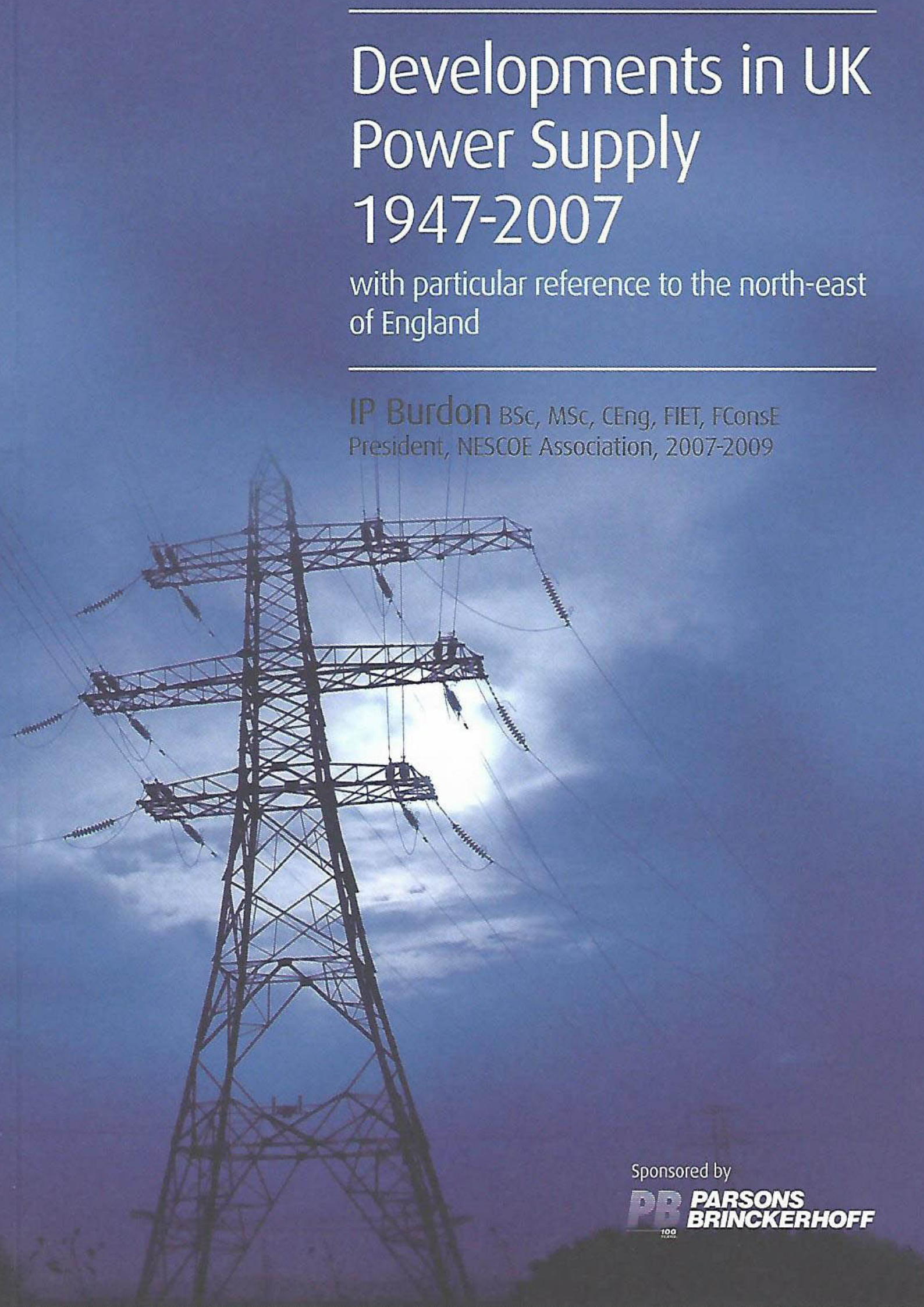
Developments in UK Power Supply 1947-2007

with particular reference to the north-east of England

IP Burdon BSc, MSc, CEng, FIET, FConsE
President, NESCOE Association, 2007-2009



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Published with corrections July 2010

Dedicated to the memory of Jim Porteus, 1926 – 2009,
a gentleman, an Engineer and a staunch supporter of the NESCOE Association.

[1] This booklet is an updated version of a paper presented at an IEE Symposium "The Birth, Development and Social Impact of Electrical Technology from 1800-2000 and Beyond" held at the University of Durham, 7- 9 July 2000 and was published in this revised and updated format to commemorate the 70th Annual Reunion of the NESCOE Association.

ABOUT THE AUTHOR

Ian Burdon

Ian was President of the NESCOE Association in 2007 and 2008. He was employed by Parsons Brinckerhoff, and its predecessor company Merz and McLellan, in Newcastle upon Tyne, from 1969 until his retirement in 2010 as a Principal Professional Associate.

He has been associated with, or has led, power projects both large and small ranging from a technical investigation relating to the widespread application of domestic CHP to a major 500 MW IGCC clean-energy power project in NE England. He spent two years overseas as resident project manager for a 1,200 MW coal-fired power station in Zimbabwe and was involved in the pre-consent activities for a new 2,000 MW CCGT power station in the UK. He led the Parsons Brinckerhoff activities in connection with a tidal barrage proposal in the Severn Estuary – the Shoots Barrage.

He has a particular interest, as a Chartered Electrical Engineer, in the concept of the 'intelligent' distribution network designed for the accommodation of small embedded generators. He led the Parsons Brinckerhoff team which produced an important report intended to inform the discussion during the 2005 UK Energy Review: 'Powering the Nation – A Review of the Costs of Generating Electricity'.

Ian is a former external lecturer on project-based management at Durham University Business School and was active nationally in the affairs of the IET, IMechE, the Association for Consultancy and Engineering, and the Environmental Services Association. He was a founding member of the Energy Leadership Council in north-east England and is a former member of the technical advisory panel of the New and Renewable Energy Centre (NaREC) at Blyth in Northumberland. He has acted as a technical advisor to many developers and financial institutions involved in energy projects.

PRESIDENTS OF THE NESCOE ASSOCIATION

1932/33	Colonel W McLellan
1934	Mr R P Sloan
1935	Mr J Wright
1936/37	Mr R P Sloane
1938	Sir Arnold Gridley
1939/45	Mr R P Sloane
1946	Sir Johnstone Wright
1947/54	Sir Arnold Gridley
1955/56	Lord Gridley of Stockport
1957	Sir John Hacking
1958	Lord Gridley of Stockport
1959/60	Lt Col E H E Woodward
1969/77	Sir Harold Mullens
1978/79	Mr J E Hayes
1980	Mr A H Kenyon
1981/82	Mr J Porteous
1983/84	Mr H G Nelson
1985/86	Mr T Rutherford
1987/88	Mr R J Weeks
1989 /90	Mr A Plumpton
1991/92	Dr M W Kennedy
1993/94	Mr W Kerss
1995/96	Mr D R Morris
1996/97	Mr A Perkins
1997/98	Mr R Dixon
1999/00	Mr S Jones
2001/04	Mr A Hadley
2005/06	Mr P Webster
2007/08	Mr I P Burdon
2009/10	Mr P McCormick
2011/12	Mr C Waller
2013/14	Mr R Nicholson
2015 /16	Dr D Roddy

ERRATA

Frontispiece: The IET is the Institution of Engineering & Technology.

Introduction: Nationalisation occurred under the Electricity Act of 1947 but Vesting Day was not until 1st April 1948.

In 1947, the organisations were being readied for transfer to a new public body.

Generation and Transmission Technology: Stella South was equipped with 5 TG sets which had the benefit of river water cooling and was of 300 MW capacity. The North station had 4 sets which employed cooling towers to avoid excessive river water temperatures and was of 240 MW capacity.

Blyth 'A' was equipped with 4 Metropolitan-Vickers 120 MW turbo-alternator sets.

Environmental Impact and Renewable energy: FT Bacon's early work before the Second World War was undertaken at CA Parsons works on Tyneside.

Craigroyston pumped storage scheme was proposed by NSHEB.

Supplementary notes:

During the period 1933/39 Dunston 'B' was equipped with 4 x 50 MW reheat Parsons turbine generator sets using small range interconnected boilers. In 1945, following the war, a study of American practise was undertaken by the company in association with Merz and McLellan. This resulted in a decision to install an additional 2 x 50 MW turbo generator sets, unitised with reheat boilers. These Babcock/Parsons units, commissioned at Dunston 'B' towards the end of 1950, were ranked as the most efficient generating plant owned by BEA during the year 1951.

Blyth 'A' with 4 x 120 MW Babcock/Met Vick reheat boiler/turbine units, headed the CEGB list of most efficient stations in 1959, 1960, 1961 and 1963. In 1962 it was reduced to second place by 0.19% and in 1964 with large units in operation it was third. Combined effects of low back pressure achievable with low sea temperature and LP turbines incorporating 'Baumann multi-exhausts' were significant design features in the achievement of high efficiency.

Blyth 'B' 275 MW units were stretched versions of the 200 MW units at High Marnham employing assisted circulation twin furnace boilers and direct hydrogen cooled rotor windings using a high speed, 8000 rpm gear driven blower. The turbines were the first in the world, rotating at 3000 rpm, to have 36" long last-row blades with top-speed velocity of about Mach 1, each blade exerting a centrifugal force of 112 tonnes at the root fastening. This led directly to future single shaft 3000 rpm turbines with power outputs of 660 MW and above.

FOREWORD

Electricity has played a major part in the development of industry in north-east England for over a century. It was even prophesied by the great Victorian engineer George Stephenson, who was reported to have remarked to a junior partner in RW Swinburne & Co in Newcastle in 1847 that "I have the credit of being the inventor of the locomotive. It is true that I have done something to improve the action of steam for that purpose, but I tell you, young man, I shall not live to see it but you may, when electricity will be the great motive power of the world".[2]

The North Eastern Electric Supply Company (NESCo) was in the vanguard of technical and organisational development for the whole of its 58-year existence up to nationalisation in 1947. The NESCo system was the largest interconnected power system in the United Kingdom. NESCo was the first company to adopt three-phase electricity for industrial power supply purposes.

This little booklet has been published to commemorate the 70th Annual Reunion of the North East Coast Electricity Companies' Old Employees' Association, better known as 'NESCOE'. It describes the major events and enormous progress made in the electrification of the United Kingdom, particularly the contribution made by the many companies and organisations in the north-east of England who manufactured much of the plant and equipment necessary to bring power to the people, and the many individuals from this part of the country who rose to the highest ranks, both technical and administrative, in the new industry. This foreword explains a little of how the NESCOE Association came into being and what the Annual Reunion is all about.

You can get a feel for how venerable are its origins if you know that it was founded at a time when the cost of the inaugural banquet in a first-class London hotel was eight shillings and sixpence. For those who have neither the facility nor the inclination to do the discount calculations back from today's cost, the date was 25 April 1932. In the chair for the evening was Lt Col William McLellan, one of the founding partners of the Newcastle consulting engineers Merz and McLellan.

The first dinner of the Association then was held in London at the Waldorf. I believe it came about because of nostalgia, essentially born out of the homesickness of a group of 30 or so former senior employees of the then North East Coast Electric Supply Companies. They had been pioneers of the industry in the region and had moved on to important positions in other parts of the country.

Some of the developments pioneered by those former colleagues include:

- The steam turbine as we know it today, invented of course by Charles Parsons. The 1,500 kW set supplied for Neptune Bank power station on Tyneside in 1901 was, at the time, the largest turbo-alternator in the world and the first large machine to generate three-phase current.
- The principles of reheat.
- The first British example of a system control room and an integrated three-phase public power supply network.
- 20 kV and 66 kV cables.
- The first examples of metal-clad switchgear.
- Balanced electrical protection gear, still used and known as the Merz-Price system, which did so much to improve the reliability and security of public electrical supply.
- A power station built and commissioned in 18 months from the date of site purchase to commercial operation of the first set – Carville, built on the banks of the River Tyne near Newcastle in 1903/4. Carville was a landmark in power station design. It was the largest public supply station in Europe at the time and the first to be powered by Parsons steam turbines, which were then ten times the average size being installed elsewhere in British power stations.

Although not directly linked to NESCo, some of the other electrical innovations that had their origins in this part of the world had even wider impact: Joseph Swan invented the incandescent electric light bulb and first demonstrated it to the Newcastle Chemical Society in 1878. At Cragside in

[2] Letter to the Editor of 'The Times', 12 April 1904.

Northumberland, Lord Armstrong, the great Newcastle inventor, shipbuilder and armaments manufacturer, installed electric lights in 1880, powering them from the world's first domestic hydro-electric generator. That and many others of his inventions can still be seen there today.

The Association was formed as a reunion. The records of the inaugural dinner show that the guest of honour was Mr RP Sloan, the then chairman of the North Eastern Electric Supply Company. It was decided that the reunion dinner would be an annual affair and it was held in London for a number of years. Why the event transferred to Newcastle is now a matter of speculation. It may have been that the unhappy exiles wanted to see the old place again instead of merely talking about it. Another possible explanation is that they saw that they could save a few bob on the price of the dinner by moving the venue. It is certainly a fact that for the first dinner up here the cost had dropped to six shillings.

Eligibility for membership of the Association was soon extended to serving members of the North Eastern Electric Supply Company, its associated companies and their consultants, principal among them being Merz and McLellan. It was also decided that the association would admit to membership by invitation, people who had made a prominent contribution to the development of electricity in the north-east. Among those who joined in this way were Sir Vincent de Ferranti and Sir Claud Gibb.

Nationalisation of the industry occurred after the Second World War and with it came the formation of the BEA, to become the CEA and latterly the CEGB, together with the Area Boards. As time went on and organisations evolved, there was a need to change the original rules that controlled membership. In order to maintain a viable association, the rules were changed to include a ten-year rule, under which people whom have been involved with electricity supply for that length of time, with connections here in the north-east, became eligible for membership. Privatisation and subsequent developments have created many new names in the electricity supply business. The association membership now extends quite widely with members not only from the electricity industry itself but also from other organisations, consultants and advisers who have held long associations with it.

The Association currently has well over 300 members and the dinner in recent years has been as large as 400 members and their guests.

The purpose of the Association remains that of facilitating an informal get-together of kindred spirits engaged in the many activities which form the electricity supply industry and that is what the dinner is really all about. The function has broadened from its origins and now represents an important business function. Many corporate organisations now support it with their attendance. It is arguably second only to the Annual Dinner of the Institution of Engineering and Technology in London as the most prestigious of the annual electrical power dinners.

I hope that you enjoy reading about the history of our industry over the past 60 years.

Ian Burdon
Newcastle upon Tyne
December 2007

PROLOGUE

The winter the lights went out

Monday, 10 February 1947, dawned bleak and forbidding; a hopeless start to a hopeless week. On the previous Friday the Government had announced that from the following Monday no electricity would be supplied to industry in London and the south-east, the Midlands and the north-west.

This was a decision to stop more than half of British industry. Consumers, other than industry, were to be denied electricity from 9-12 in the morning, and from 2-4 in the afternoon.

What had compelled this drastic decision?

The year 1946 was the first year of peace. Serving men had returned to civilian life. Britain was desperately short even of the necessities of life, which were rationed. Goods which were not rationed were often unobtainable.

With tremendous zest the nation flung itself into the task of rebuilding the economy. This meant heavy imports of food and raw materials. During the war we had stripped ourselves of our foreign exchange resources; all had to be sacrificed for survival. Exports to pay for imports were therefore paramount and Sir Stafford Cripps at the Board of Trade launched a great export drive. Many manufactures had to be denied to the home market and shipped abroad to pay for imports. Also we were deeply in debt to Commonwealth countries, which had so stoutly backed us up; they clamoured to use their 'sterling balances' to buy British machinery to rebuild their run-down economies.

But there was one underlying weakness in this revival of industrial activity: a shortage of coal. Output of deep-mined coal had fallen from 231 million tons in 1939 to 175 million in 1945. This created a great shortage. There were about 70,000 fewer miners in 1946 compared with 1939 and their average annual output had fallen from 302 to 260 tons. The coal mines – like other industries – were terribly run down. In short, the coal was not there to support an industrial boom. And coal, in those days, supplied over 90% of fuel.

Factory closures

So during 1946 the coal supply position became more and more difficult. As early as July 24, Mr Shinwell had announced that the winter would begin with stocks of 11 million tons – five million less than was necessary for safety. A scheme for converting locomotives to burn oil was announced, but this would take time to have any effect.

With the onset of winter, the position deteriorated. Shortly before Christmas, Austins had to close through lack of coal. This was followed by other closures in textiles and cement. From the middle of December, a bitter winter assailed not only Britain but Western Europe. On January 7 Mr Gaitskell, Parliamentary Secretary to Mr Shinwell, referred to his Minister's warnings and said that the country was "right up against the shortage of stocks required for the winter".

The most worrying feature of the situation was, however, not coal shortage for industry but the shortage for the public utilities – above all, electricity. This was partly due to the domestic consumer. His supplies of coal were inadequate for a harsh winter, irregular in delivery and often unsatisfactory in quality. He turned therefore to the fuels at his command: gas and electricity. Domestic consumption of the latter soared.

Many cheap and shoddy electric fires were made and sold. In their desperate search for warmth, housewives lit the ovens of their gas cookers and left the doors wide open. In such straits, the Government's appeals to cut gas and electricity consumption by 10% were ignored. In any case, they might ask, 10% of what?

The power engineers were desperate. The power stations were run down; very few had been built during the war. The inadequate generating plant could not stand up to the great increase in demand.

To protect the plant, engineers had to cut out districts (power cuts), slow down the machinery (reducing the frequency), or push the electricity along more slowly (reducing the voltage).

But shortage of generating capacity was not such a menace as the shortage of coal, which was becoming so acute that some stations might have to close down. The closure of a major power station would be a disaster. Its load would have to be transferred through the grid to other stations which could not cope with the fresh burden and would in turn close down. One or two closures might therefore lead to a national breakdown, which would stop the essential services on which health and even life depended.

Drastic measures

So on January 13, Sir Stafford Cripps announced that absolute priority in the supply of coal would be given to power stations and that the coal would be found by halving the quota for industry. But before this plan could start it was knocked on the head by the most terrible winter for 50 years.

From mid-December to mid-March Britain experienced severe weather to an unprecedented degree. There were long spells when the thermometer refused to rise above freezing point. For the greater part of February London had continuous frost and did not see the sun. But perhaps the most damaging weather was a series of blizzards – in particular that of February 4 – which precipitated the crisis.

On the morning of February 5, it was clear that drastic emergency measures were unavoidable. The London power stations depended on seaborne coal from the north-east coast, but all ships up there were stormbound and could not move. Empty ships in the Thames could not leave. All over the country – especially in the north – road and rail transport was delayed, if not blocked. Many pits could not function.

So, on Friday afternoon, February 7, Mr Shinwell announced the Government's decision to deny electricity to industry across a broad stretch from Lancashire to the south-east. These areas received imports from the coalfields. Lancashire, for instance, depended on rail-borne coal through the Woodhead tunnel, which was blocked.

Unemployment

Consumers in these areas, other than industrial, were to go without electricity for three hours in the morning and two hours in the afternoon; this cut was later extended to the whole country.

The industrial cuts could be enforced – after all, many people would know if a factory started using electricity. But domestic consumers could not be policed, and though some cases were reported no prosecution took place. There is little doubt however that, on the whole, consumers behaved responsibly.

The industrial cuts soon produced about two million unemployed, and by the third week the number had risen to 2.4 million. In the Midlands, electricity was restored to industry after a fortnight, Lancashire and the south-east had to wait another week. By Monday, March 3, industrial supplies were everywhere restored.

Gas had not been subjected to the same official restrictions as electricity. But the gas engineer protected his inadequate supplies by reducing pressure so much that gas consumers were exasperated. The wise cooked breakfast at 6 o'clock in the morning, when there would be a reasonable pressure.

The domestic consumer was not, however, freed from his restrictions through March and April and, on May 1, an order was issued banning all forms of heating by gas and electricity throughout the summer. Mr Gaitskell explained that the order "was not fully enforceable and depended on voluntary co-operation."

There was a great outcry against this sweeping order and on May 6 a general licence was issued allowing gas and electricity to be used for children under three and old people over 70; also for drying out flooded homes. A Lancashire major described the order as out of touch with reality. Fortunately, the summer of 1947 proved so warm that the order soon lost all meaning.

On March 5 the Prime Minister announced that the total saving of coal during the restrictions amounted to 550,000 tons. This was much less than one day's output from the mines. For this pitifully small amount of coal, the country endured great misery and unemployment and lost £200 million of exports, which was the estimate given on May 4 by Sir Stafford Cripps.

A major risk

If the "absolute priority for power stations" which he announced on January 13 had been decided on two or three months earlier, the disaster might have been avoided. No one, it is true, could foresee the appalling weather which gripped the country for three months; but even with a normal winter, the inadequate stocks of coal at the power stations at the start of the winter constituted a major risk.

The fuel crisis penetrated all spheres of life. The BBC strangled the infant television programme – there were only 20,000 viewers. Of course, the Third Programme was sacrificed. Periodicals ceased publication. Dog racing was closed down. Many shops in Oxford Street decided not to open. Others kept going by candlelight and found to their surprise that trade boomed: there was novelty in shopping by candlelight.

Children suffered. The sweet ration was cut from four to two ounces a week. The potteries, closed by lack of electricity, could not produce jam pots and the weekly ration of jam was imperilled. But, of course, the greatest suffering arose from the difficulty of keeping warm, and shivering guests at Guildhall huddled together in overcoats.

The permanent effects of the fuel crisis were serious. It was seen as a collapse of electricity supplies, preceded by and followed by numerous power cuts, and so on. The result was national determination to have ample electricity – regardless of cost.

So investment in electricity became more and more massive throughout the 1950s and 1960s. Fuel for electricity generation became super abundant. But plant to cope with the peak loads of a severe winter – such as 1962-63 – was often touch and go. Such peak loads were largely due to domestic space heating by electricity. Whether massive investment to provide plant for such peak loads is nationally desirable is a question not yet answered[3].

[3] Taken from an article in 'The Daily Telegraph' of 10 February 1967 written by Reuben Kelf–Cohen, Under-Secretary at the Ministry of Fuel and Power from 1942 to 1955, who was responsible for much of the legislation which nationalised the coal, electricity and gas industries in 1946,1947 and 1949.

INTRODUCTION

It is a near-impossible job to even scratch the surface of this topic in the few dozen or so pages of this small booklet. Leslie Hannah, in his masterly account of the first 15 years of the industry after nationalisation, required more than 300 pages of text to cover the developments. A thousand pages would still not do justice to the subject.

This short account of the last 60 years of the UK electricity supply industry deals with the topic under five broad headings:

- The political, policy and organisational issues, including nationalisation in 1947 and privatisation in 1989.
- Planning in the industry, including fuel supply.
- The technical issues, particularly generation and transmission technology.
- Nuclear power which, given its tortuous history in the UK, deserves a section in its own right.
- Last, but not least (indeed, some would argue, the most important), the environmental impact of the industry and the moves towards the exploitation of renewable energy resources.

Whilst particular reference is made to significant events in NE England during the period, the principal national events and milestones in the development of an industry which many would argue only came into being as an integrated utility in 1947, are described.

The beginning

In 1947 where this chronicle starts, some 200 private companies and 369 local authority undertakings, together with the Central Electricity Board (CEB) and the 300 or so power stations owned and operated by these organisations, were transferred to a new public body, the British Electricity Authority (BEA).

The weather at the end of January 1947 conspired to ensure that the electricity supply industry (ESI) got off to a bad start. With temperatures well below freezing and snow covering most of the country, England was firmly gripped in its coldest period for many years. A record cut of 25% in electricity supplies was made on 29 January and the CEB announced that supplies might be cut still further from 7 am to 7 pm unless consumption was voluntarily reduced.

This, then, was the setting in which this story begins with weather conditions more extreme than had ever been seen before and a new Government with plans to take a major section of the British economy into public ownership.

1. POLITICAL, POLICY AND ORGANISATION

For 42 of the past 60 years, the UK ESI has been controlled by the State.

In the period under review it could be argued that a wheel has turned full circle in the industry. On 13 August 1947, the Electricity Bill to nationalise the supply industry received Royal Assent. On 27 July 1989, Royal Assent was given to return the industry into private hands.

The centralised organisation which took over at vesting day on 1 April 1948 inherited assets of £831 million and planned new investment of £650 million. It would be the largest electric utility unified under common ownership in the western world, whether measured by assets, employment or number of customers. The combined stock market values of Imperial Tobacco and ICI at the time, for example, were not much more than one-half that of the ESI.

To help the reader appreciate the true value of the cost figures quoted in this treatise, I have given, in Figure 1 in the Appendix, the relative value of the £ sterling over the period 1947-2006.

The electricity industry plays a central role in the UK economy and, in 2006, the industry contributed about 1.7% of Gross Domestic Product (GDP). The industry re-invests around two-thirds of the total profit back into the business to ensure high quality service to customers. In 2006, investment by the industry of around £4.4 billion represented about 18% of all industrial investment in the UK. Between 2005 and 2010, £5.7 billion of investment is expected to be made in the distribution networks to replace ageing assets. Another £4.3 billion is to be spent on replacing and adding to the transmission infrastructure between 2007 and 2012[4].

To return to the beginning of the period under review: the major shift in apparent ownership implied by the word 'nationalisation' and the associated rhetoric included in Clause 4 of the Labour Party's manifesto was not, however, all that it seemed.

The movement to public ownership in the industry had, by 1947, already gone a long way and had been as much the work of the Conservatives as of Labour. Many municipalities, particularly in the large provincial cities, had entered the business of distributing electricity and these local authorities soon accounted for two-thirds of electricity sales. The remaining one-third of sales - mainly in London and in the less prosperous rural districts and market towns – were in the hands of private sector companies. Most of their franchises were, however, due to expire and only the War had prevented those local authorities who wished to do so from exercising their purchase rights. Private enterprise had a future only in power generation and bulk supply, where companies typically had large franchises, and had raised their share of British electricity production to one-half, the rest being generated by the municipalities themselves. Even in bulk supply, the CEB, a public corporation established by the Conservative Government in 1927, had controlled the operation of power stations since the completion of the initial National Grid transmission network in 1933. Thus, whilst rather more than a third of the capital in the industry was still under private control in 1945, public ownership already dominated and there was a wide degree of public supervision.

Political intervention in the industry after nationalisation in 1947 soon began with the introduction of the 'Control of Turbo-Alternators (No 1) Order' issued by the Ministry of Supply on 7 November 1947, which standardised the production of steam turbo-alternators of over 10 MW capacity to two set sizes with prescribed steam conditions: 30 MW operating at 600 psi and 850°F, perpetuating a design of some 18 years earlier, and 60 MW operating at 900 psi and 900°F. The object of this order was to try and improve the delivery position on such plant. It managed to cut about 6-9 months off the manufacturing period by allowing economies of standardisation to be applied to the production process. This control was to remain in force until 1 August 1950 when the manufacturers persuaded the Government to withdraw the restrictions and allow the first of the 100 MW sets to be ordered.

Interestingly, some 30 years later, the then Prime Minister, James Callaghan, asked the Central Policy Review Staff (CPRS) to study some alternative turbo-alternator designs for the future nuclear AGR

[4] Electricity Industry Review 11. Electrica Services Ltd, June 2007.

stations. The alternatives were the NEI Parsons six-flow machine and the GEC four-flow exhaust designs. CPRS was, however, unable to decide on this technical issue and Torness was ordered with the GEC design and Heysham II with Parsons machines.

The first few years of the nationalised industry saw construction of power stations on a vast scale. Halcyon days indeed for the plant manufacturers when one considers that the construction programme envisaged two boilers and a turbo-alternator set being commissioned, on average, every 12 days in the first few years of the post-war construction programme. There was, however, substantial under-achievement of planned new generation rising to a 42% shortfall in 1952. Some 17% of the winter peak load had to be shed in 1951. At that time, because of shortages of coal, domestic space heating constituted about one third of the peak load on the system. This topic is referred to again in Section 4.

The delays in completing new power stations were progressively reduced in the 1950s but they were still taking more than five years on average. In the mid-1950s only a few of the simpler, standard, power stations were beginning commissioning 3 to 3.5 years after the start of work on site. BEA, interestingly, failed to get its average performance near that of the United Kingdom Atomic Energy Authority (UKAEA) in developing its smaller, but more challenging, demonstration nuclear plants. For example, Calder Hall was built in a little more than three years. The UKAEA engineer responsible for Calder Hall, Christopher (later Lord) Hinton condemned most BEA project teams as being “beaten before they started”. The fastest power station construction time ever achieved by the nationalised industry was at Rogerstone in South Wales, where the first 60 MW set was commissioned in September 1957 after three years’ work on site, about the same period of time it currently takes to complete a gas-fired CCGT station.

The problems encountered on those large power station construction projects were variously blamed by the Beaver Committee, who reported in 1953, on restrictive practices by site labour, inadequate resources at the design stage, insufficient materials priorities for the industry and ineffective project management combined with over-centralisation of detail. These delays were to remain a seemingly insoluble problem, not only in the ESI, but also in a wide range of other industries embarking on large capital projects for decades thereafter. Despite this, however, BEA was, in the first ten years of nationalisation, to double the capacity of grid-connected power stations.

In 1954, the two Area Boards in south-east and south-west Scotland were merged to form the South of Scotland Electricity Board (SSEB) and the BEA was renamed the Central Electricity Authority (CEA) but only until 1957 when it was renamed the Central Electricity Generating Board (CEGB).

The organisation of the industry remained remarkably free from political intervention on organisational matters for the next ten years. Indeed, in 1963, the Select Committee on Nationalised Industries looked at the way the ESI was organised and operated and reported that “the industry’s structure appeared sound, and, if it was open to criticism, this should be confined to its performance”. Five years later, however, the same Select Committee recommended a single ‘Ministry of Nationalised Industries’ with greater managerial freedom being given to the boards of those industries. This was rejected the following year by the Labour Government.

In 1968 also, although at that time we were not members of the European Community, the ‘First Guidelines for a Community Energy Policy’ were presented by the European Commissioners to the Council of Ministers. In order to reduce its dependence on oil, the Commission wanted more use of natural gas, solid fuel and nuclear power, increasing the share of each by one third. In this way, reliance on oil would be cut from 60% to 50% of total energy requirements by 1985. We shall return to Community energy policy a little later.

In 1969, proposals for the reorganisation of the ESI in England and Wales were put before the House by the Minister of Power. The Electricity Council, which had been set up along with the CEGB in 1957, was to be renamed the Electricity Authority, and it would have new powers to plan and control the policy of the industry as a whole. These proposals led to the publication of an Electricity Bill on 9 March 1970. This Bill reached a second reading but lapsed when Parliament was dissolved in May 1970.

In 1970 also, the Electricity Council set up an Overseas Consultancy Service, much to the dismay of the long-established and successful UK private engineering consultancy practices. This was strengthened still further in 1975 by the establishment of British Electricity International (BEI) as a trading subsidiary of the Electricity Council.

In 1971, the CEGB was divided up into five regions and empires began to be built with the establishment the Generation Development and Construction Division, and the Transmission Development and Construction Division. A high degree of delegated authority was given to the regions.

Energy policy has, perhaps, been a legitimate political football ever since the Haldane Committee on Reconstruction reported in 1918, the recommendations of which, ultimately, led to the establishment of an electricity 'grid' system first proposed by Charles Merz.

In 1974, an Advisory Council on Energy Conservation was established, chaired by Sir William Hawthorne. The Council was to advise and assist the Secretary of State for Energy in carrying out his duty of promoting economy and efficiency in the use of energy. It reported a year later that energy prices should reflect the full cost of production and that combined heat and power should be positively encouraged. The contents of the report were largely rejected by Government in a White Paper the following year.

The first National Energy Conference was held in June 1976 "to encourage and stimulate discussion amongst a wide range of interests and to draw on their advice in preparing a national energy policy". Four weeks later, the Secretary of State announced that the forum had indicated a need for a more permanent body to consider energy policy. An Energy Commission was duly formed in 1977 to advise the Secretary of State. Membership was drawn from the energy sector, TUC, industry and consumer interests. A Green Paper entitled 'Energy Policy: A Consultative Document' was published the following year to outline Government's energy strategy proposals. The Energy Commission did not survive very long however: it was dissolved after the election in 1979, the new Secretary of State for Energy saying that there were better forms of consultation for energy policy. Many of us here, no doubt, some 21 years later, are still awaiting an announcement on those better forms.

Organisational stability remained for another five years until January 1976, when a Committee of Enquiry chaired by Lord Plowden recommended that there should be a single statutory body, the Central Electricity Board (echoes of 1926!). This was proposed to take over the responsibilities of the CEGB, the Area Boards and the Electricity Council. In July 1977 the Secretary of State for Energy announced that a Bill would be introduced to create a new central body for the ESI in England and Wales with overall responsibility for financial, commercial, engineering, research and industrial relations policies, the promotion of industrial democracy and the 'safeguarding of consumers interests'. These proposals led to the publication of a White Paper in 1978 and affirmation from the Select Committee on Nationalised Industries that there was general desire for legislation to reorganise the ESI to which successive Governments had failed to give sufficient priority. By July 1980, however, governments and minds had changed and the Secretary of State for Energy announced that there would be no new legislation to change the organisation. In December, Sir Francis Tombs, chairman of the Electricity Council, resigned in protest.

The following year, the Monopolies and Mergers Commission, in a major report, found that the CEGB's operations were efficient but that its purchasing policy was affected by Government policy and that its investment appraisal operated against the public interest.

The new Conservative Government under Margaret Thatcher wasted no time in devoting its intellectual efforts to change the way the ESI should operate and, in March 1982, Patrick Jenkin, the Secretary of State for Industry, announced that strategic objectives were to be agreed with each nationalised industry in order to provide a clear framework for its operations.

The changes would "ensure that the industries, which are not subject to the financial disciplines of the private sector, and, in many cases are not exposed to market forces, nevertheless operate as efficiently as possible". At that time (1982-83), investment in the ESI was £1,845 million, second only

in the public sector to British Telecom who, at £2,380 million, were spending twice what they had three years earlier.

In an interview in the 'The Financial Times' on 10 April 1982, Nigel Lawson, the Energy Secretary, hinted at the possible privatisation of oil, gas and electricity. 11 weeks later he went further, and said that "he did not see Government's task as being to try to plan the future shape of energy production and consumption" but to "set a framework which will ensure that the market operates in the energy sector with a minimum of distortion". He went on to say that "the key to improving the efficiency of the energy industries lies in increasing the responsiveness of these industries to the forces of the market place".

In February 1983, the DTI published 'The Regulation of British Telecommunications' Profitability' by Professor Stephen Littlechild. This introduced the concept of the RPI-X price control formula which would later be implemented in electricity also.

In March 1983, the Secretaries of State for Energy and Scotland announced new objectives for the CEGB and the Scottish Boards. The Chairmen were required to increase the scope for competition, review prospects for injection of private risk capital and develop cogeneration with private generators. The CEGB was charged with exploiting the full potential of nuclear power and Area Boards were to be encouraged to adopt and support schemes for combined production of heat and power.

The 1983 Energy Act received Royal Assent on 9 May. This gave powers to independent generators to require the Area Boards to purchase electricity generated by them and gave them the right of access to the transmission and distribution networks to supply electricity direct to customers.

In July 1983, Lloyds Bank Review published 'Privatisation: principles, problems and priorities' by Professor Michael Beesley and Professor Littlechild in which the authors called for the privatisation of the coal, rail, post and electricity industries. Gerald Howarth in the Commons tabled an early day motion congratulating the professors on their work.

In 1983, two giants of the post-war electricity industry died: Lord Citrine at the age of 95 who was the industry's chairman for its first ten years, and Lord Hinton who, as Christopher Hinton, began the most heroic phase of his career at the age of 45 when, in 1946, he was charged with producing the fissile material needed for nuclear weapons and thus was to direct the development of nuclear energy in Britain. In the words of his biographer he "bestrode his profession like a colossus". He went on to become the first chairman of the CEGB in 1957. Citrine's reputation as an autocratic and firm chairman is recounted by Leslie Hannah in his book on the post-war industry in connection with the battle within the BEA in 1950 between the administrators and the engineers over the locus of control over contractors who, at that time, were generally thought to be exploiting a seller's market. The deputy chairman, Sir Henry Self, wanted to establish a Contracts Department as a step towards firmer financial control over the engineers. This was strongly opposed by the engineers but Citrine backed the idea at a meeting of the BEA in March 1950. The meeting was one of the most acrimonious anyone on the Authority had experienced with Citrine eventually firmly overruling the engineers, saying:

"Gentlemen, we are here to decide whether to establish a Contracts Department.
I have decided there will be one. Now we must go to lunch."

On 5 March 1984, coal miners went on strike for a year and political attitudes towards the coal and the electricity supply industry were galvanised. The effect of the strike, apart from the acceleration of pit closures with enormous job losses, was an increased determination by Government to privatise both coal and electricity.

A conference on the future of the ESI was held at the Polytechnic of the South Bank in June 1985 at which papers discussed, amongst other things, privatisation (or decentralisation as it was called) and economic pricing.

The following month, in July 1985, John Moore, Financial Secretary to the Treasury, reinforced the Government's commitment to return state-controlled industries to the private sector and extend the 'benefits' of privatisation to natural monopolies.

A year later however, in July 1986, Alistair Goodlad, Parliamentary Under-Secretary of State for Energy, stated that the Government had "no present plans" to privatise the ESI and could not give an undertaking that it would be a manifesto commitment for the next general election.

He reaffirmed this in February 1987 in response to a Parliamentary Question. Some seven weeks later, Peter Walker, Secretary of State for Energy, stated that the Government "had no plans to privatise the ESI and could not comment on any details of such a scheme should it take place in the future."

Political minds appear to have changed quickly however and events unfolded fast in the following five months, including a general election on 11 June 1987, although no mention was made of electricity privatisation in the Queen's Speech on 25 June 1987. On 13 July, however, Cecil Parkinson, the new Secretary of State for Energy, made a statement to the effect that the Government was "working to secure a very successful future for the electricity industry in the private sector". By the end of July 1987, Kleinwort Benson, the merchant bank, had been appointed to advise the Government on the structure of the electricity industry sale and on 10 August 1987, Merz and McLellan was appointed as technical adviser.

The White Paper 'Privatising Electricity' was published in February 1988. The Electricity Bill received its first reading on 30 November and the Royal Assent on 27 July 1989.

Stephen Littlechild was appointed as Regulator on 1 September and four weeks later, because of the nuclear debacle which resulted in the nuclear stations being withdrawn from sale on 9 November, vesting day was postponed from 1 January 1990 to 31 March 1990.

Lord Marshall resigned as chairman-designate of National Power on 18 December 1989 as a result of the withdrawal of nuclear power from the privatisation programme.

On 11 December 1990, the RECs were floated and the industry entered a period of temporary stability which ended when the Government's 'golden share' lapsed on 31 March 1995. Over the following two years, bids were made and takeovers completed for 11 of the 12 regional companies. Only Southern Electricity remained unaffected by the takeover fever which saw seven of the companies acquired by North American power companies, Norweb and Swalec acquired by UK water companies and Manweb and Eastern acquired by Scottish Power and Hanson respectively. Many further ownership changes have, of course, occurred since then.

The legislators have not been content to sit on their hands, however, and in 1999 the regulatory offices of the electricity and gas industries merged to form Ofgem, followed soon after by a new Utilities Act on the statute book which included far-reaching changes in the way electricity is traded, additional obligations on electricity suppliers with regard to renewable electricity and the separation of the distribution and supply businesses of the regional companies.

2. PLANNING AND FUEL SUPPLY

Sales of electricity in 1948 were almost double those of ten years earlier but the installed capacity of power stations had been increased by less than one-half. Some comparative statistics for system capacity, units sold and customer numbers are shown on Figure 2 in the Appendix. By the later 1940s, domestic sales were approaching nearly three times the pre-war level. The British public, after years of sacrifice, were less and less inclined to tolerate prolonged austerity. Electricity was a major loophole in the post-war rationing system. Coal was rationed to conserve supplies for industry. The public had the option, though, to switch on electric fires. These were cheap to buy and easy to install. By 1948 the average domestic consumer was paying only half as much for his electricity than a decade earlier in real terms. A committee was established in 1948 to examine the problem under Sir Andrew Clow who recommended seasonal tariffs. The Area Boards duly introduced a surcharge on the domestic price during the 1948-49 winter three months and a rebate in the ensuing nine months. It had no appreciable effect on peak demands and was not repeated.

In 1952, Eastern Electricity Board introduced day and night tariffs which followed its development, some two years earlier, of a prototype storage radiator.

Viscount Ridley chaired a committee which had been charged with recommending a national policy on the use of fuel and power resources. In 1952 it urged greater efficiency in the use of fuel, research into total gasification of coal and a move away from the use of coal on the railways. It expected the National Coal Board (NCB) to be able to expand coal production in the medium term to meet an increasing demand for coal at prices which would remain competitive with oil.

Two years later, in 1954, as part of the Government's fuel policy to meet a likely coal shortage, plans were put in hand to burn oil at 17 power stations. Marchwood at Southampton with 8 x 60 MW sets was commissioned in 1955. Other stations included in the programme included Fawley, Pembroke and Kingsnorth. From about 1965 relative fuel prices provided a case for an increased oil burn but, until 1970, conversions to oil were largely prevented by the Government's support for the coal industry. After 1973 oil became more expensive than coal.

In 1954 also, the report of the Scottish Peat Committee was published. Under the chairmanship of Sir Edward Appleton, they recommended that a survey of peat deposits and their commercial exploitation be made. They recommended, also, that the North of Scotland Hydro-Electric Board (NSHEB) should bring into operation two peat-fuelled gas turbine generator sets. This followed an experiment at John Brown's works on Clydeside with a 500 kW set running on pulverised peat.

A co-ordinated national fuel policy was still being sought more than ten years later when, in October 1965, the fuel policy White Paper was published. It still recommended that "the electricity supply industry should continue to give preferential treatment to coal over other fuels". The shape of things to come, however, was there for all to see when, only a few weeks later, the first find of North Sea gas was made by BP in the West Sole field about 40 miles off the Humber. Supplies came ashore at the Easington terminal in 1967.

That same year saw a 65 MW unit at Hams Hall 'C' converted (as an experiment) to dual coal/natural gas firing. Conversion of all six 65 MW units was completed in 1971.

In 1965 also, a new bulk supply tariff was introduced by the CEGB with rates based on the running costs of power stations at the margin, rather than on average costs. Two capacity charges were introduced also: one related to basic system capacity costs, the other to the cost of plant used during peak periods only.

On 18 July 1967, the Minister of Power announced that the supply industry had been asked to increase its coal burn by up to 6m tonnes per annum. A White Paper on fuel policy was published the same year which addressed the new sources of primary fuel, particularly gas and nuclear. Government accepted, as in the national interest, the rapid introduction of nuclear power and North Sea gas and that support should be given to the coal industry to leaven the social consequences of the inevitable contraction of that industry.

By 1972, the words had changed somewhat and, in December, the Secretary of State for Industry announced a programme of financial support for the coal industry aimed at preserving a viable industry in a situation of possible world energy shortage and uncertainty about future world fuel prices. The following year saw the introduction of the Coal Industry Act under which payments (or subsidies) were given to NCB rather than the generators.

Cynics will no doubt recall that, earlier in 1972, we had had the miners working to rule and power cuts imposed because of restrictions on coal supplies to the power stations.

On 17 October 1973 the oil supply crisis began and an NUM overtime ban followed soon after on 12 November. A State of Emergency was declared on 13 November. Voltage reductions were in force but load disconnections were required on only two occasions. A Labour government was formed on 4 March and life was more or less back to normal by 24 March 1974.

A 'Plan for Coal' was published in 1974 by NCB which envisaged a demand of 150 m tonnes pa by 1985 and proposed capital investment of £6,000 million to provide 42 m tonnes of new capacity to replace depletion.

Three years later, 'Coal for the Future' was published by Department of Energy on behalf of the tripartite coal industry working group, ie Government, NCB and the unions. It proposed strategic plans to expand coal production to 170m tonnes pa by 2000.

We burned less than a quarter of that in the power stations ie 47 m tonnes of coal in 1998. More financial support was to be given to the NCB to meet part of the cost of increased consumption of low-volatile Welsh coal at Aberthaw 'B' and Carmarthen Bay stations up to 1978. Similar support was given to the coal industry the following year for coal to other South Wales power stations.

Later in 1978 still further support was announced to increase CEGB winter coal consumption by 3m tonnes. The payment to NCB allowed the CEGB to be offered lower prices. In the following year (1979) operational grants to NCB were increased from £100 million to £175 million for promoting the sale of coal to power stations and financing stocks.

Following industrial action by the NUM in 1981 against proposals for pit closures, Government convened the Coal Industry Tripartite Group which withdrew the list of closures and agreed to reduce imports of coal to a minimum. The resulting increase in subsidies would amount to an extra £300 million in the grant and £231 million on external finance limits for 1982-1983.

By 1983, the CEGB and NCB had agreed that a minimum of 70 m tonnes per annum would be taken in the period November 1983 to October 1987.

In March 1984 the miners' strike began.

A report by the Select Committee on the European Communities that same year concluded that, although EEC coal demand was likely to appreciate considerably by 2000, probably almost all the increase would be met from outside the Community. EEC coal industries had to surmount the difficulty of continued production at manifestly uneconomic pits. Government could best help Community needs by modernising plant, closing uneconomic pits, introducing new economic capacity and achieving profitability.

The miners conceded defeat in March 1985 and the Government had its way with an accelerated programme of pit closures. In December 1985, oil prices fell as OPEC countries endeavoured to increase free market share. Within a few months, the price of oil had fallen from $25 a barrel to below $10. At a price of about $17, oil-fired generation was cheaper than using British coal.

Privatisation of both the coal and electricity industries, as we have seen, was firmly in the mind of Government by then and the release of the control on the use of gas for electricity generation was to follow in 1991.

Within ten years, the capacity of coal-fired generation on the UK system had fallen from a 1985 level of 53,000 MW to 41,000 MW. Gas-fired generation filled the gap by increasing from almost nothing to more than 12,000 MW.

In spite of the ESI having passed into private ownership in 1990, fierce lobbying from sectoral interests in the industry resulted in further Government intervention. In March 1992, reports were appearing in the press that the 'dash for gas' was likely to have serious consequences for the British coal industry.

In October of that year, British Coal announced that it was to cease production at 31 of its deep mine collieries because of a reduced demand for coal. Political intervention resulted in a Command Paper, 'The Prospects for Coal', which published the results of Government consultations on the British Coal proposals. One of the recommendations was that an Energy Panel should be set up to advise the DTI on energy policy. Twelve of the pits previous scheduled for closure were to remain open.

Intervention continued and, in late 1997, Merz and McLellan was commissioned by DTI to advise the Secretary of State and prepare a report on the security and stability of the England and Wales system arising from the anticipated high levels of gas-fired generation (60% in 2010 and 90% in 2020). When the report had been completed, Government announced a short-term restriction on consents for further gas-fired power stations which was not eased until the end of 2000.

3. GENERATION AND TRANSMISSION TECHNOLOGY

In the 1950s, the BEA and its successor, the CEA, were oblivious to market forces as we know them today. New investment in plant and equipment, irrespective of any rate of return required, was determined by non-too-accurate predictions of demand. No allowance was made for the effect of electricity price increases. The Authority felt that prices and interest rates should be kept down to further their objectives of cheap electricity. In pursuit of this goal, the industry borrowed hugely throughout the 1950s, rather than financing expansion through higher earnings. This gave rise to allegations that electricity was crowding out more desirable investment projects with potentially higher rates of return. The argument then, which has arisen over and over again, was why should present-day consumers bear an unfair proportion of the costs of supplying electricity in the future?

The industry in the first decade of nationalisation did succeed in bringing electricity to the population at large: at vesting day in 1947, one-quarter of domestic premises were without a connection to the system. Within ten years, this proportion had fallen to one-tenth.

Technically, however, the achievements of the BEA and the CEA were not so great: they fell short of almost every target date for new power station completion and, in 1953, the Beaver Committee blamed ineffective project management – a criticism which was to be made continuously for more than 30 years further.

Generation

The generation engineers were very slow to accept innovation, preferring to tread a more cautious path. Nevertheless, the cost per kW of new stations fell by one-third during the first decade in the period under review.

Reheat, which was pioneered by Charles Merz at North Tees in 1918, and later at Dunston, was not generally adopted by the CEA until after 1952, the first reheat sets being ordered for Blyth in March of that year. The use of unit boilers, which was again introduced on the NESCo system by Merz many decades earlier, was not incorporated in BEA designs until the mid-1950s.

There is no doubt that, in hindsight, conservatism by a national monopoly, both in transmission and generation, seriously damaged the ability of UK plant builders to compete with overseas manufacturers in later decades in the provision of technologically advanced products to international markets. They certainly suffered substantial damage from the confusion over nuclear policy.

The technical part of this chronicle begins in 1947 with the commissioning of the first post-nationalisation power station, Meaford ‘A’, engineered by Merz and McLellan, near Stone in Staffordshire with 4 x 30 MW sets.

A year later, the NSHEB commissioned its first new stations, 600 kW at Morar and 1,000 kW at Lochalsh. The Loch Sloy and the Tummel-Garry schemes were to come into operation two years later in 1950. Merz and McLellan in Newcastle upon Tyne played a significant part in the design of 23 such stations between 1946 and 1959.

In 1949, the first hydrogen-cooled alternator, a 60 MW set at Littlebrook ‘B’, was commissioned. This technical development lowered capital costs and eased transportation from the manufacturer’s works.

The first of the new generation of power stations using standard 60 MW sets in the Trent Valley, where there were ample coal reserves in the East Midlands coalfield and good supplies of cooling water, was commissioned at Staythorpe, near Newark, in 1950. The introduction of the 275 kV grid would allow many more stations to be built in that area and transmit ‘coal by wire’ to the major load centres in south-east England.

An important example of combined heat and power in the UK was commissioned in 1951 with the inauguration of the Pimlico district heating scheme, using hot water supplied from the Battersea power station across the River Thames.

1951 also saw construction commence on two new coal-fired power stations to the west of Newcastle – Stella South and Stella North – which faced each other on opposite sides of the Tyne. Each of 480 MW capacity, they began to generate at the end of 1954 and were demolished in the late 1980s.
1952 saw the commissioning of the first 60 MW set at Bankside 'B' station (now 'Tate Modern'), the first large public supply station in the UK to be specially designed for oil firing. Bankside, and Battersea before it, were the only stations in Britain to have full-scale flue gas desulphurisation plant.

Sir Hugh Beaver reported in 1953 that new power stations should have units of at least 400 MW capacity with greater simplification and standardisation in the finish and design of plant.

Steam conditions began to advance the following year with the 60 MW sets at Stourport 'B' having 1,500 psi and 1,050°F at the stop valve.

1956 saw the commissioning of the first 100 MW set at Castle Donington, the first to break way from the standard 30 MW and 60 MW set sizes. A water-cooled 30 MW alternator was commissioned at Bold 'A' power station that same year.

Two years later saw the commissioning of the first reheat 120 MW units in the UK at Blyth 'A' on 23 December 1958, beating Kincardine by five days. Steam conditions were 1,500 psi and 1,000°F with reheat to 1,000°F. Forty-four of these standard units were to be installed in 14 stations. Blyth 'A' later went on to break records when, in 1989, the station earned a place in the Guinness Book of Records on the attainment of 200,000 running hours for one of its Parsons 120 MW turbo-alternator units.
In 1959, the first 200 MW set was commissioned at High Marnham on the Trent. It had the most advanced steam conditions yet at 2,350 psi and 1,050°F with reheat to 1,000°F. The station was Europe's first 1,000 MW station and the first to employ merry-go-round coal unloading.
Little Barford 'B' station was commissioned that year and was another 'first of its type' with comprehensive installation of an automatic electronic boiler control system using computers.

Towards the end of that year, the CEGB began work on magneto-hydrodynamic generation. North-east firms played an important part in the R&D activities of this technology but work was abandoned by the CEGB in the late 1960s as uneconomic.

Another first on the C&I side arose in 1960 when the first 120 MW unit at Northfleet was provided with continuous data logging of plant conditions.

Supercritical technology was introduced to the UK that year also with a 240,000 lb/h boiler at the Margam 'B' power station of the Steel Company of Wales. Steam conditions at the stop valve were 3,000 psi and 1,050°F. The technology was introduced on the public supply system in 1967 when a Babcock and Wilcox 2,500,000 lb/h boiler steamed an English Electric 375 MW set at 3,500 psi and 1,100°F/1,000°F reheat at Drakelow 'C' power station. The first UK dry cooling tower was put into service the following year at Rugeley 'A'.

At the end of 1962, the first 275 MW unit was commissioned at Blyth 'B'. Steam conditions were 2,300 psi and 1,050°F with reheat to 1,050°F. These sets were the only ones of their type ever installed on the system. Two further sets, Units 7 and 8, were rated at 350 MW and, again, were prototype designs. The station was closed in 2001 and subsequently demolished. At the time of writing, RWE have plans to build a 2,400 MW coal-fired power station on the site of the former coal store to the north of the old 'A' and 'B' station sites. This would have supercritical boiler technology, and be capable of post-combustion CO_2 capture, should such technology be proven to be economic.

Europe's largest units at the time were commissioned at Thorpe Marsh in December 1963. Two 550 MW cross-compound sets were steamed from a single 3,750,000 lb/h boiler.

In 1964, the world's first application of computer control to the raising of boiler pressure, turbine run-up to full load and subsequent loading of the generator was introduced on a 200 MW coal-fired set at West Thurrock.

1966 saw the introduction of the first of the 500 MW sets at Ferrybridge 'C'. Plant programmes at the time included for 49 of these standard units to be installed in 14 new stations.

The world's first 2,000 MW steam stations were completed in 1968 at Ferrybridge 'C' and West Burton but delayed completions in the industry were endemic. The Wilson Committee reported in 1969 that the "effectiveness of management and the productivity of labour on some sites remained distressingly low". Strong remedial actions had been taken, however, and new methods introduced which were intended to avoid, in the future, the causes of delay over the previous ten years.

The oil-fired station at Fawley came into service that year also with the most advanced control system on the sets in the world at the time. Each of the four 500 MW units had computer controls capable of loading the set from hot conditions to a selected target without intervention of the operator, taking corrective action if a fault occurred and shutting down if necessary. Temperature, pressure, flow and operator actions taken were displayed on a VDU.

1970 saw Europe's largest coal station begin operation at Longannet in Scotland. Designed by Merz and McLellan, its 4 x 600 MW sets were the largest on the British system.

Within four years, the record for size had been broken again with the commissioning of the first 660 MW Parsons set at Drax. Originally intended to have supercritical steam conditions, it was decided to revert to the same conditions that applied to the 500 MW sets, namely 158.58 bar and 565°C/565°C reheat.

Five years later in 1979, the first of 5 x 660 MW units was commissioned at Grain oil-fired power station and it took the record for Europe's largest power station.

The industry dabbled with possible uses for waste heat from power stations: a fish hatchery was established at Hunterston 'A' nuclear station in 1974 and, in 1978, an eel farm was established by Rank Hovis McDougal at Drax. Half an acre of glasshouses for tomato growing was constructed. The eel farm closed in 1984 when the station operated on reduced load during the miners' strike.

Energy Paper 35 was published that year and the Combined Heat and Power Group, chaired by Dr Walter Marshall, recommended that one or more lead city schemes to use heat discharged from power stations should be set up as soon as practicable. The waste heat could provide 30% of Britain's space heating and hot water needs, saving 30 million tonnes of coal per annum. Nothing of significance was to result from this initiative.

In April 1990, the first of a new generation of gas-fired CCGT power stations was licensed at Roosecote near Barrow-in-Furness. The 230 MW station came on stream 18 months later. A further 21,000 MW of gas-fired capacity would be commissioned over the next ten years.

These gas turbine power stations were not, however, the first of their type on the UK system. In August 1952, a 15 MW open compound-cycle gas turbine set was put on load at the Trafford power station in Manchester. It did not, however, enter commercial operation until 1957.

In July 1955, a 12 MW closed-cycle gas turbine was connected to the system for the first time at Carolina Port in Dundee. Trials continued until 1959 when the project was abandoned as reliable commercial operation seemed unlikely. Another 15 MW set, fired on pulverised coal, was commissioned by the CEA at Dunston in November 1955 but was taken out of service in 1960.

A gas turbine designed to run on milled peat was started up in June 1958 at Altnabreac in the north of Scotland. The experiment was abandoned two years later.

A Bristol Siddeley Proteus 3 MW machine was commissioned by South Western Electricity Board in 1959 at Princetown for peak-lopping duties. This represented the first fully-automatic remote-controlled thermal power station in England.

Three years later, in 1962, a 15 MW Bristol Siddeley Olympus aircraft-type engine went into service at Hams Hall 'A' for assessment as a possible means of meeting peak-load and emergency requirements.

Such machines were destined to become the standard arrangement for meeting the system peak loads with most of the stations being engineered by Merz and McLellan. The first peak-lopping installation was at Earley power station near Reading, where a 56 MW machine, powered by four Rolls-Rolls Avon engines, went into service in 1965. The CEGB applied for consents in 1970-1972 for a further 12 sites, totalling 2,550 MW, using industrial, rather than aircraft, gas turbines although four 70 MW stations were later commissioned using aircraft-type engines.

Transmission and distribution

Not far into the period under review, a major supply interruption, characteristic of many that were to occur at various times in various places in the UK over the next 10-15 years, occurred in south-east England. A fault on the Kings Lynn-Norwich 132 kV circuit caused cascade tripping, leaving large sections of the south-east isolated from the grid. System frequency fell rapidly, power station auxiliaries tripped out and generating plant had to be shut down. An area from Norwich and Yarmouth in the north, across to Luton and down to the south coast between Folkstone and Worthing, including most of London, was affected between 12.25 pm and 3.25 pm. At 8.45 pm, a circuit which had been out for maintenance tripped out when re-energised. Cascade tripping occurred over an even more extensive area, reaching to the west coast. Load shedding in excess of 25% had to be implemented to avoid shutting down power stations again before supplies were restored at 10.38 pm.

Events such as these emphasised the need for substantial reinforcement of transmission capacity in England and Wales. Mr TGN Haldane, a partner in Merz and McLellan, strongly argued, in his Presidential Address to the IEE in 1948, for an increase in the main grid transmission voltage. The BEA at the time was proposing to divide the 132 kV grid into three parts to cope with the enormous growth in load. Haldane argued for a higher voltage which would, effectively, allow energy to be transmitted from the mines to the load centres by wire rather than by rail, echoing the ideas of Charles Merz 25 years earlier.

In 1949, an inter-departmental committee of the BEA recommended the adoption of a higher voltage system, superimposed on the 132 kV system. The possibility of substantial reinforcement or addition of 132 kV high-capacity circuits had been considered but it was decided that a system consisting of fewer circuits operating at a higher voltage would be technically much more satisfactory and no more costly. The initial voltage of the superimposed system was to be 275 kV but, for bulk transmission circuits, the towers were designed for future uprating to 380 kV (later 400 kV). Total capital cost was estimated to be £52 million and the recommendations were adopted in July 1950. By the end of 1951 contracts had been placed with British manufacturers, including Reyrolle at Hebburn, for switchgear, transformers and for the major portion of overhead line required for Stage I of the scheme at a cost of £20 million.

The fundamental design of the 275 kV Supergrid differed from its 132 kV predecessor in that the earlier system was designed only to allow pooling of spare plant on a regional basis. Single-circuit lines between the seven independent regions of the UK were intended to facilitate maintenance but were not planned or normally used for transmission between areas. This changed somewhat after 1938 and the inter-regional tie lines were then used for fully interconnected working to enable better use to be made of all spare plant available. The disturbances to normal load trends on the grid system during the war, including restrictions on new generating capacity, further accentuated the advantages of integrated operation of the whole system. The 275 kV system, unlike the 132 kV grid, was designed both for regional interconnection, to facilitate the pooling of spare plant, and for the bulk transmission of power from the coalfields of East Midlands, Yorkshire and the north-east, where the new power stations would be sited, to the load centres of London and the southern counties and in the Manchester and Merseyside districts. The concept of 'coal by wire' ie bulk transmission of power from the stations on the coalfields to the major load centres, was predicted to save some £2.5 million per annum (1949 prices) compared with the alternative of transport of coal by rail, as well as easing congestion on the railway systems.

In addition to inland transmission reinforcement, a joint EdeF/BEA Cross-Channel Interconnection Study Committee held its first meeting on 23 March 1950 and, in its interim report issued in May 1952, recommended that construction of a 132 kV cross-channel cable circuit was practicable and economic. Cable-laying trials were carried out in 1953. In 1956, the CEA approved in principle the construction of a dc link and this was approved by the Ministry of Power in 1957. The cable was commissioned in 1961, operating at ±100 kV and capable of transmitting 160 MW. Availability, however, was poor owing to repeated fouling of the cable by ships' anchors and it was decommissioned in 1982. It was replaced in 1986 by a 2,000 MW link operating at ±270 kV which has the cable buried 1.5 m in the sea bed and which, currently, is a major importer of French power into the UK.

On the distribution front, Midlands Electricity Board began investigations in 1950 into the use of auto-reclosing circuit breakers on 11 kV overhead line networks. These were ultimately adopted throughout the whole country and considerably reduced supply interruptions caused by transient faults such as lightning strikes.

On 21 May 1952, DP Sayers, JS Forrest and FJ Lane read their landmark paper before the supply section of the IEE entitled '275 kV Developments on the British Grid System'.

In June 1953, the House of Commons resolved that steps should be taken to develop the supply of electricity in rural areas as much as and as fast as possible. The Minister of Fuel and Power relaxed restrictions on capital expenditure and the supply industry announced a rural electrification programme with a target of 85% of farms to be connected by 1963. The target was achieved 18 months ahead of schedule.

In July 1953, the first section of the 275 kV grid, 41 miles of single-circuit line between Staythorpe and West Melton, was commissioned. Scotland saw its first section commissioned between Clydes Mill and Harker five years later.

In 1956, testing of 275 kV cables began at a new testing station near Staythorpe power station. Test lengths submitted by the manufacturers were connected to the Staythorpe-West Melton 275 kV grid line.

In 1959, the Severn and Wye 275 kV crossing was commissioned between Aust and Beachley, including a one mile span across the Severn supported on towers 488 feet high.

The first operational use of 275 kV cables occurred the same year at Drakelow 'B' power station to connect No 5 generator transformer to the new Supergrid.

Another major power failure in south-east England occurred on 15 May 1961 when a fault cut off supplies from the Midlands and cascade tripping occurred, eventually isolating the south-east area where power stations tripped out as system frequency fell. Subsequently, gas turbine sets were installed at new stations to safeguard auxiliary supplies.

At the end of 1961, the 275 kV Supergrid comprised some 1,700 route miles of overhead line, mainly all double circuit and 46 switching and transforming stations with a total transformer capacity of 14,000 MVA. Consumption on the system had risen so rapidly that the demand predicted for 1965-75 (30,000 MW) was exceeded in the winter of 1962-1963. Interestingly, in the discussion on the IEE paper read in 1952 on the 275 kV system referred to earlier, TGN Haldane opened the discussion by strongly suggesting that "a demand of 30,000 MW will be reached much nearer 1965 than 1975. It might even be reached before 1965". The authors of the earlier paper, in reply, said that they "preferred to use their own conservative estimates knowing that the development of the (275 kV) scheme can be accelerated if the actual group of load over the next few years shows this to be necessary".

The end of 1962 saw ES Booth, D Clark, JL Egginton and JS Forrest of the CEGB deliver their paper 'The 400 kV Grid System for England and Wales' to the IEE. The new Supergrid was to be designed for a simultaneous system demand of 70,000 MW and a generating plant capacity of 80,000 MW which, in 1962, corresponded to roughly three times the then size of the Grid system. It was assumed

that the forecast load would be attained in 1978. On 10 December 2002, between 5.00 and 5.30 pm, system maximum demand in Great Britain was 60,100 MW, an all-time record.

The studies by the CEGB into the introduction of a transmission network operating at a higher voltage than 275 kV considered both 400 kV and 500 kV. Operationally and economically, there was little to choose between the two voltages. Adoption of 500 kV, however, would not allow the existing 275 kV system to be uprated and utilised for 500 kV working (this future provision had been incorporated in the 275 kV system from the outset for the major transmission routes). Thus a much more obtrusive 500 kV system would have had to be superimposed on the 275 kV system throughout. Having regard to the CEGB's statutory duties to preserve amenity under the 1957 Act, it was decided that the balance of advantage lay with 400 kV.

In April 1962, the 400 kV Supergrid crossing of the Thames was completed between Northfleet in Kent and West Thurrock. Designed for 275 kV initially, and 400 kV ultimately, tower height was 630 feet and the crossing span was 4500 feet.

In 1963, the first 400 kV tower was erected at Thorpe Marsh, near Doncaster. Later that year, the 64-mile section of re-insulated 275 kV line between Monk Fryston and High Marnham was re-energised at 400 kV. The first new 400 kV line was completed also between West Burton and Sundon in Bedfordshire. With a normal weather capacity of 1,800 MVA per circuit, the line had three times the capacity of a heavy duty 275 kV line and 18 times the capacity of the original 132 kV line.

Meanwhile, on the distribution system, Eastern Electricity Board was carrying out field tests on 11 kV vacuum circuit breakers imported from the USA in 1965.

The following year, the CEGB commissioned their first SF_6 circuit breaker at Hall Green, in Birmingham. In 1968, the first 132 kV vacuum circuit breakers were installed by the CEGB at its West Ham substation and, in 1969, the first 275 kV SF_6 circuit breaker to be made in the UK entered service.

The country was not free, however, from major supply interruptions. In December 1981, severe winter weather and gale-force winds caused exceptional ice loading of overhead lines giving rise to some 300 transient faults. A blizzard on 13 December lost bulk supplies to over one million consumers in southern England.

The last public dc supply was shut down in February 1984 when Associated Newspapers in Fleet Street ceased to be supplied from a motor converter and mercury arc rectifier at the Dorset Rise substation of London Electricity Board.

Technical achievements on a grand scale were less conspicuous over the next couple of decades. Privatisation of the industry in 1990 brought intense pressure to bear on the costs and investment of the monopoly transmission and distribution systems. Research and development, which had been such a major activity in the CEGB and Electricity Council research centres, diminished considerably. In-house construction and maintenance activities were scaled down, eliminated or bought in. The 1993 Procurement Directive from the European Commission opened up compulsory competitive tendering for equipment supply and construction work to all member states and the UK electricity supply industry, which for so long had been the exclusive preserve of UK plant manufacturers, expended its capital with many more organisations in many more countries. Globalisation of plant and equipment supply, which had begun after privatisation, was total in its extent by the end of the century.

4. THE NUCLEAR POWER STORY

The saga of nuclear power development is as complex technically as it is politically.

The story begins with the start-up of the first atomic reactor in the UK on 15 August 1947. The Graphite Low-Energy Experimental Pile (GLEEP) began life at the Atomic Energy Research Establishment at Harwell and the nuclear power age was born in Britain. In the later 1940s and early 1950s, electricity supply industry personnel, from the BEA Chairman, Walter Citrine, down to some of the more privileged engineers, had taken part in tentative discussions with scientists at Harwell on the potential for electricity production from nuclear reactors.

Electricity was first generated from a nuclear pile in the USA in 1952 and, in the same year, the British nuclear programme, which had previously concentrated on the atom bomb, began to devote substantial resources to developing civil nuclear power stations.

A nuclear power branch was established by the BEA in 1953 in its Chief Engineer's Department under JC Duckworth to study, plan, design and eventually arrange for construction of nuclear stations.

A year later, in 1954, a Treasury working party reported on the economic feasibility of a civil nuclear power programme. It recommended some 1,700 MW of nuclear capacity by 1965 from 12 reactors. Despite the great difficulty in estimating nuclear costs accurately, and the fact that a nuclear programme might only be economic in its later stages, the coal shortage justified taking technical and economic risks. That same year, the UKAEA was born.

The 'Nuclear Plan', announced in February 1955, envisaged a ten-year programme comprising 1,500-2,000 MW of gas-cooled graphite-moderated stations, using natural uranium clad in magnesium alloy – the so-called 'Magnox' stations.

In October 1955, the sites for the first two nuclear stations, at Berkeley on the Severn estuary and Bradwell in Essex, were announced.

In those days, there was no difficulty in finding sites. Indeed the BEA and Ministry of Fuel and Power were lobbied by local groups requesting a station be sited near them because of the employment prospects they would bring.

The programme was expanded in 1957 because of the technical progress made and in the light of the Suez crisis. In its final form, the programme comprised nine stations with a design output capacity of almost 5,000 MW. The last reactor, at Wylfa, was commissioned in 1971.

The first real public vision of nuclear power arrived in the summer of 1956 when Calder Hall started to produce power. The plant at Calder Hall, although heralded as the dawn of the civil nuclear power age, was optimised for the production of weapons-grade plutonium.

Initial estimates of capital cost (including fuel) of the Magnox stations indicated they would be about 3.5 times more expensive than those for a conventional station. UKAEA representatives were confident that increases in scale and improvement in techniques would reduce this to 2.5 times. The plutonium 'credit', which was expected to redress the balance, proved to be illusory such that, by the later 1960s, its contribution was to become negative as it become evident that no economic use could be found for the waste plutonium and the reprocessing of the used fuel cans proved to be a costly business.

In October 1957, an accident at the UKAEA's Windscale plant caused the release of radioactive materials into the atmosphere. No serious damage was done and there was only mild public disquiet. Enquiries showed that it stopped just short of a major nuclear incident and there were clear faults in research, instrumentation and organisation at Windscale which indicated that Britain's nuclear expansion was severely overstretching staff and other resources.

With the Windscale accident, operating safety features were given more attention. This substantially increased the capital costs of the Magnox reactors, as design modifications to overcome the shortcomings of the original graphite core proved necessary.

A further White Paper on 'The Nuclear Power Programme' in 1960 conceded that nuclear power would not compete in costs with conventional power as early as expected and the Government extended the period of the programme to provide for 5,000 MW of capacity by 1968.

In 1962, the first two Magnox stations at Berkeley and Bradwell were commissioned two years late. Hunterston 'A', the third Magnox station to be ordered, was more than four years late (and cost twice its initially estimated cost). This was at a time when conventional stations were being completed within a few months of their planned target date.

That same year, the advanced gas-cooled reactor (AGR) of the UKAEA began operation at Windscale and in 1965 the Minister of Power announced that the next generation of nuclear power stations would be based on the AGR design. The first station, Dungeness 'B', was announced as a significant cost breakthrough in nuclear power technology, but proved to be nothing of the kind. It was not finally commissioned until 1985, almost 19 years after construction had commenced. The next two stations, Hunterston 'B' and Hinkley Point 'B', were better designed and began operating in 1975/1976 – only a few years late!

It must now be accepted that the series of decisions of the mid-1960s to invest prematurely and heavily in several different and inadequate designs of AGR station represented one of the major blunders of British industrial policy. It was fortunate that the CEGB, though in 1965 taken in by the forecasts that the AGR stations would be cheap and effective, had been sufficiently cautious to insist that the even larger AGR programme initially advocated by the UKAEA should be halved.

In 1965-1966, a further four Magnox stations at Trawsfynydd, Hinkley Point, Dungeness and Sizewell were commissioned. Oldbury came on stream the following year. Completion of Wylfa, on Anglesey in 1971, completed the first British nuclear power programme.

In the north-east of England, construction of the 1,210 MW AGR at Hartlepool began in 1969 and it commenced generating on 1 August 1983.

Future nuclear strategy was discussed and debated in the DTI in 1972 by the Vinter Committee and it recommended to the Secretary of State for Trade and Industry that the first full-scale order for a sodium-cooled fast reactor be placed in the latter part of the 1970s and that, from the mid-1980s, a major part of nuclear orders should be for this type of station. The Secretary of State was later to set up a nuclear power advisory board to advise the Government on nuclear reactor policy. The Board, which comprised Chairmen of the CEGB, Electricity Council and SSEB amongst others, was to report in 1974 that it had been unable to agree as to whether the choice of thermal reactor should be a pressurised-water reactor (PWR) or a steam-generating heavy-water reactor (SGHWR).

In 1973, the National Nuclear Corporation (NNC) was established from the consortia groups that had built all the early gas-cooled reactors with GEC holding 50% of the shares, other engineering firms 35% and Government, though the UKAEA, initially holding 15%. The Government share gradually increased up to 35% until, in 1996 once the Government decided to stop building nuclear power plants, all the shares were sold to GEC. When GEC was broken up in 1999, NNC was the subject of a management buy-out and grew rapidly though acquisition but was subsequently sold to AMEC in 2005.

Meanwhile, in 1974, the European Communities Commission published a new energy strategy policy for the Communities which recommended that by year 2000, nuclear energy should provide at least 50% of the Communities' energy requirements. This was thought, both by a House of Lords' Select Committee and the Secretary of State for Energy, to be unrealistically high!

In 1978, the Government authorised the CEGB and SSEB to order one AGR station each and endorsed also the ordering of one PWR station. The AGRs were ordered at the end of 1980 at

Heysham and Torness for commissioning in 1987 and the CEGB began the long process to obtain consent for Sizewell 'C', which was not to begin commercial operation until 15 years later.

The CEGB's nuclear programme was again questioned by a Select Committee in 1981 which cast doubts both on the CEGB load forecasts and the need for such a large programme of replacement of coal and oil-fired stations by nuclear plants. The Government later dismissed the criticism stating that one new nuclear station a year would need to be ordered in the decade from 1982 and confirmed the choice of the PWR as an alternative to the AGR.

In 1985, the first of the two 600 MW reactor units was commissioned at Dungeness 'B'. Work on site had started in 1966. That same year, the SSEB's Hunterston Magnox and AGR reactors – which had been completed so late and had initially given so much trouble – were said to have achieved an average load factor of 79.45%, the world's best at that time.

By that time, privatisation of the industry was looming on the horizon with the White Paper only three years away. The nuclear stations were included in the sale portfolio. Financial minds in the City of London were greatly exercised by nuclear power or, more correctly, the financial risks associated with the risks of decommissioning nuclear power stations. Dire predictions about the success of the flotation were made if the nuclear risk was allowed to remain. The controversy continued through 1989 and, in July, Cecil Parkinson announced the withdrawal of the seven Magnox stations from the sale. Concern over the nuclear risk remained unabated however and, in November 1989, the Government announced the withdrawal of the other 14 stations.

They remained in Government hands until March 1996 when British Energy was formed, owning the AGRs and the PWR; and Magnox Electric, still Government owned, acquired the Magnox stations. Less than two years later, Magnox Electric was to become a subsidiary of British Nuclear Fuels Ltd (BNFL).

Nuclear generation in the UK presently accounts for about 16% of system capacity and it produces about 20% of the electrical energy we consume. Availability and load factors have steadily increased in recent years. Whether it will ever be seen in retrospect as a good investment will be argued for many years to come.

5. ENVIRONMENTAL IMPACT AND RENEWABLE ENERGY

The first reference I can find to matters environmental in the industry's chronology is the report of the Committee on Air Pollution in 1954 chaired by Sir Hugh Beaver, which looked into the causes and effects of air pollution and the efficacy of preventative measures. Coal-fired power stations were major contributors to pollution. The Committee's recommendations were embodied in the Clean Air Act of 1956.

By 1984, the Tenth Report of the Royal Commission on Environmental Pollution entitled 'Tackling Pollution – Experience and Prospects' emphasised the importance of the 'best practicable environmental option' and advocated a general right of access to data collected by pollution control authorities. It also recommended that the CEGB should introduce abatement of SO_2 emission from power stations on a pilot basis. It suggested that the highest priority should be given to the appraisal of alternative energy scenarios.

That same year, an EEC Directive was issued which included the requirement that, by the end of 1995, a reduction on 1980 levels of 60% in SO_2 emissions and 40% in both NO_x and particulate emissions should be achieved.

The Fourth Report of the Environment Committee was published in 1984 on acid rain. CEGB witnesses said that a combination of ozone and drought might account for German forest damage which first showed up on the silver fir. Emissions of NO_x and hydrocarbons, together with sunlight, were precursors of higher-than-natural ozone levels. The Report stated the Directive, referred to previously, would have the effect of increasing the cost of generation at stations affected by about 10% and raise total costs of generation by about 8% in respect of SO_2 abatement.

The Government's reply, published later in the year, stated that the very substantial expenditure required to install flue-gas desulphurisation plant at existing power stations could not be justified while scientific knowledge was developing and environmental benefits remained uncertain.

A report by the Energy Technology Support Unit of DTI (ETSU) at that time stated that SO_x and NO_x emitted into the atmosphere could possibly cause detectable damage but that many aspects of environmental acidity remained poorly understood.

A memorandum was submitted by the CEGB to the House of Lords' Select Committee on the European Communities which was published in their 22nd report. It considered that, based on a 1% growth in GDP to 2000 and allowing for nuclear power development, a 60% reduction in sulphur emission by flue-gas treatment would involve capital expenditure of £1,430 million at 1983 prices, plus £560 million to replace loss of capacity of 663 MW. Annual operating and maintenance costs would reach £350 million after 1995. A 40% reduction in NO_x would involve the replacement of burners in boilers at a cost of at least £225 million.

The CEGB, in the same year, sponsored a £5 million, five-year research programme to investigate causes of acidification of Norwegian and Swedish surface waters. The CEGB at that time had already spent £8 million on acid rain studies, including tracking emissions from Eggborough coal-fired station. Over three years it planned to spend over £20 million investigating sulphur reduction in coal, desulphurising flue gas, fluidised-bed combustion, low NO_x furnace burners and coal gasifiers with reduced emissions.

In due course, the CEGB was to fit flue-gas desulphurisation (FGD) plant at its largest station, Drax in Yorkshire, and PowerGen was later to retrofit FGD at Ratcliffe also.

The advent of gas-fired power stations with their low-NO_x emissions and absence of SO_x, has improved the situation considerably but the requirements of the 2001 Large Combustion Plant Directive mean that about 30% of coal-fired generating capacity (around 8,000 MW) will be taken out of service by 2016. The remainder will be fitted with NO_x and SO_x abatement equipment to allow them to continue to operate.

Alternative technologies for producing electricity seem to have interested those responsible for electricity supply since at least the early 1950s. In 1953, a 100 kW wind generator, under development at Costa Head in Orkney by NSHEB, ran at full output for the first time. The experiments were taken over by the Electricity Research Association (ERA) in 1956. In 1955, an experimental 100 kW Andreau machine developed by Enfield Cables was commissioned by the BEA at a temporary site near St Albans.

Also in 1956, a 10 kW wind generator built by the Dowsett organisation was erected at the ERA station at Cranfield for the Ministry of Power.

Not much more of significance in wind energy appears to have happened until 1982 when the CEGB commissioned a 200 kW James Howden machine at Carmarthen Bay. It was said to represent the first stage in CEGB strategy to assess the commercial potential and environmental acceptability of wind power on lowland sites. In 1985 it was uprated to 300 kW. That year saw two further machines commissioned on Orkney, a 250 kW Wind Energy Group machine and a 300 kW prototype turbine, again manufactured by James Howden.

In 1984, Britain's first national wind power test centre on a moorland ridge near East Kilbride was established. It was intended to test and accredit British-built wind turbines under supervision of the DTI's National Engineering Laboratory.

Photo-voltaic and solar energy seems to have interested the nationalised industry from time to time. In 1983, an experimental 30 kW solar installation at the CEGB's Marchwood Laboratories began supplying power.

On a more advanced technological frontier, FT Bacon, a former Parsons employee at Newcastle, whom some would regard as the 'father' of the fuel cell, demonstrated his 'Hydrox' fuel cell at Cambridge in 1983. This had been developed over 27 years of research at the University. It was claimed to be the first to be a commercial proposition. Charles Merz gave considerable support to Bacon in his early work.

Wave power received some encouragement in 1974 by Lord Rothschild who chaired a CPRS Committee Study into Energy Conservation. That was a busy year on the fringes of the ESI: ETSU was established as a department of the DTI at Harwell, and Sir William Hawthorn was appointed Chairman of the Advisory Council on Energy Conservation. Its function was to advise and assist the Secretary of State for Energy in carrying out his duty of promoting economy and efficiency in the use of energy, in particular, by identifying areas for improvement and methods of conservation.

Also that year, the RSA published a report prepared by a Committee, chaired by Lord Nathan, and set up jointly by the Committee for Environmental Considerations (the forum for the main conservation and amenity bodies in Britain), the RSA and the Institute of Fuel. It recommended the establishment of an Energy Commission to plan energy programmes, discourage open competition between energy suppliers, and an independent body to consider possibilities of small-scale decentralised generation making use of reject heat. Four years later, such an Energy Commission was established but it was scrapped in July 1979 under the new Government.

In 1977, the third and fourth reports from the Select Committee on Science and Technology were published entitled 'The Development of Alternative Sources of Energy for the United Kingdom; the Exploitation of Tidal Power in the Severn Estuary'. It concluded that Government spending on renewable sources of energy had been 'grossly inadequate' and its attitude to a possible tidal power project 'excessively timid'.

The report stirred something up nevertheless because three years later, in 1980, the Severn Barrage Committee stated in an internal progress report that large-scale tidal power from the Severn Estuary was technically feasible, but it seemed unlikely that its cost could complete with nuclear generation. It might compete with fossil-fuel generation if coal and oil prices continued to rise in real terms. A year later the Committee, which was chaired by Sir Hermann Bondi, said the scheme would cost about £5,600 million (at 1981 prices) in other words about £13 billion now, and would generate about 13

TWh from a capacity of 7.2 GW, which is about 5% of national requirements. Later that year, GEC, Balfour Beatty, Sir Robert McAlpine and Taylor Woodrow announced their joint investigation of a £3,300 million private-sector scheme.

Two years later, Wimpey Construction and WS Atkins proposed a lower cost scheme at £885 million with 42 x 24 MW units to generate 204 TWh. The latter scheme, now known as the Shoots Barrage, located close to the second Severn road crossing, is now being actively promoted by Parsons Brinckerhoff (the successor to Merz and McLellan in Newcastle) who owns the intellectual property in the project. A Mersey barrage was studied in the same year.

Considerable capacity of hydro pumped storage was planned and built in the period under review including Ffestiniog which had been commenced by the CEA in 1955 and was commissioned in 1961. At the time, it was amongst the largest schemes of its type in the world at 360 MW. Cruachan followed in 1965 with 4 x 100 MW sets and, with a head of 1,200 feet, it was the highest in the world for the type of plant. 1972 saw consent being given to Dinorwig which was commissioned in 1983 and could provide primary response capacity of 1,320 MW within ten seconds, sufficient to compensate for the loss of 2 x 660 MW thermal sets on the system. In 1974, Foyers was commissioned on Loch Ness with 2 x 150 MW reversible-pump turbines as part of NSHEB's Great Glen group of stations under remote control from Fort Augustus. In 1975, SSEB, with the engineering support of Merz and McLellan, proposed to establish an even larger pumped-storage scheme at Craigroyston on Loch Lomond. At 3,200 MW it would have, even now, been bigger than anything else in the world. Development work ceased a year or two later no doubt because of the potential environmental protests that were beginning to arise.

Closer to home, the 6 MW Kielder hydro scheme was commissioned as a joint venture between the Northumbrian Water Authority and the CEGB.

The last 18 years since privatisation of the industry have seen an increasing emphasis being placed on renewable energy with, currently, a Government target of 10% of electricity to be derived from renewable sources by 2010. Current energy production from renewables is about 5% from a capacity of just over 5,000 MW of which about 30% is hydro. Considerable support (from electricity consumers) has been given to renewables under the 2002 Renewable Obligation Order. The recent 2007 Renewables Directive of the European Commission, which requires member states to source 20% of all energy (ie including transport and other such fuels as well as electricity) from renewable resources, is estimated by the UK Government as likely to cost up to £22 billion. This could add up to 25% on UK electricity prices if implemented in full.

6. THE INDUSTRY IN THE 21ST CENTURY

The last 20 years or so have seen enormous changes in one of the UK's largest industries. The production side and many parts of the secondary distribution side are now dominated by German, Spanish and French utilities. The primary distribution organisation – National Grid – has extended its sphere of operation into North America and Australia with some success.

The raw materials used by the industry to produce its primary product – electricity – have changed over the period from largely indigenous coal to gas which is now increasingly sourced from Norway and Russia. Several liquefied natural gas facilities are now being built to receive gas from even farther afield. Nuclear power has, at its peak, provided almost a quarter of our electricity and is now on the wane and set to disappear altogether in another 20-30 years. Renewable electricity has increased as a proportion of total electricity produced from 0.6% in 1947 (all hydro-electric) to almost 5% in 2006, about two-thirds of which comes from hydro-electric stations and onshore wind farms.

The capital assets of the industry now total more than £50 billion. Employee numbers have fallen by more than half over the last two decades, from over 150,000 in 1989, to around 63,000 in 2005. Many of the capital assets are now reaching, or have reached, the end of their nominal working lives. Industry estimates of new investment required over the next 20 or so years are about £15-20 billion on generation and £10 billion on transmission and distribution. Huge sums by anyone's measure and comparable with that made in North Sea oil and gas exploration and production in the 60s and 70s.

It would be a bold man who would try to crystal ball the future of the UK electricity supply industry over the next 40-50 years. Many industry pundits find it difficult to predict even a few years ahead, such are the effects of externalities on the industry – like environmental directives, fuel stocks and the rapid pace of technical advancement in power equipment technology.

I would expect to see an industry not too dissimilar from that which exists today: new coal-fired power stations with CO_2 capture and sequestration, new nuclear capacity with an inherent ability to be safely deconstructed, some gas-fired generation capable of two-shift operation, much waste-fired generation, offshore wind, a tidal barrage or two and some marine current driven power stations. Nuclear fusion may (or some would say will still!) be on the horizon. Demand for electricity will be less in 50 years' time than in 20 years' time because of more energy-efficient conversion devices such as motorised drives in industry and more effective home insulation and the use of photovoltaic and energy storage devices to capture and make available electricity for small power devices in households.

EPILOGUE

I think Hannah, writing in 1982, admirably summed up the industry's first century with the following words in the closing paragraph of his magnum opus:

"From the 1880s to the mid-1960s, the industry's decision makers had lived in conditions of unusually stable expectations. Improved steam conditions and economies of scale would lead to continually falling costs. Sales would continue to grow and electricity would continue to win market share. In the late 1960s and the 1970s, these assumptions, built up over more than six decades, proved false. The industry is now less sure that the future will be an extrapolation of the past. Management problems have become less tractable as decision making depends more widely on dealing with uncertainty and geopolitical factors and less completely on technical factors within a given framework of analysis. With their recent experience, the industry's managers do not need to be reminded that it may be the challenge of change and the unexpected that will stretch them most in the years to come".

Prophetic words indeed!

ACKNOWLEDGEMENTS

I should like to thank the Directors of Parsons Brinckerhoff (which now includes the former power business Merz and McLellan) for giving permission to publish this booklet and supporting its cost. I would emphasise that the opinions I have expressed are entirely my own and no way reflect the corporate attitudes or views of Parsons Brinckerhoff.

I should like to acknowledge the extensive and very helpful information contained in the official history of the UK supply industry in the two works by Leslie Hannah and the very useful chronological material obtained from the former Electricity Council's publications on UK electricity supply and the more recent chronologies published by the Electricity Association on the privatised industry.

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APPENDIX

Figure 1 - Relative Value of Money

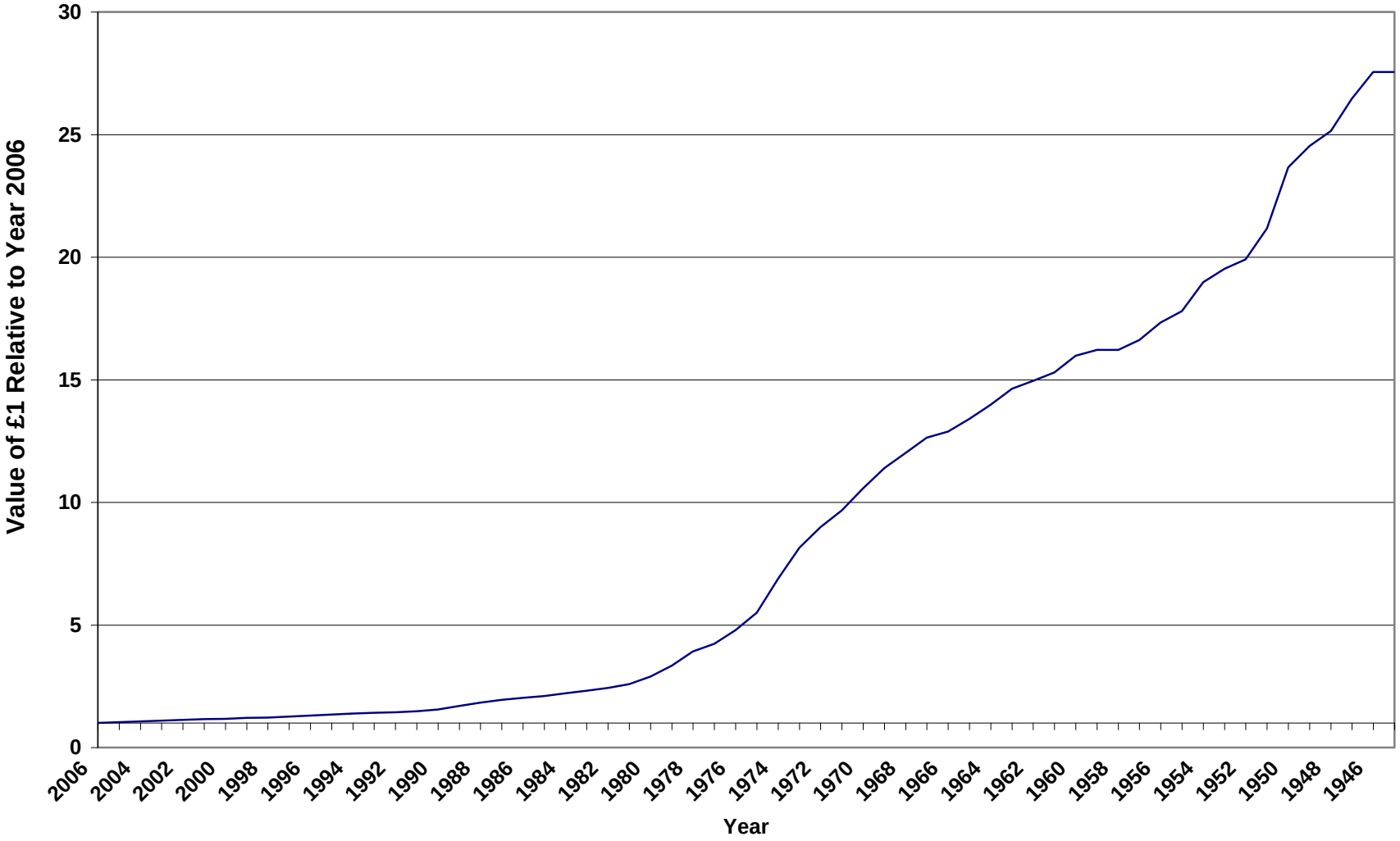
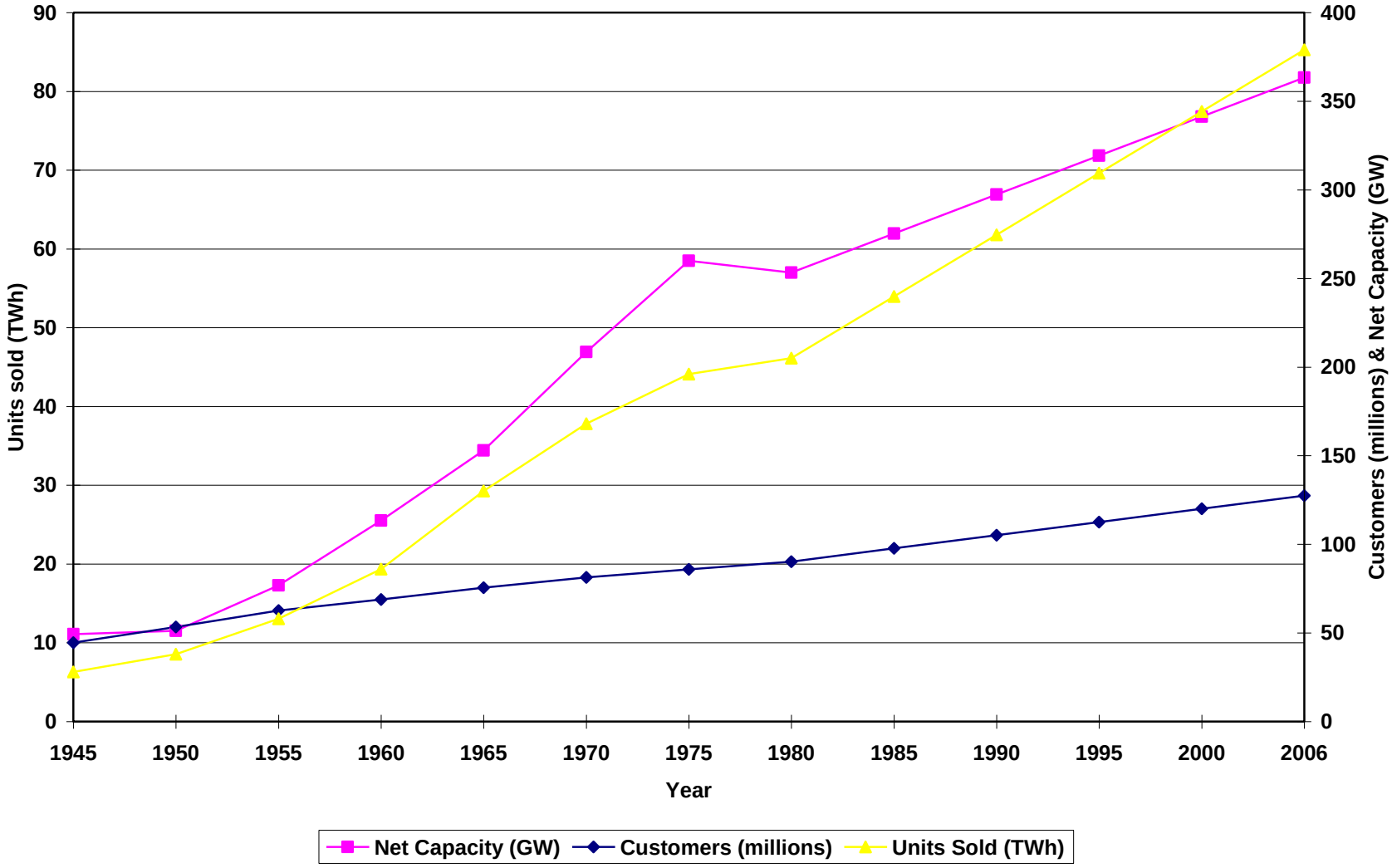
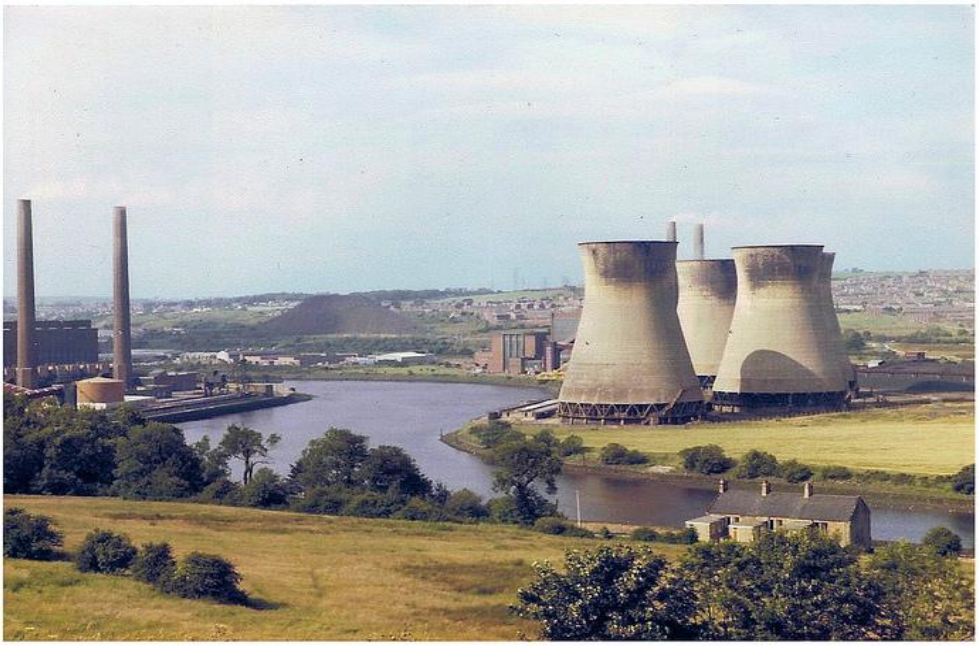


Figure 2 - Progress in electricity Supply 1945-2006





Stella Power Station – before and after demolition in the early 1990s

Hartlepool Nuclear Power Station