a private place only seen and attended by a few dozen people serving an unseen power – electricity. As Tate Modern the cathedral of power was transformed to a cathedral of art. In 1994 a survey of the fabric remarked that the cathedral metaphor was evoked by the stripped-down boilers with their organ-like pipework exposed (see Figure 6.6).[136] The functional name of the turbine hall was retained in Tate Modern despite the turbines having been removed. This large space with its columns, side aisles and 'chapels' – the boiler and switch house and individual galleries – together with the great east and west windows is reminiscent of the nave of a cathedral. There are critics of the space: it has been said that 'the emptiness of that hall delivers nothing but an overwhelming spatial experience'.[137] To conclude the cathedral metaphor, Tate Modern's grand entrance is at the west end and a public / private division, as between nave and chancel, is evoked during exhibitions when a segregated ticketed space is created at the east end of the turbine hall.

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vertical lines and hidden windows? Is it a new cathedral by that interesting church fellow up in the north, F.X. Verlarde?'. C.H. Reilly, 'The Years' Work at Home', *Architects' Journal* (January 1934), p.65. Verlarde was the architect of the modernist St Gabriel's church, Blackburn, Lancashire.

[136] The Royal Commission on Historical Monuments of England said 'The building represents the final resolution of the monumental 'brick cathedral' approach to power station design […] Bankside is exceptional for the simplicity, integrity and formal strength of its design – a low rectangular block with a single central 'tower' to the river'. Its brick elevations are finely judged, both in overall massing and in detailing such as the use of subtle polychromy', P. Guillery, *Bankside Power Station*, NBR Index No 93651 (London, 1995). Peter Guillery recalls that they had to finish their survey quickly because Nicholas Serota was just arriving to visit the building, P. Guillery, personal correspondence, June 2012.

[137] Davidts, 'Art Factories', p.35.

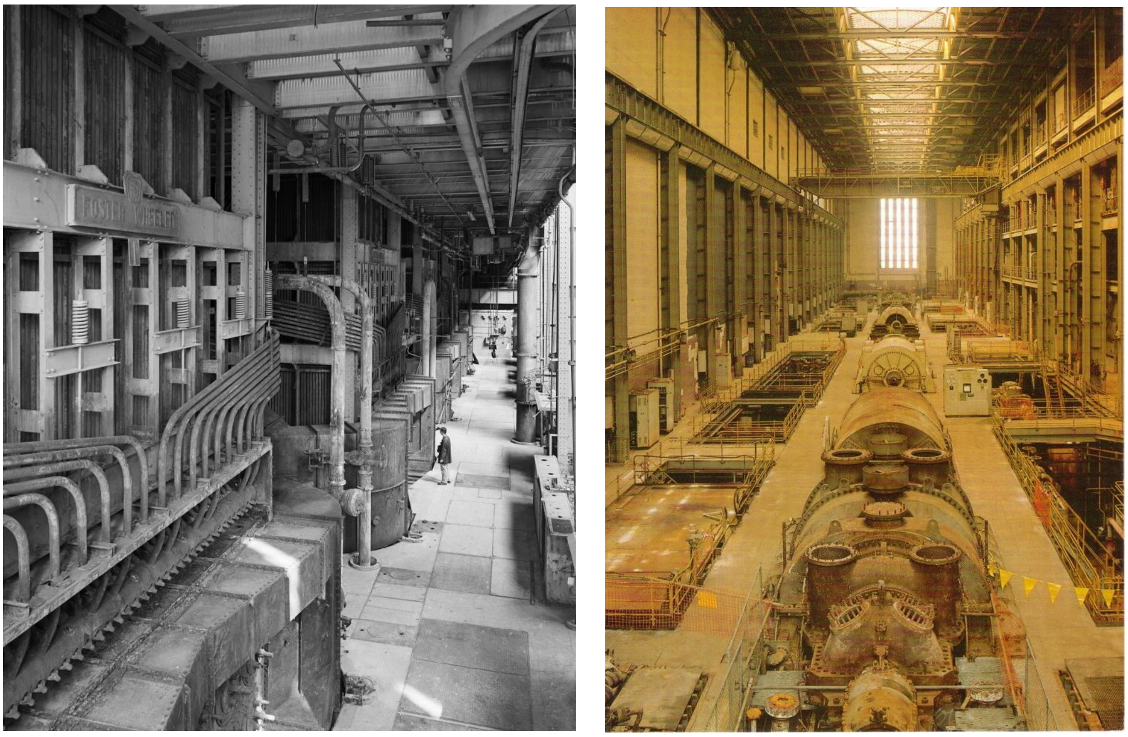

Figure 6.6: Bankside: interior of the redundant 'cathedral of power', 1993.

Sources: English Heritage, Photograph Collection, photo BB93_14537, Bankside Power Station boiler house, 1993. Reproduced with permission. © Crown Copyright, English Heritage (left). Turbine hall before Conversion. Reproduced with permission. © Marcus Leith, Tate Photography (right).

Note the organ-like boilers (left), and the nave-like turbine hall (right).

The above outline has made explicit the connections between the physical spaces of Bankside power station and Tate Modern. The architectural scholar Phoebe Crisman asks questions of these industry-to-museum buildings:

> what is it that is being preserved – the physical stuff of the architecture, the cultural significance of the place, or the palpable material traces of the passing of time and inhabitants?[138]

In the case of Bankside / Tate Modern, and despite some demolition, much of the physical stuff of the architecture has been retained, such as the form of the building, its outer walls and chimney. The cultural significance of the place was transformed with

[138] Crisman, 'From Industry to Culture', p.405.

the change in use of the building from the production and distribution of power to the consumption of art. This thesis aims to recover some of the cultural and historical significance of Bankside power station. For the informed visitor to Tate Modern the material traces of the past are evident in the remaining fabric and the knowledge – however sketchy – of the building's former function as a power station. Returning to Crisman's questions I suggest that the former inhabitants have been largely forgotten.[139]

Tate Modern is one of a number of similar international conversion projects. In some, the connection between the former and present use is more explicit. For example, the Zollverein XII coal mine complex near Essen, Germany, retains some its equipment:

> the giant boilers, rusted steel structure and broken pressure valves of the Design Zentrum serve as a foil for the newly inserted glass and stainless steel walkways and innovative displays of contemporary design objects.[140]

As I have suggested, the form of Bankside power station has been retained but there is little visible material connection to its former function. Nevertheless, the electricity distribution function does remain, although hidden from public view, as discussed below.

Tate Modern was critically acclaimed and proved to be very popular from the time of its opening in May 2000.[141] It has been remarked that 'it isn't only exhibitions

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[139] I have been able to contact a few people who worked at Bankside for a short time or recall visiting the working power station. Only one account appears to have been published, see N. Clarke, 'Generation. Generate', *Critical Quarterly* 43:3 (2004), pp.20-25.
[140] Crisman, 'From Industry to Culture', p.410.
[141] Comments include: 'the brooding volumes of Scott's industrial monolith are simply and rationally converted to make a variety of spaces for art', Anon, 'South Bank Show', *The Architectural Review*, CCVII (April 2000), p.48; 'the finished product reflects an admirably fine balance between respect for

that are blockbusters now, the museums themselves are a draw'.[142] In its first year Tate Modern attracted 5¼ million visitors and was the most visited museum of modern art in the world. There were wider benefits: Tate Modern is estimated to have brought an economic benefit of about £100 million and created about 3000 new jobs, half of them in Southwark.[143] The popularity has been sustained since the gallery opened and the building was a major force in the redevelopment and regeneration of the surrounding area. As the planning geographer Paul Teedon has said Bankside was 'an emerging (new) landscape of cultural consumption'.[144]

The conjunction of the sale of the site, the needs of the Tate Gallery and access to funding were crucial to Bankside's transformation. This study has drawn together the existing planning and architectural literature on the transformation and shown how other actors such as English Heritage had an interest in this process. The essential form and appearance of 'Scott's masterpiece' has largely been retained but very little of its historical function has been preserved. Scott's private cathedral of power was transformed to a public cathedral of art. Tate Modern has provided a significant direct economic benefit to the area including employment for local people, and a significant impetus for the regeneration of the locality.

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what existed and the need to innovate, transform and adapt it to new use', K. Powell, 'Powerhouse', *The Architects' Journal*, 211:16 (27 April 2000), p.28; but Martin Spring complained of the Spartan industrial aesthetic of the building and asks 'surely modern art calls for the most truly modern, creative and daring building in the country?', M. Spring, 'The Troubled Marriage of Art and Industry', *Building*, Issue 15, 14 April 2000, p.4.; and one critic Jed Perl said the building 'was a fascist nightmare', quoted in A. Searle, 'Happy Birthday, Tate Modern', *Guardian Arts* (5 May 2005), p.14.

[142] For example the Guggenheim in Bilboa, the Pompidou Centre in Paris, and MOMA in New York, quote from Searle, 'Happy Birthday, Tate Modern', p.14.

[143] M. Kennedy, 'This is the Favourite Exhibit in the World's Favourite Museum of Modern Art', *Guardian*, 12 May 2001, p.3.

[144] Teedon, 'Designing a Place Called Bankside', p.467.

Transformation 2: redefining and regenerating the Bankside area

As discussed earlier the area around Bankside power station has been the subject of several urban plans: from the projected riverside boulevard; the flats and offices of the 1943 *County of London Plan*; to the low-cost housing of 1980s 'popular planning'. The reality in the late-1980s was that Bankside was a mixed-use area of dreary office blocks, a few light industries, some mainly council-owned residential properties, and the 1977 riverside garden and walkway.[145] In this section I show that the presence of Tate Modern and Shakespeare's Globe provided a major impetus for the redevelopment, transformation and redefinition of the function and nature of the whole Bankside area.

In 1989 the London Borough of Southwark identified Bankside as one of five key areas to which investment for regeneration might be attracted (see Figure 6.1).[146] They recognised that Bankside's old industrial base had declined, the area was becoming run-down and potentially valuable property and land was not being fully exploited.[147] In the period 1989-94 about £125 million of public and private investment was made in the area.[148] Developments included new office buildings, Shakespeare's Globe, a riverside walk beneath Blackfriars Bridge and the creation of a distinct identity for the area through marketing and signposting. A visual survey, commissioned by the Tate Gallery in 1995, noted that some local street improvements were taking place but that the areas around the proposed Tate Modern needed improvement. The poor accessibility through the area was noted, particularly where

[145] Jacques Herzog's reaction to the benches and street furniture of the walkway was 'All that shit goes away?', Sabbagh, *Power into Art*, p.55.
[146] The other areas were Peckham, Burgess Park, Elephant and Castle and the Old Kent Road. J. Frankham, 'Southwark Perks Up', *Municipal Journal*, No.36 (9-15 September 1994), pp.21-22.
[147] M. Nixon, A. Potts, B. Fer, A. Hudek, and J. Stallabrass, 'Round Table: Tate Modern', *October*, 98 (Autumn 2001), p.20.
[148] McCarthy, 'The Evolution of Planning Approaches', p.150.

historic routes had been obliterated by twentieth-century office blocks.[149] Land-use in the area was analysed and outlined in the Tate's 1994 Architectural Competition document. The area covered by the land-use map (see Figure 6.7) was exactly the quadrilateral that had been identified in the 1947 public inquiry (see Figures 3.3 & 3.6) demonstrating the persistence of this distinct area.

The Bankside locality was predominantly office accommodation (shaded blue in Figure 6.7) this was in marked contrast to the two small 'commercial office' areas in 1947 and reflects the major office developments of the 1950s and 1960s. However, as English Heritage noted, these post-war redevelopments were responsible for 'the rather "inhuman" scale and character of the area, especially the monolithic buildings such as Lloyds Bank computer centre on Hopton Street and St Christopher's House on Southwark Street'.[150]

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[149] Tate Archives, TG 12/8/2/1, 'Visual Analysis of Bankside', *c*.1995.
[150] LMA, LMA/4441/01/4842, English Heritage file note 'Tate MOMA and the Bankside Area' by Lesley Fraser, dated 27 June 1994.

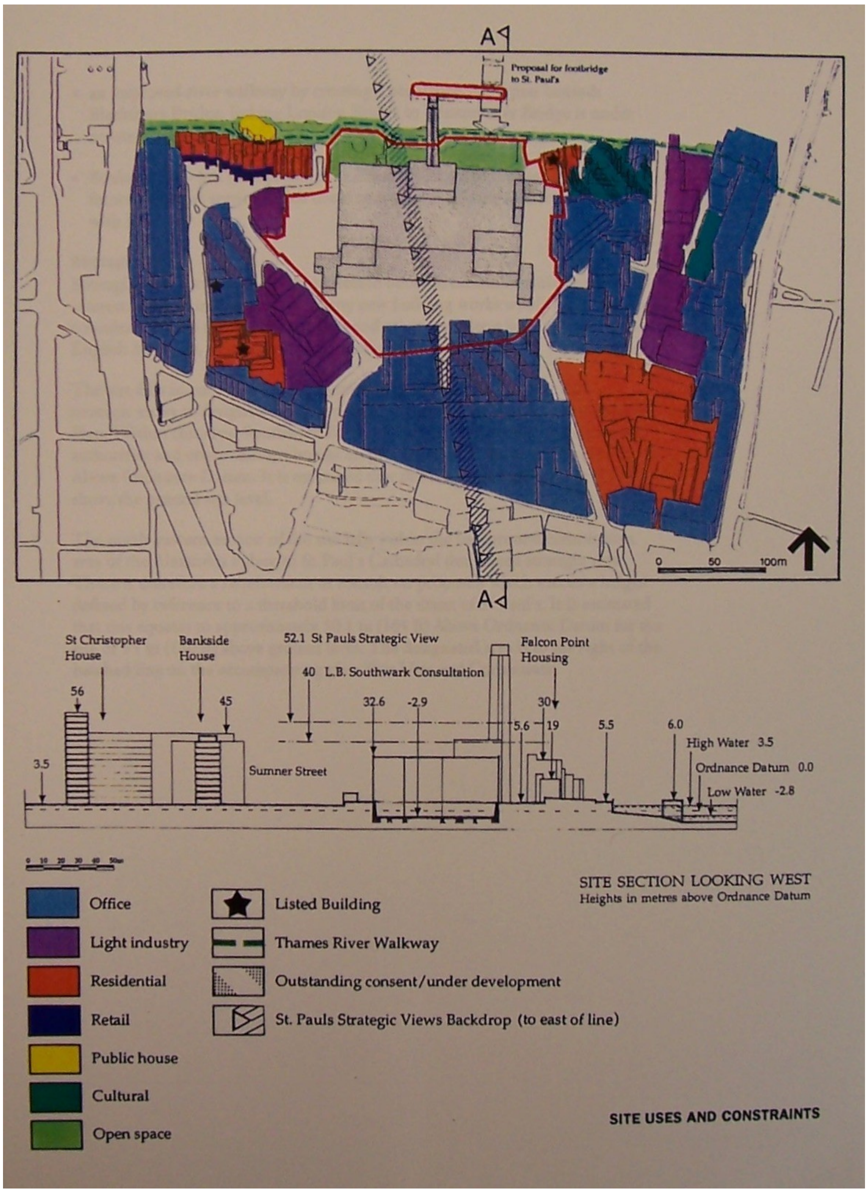

Figure 6.7: Land use around Bankside, 1994.

Source: LMA, LMA/4441/01/4842, Tate Gallery of Modern Art: Competition to Select an Architect, 1994. Reproduced with Permission. © Tate, London 2013.

Residential accommodation (orange) had been increased by the 1978 Falcon Point council flats to the west of Bankside, but was otherwise the same as in 1947. The riverside industry and warehouses had disappeared and had been replaced by public open space along the river front. There were three small areas of light industry (purple) which were redeveloped as residential properties over the following decade. Shakespeare's Globe and its educational centre, together with the remains of the Rose theatre rediscovered in 1989, are identified as cultural areas (dark green) to which the Tate Modern was to be a major addition. This spatial analysis supports my contention that the Bankside area had evolved, rather than being radically transformed by strategic planning, over the period 1947-94.

By the millennium the Bankside area was being changed from a decaying, run-down deindustrial location into a 'new locus as part of an international high-culture market, with all its attendant commodities'. It was noted that 'restaurants and small businesses are moving in […] the walkway along the river is filled with life'.[151] Bankside is still a mixed-use locality as it was when the power station was established in 1891, although specific uses have declined and developed. It could be said that these changes are part of long-term shifts in the use of the area. The twenty-first century cultural quarter reflects a much earlier period when Bankside was the site of popular entertainments of the early modern period.[152] Apart from the Borough of Southwark's regeneration area status there was no detailed plan for the redevelopment of Bankside. The transformation was again a piecemeal process, with individual developments such as new office blocks, and new and converted residential properties. As a consequence changes have taken place over an extended period from 1993 to date (2014) and are continuing.

Aside from Tate Modern and Shakespeare's Globe, the material changes on Bankside were largely corporate property developments. Many were uncontroversial but some were heavily criticised. The former CEGB headquarters at Bankside House

[151] Teedon, 'Designing a Place Called Bankside', p.475; D. Kennedy, 'Shakespeare and Cultural Tourism', *Theatre Journal*, 50 (1998), p.186.
[152] From the 1590s there were four theatres on Bankside – the Rose, the Swan, the Globe and the Hope – together with bull- and bear-bating rings built in the 1550s. Reilly and Marshall, *The Story of Bankside*, pp.21-26.

was converted to halls of residence for the London School of Economics. St Christopher's House, the 'dreary bureaucratic Government office', was demolished in 2003 and the site was redeveloped with three office buildings with shops and leisure amenities at ground level.[153] This development allowed the opening of routes that had been obliterated by St Christopher House. There were, however, concerns about the power of developers. One proposal was for Bankside Tower, a 29-storey (later 32-storey) residential development, immediately to the west of Tate Modern. The tower was seen as a direct affront to Tate Modern both in its dominating physical presence and as the Tate's director Nicholas Serota said 'an opportunistic attempt to cash in for private gain on the public benefits'.[154] The Tate's concerns were shared by a vocal and well-connected local campaigning group.[155] The controversy escalated through the planning process and went to the Court of Appeal and to the European Court of Human Rights. The developers eventually abandoned their plans. The urban geographer Andrew Harris has argued that the controversy reveals how corporate property-led development had come to dominate the efforts to regenerate and re-imagine contemporary London.[156] This is true of Bankside, where corporate property development has been a significant instrument in the regeneration of the area surrounding Tate Modern. Dean *et al* have suggested that the process was two-way since 'Tate Modern is a clear success in relation to its impact on the urban fabric

[153] The 'dreary' quote is from Tate Archives, TG 12/8/2/1, 'Visual Analysis of Bankside', *c.*1995. The three office buildings were called Bankside 1/2/3, thereby appropriating the Bankside name, despite not being located on Bankside.
[154] Harris, 'Livingstone Versus Serota', p.293.
[155] The residents formed the Bankside Residents for Appropriate Development (BROAD) and recruited the prominent law firm Mishcon de Reya to co-ordinate the case against the tower, see Harris, 'Livingstone versus Serota', p.294.
[156] Ibid, p.289.

having stimulated and benefited from huge infrastructural investment immediately to its south'.[157]

In addition to the material and cultural transformations there was an associated social transformation. Unlike many other parts of London, the Bankside area had not been gentrified during the 1980s. Andrew Harris, in his comparative study of Bankside and the Lower Parel area of Mumbai, has noted that:

> until the 1980s, although Bankside possessed a more diverse economic base, both areas were associated with polluted urban landscapes and industrialisation. Without a large stock of devalued 19th-century houses, they were not gentrified in the classic form outlined by Ruth Glass.[158]

The gentrification of the Bankside area was not achieved by the displacement of a working-class population but by the addition of up-market warehouse conversions and new apartment developments from the mid-1990s.[159] These included 'stunning' and 'prestigious' residential developments such as Bankside Lofts, Gallery Lofts, Benbow House and more recently NEO Bankside.[160] This process too has not been without criticism. The industrial warehouses to the south-west of Tate Modern were demolished and Bankside 4, or NEO Bankside, was built. This is a residential development comprising four buildings up to 24-storeys high; in 2012 the apartments were being offered for sale at between £1 million and £6½ million.[161] The cultural geographer Matthew Gandy has said that this development represents 'a colossal misappropriation of resources at a time of intensifying housing shortages in

[157] Dean *et al*, 'Tate Modern: Pushing the Limits', p.82.
[158] Harris, 'From London to Mumbai', p.2412.
[159] Davidson and Lees insist that new-build residential development still constitutes gentrification, see M. Davidson and L. Lees, 'New-Build 'Gentrification' and London's Riverside Renaissance', *Environment and Planning A*, 37 (2005), pp.1165-90.
[160] Bankside Lofts, immediately to the west of Tate Modern, was built in 1995-98 and comprised 120 apartments built partly in a Victorian Warehouse; Benbow House to the east was built on a vacant car park site at the corner of Bankside and New Globe Walk and was completed in 2000. Sales literature and billboards in the area ubiquitously describe Bankside properties as 'stunning' and 'prestigious', personal observation.
[161] Personal observation, July 2012.

London'.[162] The Bankside area still retains social housing, namely the Peabody estate and Sumner Buildings in the south-east corner of the quadrilateral (see Figure 6.7) and some of the flats in Falcon Wharf are still owned by the local authority. Overall Bankside is socially mixed in terms of its residential population, although there are distinct areas of different types of residential property.

Transport connectivity has also improved on Bankside. The Tate's survey in 1993 recognised that public transport in the area was poor. Tate Modern and the Bankside area have benefited from several developments since the late 1990s. The idea of a pedestrian bridge to provide a link between the City and Bankside had been suggested in 1989 and became a serious consideration in 1994.[163] The bridge, again part funded by the Millennium Commission, was actively supported by local organisations and businesses which saw it as a benefit to enhance the area.[164] The Millennium Bridge provides an important pedestrian route and attracts people to Bankside; it has been said that it 'unites the noble bosom of St Paul's with the brick phallus of Tate Modern in a happy synthesis of yin and yang, ancient and new'.[165] The Jubilee line underground extension, from the West End to Canary Wharf and the docklands, opened in 1999 and included a new station at Southwark to the south-west of Bankside. Bankside Pier in front of Shakespeare's Globe was commissioned by the

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162 M. Gandy, 'NEO Bankside', *Architectural Design*, 82:1 (2012), p.53. The lack of affordable housing was been seen as the most pressing issue facing London in a Ipsos MORI poll in 2014. J. Prynn, 'Housing Crisis is Now Main Worry for Four Out of Five Londoners', *Evening Standard* (13 January 2014), p.4.

163 Pearman, 'Opera Plan for Power Station' (1989).

164 English Heritage had mentioned the bridge in the Bankside Area review, and the Financial Times whose headquarters were on Southwark Bridge supported the proposal which they thought 'will benefit and enhance the area', LMA, LMA/4441/01/4842, Letter from the Financial Times to English Heritage, dated October 1994. The bridge is on the site of St Paul's bridge that had been proposed by the Corporation of London in 1911, see Chapter 2.

165 J. Walsh, 'Welcome to the Indiana Jones Memorial Bridge', *Independent* (12 June 2000), p.5. The bridge was designed by Norman Foster and Anthony Caro, see Sabbagh, *Power into Art*, pp.116-24 for an account of the discussions concerning the southern end of the bridge within the Tate's property.

Borough of Southwark. It was one of several new piers built for a riverboat service for commuters, residents and tourists. The service includes the 'Tate to Tate' realising one of the Tate's objectives of directly linking Tate Britain to Tate Modern. The national railway infrastructure owner Network Rail has developed the 'Thameslink' project which entailed the rebuilding of Blackfriars station along the length of Blackfriars railway bridge and included a new entrance on Bankside.[166]

In summary, the presence of Tate Modern and Shakespeare's Globe provided a major impetus for the redevelopment, regeneration and transformation of the Bankside area from a dreary and run-down locality to a modern cultural quarter. Aspects of regeneration are addressed in the existing literature on urban planning. This study draws on several new sources such as the English Heritage and the Tate's archives to demonstrate how this process specifically functioned around the Tate Modern and Bankside area. The redevelopment of the Bankside area was largely piecemeal and was enacted through private-sector property development. This process brought about a middle-class colonisation of the area which added to, but did not displace, the pre-existing residential population. The developments were not without controversy: including concerns about private developers making profits from publicly funded projects, and the lack of affordable housing. By 2014 there were very few areas of un-redeveloped property in the Bankside quadrilateral.

[166] The Blackfriars development had been proposed as early as 1992 see G. Barrie, 'Farrell and BR Propose Station to Span Thames', *Building Design*, 1089 (July 24/31 1992), p.1. The station entrance on Bankside opened in April 2012.

Transformation 3: extending Tate Modern

In addition to the changes in the Bankside area brought about by Tate Modern, the building itself is undergoing a further transformation with a new extension. This development was, in part, related back to Bankside power station and the technology that was deployed there. The power station's oil tanks and the function of distributing electricity both contributed to this on-going transformation.

Tate Modern had been designed for 1.8 million visitors a year. It proved to be so popular that it had to accommodate an average of over four million visitors a year. As a result the galleries and public spaces were overcrowded.[167] The Tate had always intended to develop the power station's three disused underground oil-storage tanks into exhibition spaces. To ease the overcrowding the Tate planned a new 12-storey extension – originally called Tate Modern 2 (TM2) and later The Tate Modern Project – to the south-west of the original building, which included the oil tanks in the basement. The opportunity to undertake this extension had been brought about by access to the south-west part of the building. The electricity switch-house along the south of the building had continued, and continues, to supply electricity to the surrounding area and to the City of London. The transformers and electrical equipment were upgraded in 2007. The new equipment was more compact and was consolidated in the east switch-house allowing EDF Energy to give up the west switch-house.[168] The configuration of the Bankside site and the location of the former oil tanks were

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[167] Jonathan Glancey has said 'On some days it feels a little too much like Brent Cross or Lakeside – a shopping mall with busy cafes and queues for the lavatories, only with a pretty good art collection', J. Glancey, *London: Bread and Circuses* (London, 2001), p.76.

[168] Waste heat from the new EDF Energy transformers is recovered and used to provide space heating for Tate Modern and in future for TM2, this is claimed to reduce gas consumption for heating and the carbon emissions of the building, the waste heat will meet 72 per cent of the space heating required by Tate Modern. London Borough of Southwark, Planning Department, Max Fordham Consulting Engineers, *Transforming Tate Modern Energy Assessment* (London, 2008), pp.8-9.

fortunate for the new development. The 'strategic view sightline' of St Paul's cathedral passes through the Bankside site (see Figure 6.7) this limits building heights to the east of the line. The extension, at 75 metres high, could have only be built above the tanks on the west side of the sightline.[169]

The 2006 designs for the extension, again by Herzog & de Meuron, were for a pyramidal stack of glass-clad boxes. The Greater London Authority (GLA) supported the development and noted that the extension 'would support policies relating to London's world city status and for cultural and tourism facilities'.[170] The Tate embarked on a community relations exercise to promote the extension. From their experience with the development of Tate Modern, which they saw as a 'textbook example of community relations', the Tate knew that communication and involvement of the local community was crucial.[171] The redevelopment of the area since the mid-1990s meant that the local community was considerably larger and was, potentially, a group of articulate and influential objectors. Local residents had already successfully campaigned alongside the Tate against the proposed Bankside Tower, as discussed above.[172] As part of the consultation process the Tate established a community liaison group, published newsletters, and held a public exhibition. Local residents and businesses were generally supportive of TM2; one resident commented that the development would be 'an enormous contribution to London's cultural life, tourism

[169] The St. Paul's Strategic Views Backdrop that included the east side of Bankside/Tate Modern was a consultation zone aimed at preserving the view of St. Paul's from Alexandra Palace, L. Markham, 'The Protection of Views of St Paul's Cathedral and its Influence on the London Landscape', *The London Journal*, 33:3 (2008), pp.271-87.

[170] London Borough of Southwark Planning Department, Documents for planning application 09/AP/0039 Tate Modern Extension SE1, Letter from the Giles Dolphin (GLA) to Adrian Dennis (LBS), dated 5 March 2009, http://planningonline.southwarksites.com/planningonline2/AcolNetCGI.exe?ACTION=UNWRAP&RIPNAME=Root.PgeDocs&TheSystemkey=9530974 [accessed July 2012].

[171] Sabbagh, *Power into Art*, p.12 and pp.84-86.

[172] Harris, 'Livingstone Versus Serota', p.293.

and economy'.[173] However, the residents were concerned about local impacts such as additional traffic, noise, loss of light and potential loss of open space, but also about the height, size and bulk of the extension and that the 'glass box' design would detract from Scott's original building.

Others individuals and organisations were also concerned about the architectural treatment of the new development. The Twentieth Century Society objected that the new building would be 'a very dominant and overpowering structure that would have a distinctly negative impact on the former power station building'.[174] Gavin Stamp was concerned about the demolition of yet more of Scott's power station (the west switch-house) and that the symmetry of the building would be compromised.[175] The London Borough of Southwark, as the planning authority, were also concerned about the effect on the symmetry but recognised that since the existing building had no statutory protection through listing, a refusal would be difficult to defend.[176] In view of the objections the design was revised to a truncated pyramid clad in brown brick rather than glass and the height was reduced. It was envisaged that this revised form would 'serve to integrate the new building both with the existing TM1 building and the local environment' (see Figure 6.8).[177]

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[173] LBS Planning, LBS Development Control Report, dated 27.03.07, paragraph 42.
[174] Ibid, paragraph 44.
[175] Ibid, paragraph 45.
[176] Ibid, paragraph 35.
[177] LBS Planning, Letter from Drivers Jonas to LBS, dated 9 January 2009, f.1.

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Figure 6.8: Tate Modern extension, south elevation.

Source: LBS Planning, Transforming Tate Modern, Proposed South Elevation, document HDM-DR-A-263-3-3021. Reproduction permission refused.

Note the 11-storey truncated pyramid on the south-west of the site, 'The Tanks' exhibition space is underneath, the operational east switch-house is on the right.

The GLA's observations on the new design were again supportive, noting that 'Tate Modern has been a major driver of regeneration at Bankside' and that 'culture is a key element of London's economy'.[178] The GLA allowed LBS to determine the planning application and they granted planning consent in May 2009. The primary criterion for assessing the application was its compliance with Council planning policies including regeneration, creating employment and supporting arts, culture and tourism.[179] The LBS described Bankside as a unique location combining historic character with the best of new developments and noted it was 'a mixed use district full

[178] LBS Planning, GLA Planning Report Tate Modern, dated 4 March 2009. The GLA noted that new development did not fully comply with the London Plan in terms of accessibility considerations for disabled visitors and for some minor details of design and suggested how these might be remedied, Letter from Giles Dolphin (GLA) to Adrian Dennis (LBS), dated 5 March 2009.
[179] LBS Planning, London Borough of Southwark Planning Permission decision notice, dated 14/05/2009.

of vitality with a range of housing and employment opportunities, cultural and visitor attractions'.[180] The development therefore conformed to local authority planning criteria. It was intended to complete the extension in time for the London 2012 Olympic Games, however the financial downturn of 2008 and ensuing recession made financing of the project more difficult. 'The Tanks' underground exhibition space was opened in July 2012 and the rest of the extension is currently (2014) undergoing construction.

Conclusion

The changes in the Bankside area since 1947 and the post-closure history of Bankside power station can be seen as an interrelated set of material, social, cultural and economic changes and transformations. This chapter demonstrates that the changes in the area up to the mid-1990s were piecemeal and evolutionary. They were the result of wider changes in the economy rather than the product of strategic planning by the local authorities. This analysis reflects and supports the existing literature on the factors that influenced these changes such as the office building boom of the 1950s and the decline of riverside industry.[181] The planning of the area that took place is identified with the typology of planning styles identified by McCarthy and Brindley *et al* concerning the relationship between local authorities, private sector developers and engagement with the local community.[182] The area was variously zoned for business, residential areas, offices and river-front open space in the immediate post-war period and for housing and office development in the 1980s. Yet there were few material changes in the

[180] LBS Planning, LBS Development Control Report, dated 27.03.07, paragraph 51.
[181] Mort, 'Fantasies of Metropolitan Life', p.122; Scott, 'The Evolution', p.518; Young and Garside, *Metropolitan London*, pp.327-30.
[182] McCarthy, 'The Evolution of Planning Approaches', pp.149-50; Brindley *et al*, *Remaking Planning*, pp.8-12.

Bankside area as a direct result of strategic planning; the plans were aspirational but actual developments were dependent on appropriate financing.[183]

This chapter shows that since the mid-1990s the function, form and identity of Bankside has been transformed: the former little-known power station has become the internationally known, and much-visited, Tate Modern. An enclosed private place that had stood apart from its surrounding was integrated into the social and cultural fabric of the locality and of London. The Bankside area was itself transformed by the presence of Tate Modern and the use of private capital. The changes reflect the shift from social democratic 'public' norms in the post-war decades to the neo-liberal privatised norms of the late twentieth century. The developments outlined in this chapter represent a case study in the transformation of both an industrial building and a locality.

The transformations were the product of the contingency of circumstances. This is demonstrated in the comparative study of the fates of two of Bankside's sister stations, Battersea and Brunswick Wharf. These are framed as stories of failure and un-mourned loss. This too could have been the fate of Bankside: some of the 1980s proposals envisaged the demolition of the building. Yet, the 1980s saw a transformation in attitudes to the derelict power station. There was a growing interest in Britain's industrial heritage and Bankside became valued as a building that was worth saving.[184] It was also valued by the Government as an asset to be exploited in the run-up to the privatisation of the electricity industry. The timing was crucial:

[183] The only developments on Bankside following the 1950s building boom were the Lloyds Bank computer centre, Falcon Point flats, and the riverfront walkway, all constructed in 1976-78.
[184] It has been claimed that industrial archaeology came of age in the late 1970s, see Buchanan, 'The origins of industrial archaeology', p.28 and Pendlebury, *Conservation in an Age of Consensus*, pp.70-71.

Bankside was being sold just as the Tate Gallery were seeking a new site, and when substantial public funding was available. These factors enabled the transformation into Tate Modern. It could therefore be said that market forces were decisive in the transformation of this urban landscape. This analysis supports Madgin's contention that:

> the convergence of the public, private and voluntary sector during the late twentieth century determined the extent to which the vacant, redundant spaces of the de-industrial period could be transformed into prosperous post-industrial urban places.[185]

Tate Modern was a major impetus for the subsequent transformation of the Bankside area from one of dreary semi-dereliction to a mixed-use cultural, working and residential locality. The evidence here supports the existing lines of argument on the transformation of the area that has attracted considerable academic interest since 2000.[186] Issues such as the middle-class colonisation of the area; private developers making profits from publicly funded projects; and the lack of provision of low-cost housing are all manifest on Bankside. The present chapter extends the analysis to the on-going transformation of the gallery itself with the planning and construction of the new extension. Overall this chapter demonstrates how the obscure and derelict Bankside power station has been transformed into 'an icon, perhaps the seminal modern museum of the 21st Century'.[187]

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185 Madgin, 'Urban Renaissance', p.48.
186 See for example Teedon, 'Designing a Place Called Bankside'; Crisman, 'From Industry to Culture'; Dean *et al* 'Tate Modern: Pushing the Limits'; Newman and Smith, 'Cultural Production, Place and Politics'; Harris 'From London to Mumbai'.
187 Dean *et al*, 'Tate Modern: Pushing the limits', p.82.

Chapter 7 – Conclusions

In addressing a neglected topic in the history of modern Britain this study is a contribution to urban history, the history of technology and environmental history. With its close focus on Bankside power station and its owners; local electricity supplies; and the actors with an interest in the site and the locality, it is an addition to an under-developed historical field. The study has examined the contexts in which the building functioned including its transformation to Tate Modern and the cultural and social changes that have occurred in the locality. It has provided new examples of the operation of urban planning and urban regeneration, and the reuse of redundant industrial infrastructure.

The three research questions for the thesis, stated in Chapter 1, sought to identify the influences on the development and operation of Bankside and the impact of the building on the immediate area, together with the organisations and individuals involved in these processes. The first question asked: what were the economic, political, environmental, social and technological contexts and arguments that influenced the design, approval and operation of Bankside power station, and its later role as Tate Modern? Secondly, what were the social and environmental impacts and influences of the building on the area and the local community? Thirdly, who were the principal actors, both individual and institutional, involved in these processes; what were their positions and influence; and how, and to what extent, did they value the building and its site?

The study has addressed and responded to these questions by demonstrating that the planning, operation and redevelopment of Bankside power station was enmeshed in a web of complexity influenced by social concerns, political imperatives, economic forces, technological possibilities and environmental issues. The study has unpacked and examined these issues to demonstrate how Bankside functioned in its urban setting. The issues included the increasing demand for electricity; developments in technology; a shift in the location, size and form of power stations; government policy on the energy industries; and environmental improvements over the second half of the twentieth century. The complexity entailed the goals and interactions of a range of actors including local and central government; statutory bodies; urban planners; private companies; engineers; local residents; and influential individuals. The study has identified the variety of ways in which the power station was viewed and valued in the changing environments in which it operated. The web of complexity constitutes, as Madgin observes, a 'kaleidoscope of agency, agenda and available finance'.[1] A key finding is the primacy of economic considerations in many of the decision-making processes that took place around Bankside power station / Tate Modern.

The close focus on an individual power station has identified issues that are not revealed in the existing macro-scale broad-brush historical approaches to the electricity industry. In response to the first research question on influences, the study has identified that the location of the power station was determined by technological and economic requirements. Once established the power station and its site acquired 'momentum of place'. The electricity distribution infrastructure sustained the existence of an operational power station on the site for 90 years. This infrastructure was a key factor in the decision to retain the power station on the site during the 'battle for Bankside' in 1945-47. The momentum continues with part of the site's function as an

[1] Madgin, 'Urban Renaissance', p.210.

electricity sub-station, and with the reuse of the shell of the building as Tate Modern. In answer to the third research question a principal actor was the City of London Electric Lighting Company Limited (CLELC) which strove to expand the demand for, and supply of, electricity to the City of London and to improve its financial profitability. The company's growth was largely enabled by its specific situation with its compact area of supply and a high density and large number of relatively wealthy electricity users. This constitutes a counter example to the general assertion that London's electricity undertakings lacked the opportunity and incentive for expansion.[2] I have demonstrated that Bankside was a major power station: in 1912 it was the ninth largest generating station in Britain and its generating capacity was comparable with power stations in the USA and Germany. Growing demand in the City of London was met through the redevelopment of Bankside in terms its equipment and the physical expansion of the site. One of the responses to the second research question on the impact of Bankside on its surroundings was that the redevelopment process had significant social consequences as neighbouring properties were demolished and people were displaced.

A political context, relating to the first research question on influences, was that local and regional integration of electricity supplies did occur in London, contrary to contemporary views of the lack of electricity centralisation in Britain.[3] A regional authority, the London and Home Counties Joint Electricity Authority, was established and several London electricity undertakings, including the CLELC, entered into joint agreements and integrated their activities and electricity systems. From the perspective of profitable London undertakings such as the CLELC the pre-1926 structure of the

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[2] Hughes, *Networks of Power*, pp.463-64.
[3] For example the 1925 Weir Report, and later commentators such as Hannah, *Electricity*, pp.90-96.

industry was not, or was not seen as, a failure. This study has only touched on the economic profitability of the CLELC; a more detailed analysis of the company's accounts would be instructive. Comparison with other electricity undertakings in London and elsewhere may provide further examples of specific situations and operating circumstances. The national grid was one of the remedies for the lack of integration and was widely regarded as a success. It allowed the CLELC to operate more efficiently and to supply a wider area of London. However, the new structure of the industry led to a complex system of statutory oversight and control. The CLELC lost its autonomy in decision-making and had to consult, make applications to, and receive directions and approvals from, several statutory bodies. The result was a bureaucratic system where decision-making could be protracted.

A significant theme of this study is the process of decision-making. This is in response to the first and third research questions on contexts and actors, which encompassed the range of interested parties, their positions, and how, and in what ways, they influenced decision-making processes. The battle for Bankside was not solely about the merits and demerits of an urban power station – a tension between plans for the renewal of London and the economic recovery of the country – but also the principle of rational urban planning. The arguments on both sides were compelling and neither a satisfactory compromise nor a resolution was achieved despite several alternative proposals such as Rotherhithe. The decision-making process escalated from local discussions, through a public inquiry to Ministerial level. This was partly due to the importance of the planning issue but also the legislative structure of the planning process for the electricity industry in this period. The study has demonstrated why and how individuals in the political elite manoeuvred to influence the outcome of the decision-making process. I have argued that approval for Bankside power station was granted as a consequence of the fuel crisis of 1947 and the imperative of providing and increasing electricity supplies in London. The decision itself acquired momentum and despite later evidence of the high cost of running Bankside, Attlee's Government acknowledged that it would be politically embarrassing to reverse the decision.

Given the sensitive location of Bankside opposite St Paul's cathedral the issue of amenity was central to the design and operation of the post-war power station. This relates to the second research question concerning the impact of Bankside on its locality. To reduce its amenity impact the Cabinet imposed two conditions: Bankside was to be oil-fired and was to a have flue-gas washing plant. Politicians made this strategic decision without consulting the CLELC or the CEB on the practicability, the technical implications, or the costs of these requirements. The study examines how Bankside's designers were able to provide engineering solutions to the imposed conditions.

Novel and alternative technologies that were proposed for Bankside have been examined together with an analysis of why they were either deployed or rejected. This analysis redresses Stewart Russell's assertion that the history of technology tends to ignore alternatives which remain undeveloped.[4] This analysis has responded to the first research question on influences by demonstrating that many of the proposals demonstrate a tension between political imperatives, the social aspects of amenity, and financial considerations. It has been identified that an electricity network may be seen as a sociotechnical system where economics is just one of a number of forces acting

[4] Russell, 'Writing Energy History', p.44.

on, and within, the system.[5] Bankside too may be seen as a sociotechnical system. The study has identified several instances where economics was the determining factor in the deployment of technology. District heating was practicable, as had been demonstrated at Pimlico, but the marginal cost benefits of the (over)ambitious City of London district heating scheme of 1957 counted decisively against it. Economic considerations were also crucial to the other district heating proposals, including the partly constructed system of the early 1970s. Similarly, in 1975 a potential solution to the problem of plume droop at Bankside was considered but it was observed that 'the financial climate is not yet right'.[6]

The first research question on contexts and influences has been addressed through my assertion that technology was an enabling factor for changes in the electricity industry. This study has illustrated how technological change affected Bankside and influenced developments in the electricity supply industry. Technological change was manifest in the second half of Bankside with its greater generating capacity. However, Bankside was at the limit of what was practicable in an urban setting; it was the last power station to be built in central London and was one of last 'cathedrals of power'. The greater physical size of later power stations, their fuelling and cooling requirements and increased local pollution made urban locations impracticable and undesirable. Larger power stations were associated with the locational shift away from urban locations to the river valleys of the Midlands and Yorkshire close to coal fields. The development of the enabling technology of the super-grid made it more economical to transmit electricity over long distances through

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[5] Hughes states 'the economic factor should be considered deterministic rather than determining', Hughes, *Networks of Power*, p.465.
[6] Health and Safety Executive, *Industrial Air Pollution 1981*, pp.6-7.

the national grid than to transport coal from mines to urban power stations.[7] Associated with the locational shift was a change in the form of power stations. Monumental urban 'brick cathedral' power stations were characteristic of the middle decades of the twentieth century, exemplified by Battersea and Bankside power stations. The power station as a machine became characteristic of those constructed from the 1950s.[8]

In response to the first and second research questions on influences and impacts, an analysis of the operation of Bankside power station has been undertaken. For two decades (1952-73) Bankside 'B' was a model power station: it was effective and efficient and was highly valued by the CEGB as one of Britain's most efficient power stations. Operational issues, including the imperative of maintaining electricity supplies – keeping the lights on – affected the power station and were addressed and resolved by the CEGB. The flue-gas washing plant was also technically effective, exceeding the original operating specifications. However, it was a flawed, dead-end technology at the limit of what was possible and acceptable in terms of pollution. Although technically effective, Bankside occasionally gave rise to local air pollution and became a significant contributor to the pollution of the river Thames. This study has shown how the utilisation and efficiency of Bankside were directly related on the price of oil. This was a key factor in the economic and political context in which Bankside operated. Long-term variations in the price of coal and oil have been analysed together with the effects of these changes at Bankside and in the electricity supply industry. Government policy towards the coal and electricity industries shifted in the 1940s to the 1960s from supporting the coal industry by encouraging the use of

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[7] Rawstron, 'The Salient Geographical Features of Electricity Production', pp.73-82; and Rawstron, 'The Distribution and Location of Steam-Driven Power Stations', pp.259-63.
[8] Jordan, 'Power Station', p.230.

coal and penalising the CEGB if it burned too little, to specifying the construction of several phases of oil-fired power stations and insisting on the conversion of coal-fired ones to oil to alleviate projected shortages of coal.[9] The turning point for Bankside was in 1973 following the Middle East crisis and the significant increase in the price of oil. Bankside was demoted in the 'merit order' and its value to the CEGB fell and it was partly then fully decommissioned in 1981. This again demonstrates the primacy of economic factors.

The physical environmental in which Bankside 'B' operated shifted over its working life and influenced how the power station was perceived, this is a further aspect of the influence of externalities identified in answer to the first research question. Two inter-related factors led to an improvement in London's air quality: the post-war decline of urban industry and the impact of the 1956 Clean Air Act. The Act encouraged the introduction of urban Smoke Control Areas which precipitated an industrial and domestic shift away from coal towards 'smokeless' fuels such as coke, electricity and gas, together with social changes such as the greater use of central heating, the decline of open fires, and the promotion of electric heating including night storage heaters.[10] Improvement in air quality served to focus attention on the pollution from Bankside. This was barely tolerable when the power station was commissioned in 1952 but became increasingly unacceptable; evident in the large number of complaints about the station in the 1970s. The condition of the river Thames also improved from

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[9] See Chick, *Electricity and Energy Policy*, pp.7-29; Hannah, *Engineers*, pp.169-70 and pp.237-38; Sheail, *Power in Trust*, pp.88-91.
[10] Ashby and Anderson, *The Politics of Clean Air*, pp.116-17; Clapp, *An Environmental History of Britain*, pp.51-53.

the 1960s as a result of concerted efforts to clean up the river, by the early 1970s the water effluent from Bankside was inhibiting further improvements.[11]

The phenomenon of pollution transfer has been examined. Joel Tarr has identified some examples in the United States, including the effects and fate of pollutants discharged into the 'ultimate sink' of the environment. This study has extended this analysis by providing a number of British examples. The pollution of the river Thames by effluent from Bankside is one example. Others include the tall chimneys of power stations; district heating schemes; and the proposals for the use of town gas and gas-turbines at Bankside. There were associated social and economic issues around the cost of pollution, pollution mitigation, and how the effects of pollution were 'valued' by those affected. Quantifiable costs include the repair of buildings damaged by acid rain and the higher cost of electricity produced at power stations provided with flue-gas cleaning plant. Less quantifiable costs are the impact of air pollution on health and the environment. The phenomenon of pollution transfer would repay further research and would add a more nuanced dimension to studies of urban pollution.

The built environment of the Bankside area is another significant context of this study and encompasses all three research questions on influence, impact and actors. The CLELC bought land and neighbouring properties from the 1890s to the late 1930s which displaced some of the local population. I suggest that the infrastructure changes in the area over the period 1947-93 were unplanned and piecemeal. This was despite the (unfulfilled) *County of London Plan* and the zoning of the area for business

[11] Wood, *The Restoration,* pp.112-19.

and residential purposes. The physical changes that took place reflected the wider economy such as the decline of riverside industry and the office building boom of the 1950s and 1960s. There were several proposals for the redevelopment of the power station, or its site, after it closed; but none proved to be financially viable in the economic climate of the early 1980s. In response to economic decline, especially deindustrialisation, the Borough of Southwark and the GLC adopted policies for the regeneration of the Bankside area.[12] Local authority policies – another political context – increasingly sought to use private capital for redevelopment. This exemplifies the shift from the post-war social democratic norms to neo-liberal privatised policies of the late twentieth century.

Influences and actors – the first and third research questions – encompass the shifts in attitudes to industrial buildings that affected the ways in which Bankside power station was viewed. From its inception in 1947 the 'brick cathedral' style was criticised by the Royal Fine Art Commission and others as the 'divorce of structure and design'.[13] Bankside was also seen as a gloomy presence on the South Bank. From about 1980 it was viewed as a significant architectural achievement. I suggest this was linked to the growth and recognition of industrial archaeology as a popular field of interest and as an academic discipline.[14] The formal listing of Bankside was refused in 1987 and 1992 because the building was seen by the Government as an asset to be exploited in the run-up to the privatisation of the electricity industry. Bankside was therefore valued as both a building to be protected and an asset to be exploited. These two positions were resolved in the building's transformation to Tate Modern. Local

[12] Teedon, 'Designing a place called Bankside', p.464.
[13] Jordan, 'Power Station', p.230.
[14] See for example Buchanan, 'The Origins of Industrial Archaeology', p.28.

community groups at Bankside opposed the retention of the power station and campaigned for affordable housing, although this aspiration was not achieved. This study has illustrated the dependency of deindustrial redevelopment on favourable circumstances, another example of the web of social, political and economic influences and significant actors. The conjunction of location, timing and financing for major urban redevelopment projects was crucial to the success, or otherwise, of such schemes. The transformation of Bankside to Tate Modern succeeded through of the contingency of the sale of site by Nuclear Electric, the Tate Gallery seeking a location for a museum of modern art, and financing from the Millennium Fund. The contrasting examples of Bankside, Battersea and Brunswick Wharf power stations have served to illustrate the significance of the conjunction of circumstance; three similar buildings in run-down deindustrial areas, had different fates: successful conversion, dereliction, and demolition. Tate Modern was critically acclaimed and has proven to be a popular addition to the London tourist scene. However, I have demonstrated that it is only the outer physical appearance and the shell of the building that has been preserved at Tate Modern.[15] Only a trace of the building's former function remains in the switch house and the name of the turbine hall. It is an art museum in an industrial building and is not, nor was it intended to be, an industrial museum. Another ghost of the former function is the extension of the 'cathedral of power' metaphor to the building's new function as a cathedral of art.

In response to the second research question on the impact of the building on the locality, it has been identified that Tate Modern was a catalyst for the regeneration and transformation of this post-industrial locality. This was a two-way process, Tate

[15] Phoebe Crisman asks of such 'industrial to cultural' buildings what it is that is being preserved, Crisman, 'From Industry to Culture', p.405.

Modern both stimulating and benefiting from the infrastructural investment in the area. Private sector property development led to the construction of expensive apartments and prestigious commercial buildings. The middle-class colonisation of the area that has occurred since the mid-1990s was by means of warehouse conversions and new-build high-rise developments. These, not uncontroversial, buildings co-exist with earlier social housing. Bankside is still a mixed-use locality as it was when the power station was established in 1891, although the composition of the mix has changed significantly. The transformation of the former Bankside power station is currently an on-going process. The recent extension to Tate Modern aligned with local authority policies for promoting employment, tourism and regeneration, for supporting the arts, and for promoting London as a major world cultural city. However, there were concerns about the effect that the extension would have on the integrity of an important mid-twentieth century building.

In conclusion, this study has addressed, through three research questions, the contexts and influences on, the impact of, and principal actors involved in the development and redevelopment of Bankside power station from the 1880s to the present day. The study is a significant contribution to the history of the British electricity supply industry, the history of technology and environmental history. It also contributes to debates about urban planning and regeneration. The methodological focus on a single power station has revealed issues that are not apparent in macro-scale broad-brush approaches to the history of the industry. Indeed, this study has identified counter and qualifying examples to the established historiography. The particular situation of Bankside with its supply area in the City of London, its location opposite St Paul's cathedral, and its transformation to Tate Modern make it an important case study in urban history. The longitudinal analysis of its history has identified the changes that have occurred in the electricity industry over an extended period and in the wider political, economic, social and environmental contexts in which the power station operated. These shifting contexts influenced the operation and the effectiveness of the power station and changed how the building was viewed. Bankside power station, as a private industrial place, had largely stood apart from its surroundings. The building had been transformed into a new public space that has been integrated into the material, social and cultural fabric of London.

Appendix A – Bankside power station: technical details

This appendix describes some of the technical details of the design and operation of Bankside 'B' together with an outline of relevant technologies at other power stations.[1] The principles of the operation of the power station are outlined together with a summary of the technical specification of some of the plant. An account of the significance of the cooling water supply and the use of cooling towers where the availability of water is limited is given. The operation of Bankside's flue-gas washing system is described including the process for treating the water effluent before discharge into the Thames. The appendix concludes with a discussion of the height of the Bankside's chimney.

Principles of power station operation

A thermal power station such as Bankside operates by undertaking a series of energy conversions mediated by technology.[2] The chemical energy contained in a fuel – coal, gas, biomass, or in the case of Bankside 'B' oil – is converted to heat or thermal energy when the fuel is burned in a boiler. Thermal energy is converted into pressure energy within a boiler: the heat is used to evaporate water to generate steam at high pressure and temperature. The energy contained in the steam is then converted into mechanical energy in a steam turbine. Steam is made to expand from high pressure to a lower pressure through the blades of the turbine, in doing so it transfers its energy to the turbine which rotates at high speed. The final conversion is from mechanical to electrical energy. The rotor of the steam turbine is mechanically linked to an alternator where the rotating electromagnetic fields generate electricity. The coupled steam

[1] A full description and specification of Bankside 'B' is given in *The Engineer*, 23 January 1953, pp.143-44; *The Engineer*, 30 January 1953, pp. 167-70; *Engineering*, 23 January 1953, pp.107-12.
[2] Clarke, *Electricity Supply and the Environment*, pp.2-3.

turbine and alternator are known as a turbo-alternator. A schematic of these operations at Bankside 'B' power station is shown in Figure A.1.

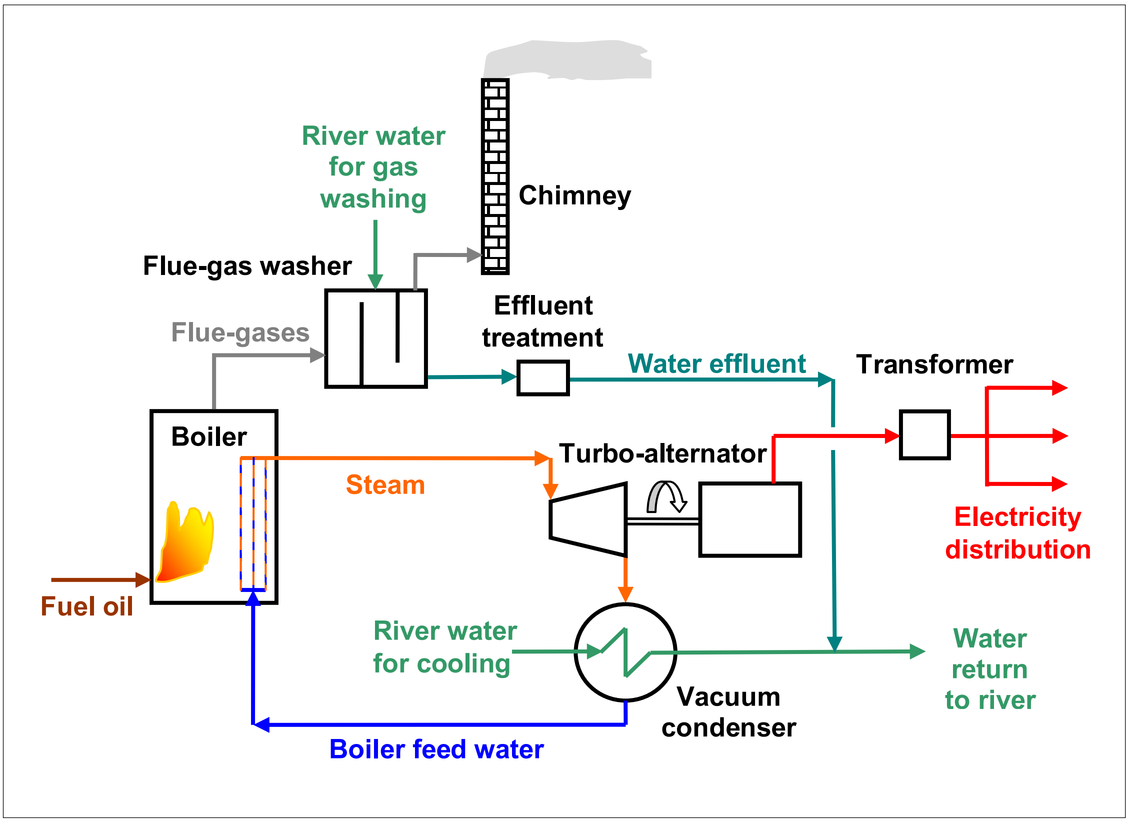

Figure A.1: Schematic of Bankside 'B' power station operations.

Source: Adapted from CEGB, *How electricity is made and transmitted* (London, 1982).

Each of the energy conversions entails some loss of efficiency. For example, not all the thermal energy generated in the boiler is transferred to the steam since some heat is lost with the flue-gases. Engineers aim to make the energy transfers as efficient as possible as this makes the most effective use of the fuel. Technological developments improved the efficiency over time. This is demonstrated in the reduction of the amounts of coal that were required to generate a unit of electricity. In the early 1890s about 4.5 kg of coal was used to generate one unit (1 kWh) of electricity, by 1914 only 1.8 kg of coal was needed.[3] Improvements continued: Dunston 'B' power

[3] Bowers, 'The Generation, Distribution and Utilization of Electricity', p.1071.

station, opened in 1930, used only 0.6 kg per kWh, and by 1980 the average consumption of coal in British power stations was 0.49 kg per kWh, nearly a ten-fold improvement on the 1890s.[4]

Power stations operate on other principles. In a nuclear power station the nuclear reactions generate heat to make steam which is used to drive a turbo-alternator. In a gas-turbine the fuel – gas, diesel or kerosene – is burned and the large volume of hot gases thus produced is used to rotate a turbine which is coupled to an alternator to generate electricity (see Figure A.2). The more efficient combined-cycle gas-turbine operates on the similar principle, but in addition the hot flue-gases discharged from the gas-turbine are used to generate steam which is used to drive a steam turbo-alternator.

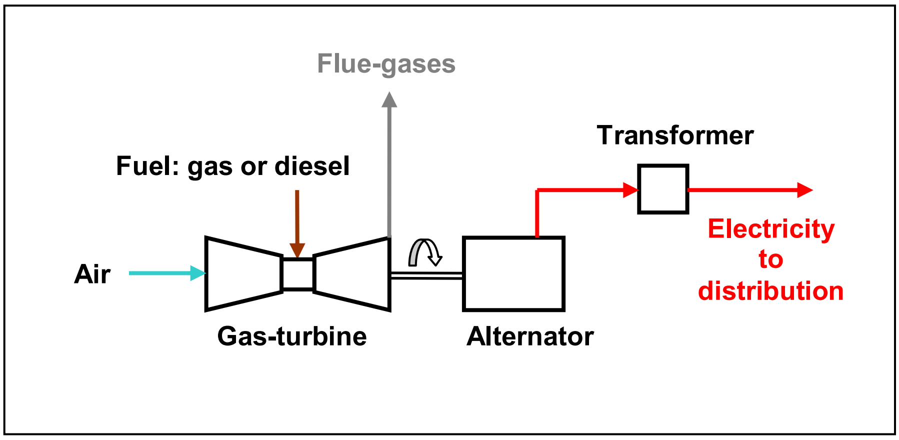

Figure A.2: Schematic of a gas-turbine generator.

Specification of boilers and turbo-alternators

The following table outlines the technical specifications for the boilers and turbo-alternators at Bankside ‘B’. The data illustrates the significant technical developments that took place in power station equipment in the decade between the commissioning of the two halves of Bankside power station.

[4] Bowers, *A History of Electric Light & Power*, p.169.

Table A.1: Technical specification of Bankside 'B' boilers and turbo-alternators.

Boilers		
Manufacturer	Foster Wheeler	John Brown Land Boilers (Brown Riley)
Commissioned	1952	1963
Number	Four	One
Steam produced (each)	375,000 lb/hr	860,000 lb/hr
Steam pressure	950 psi	1600 psi
Steam temperature	925°F	1005°F
Reheat	None	377 psi & 1005°F

Turbo-alternators			
Manufacturer	British Thomson-Houston	Associated Electrical Industries	English Electric
Number	Two	One	One
Commissioned	Nov. 1952 & Jun. 1953	late 1962	Dec. 1963
Rated output	60 MW	60 MW	120 MW
Steam conditions at turbine stop valve	900 psi & 900°F	915 psi & 900°F	1500 psi & 1000°F

Source: CEGB, *Bankside Power Station* (London, n.d. *c*.1969); CEGB, *Bankside Power Station* (London, n.d. *c*.1972)

Cooling Water

The science of thermodynamics from around 1900 had demonstrated that a vacuum condenser at the outlet of a steam turbine could double the thermal efficiency of the plant by reducing the back pressure on the turbine.[5] The vacuum condenser uses large quantities of water to condense the steam from the turbine (see Figure A.1). Riverside locations, particularly tidal ones, are ideal for power stations since they provided both cooling water and facilitate the supply of fuel by collier or oil tanker and the removal

[5] Duffy, 'Thermodynamics and Powerhouse Design', pp.216-18.

of ash by barge.[6] The completed Bankside 'B' used nearly ten million gallons of water per hour for condensing service.[7] At Bankside, water was passed through a strainer underneath the river jetty into the station via a 9 ft 8 in diameter underground tunnel (similar to Figure 4.4).[8] The cooling water was returned to the river about 15°F warmer than the abstraction temperature. To avoid recirculation, the water was discharged on the far side of the river near Blackfriars railway bridge.[9]

Not all urban power stations had access to a river. Furthermore, the size of power stations from the 1950s meant that no inland British river could supply their much greater cooling water needs. In these cases cooling towers were necessary to cool the circulating water. Grove Road power station in St John's Wood had 16 steel-plate cooling towers in 1923 and further towers were added later (see Figure A.3).

Cooling towers were expensive to build and operate, took up a considerable area of land and also raised amenity issues associated with their height, their industrial appearance and the water vapour they emitted. The adverse visual impact of cooling towers was used in the arguments against power stations – even when unfounded. During the public outcry over the decision to authorise Bankside in early 1947, an architectural academic had declared that 'condensers 200 feet high will tower above the City. Smoke will obscure St. Paul's'.[10] There had never been an intention to install

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[6] Harris, 'Electricity Generation in London', pp.127-34.
[7] The cooling water flow corresponds to 1.07 million m^3/day. This is about half the mean summer flow of the river Thames which is 1.96 million m^3/day. Wood, *The Restoration of the Tidal Thames*, p.180. The tidal maximum flow is considerably larger at about 2000 million gallons per hour, TNA, POWE 12/798, Evidence of Sir Leonard Pearce at the public inquiry, day 1, p.28.
[8] The cooling water intake and discharge tunnels at Bankside 'B' were the same diameter as the jetty access tunnel in Figure 4.4.
[9] Pugh, 'Bankside "B" Power Station'.
[10] The Professor of Architecture is not named but appears to be A.E. Richardson of the University of London. He is mentioned as an opponent to the power station in a Parliamentary debate (*Hansard*, House of Commons debates, 23 May 1947, Vol.437 cc.2702). At a meeting of the Royal Fine Art

condensers (cooling towers) at Bankside as the river provided the cooling water; the suggestion was rebutted by the managing director of the CLELC in a letter to *The Times*.[11] The increased size of power stations from the 1950s required greater cooling duties. A 2000 MW station, typical of those built from the mid-1960s, required eight concrete cooling towers each 375 ft high and 300 ft in diameter.[12]

Figure A.3: Grove Road power station, St John's Wood, 1923.

Source: English Heritage, EPW009093 Aerial view, Marylebone station area, London. Reproduced with permission. © English Heritage (Aerofilms Collection).

Note the box-like cooling towers to the right of the chimney; and the coal store bottom right.

Commission attended by Cyril Hurcomb of the Electricity Commission Richardson made a sketch showing how the power station 'would dwarf St Paul's', TNA, POWE 14/148, Ministry of Fuel and Power, Consultation with the Royal Fine Art Commission for new power stations, file note by CWH (C.W. Hurcomb) dated 12 April 1945.

[11] The anonymous quote is mentioned in a letter to *The Times* by H.J. Randall, the managing director of the CLELC. 'Bankside Power Station, a Comparison of Heights, The Company's Case', Letters to the Editor, *The Times,* 1 May 1947, p.5.

[12] Clarke, *Electricity Supply*, pp.28-31.

Sulphur dioxide and Bankside's flue-gas washing plant

Fossil fuels such as coal, oil and natural gas contain naturally occurring sulphur. Coal contains about 1.0-1.5 per cent and heavy fuel oil up to four per cent sulphur. When coal or oil is burned the sulphur is converted to gaseous oxides of sulphur, principally sulphur dioxide (SO_2). This is an acidic, corrosive and toxic gas which aggravates bronchial conditions such as asthma; it also dissolves readily in atmospheric moisture to form acid rain which erodes the stonework of buildings (see Figure 4.5); and it damages vegetation. Its solubility in water can be used to advantage to wash sulphur dioxide out of power station flue-gases prior to their discharge from the chimney.

The flue-gas washing plant at Bankside comprised a washing chamber (106 ft high, 53 ft wide and 48 ft broad) in each half of the station. Each chamber was divided into three vertical sections through which the flue-gases passed in turn. The outer sections, through which the flue-gases ascended, had slatted cedar-wood scrubber banks. Above each of these sections were tanks from which river water, with an added solution of chalk, was sprayed and cascaded down. The middle section transferred the gases from the top of the first pass to the base of the third (see Figure A.4). This 'counter-current' double washing process was an improvement on, and more efficient than, the process used at Battersea. The flue-gases leaving the washing plant had about 97 per cent of the sulphur dioxide pollutant removed prior to being discharged from the chimney. See Chapter 5 for a discussion on the operational effectiveness of the flue-gas washing plant.

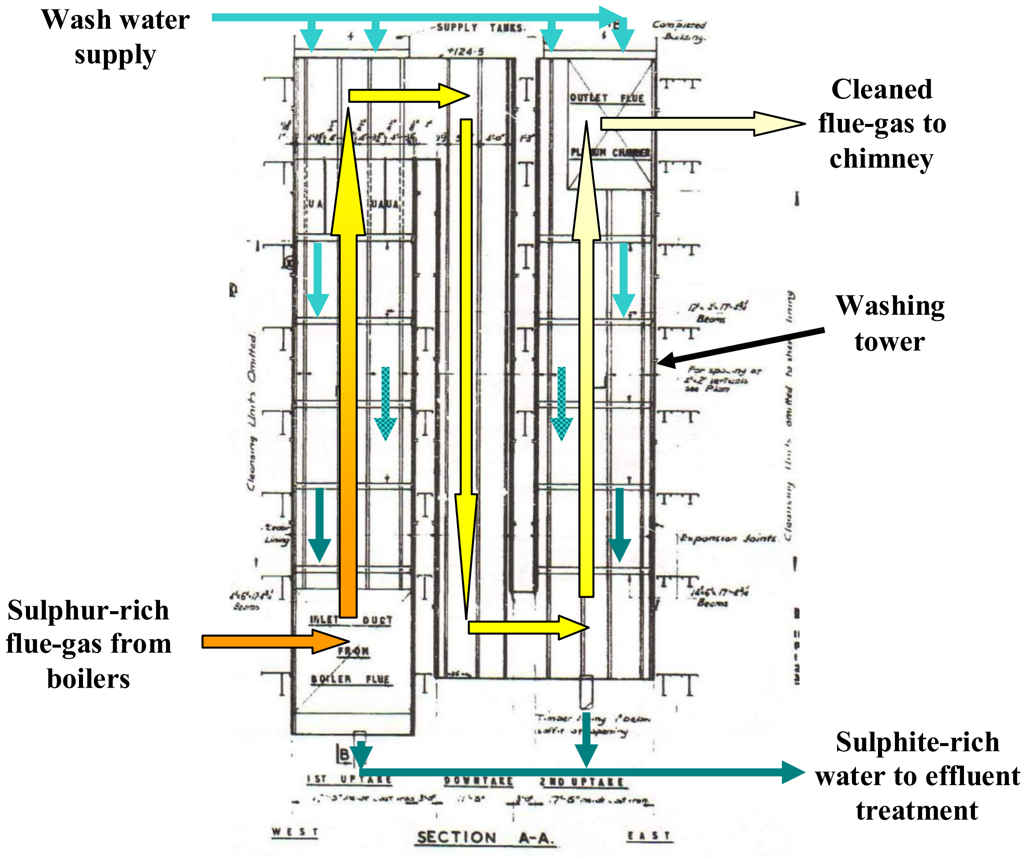

Figure A.4: Cross-section of the Bankside flue-gas washing towers.

Source: Mott, Hay and Anderson, Drawing of Bankside Generating Station, Extract of Drawing No B.G.S.D. 20C Flue gas washing, arrangements & support of timber cleansing units timber linings to uptakes. Reproduced with permission. Mott MacDonald.

Note the orange-yellow arrows indicate the path of the flue-gases through the towers; the blue-green lines indicate the flow of the wash water.

The operational experience at Battersea was used to improve the plant at Bankside in other ways. The wash water – about two million gallons per hour – was taken from the outlet of the condensers and pumped to the washing chambers. At Battersea the water was taken from the inlet of the condensers and was therefore at river temperature, whereas the wash water at Bankside was about 15°F warmer, thus cooling the flue-gases slightly less. During the washing process the sulphur dioxide pollutant in the flue-gases dissolved in the wash water and reacted with the chalk and as a consequence the wash water became acidic and was rich in calcium sulphite. This would have presented a significant pollution hazard by depleting the oxygen in the river.[13] This is an example of pollution transfer from one medium to another; reducing air pollution at the expense of river pollution. The wash water had to be treated and was transferred through rubber-lined pipes to 45 ft deep aeration tanks constructed from acid resistant bricks. In these tanks compressed air was bubbled through the solution to oxidise the sulphite to sulphate. Scientific experiments had revealed that this chemical conversion could be improved if a small quantity of manganese salts were added to the effluent to catalyse the reaction. The effluent was diluted with the outgoing cooling water (in the ratio of about five-to-one) whose natural alkalinity further helped to neutralise the acid before it was discharged into the river.[14] Despite the treatment process the pollution problem was literally washed into the river and the issue of water pollution from Bankside became more acute as concerted efforts were made to clean up the river Thames from the 1960s (see Chapter 5).

Chimney, slender tower or campanile[15]

The discharge of flue-gases from power stations chimneys had been of interest to the electricity supply industry for some years and this matter was examined by the DSIR.[16] A report on chimney emissions issued by the Electricity Commissioners in 1932 had specified that the height of a power station chimney should be at least 2½ times the height of the highest point of the main station building.[17] The original 1945 coal-fired Bankside 'B' design had a 140 ft high boiler house (see Figure 4.3) but this was later

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[13] Health and Safety Executive, *Industrial Air Pollution* (London, 1982), p.6.
[14] Anon, 'Bankside 'B' Electric Power Station', *Engineering*, 23 January 1953, pp.109-10.
[15] Scott had said: 'this station, with its slender tower, or campanile, completes a composition', 'The Bankside Power Station: Sir Giles Scott Explains', *The Builder,* 20 May 1947, p.493.
[16] TNA, DSIR 8/93, Report of the DSIR working group on the removal of sulphur compounds from the flue gases of electricity generating stations, December 1950.
[17] TNA, POWE 14/141, Letter from R.R. Martindale (LPC) to the CLELC dated 19 March 1948. The height of the chimney ensured that fumes were discharged above the turbulent air layer created by the building and were not drawn down to ground level by eddies and downdraughts.

reduced to 123 ft by relocating some of the boiler equipment.[18] The Commissioner's formula gave chimney height of 308 ft for the reduced boiler house height. Scott, for architectural reasons, had wished to make the chimney 275 ft high but the consultant engineer said that if possible the 300 ft height should be retained for effective dispersal of the flue-gases.[19] A similar situation arose concerning the height of the chimney at Ironbridge 'B' power station in the 1960s.[20] In an attempt to provide a rational and scientific basis for the height of the chimney at Bankside and its potential pollution effects the National Physical Laboratory conducted wind tunnel tests in 1950 on a model of Bankside and its surroundings.[21] The experiments were inconclusive, a report stated 'it was not easy to interpret the results of these experiments' and self-evidently observed that 'there would be less pollution if gas washing were practiced and the chimney were of suitable height and design'.[22] When the height of the boiler house was reduced to 85 ft after oil-firing was specified, the height of the chimney could have been reduced to 213 ft according to the Commissioner's formula, but the original height was retained. There is some disagreement in the sources about the height of the chimney, with a range from 296 ft to 325 ft.[23] It has also been claimed that the height

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[18] TNA, HLG 79/919, Plan No. 9, shows a parapet height of 140 ft (see Figure 4.3); TNA, HLG 79/918 'Revised Draft of Memorandum of Bankside electric generating station, f.2, dated 10 December 1946, gives a height of the boiler house, including electrostatic precipitator housing, of 123 ft.

[19] TNA, POWE 14/141, notes of Meeting at the Electricity Commission on 16 June 1947, p.4. See also POWE 12/798, public inquiry day 1, p.49. At the press conference on 19 May 1947 Scott had said: 'the smoke stack or campanile of the power station would be 275 ft. to 300 ft. in height' and that smoke would leave the power station as a 'smokeless shimmer of vapour', 'The Bankside Power Station: Sir Giles Scott Explains', *The Builder,* 23 May 1947, p.493.

[20] Stratton, *Ironbridge*, p. 81. The tension between engineering and aesthetic requirements in this case is discussed in the literature review.

[21] 'The NPL Celebrates Its 50th Anniversary: An Experiment in Progress in a Wind-Tunnel with a Model of the Bankside Power Station', *Illustrated London News*, Issue 5780, 28 January 1950, p.124. 'The Severn Bridge and St Paul's at Teddington: Special N.P.L. Tests', *Illustrated London News*, Issue 5784, 25 February 1950, p.285.

[22] TNA, DSIR 8/93, File note by A. Parker on the Report of the DSIR working group on the removal of sulphur compounds from the flue gases of electricity generating stations, dated December 1950, paragraph 9, f.3.

[23] A calculation dated 24 February 1950 of the draught produced by the chimney states it is 300 ft high, MOSI, A1989.338/17/2. The station manager H.V. Pugh states 'Rising some 300 ft. from street level', Pugh, 'Bankside "B" Power Station' memorandum dated 14.1.53. Most of the accounts in 1953 when

of the Bankside chimney was limited to be less than the height of the dome of St Paul's cathedral, however, there is no evidence in the primary sources that this was ever a consideration. In 1989 the architectural critic Gavin Stamp said: 'the single chimney rose only to 325ft, some 45ft below the height of the cross above the cathedral'.[24] In November 1993 it was said that 'the taller chimney originally designed was rejected for being higher than St Paul's' although there is no evidence of this in the sources.[25] The architectural critic Jonathan Glancey reiterated this assertion and said the chimney was 'limited to 325 feet in height (to be lower than the dome of St Paul's)'.[26] Tate Modern's book on the building repeats this contention 'Chimney 99m (325ft) high, built to be lower than St Paul's 114m (375ft)'.[27] There is no evidence in the designs that the height of the chimney would have been any greater than 325 ft.

Bankside was first commissioned use this figure. A 'single brick tower 320 ft high' is quoted in 'Bankside' *The Borough*, p.22. '98 metres (325 feet) tall' is given in the CEGB publication *Bankside Power Station*, n.d. but *c*.1972. The Tate Modern Architect Selection Competition document gives a chimney height of 314'11" above ordnance datum (AOD), the ground floor is 18'6" AOD giving a chimney height of 296'5", LMA, LMA/4441/01/4842.

[24] G. Stamp, 'A Prayer', 1989, p.19.

[25] Lawrence Hanson, 'Backward-Looking Home for Tate's Modern Art', *Independent* [letter to the editor] (5 November 1993), p.17.

[26] J. Glancey, 'The Powerhouse for Modern Art?', *Independent* (10 November 1993), p.22.

[27] Moore and Ryan, *Building Tate Modern*, p.194.

Appendix B – Principal actors

Organisations

British Electricity Authority, 1948-55. Established by the Electricity Act 1947 to own and with the responsibility for generation and main transmission together with central co-ordination and policy direction, it had the duty 'to develop and maintain an efficient, co-ordinated and economical system of electricity supply'.[1]

Central Electricity Authority, 1955-57. The BEA was renamed the Central Electricity Authority on 1 April 1955 when the South of Scotland Electricity Board was formed and took over the BEA's assets within its designated area.[2]

Central Electricity Board, 1926-48. Established by the Electricity (Supply) Act 1926 to 'construct, own and operate the grid on behalf of the state, and would exercise direct control over the operations of the best privately- and municipally-owned power-stations'.[3]

Central Electricity Generating Board, 1958-90. Established by the Electricity Act 1957 'to take over from the CEA the duties of generation and transmission'.[4]

City of London Electric Lighting Company Limited, 1891-1948.

Department of Scientific and Industrial Research, 1916-65.

Electricity Commission(ers), 1919-48. The Electricity (Supply) Act 1919 'introduced central co-ordination by establishing the Electricity Commissioners, an official body responsible for securing reorganisation on a regional basis. The Commissioners […] delineated Electricity Districts and investigated a number of regional schemes for centralising generation in a relatively small number of large generating stations owned by Joint Electricity Authorities'.[5]

Electricity Council, 1957-90. Established by the Electricity Act 1957 to 'exercise general supervisory and advisory functions on policy'.[6]

English Heritage, 1983-date. Established by the National Heritage Act 1983 to take over from the Department of the Environment the responsibility for ancient or historical monuments and buildings.

Greater London Authority, 2000-date.

Greater London Council, 1965-86.

London and Home Counties Joint Electricity Authority, 1925-48. The duty of the Joint Electricity Authority was 'to provide or secure the provision of a cheap and abundant supply of electricity within its district' to carry out this duty it could

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[1] Electricity Council, *Electricity Supply*, p.60; Electricity Act, 1947, Section 1.
[2] Hannah, *Engineers*, p.162.
[3] Hannah, *Electricity*, pp.100-01.
[4] Electricity Council, *Electricity Supply*, p.73. The CEGB was legally dissolved in 2001.
[5] Ibid., pp.41-42.
[6] GLC, *London Statistics 1955-65*, Vol.7, p.194.

'construct generating stations, main transmission lines, and other works and acquire undertakings of authorised distributors'.[7]

London County Council, 1889-1965.

London Electricity Board, 1948-90. Established by the Electricity Act 1947 for 'the efficient and economical distribution of electricity to consumers in the London Area'.

London Power Company, 1925-48. Established by the London Electricity (No.2) Act 1925. The LPC commissioned and owned Battersea power station.

Ministry of Fuel and Power, 1942-57. Established as a war-time measure in 1942, renamed the Ministry of Power 1957-69, absorbed into the Ministry of Technology 1969-70, then into the Department of Trade and Industry 1970-74, became the Department of Energy 1974-92.

Ministry of Town and Country Planning, 1943-50, renamed the Ministry of Local Government and Planning 1951, then the Ministry of Housing and Local Government 1951-69.

Nuclear Electric, 1990-95. The owner of non-privatised 'stranded assets' – nuclear power stations and some redundant conventional power station sites – following electricity privatisation in 1990.[8]

Southwark local authority: St Saviour's District prior to 1900; Metropolitan Borough of Southwark, 1900-65; London Borough of Southwark, 1965-date.

Dramatis personae

Abercrombie, L. Patrick	Architect, Professor of Town Planning UCL, 1935-46.
Attlee, Clement R.	Prime Minister, 1945-51.
Barlow, A. Montague	Industrialist, Royal Commission on the Distribution of the Industrial Population, 1937-40.
Beaver, Hugh E.C.	Civil Engineer, Committee on Power Station Construction, 1952-3; Committee on Air Pollution, 1953-54.
Bevan, Aneurin	Minister of Health, 1945-51.
Brown, F.H. Stanley	Chief engineer of BEA, 1952; Chairman of CEGB, 1965-72.
Citrine, Walter	Chairman of BEA / CEA, 1948-57.
Cox, Harold Roxbee	Aeronautical Engineer, Chief Scientist Ministry of Fuel and Power, 1948-54.
Cripps, Stafford	President of the Board of Trade, 1945-47; Chancellor of the Exchequer, 1947-50.

[7] LCC, *London Statistics 1932-33*, Vol.37, p.331.
[8] The 'stranded asset problem' is described in Chick, *Electricity and Energy Policy*, p.115.

Dalton, Hugh	Chancellor of the Exchequer, 1945-47; Minister of Town and Country Planning, 1950-51.
Dodd, K.S.	Chief Inspector of the Ministry of Town and Country Planning (public inquiry 1947).
Forshaw, John Henry	Architect to the LCC, 1941-46.
Gaitskill, Hugh	Minister of Fuel and Power, September 1947-1950; Chancellor of the Exchequer, 1950-51.
Hacking, John	Chief Engineer of CEB, 1944-48; Deputy Chairman of BEA, 1948-53.
Hinton, Christopher	Chairman of CEGB, 1958-64.
Holden, Charles Henry	Architect, City of London Plan, 1946-47.
Holford, William Graham	Architect, Royal Fine Art Commission, Professor of Town Planning UCL; Committee member CEGB, 1957-73.
Hurcomb, Cyril William	Electricity Commissioner, 1937-48; Chairman, 1938-47.
Isaacs, George Alfred	MP for Southwark North, 1929-31 & 1939-59; Minister of Labour and National Service, 1945-51.
Jowitt, William	Paymaster General, 1942; Lord Chancellor, 1945-51.
Kennedy, John M.	Electricity Commissioner, 1934-48; Chairman, 1947-48.
Latham, Charles	Leader of the LCC, 1940-47.
Lloyd, Geoffrey	Minister of Fuel and Power, 1951-55.
Lloyd-George, Gwilym	Minister of Fuel and Power, 1942-45.
Morrison, Herbert Stanley	Minister of Transport, 1929-31; Leader of LCC, 1934-40; Lord President of the Council, 1945-51.
Morrison, William S.	Minister of Town and Country Planning, 1943-45.
Pearce, Standen Leonard	Electricity Commissioner, 1925; Engineer-in-chief of the LPC, 1926-47 and consulting engineer to CLELC.
Pugh, Harold V.	Controller London Division of the BEA.
Randall, Henry John	Secretary then Managing Director of CLELC until 1948, Chairman of LEB from 1948.
Scott, Giles Gilbert	Architect, Battersea and Bankside power stations.
Serota, Nicholas	Director of the Tate Gallery from 1988.
Shinwell, Emanuel	Minister of Fuel and Power, 1945-September 1947.
Silkin, Lewis	LCC Housing and Public Health Committee, 1934-45; Minister of Town and Country Planning, 1945-50.
Tizard, Henry Thomas	Chemist, Permanent Secretary to DSIR, 1920-29; Advisory Committee on Scientific Policy, 1947-49.

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TNA, BT 31/4980/33297, Board of Trade, Companies Registration Office, City of London Electric Lighting (Pioneer) Company Limited, Company No: 33297, 1891-1916.

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TNA, CAB 129/12, Cabinet Office, Geoffrey de Freitas 29 July 1946; Location of Power Stations, Sec of State for Air, 29 July 1946.

TNA, CAB 129/15, Cabinet Office, Draft Electricity Bill, 14 December 1946.

TNA, CAB 129/18, Cabinet Office, Memorandum Power Station at Bankside, Hugh Dalton 26 March 1947; Memorandum Power Station at Bankside Sec of State for Air, 31 March 1947.

TNA, CAB 129/19, Cabinet Office, Memorandum Power Station at Bankside, Lord President, 21 May 1947.

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TNA, DSIR 8/93, Department of Scientific and Industrial Research, Removal of sulphur compounds from the flue gases of electricity generating stations, 1944-59.

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Norma Clarke, her father worked at Bankside power station from the 1950s to 1981, interviewed 11 August 2011.

Peter Guillery, undertook a survey of Bankside power station in 1995 for the Royal Commission on the Historical Monuments of England, personal correspondence June 2012.

Barry Henniker, worked in the offices at Bankside power station in the late 1980s, interviewed 13 November 2013.

Barry Kett, worked on the Bankside District heating scheme in 1973-74, interviewed 10 November 2011.

Geoff Marshall, London and Southwark local historian and worked at the CEGB research laboratory Leatherhead, personal correspondence May and June 2011.

Peter White, worked as a junior engineer on the commissioning of Bankside's 120 MW turbo-alternator set in 1962-63, personal correspondence June 2012.

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