Advanced Power Generation Task Force

an Associate Programme of Fore*sight*

ANNUAL REPORT 1999/2000

Fore*sight*

Making the future work for you

Chairman's Introduction

It is my pleasure to introduce the UK Advanced Power Generation Task Force (APGTF) and to report on its activities after its first year of operation. The formation of this Task Force represents an important step in establishing the strategy for the UK in the field of energy from fossil and associated fuels. It has been done under the auspices of Energy Foresight, launched by the UK Government in 1993 and which has proved to be an excellent vehicle for industry in conjunction with other major interested parties to fill the void left by the privatisation of the CEGB some years ago.

This Task Force is led by industry with representation through the key Trade Associations. Also involved are the university networks set up for power generation, the Research Councils and the DTI from the Office of Science and Technology as well as the Energy Directorate. It is able therefore to speak from a full sector viewpoint and to recommend priorities for the UK that will provide benefits nationally in terms of wealth and job creation, as well as in improvements to the environment.

This is against a background of change in the Energy sector; not only in the UK but also world-wide where the impact of deregulation, liberalisation and privatisation will continue to have significant effects on the market. This in itself will continue to have impact on the technologies and products that need to be developed in order to satisfy the market in the immediate, mid and longer term.

The other major driver is coming from the Environment with the ever increasing desire to address Climate Change issues, both on a national and global level. Clearly this will also have a major effect on future strategy for Energy Research and Development.

This report sets out the activities to date of the Task Force and gives an indication of how these are being taken forward into the next round of Foresight. A major event is to be held in September 2000 at which it is anticipated that an UK national 'vision' will be developed, importantly in a European and global context. I am particularly grateful for the support from the DTI and EPSRC to make this Forum happen, and also for their continued support over the year.

I look forward to another challenging year, the major objective being to ensure that the UK Energy Sector has the technologies in place to take advantage of the undoubted opportunities that the changes in the market as a whole will bring.

Nick Otter
ALSTOM Power
Chairman of UK Advanced Power Generation Task Force

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Purpose of the Report

The purpose of this document is to set out the progress achieved by an industry led Task Force to encourage the development of collaborative Research Technology Development and Demonstration (RTDD) in the field of advanced power generation. This work builds on two major Foresight reviews on Cleaner Coal Technology and Gas Turbine and Advanced Combined Cycle Technology undertaken in 1998.

The UK has a wealth of expertise and know-how in both technology areas and there are substantial opportunities to develop the UK further as a centre of excellence and exploit home and export markets for the technologies. This is the first of a planned annual cycle of publications to report progress and further promote the activities of the Task Force.

Background

The UK's Foresight programme was first announced in the 1993 White Paper Realising our Potential.[1] Its aims are to create sustainable competitive advantage and enhance the quality of life. Foresight is bringing together business, the science base, and Government to identify emerging opportunities in markets and technologies, and respond to them. The first round of Foresight identified Cleaner Coal Power Generation Technology and Advanced Combined Cycle/Gas Turbine Technology as key priorities and established a Task Force for each. Both Task Forces identified the need for a common structure to co-ordinate and evaluate future research, development, and demonstration. In response, a new industry-led Advanced Power Generation Task Force (APGTF) was set up in early 1999 with a wide remit to maintain the impetus of Foresight

The current round of Foresight which started in April 1999 is spearheaded by ten sectoral and three thematic panels. One of the ten sectoral panels, the Energy and Natural Environment (ENE) Panel, has objectives to enhance the UK's capacity to contribute to wealth creation and the quality of life in the energy and environment fields, and to foster the development of collaborative networks and 'clusters' in a number of key areas in the fields of energy and the natural environment. It is a key feature of Foresight that panels will be assisted in their work by contributions from task forces and associate programmes. At an early stage of the Advanced Power Generation Task Force's constitution, it was recognised that it would be of benefit to collaborate with the ENE Panel and seek associate programme status.

The APGTF is primarily concerned with power generation from fossil fuels and associated technologies. Its membership and expertise reflects this and the onus to take forward the work of the two previous Foresight Task Forces. Nevertheless, the Task Force is not confining itself to cleaner coal and gas turbine technologies, but reviewing developments generally in the fields of power generation from fossil fuels, and from waste and biomass, either alone or in conjunction with other fuels. Power generation using solar, wind, or tidal energy is not part of the Task Force's specific remit, neither are nuclear issues. Other associate programmes under Foresight are, however, covering some of these subjects.[2]

Industrial Trent Gas Turbine (courtesy Rolls-Royce)

The first meeting of the Task Force was held on 2 February 1999. This report covers its activities from that date to the end of March 2000.

[1] *Realising Our Potential: A Strategy for Science Engineering and Technology*, Cmnd 2250 (HMSO 1993)

[2] Two associate programmes already established are: 'Solar Photovoltaics in the UK: A Stakeholder Dialogue' and 'Nuclear Technology Requirements out to 2020'. Details may be found at *www.foresight.gov.uk*.

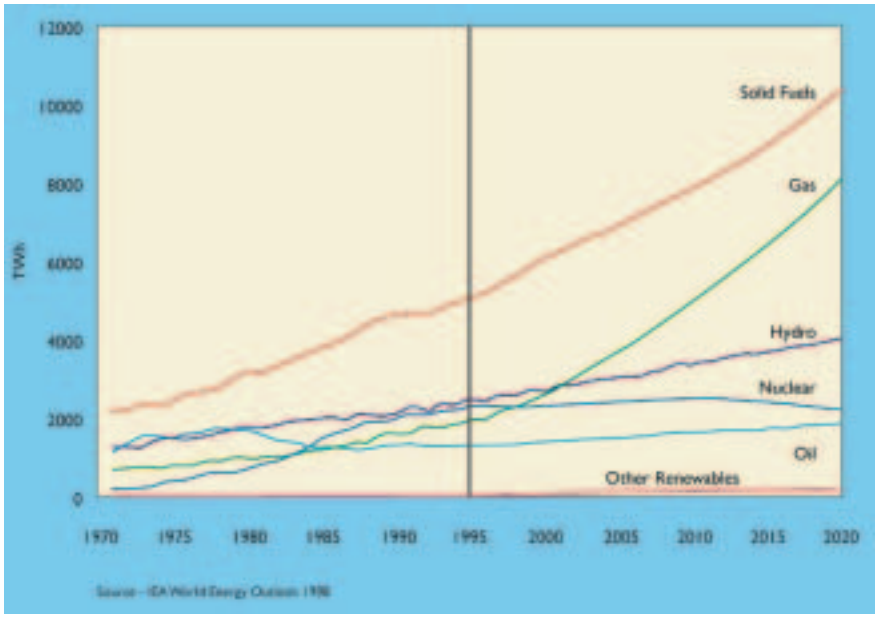
Setting the Scene

Power generation from fossil fuels and associated technologies may be considered by some as an archetypal 'old' economy sector. Yet it remains vital to energy production in the UK and Europe and even more so in the wider world. Nor has the technology stood still: in particular, the development of modern large gas turbines for combined cycle power generation over the last two decades has yielded tremendous benefits, both for the cost of power and for the environment.

For the next 25 years, the IEA and World Energy Council[3] predict an increase in global energy demand of 2%-3% per annum. In this period, the overall increase in energy demand will be matched by an increase in electricity generation. At current levels of economic activity, world power generating capacity will practically double from 3100 GW to 5900 GW. To meet the increased demand of 2800 GW, and to replace 680 GW of retired plant, 3500 GW of new electricity generating plant will be required (ie, more than is currently installed world-wide). This is about 140 GW of new plant each year. Growth is expected to be highest in China and Asia – 7% p.a. compared with 5% p.a. in other developing countries, and 2% p.a. in the EU. This growth will be against a background of sustained pressure for a higher priority to be placed on the environment and arguments against growth and for global sustainability. These pressures may be ultimately successful in changing perceptions but it seems unlikely there will be any radical alteration to growth in energy demand in the next 20 years.

Moreover, most future predictions still see a strong need for the large, central power stations for new build plant over the next 10 to 15 years. Those stations are mainly going to be fossil-fuelled. For example EU predictions for European electricity generation in 2020 are:[4]

Renewables	18%
Nuclear	13%
Fossil	69%



Future Energy Use (courtesy ETSU)

and the dominance of fossil fuels will be even more pronounced world-wide; some 38% of the world's electricity will be still be generated from coal by 2020.

Any significant impact from renewables is unlikely to be felt much before 2020. In the meantime, there will be a continuing drive to make fossil-fuel plant more efficient at the same time as reducing emissions and lowering costs. This could act against the large central power station in favour of distributed generation and combined heat and power plants. Natural gas will often remain the fuel of choice where it is available, because of its lower carbon content and cost. However, coal will still have a major role to play, particularly where gas is unavailable or expensive (eg, China and India) and in locations close to areas of low-cost coal production (eg, parts of North America, Australia and South Africa).

The APGTF therefore continues to focus attention in the medium – long term on technology improvement for fossil

and associated fuel plant whilst not losing sight of possible imperatives for significant changes to the technology mix later in the new century. The commercialisation and successful development of CO_2 capture and storage technologies could have a significant impact in the longer term on whether all fossil fuels, not just coal, contribute to future energy supply.

The UK has a long-established strength in power generation technology. In 1998 the sector[5] had a turnover of £13.3 billion and employed around 165,000 people. Exports of machinery and equipment totalled £8.0 billion against imports of £7.5 billion. The value of the world-wide market for combined cycle and fossil fuel power generation could be as high as £500 billion over the next 15 years[6]. Decreasing cost/kW of new plant is being more than off-set by massively increased service functions for new and existing plant. This is a global business, with large, multi-national suppliers. However UK businesses large and small can maintain and increase their presence in the market by continuing to supply advanced components and systems that offer innovation and improvements in efficiency and environmental performance.

[3] International Energy Agency *World Energy Outlook* (IEA, 1998) and World Energy Council *Joint Study by the World Energy Council and the International Institute for Applied Systems Analysis (IIASA)* (WEC, 1998)
[4] European Union *European Union Energy Outlook to 2020* (EU, 1999)
[5] Information from BEAMA, the Electrotechnical Sector Trade Association
[6] Figures extrapolated from FT World Energy Survey 1999

Flue Gas Desulphurisation (FGD) Plant at Ratcliffe-on-Soar Power Station (courtesy Powergen UK plc)

Objectives

The primary role of the APGTF is to provide a focus for the power generation sector in the UK on fossil fuel and associated technologies, and to ensure:

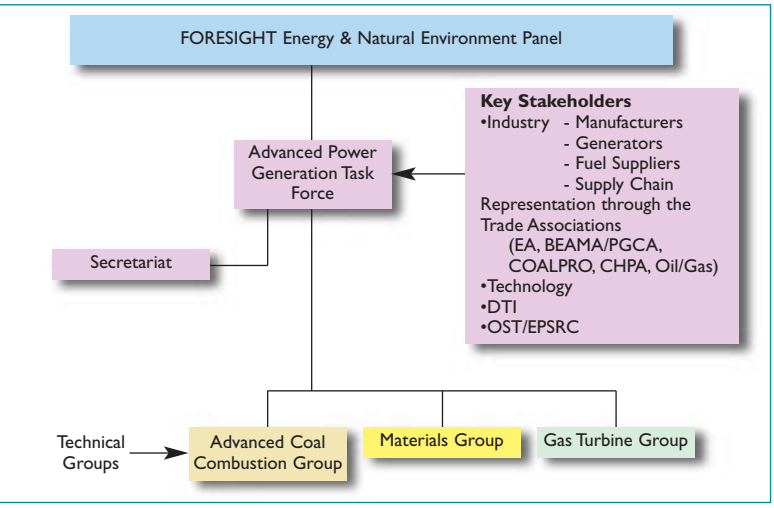
- There is continuing review of existing energy Foresight initiatives and informed contributions made to the new Foresight programme
- UK industry takes advantage of the global market opportunities in the first two decades of the next century
- There is a significant contribution to UK wealth creation
- The UK contributes to improved quality of life through reduced environmental impact, both nationally and globally

Organisation and Composition

Membership

The Task Force is industry-led, with the Chairman employed by a major equipment manufacturing company. The onus is increasingly on these companies to set the product strategy to satisfy future markets. Membership of the Task Force represents the complete power generation sector, including

- Power generating companies
- Equipment manufacturers
- Fuel suppliers
- Technology providers (eg, universities)
- Government and the public funding providers



APGTF Structure

Industrial representation is achieved through a strong involvement of trade associations with nominations coming from their membership. Key organisations are:

- The Power Generation Contractors Association (PGCA, a member of the Federation of British Electrical and Allied Manufacturers' Associations, BEAMA),
- The Electricity Association
- The Confederation of UK Coal Producers (COALPRO)
- The Combined Heat and Power Association (CHPA)

There is also representation from the oil and gas sector. Research representation is provided by the Power Generation University Network, and the Engineering and Physical Sciences Research Council (EPSRC). The Department of Trade and Industry (DTI) is represented both by officials from the Energy Group's Sustainable Energy Policy Unit, and the Office of Science and Technology (OST). OST is responsible for overall direction of the Foresight initiative.

Technical Groups

At the time of formation of the APGTF it was agreed that a series of Technology Co-ordination Groups would be established to provide additional technical advice. These groups would have the responsibility of taking the strategic targets and market oriented requirements from the Task Force and translating them into specific technology areas in which work is required. It is the intention to provide a new focus to already existing groups rather than to replicate activity.

The groups therefore define priority areas for research and development and report them in such a way as to provide clear direction for a range of programmes. One of the primary objectives is to influence the content of extant programmes and if necessary encourage the initiation of new ones to address key issues.

Involvement of Small and Medium-sized Enterprises (SMEs)

Many of the most innovative ideas are to be found in small firms, but lack of resources and cash constraints may be barriers to taking on the risks of research and development. By the nature of the business, the power generation industry is largely concentrated in the hands of a small number of major companies. However, the supply chains for these companies include a myriad of often locally based small and medium sized concerns. For example the Industrial Gas Turbine Segment of ALSTOM Power in Lincoln spends

£180 million/annum with over 600 UK sub-suppliers, many of whom are SMEs. In support of the Task Force, the National Engineering Laboratory (NEL) is carrying out a mapping exercise of sub-suppliers in the Power Generation Sector. ALSTOM Power and Rolls-Royce are carrying out a more detailed analysis of their sub-supplier bases from a regional perspective.

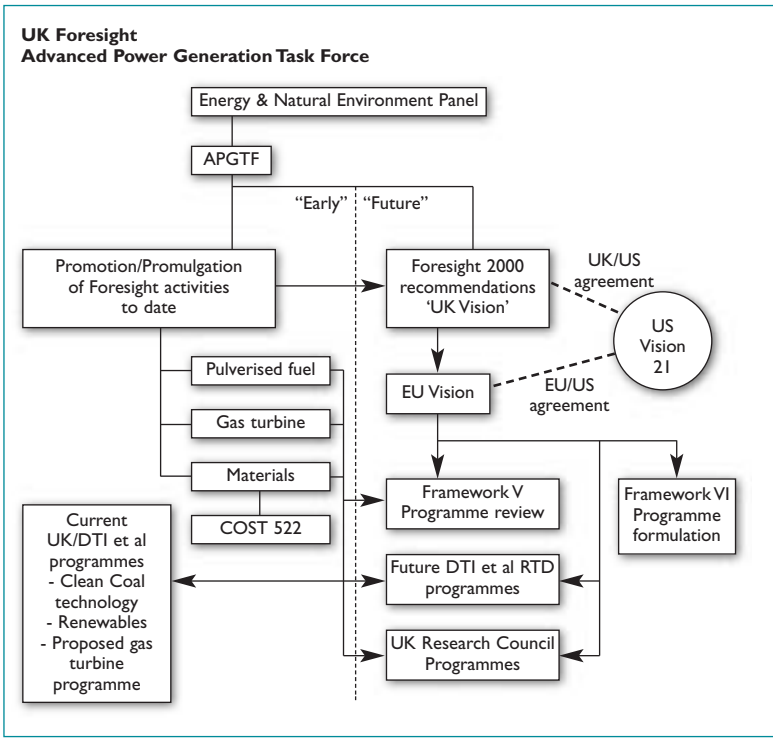
In addition a conscious attempt is being made to involve smaller firms in the work of the Task Force and the technical groups. This reflects the concern of Government that research funding should not over-benefit large concerns, but help to unlock the potential for innovation within SMEs. One of the two BEAMA/PGCA places on the Task Force is reserved for an SME representative.

Scope of Work

The Terms of Reference for the APGTF define five primary tasks:

- To identify RTDD strategy targets and priorities for the UK Power Generation Sector to gain both maximum economic benefit and improvement of the environment.
- To promote this RTDD strategy throughout the sector, including industry, the academic and research communities, Government, the European Union, and public funding bodies.
- To identify strategic technologies and components within Advanced Power Generation, such as clean coal technologies and gas turbines, both for small and large plants, the development and promotion of which will result in direct benefit to the UK.
- To recommend programmes necessary to advance technology, skills and underlying sciences and to underpin the RTDD strategy through all phases to component and plant demonstration, and ensure recommendations are reported and disseminated
- To review and evaluate both new and existing programmes, to ensure that objectives are met and provide guidance and direction in line with the overall RTDD strategy

The accompanying figure illustrates in simplified form how the APGTF intends to interact both with current and future programmes. The Task Force under the auspices of the Foresight ENE Panel will promote and promulgate completed and current Foresight activities. With the help of the technical groups it will review progress with relevant projects in the UK managed by the DTI and the Research Councils. Progress with the current EU Fifth Framework Programme will also be monitored. In parallel, the Task Force will seek to influence the direction of RTDD in the medium term (for example by helping to formulate policy for a possible EU Sixth Framework Programme) and in the longer term by contributing to the overall Foresight vision for 2020 and beyond. It is recognised that there is a need to look beyond the UK and develop a national strategy in an international context.



Inputs to Priorities for Energy RTD

Activities in the Review Period

Meetings of the Task Force – Establishment of Technical Groups

The inaugural meeting of the APGTF was held on 2 February 1999. Since that date a further five meetings have been held, in April, June, and October 1999, and in February and March 2000.

The Task Force has initially established three technical co-ordination groups that between them cover most of the key underpinning technologies. Two of these, covering materials and pulverised fuel plant and coal combustion, are based on existing industry groups; the third deals with gas turbine technology and fluid dynamics. The coverage and composition of these groups permits knowledgeable and focused debate and action without unnecessary duplication. As the work of the APGTF and the groups progress it will become clearer what other issues need to be addressed, and which additional groups need to be formed.

Didcot B Power Station Control Room (courtesy National Power)

Presentation and Dissemination of Foresight Activities

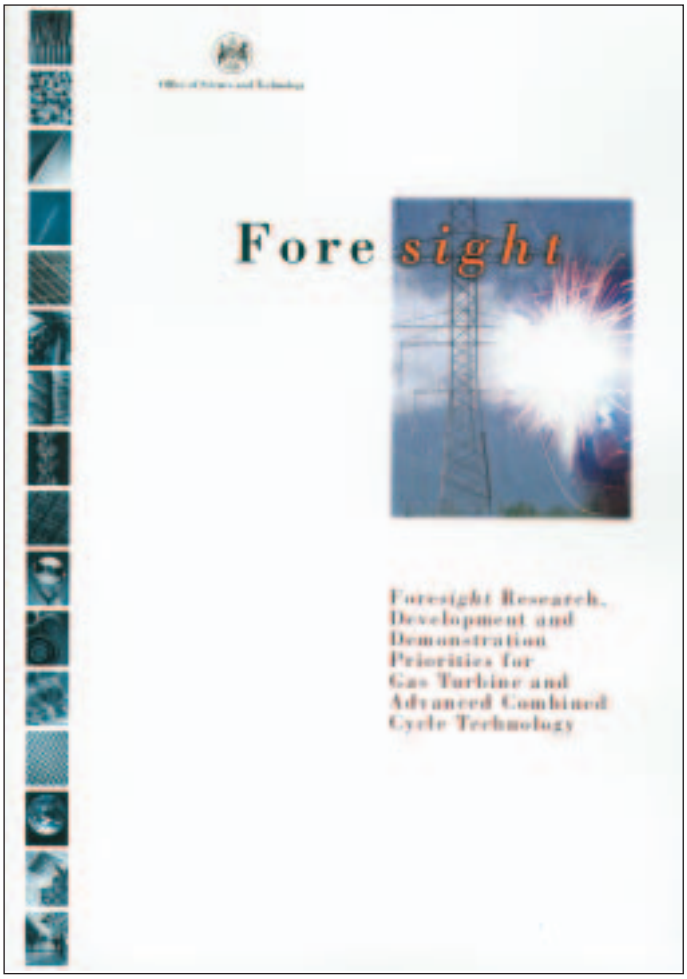
During the period under review, reports from the two Foresight Task Forces on Cleaner Coal Power Generation Technology and Gas Turbine and Advanced Cycle Technology were published by OST.[7] The latter report was introduced at a seminar in November 1999 held under the auspices of the APGTF at National Power's Didcot A power station. This successful seminar had an attendance of approximately 80 with presentations from manufacturers and generators on perspectives on future gas turbine and combined cycle research.

The broader subject of dissemination of the APGTF's activities and promotion of the power generation sector in general through Foresight is a priority for the Task Force. A discussion document suggesting how opinion formers, SMEs, academics, and young people could be approached has been prepared. A small team including representatives of industry, OST, and EPSRC has been established to implement an action plan. Many of the sector's major stakeholders are based in the East Midlands, and consideration is being given to co-operation with regional bodies.

Interaction with Existing and New Programmes

The two Foresight Task Forces on cleaner coal power generation technology and gas turbine and advanced cycle technology both recommended RTDD programmes structured as partnerships between private and public funding. In April 1999, the Government announced it was establishing a new Cleaner Coal Technology (CCT) Programme with a 6 year timescale and Government funding of £12 million over the first 3 years.[8] It is not part of the Task Force's remit to oversee this programme – an advisory committee has been set up for this task – but regular reports have been received by the Task Force and feed back given. This process is facilitated by some common membership of the Task Force and the advisory committee. The Government

[7] OST, *Foresight Research, Development and Demonstration Priorities for Cleaner Coal Power Generation Technology* (DTI, 1999), and *Foresight Research, Development and Demonstration Priorities for Gas Turbine and Advanced Combined Cycle Technology* (DTI, 1999).
[8] *Cleaner Coal Technologies,* Energy Paper 67 (DTI, 1999)



has not yet committed itself to a similar advanced gas turbine programme, although this was a major recommendation from the early Energy Foresight work. The Task Force has endorsed the need for such a programme and has been supportive of the joint efforts of industry and Government to agree the most effective approach.

The Task Force has provided a forum for review of progress with European and Research Council programmes, in particular the new EU Fifth Framework Programme, and the EPSRC targeted programme for research in support of electricity supply industry need for the 21st century ('ESR21'). In addition the Task Force contributed a co-ordinated response to OST on a possible future EU Sixth Framework Programme, and the future of European research generally.

Developing a Strategic Vision

A central theme of the current round of Foresight is developing visions of the future. Groups and organisations are being encouraged to develop scenarios for their fields and identify potential needs together with strategic threats and opportunities. The ideas should be tested and discussed beyond the normal sectoral boundaries. The ultimate aim is to encourage people and organisations in the UK to act now to meet future challenges and take advantage of emerging opportunities. The Task Force is keen to develop its view of the future for power generation from fossil and associated fuels and open this to debate as part of the Foresight process. As a first step the Task Force has produced an outline framework report for discussion within the Task Force, which will form the basis of a strategy document for wider dissemination and consultation.

Formalising a Role

Following initial meetings and formulation of a programme of work, it became clear that there would be benefits to all if the APGTF were an associate programme of Foresight. Accordingly, a formal Memorandum of Understanding was signed by the Task Force Chairman and OST in March 2000.

Two Industrial RB211s with Heat Recovery at Samarinda Power Station, Indonesia (courtesy Rolls-Royce)

Technical Group Activities

Formation and Terms of Reference

Three technical co-ordination groups have been formed to date each with common Terms of Reference. The objective is to establish each group as the national focus for the particular technical area by:

- Developing and communicating a shared understanding of industry, funding agency and other stakeholder needs and priorities for research and technology development
- Maintaining an overview of UK competitiveness and how this relates to other initiatives globally
- Advising on the main areas where research and technology development needs to be encouraged and supported to enable UK industry and technological providers to compete effectively in world markets
- Assessing and evaluating the status of current research and technology development programmes
- Producing, through the Task Force, authoritative recommendations on the future direction of technological development and associated research needs, taking into account European and international initiatives

Alborg Unit 3 Double Reheat Supercritical Coal-Fired Plant at Vendsysselvaerket (courtesy ETSU)

Advanced Coal Combustion Group

Background

The group has evolved from a UK strategy group for pulverised coal combustion established in October 1996. The aim of new group is to assess the issues that are important to UK industry's drive to maximise its share of both domestic and global markets for coal combustion power technologies.

Composition

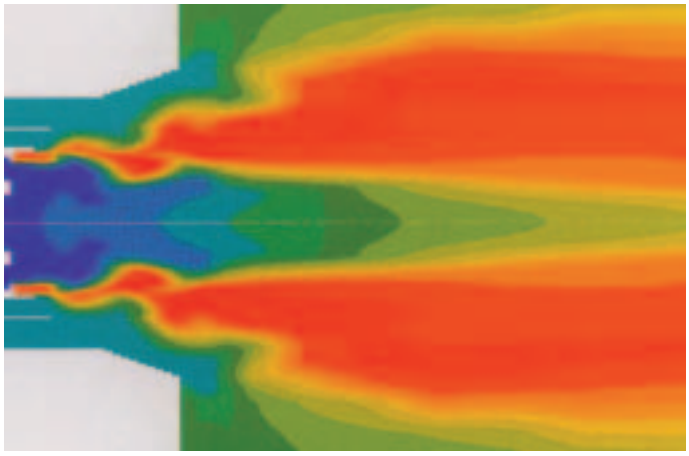
The group is chaired by National Power and includes representatives from major UK generators and utility boiler manufacturers. It currently comprises PowerGen, Scottish Power, ALSTOM Power, TXU Europe, Edison Mission Energy, Mitsui Babcock and Nigen.

Scope

The group covers fuel characterisation and related sciences, fuel processing, plant impacts, combustion, emissions control, and through life plant costs, extending from the fuel handling preparation plant through the boiler and cleanup equipment to the stack.

Progress

The group has held four meetings in the period. It has sought to provide feedback to the Task Force on the status and successes of current research and development and make authoritative recommendations on the future direction of technological development and associated research and education needs, taking into account European and international initiatives. One mechanism for this feed back was a strategy paper on advanced coal combustion plant produced in April 1999



CFD Modelling of a Low NOx Burner (courtesy Mitsui Babcock Energy Ltd)

and given wide distribution.[9] The paper was a revision and expansion of an earlier paper produced by the strategy group in April 1997. The new document provides an industrial consensus of the technological developments and associated research needed across all major plant areas from the stockyard to the stack in developing cleaner, advanced power generation from pulverised fuel. It identifies key market drivers, plant design considerations, process issues and underpinning sciences.

The group has reviewed subjects for Technology Status Reviews to be commissioned by DTI, and reports have been commissioned accordingly.[10] The group has also acted as a focal point to develop good quality research proposals. These activities are being seen to yield real benefits and helping to maintain the competitive advantage of UK industry in world markets.

Cooled Turbine Blades (courtesy ALSTOM Power)

Materials Group

Background

The current group is based upon the Institute of Materials (IOM) Task Force set up under Foresight in the mid-90's to define specific material requirements for advanced coal-fired power plants over the next 15 to 20 years. The work of this Task Force culminated in the publishing of a report in September 1997[11], which highlighted the major areas where materials research was required for the following power generation equipment:

- Steam turbine
- Gas turbine
- Conventional boilers
- Fluidised bed and gasification plant

Composition

The original team was made up of mainly original equipment manufacturers (OEMs) and utilities. The materials support group has now been expanded to include materials suppliers and other organisations involved in the power generation supply chain. The current membership comprises: ALSTOM Power, Mitsui Babcock, National Power, PowerGen, Siemens, British Gas, Corus, Special Metals Wiggin, Chromalloy, NPL, Cranfield University (representing the University network), DTI, EPSRC, and the Institute of Materials (providing secretariat services).

Scope

The tasks of the group involve:

- Defining the materials route map for the UK power generation industry and identifying specific opportunities for the UK materials supply chain.
- Promoting the route map to UK government, industry, academia and research institutes
- Prioritising areas for materials RTDD and to influence existing and new programmes.
- Ensuring that there are no gaps in technology development.

Progress

The group has held two meetings and agreed the following initial strategy:

a) to review the IOM Task Force report and update it to reflect changes and progress since publication.
b) to prioritise key areas and identify programmes
c) to quantify benefits and estimate programme size.
d) identify funding opportunities in Europe and the UK

An initial survey of the first two tasks has been undertaken and this will result in a more detailed report towards the end of 2000.

[9] *A Strategy Paper on Advanced Coal Combustion Plant* (Advanced Coal Combustion Plant Co-ordination Group, April 1999)
[10] For example on pulverised fuel flow measurement and control devices.
[11] Allen, D. H., Beech, S., Vanstone, R., Buchanan, L. and Oakey, J. *Requirements for Materials R&D for Coal-fired plant:- Into the 21st Century.* IOM Task Force report, (September 1997).

Gas Turbine Group

Background

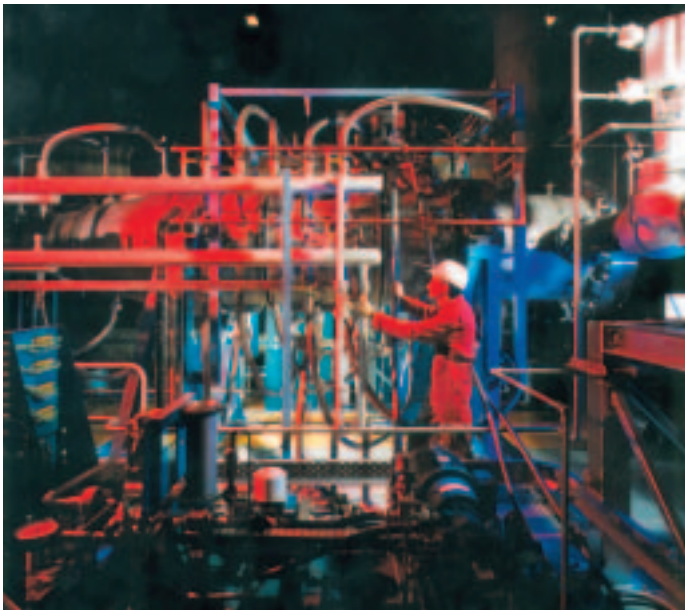
This new group was formed to address all aspects of gas turbine technology including aerodynamics and combustion, materials and lifing, control, system optimisation, balance of plant, and mechanical design and manufacture. The starting point for the group was the November 1999 Foresight Report.

Scope

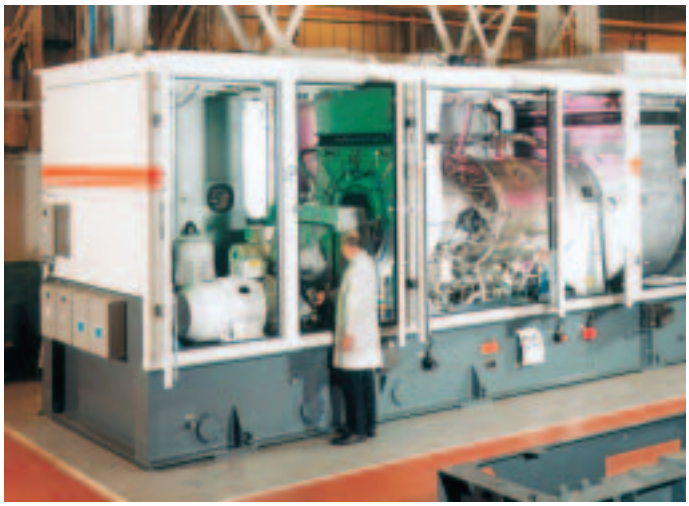
The group has agreed to concentrate on machines up to 100MW, as this is the size range produced by UK industry.

Composition

The group currently comprises representatives from Rolls-Royce, National Power, PowerGen, ALSTOM Power, Cranfield University and Leeds University and will be expanded to include EPSRC and DTI representation.



High Pressure Gas Turbine Combustion Rig (courtesy ALSTOM Power)



Tornado Gas Turbine, Sonatrach Mesdar, Algeria (courtesy ALSTOM Power)

Progress

Two meetings have been held. It has been agreed that the RTDD programme should be focused on the near term with long term research accounting for 20% of the programme.

The group identified the following main areas of work over a 10 year timescale:

- Political/environmental concerns
- Revolutionary product development
- Competitive threats
- Evolutionary product development

For the generators the priority is increased efficiency at reduced cost.

The group has also reviewed opportunities for external funding, especially those associated with the EU Framework RTDD Programmes within which it is recognised that the gas turbine, of all sizes and applications, will be a critical technology to meet the energy demands of the 21st Century. A major issue to be addressed will be the interaction of national and EU programmes, especially in relation to US RTDD programmes that allow the US to take a commanding position internationally.

Future Plans

The APGTF's activities in the coming year will be closely aligned to the timetable and milestones for the latest round of Foresight. Foresight panels will be preparing reports incorporating feedback from debate between April and November 2000, allowing the Foresight Steering Group to produce an overarching report. As part of the process of report and consultation, the Task Force will hold a two-day 'Power Generation Forum' in London in September 2000. At this event, the Task Force's activities will be introduced and reviewed, and in particular the final version of the consultation 'vision' document will be presented for discussion and comment. Following this, a strategic advanced power generation futures document will be prepared, and the main conclusions submitted to the Foresight ENE Panel.

The Task Force will continue to review progress with UK and European Research programmes, in particular seeking to influence the form and content of the EU Sixth Framework programme. It will continue to argue the case for research programmes that will result in benefit to the Energy Industrial Sector in the UK. A critical area in this respect will be that of Gas Turbine Plant and System Technology, increasingly becoming accepted as a key issue for the 21st Century.

Representatives from the Task Force will participate in EPSRC's review of its general programme in relation to the UK energy sector. The Task Force will also continue to develop its dissemination activities.

The Task Force has been well supported since its initiation and it will continue to operate at the same level of activity throughout the forseeable future. The number and composition of the technical groups will be kept under review and will reflect the changing priorities and requirements of the sector in time.

South Humber Bank 1,260 MW Combined Cycle Power Plant (courtesy ALSTOM Power)

Membership

Membership of Advanced Power Generation Task Force February 1999 – March 2000

Chairman:
Mr N R Otter, Director, Technology and External Affairs, ALSTOM Power

Secretary:
Dr M Mordecai, Consultant

Representing BEAMA/PGCA:
Mr A R Marshall, Advanced Coal Technology Manager, Mitsui Babcock Energy Ltd
Mr M Browne, ABB Combustion Services Ltd (to October 1999)
Mr W P Setchfield, Chief Executive, ME Engineering Ltd

Representing CHPA:
Mr N O'Sullivan, Rolls-Royce Industrial & Marine Power Ltd (to December 1999)
Mr J F Clark, Head of Advanced Engineering Centre, Rolls-Royce plc (from January 2000)

Representing the Electricity Association:
Dr A Oliver, National Power plc (to October 1999)
Mr M Evans, Plant Engineering Manager, National Power plc (from November 1999)
Dr J Billingsley, Branch Manager Structural Integrity, Power Technology Centre, PowerGen plc

Representing the University Network:
Mr J E Oakey, Manager, Power Generation Technology Centre, Cranfield University

Representing DTI:
Dr A J Heyes, Deputy Director, Sustainable Energy Policy Unit

Representing OST:
Mr J Rogers, Foresight Directorate

Representing EPSRC:
Mr L Atwood, Engineering Programme – Energy (from April 1999)

Representing COALPRO:
Mr G Mouseley (from June 1999)

Representing Oil/Gas Sector:
Dr D Brown, Leader, Power Generation Technologies (from March 2000)

Representing Technical Groups:
Dr D Pollard, ALSTOM Power
Mr M Evans, National Power
Dr D H Allen, ALSTOM Power

Technology Foresight Programme Publications

(i) OFFICE OF SCIENCE AND TECHNOLOGY, *Progress Through Partnership – Report from the Steering Group of the Technology Foresight Programme* (HMSO, 1995), 126pp

(ii) ——, *Progress through Partnership, 13, Energy* – Report from the Energy Panel (HMSO, 1995), 126pp

(iii) ——, *Progress through Partnership, Advanced Combined Cycle and Gas Turbine Technology* (HMSO, 1996), 4pp

(iv) ——, *Progress through Partnership, Clean Coal Power Generation* (HMSO, 1996), 4pp

(v) ——, *Winning through Foresight – Action for Energy* (DTI, 1997), 16pp

(vi) ——, *Foresight for Energy – Advanced Combined Cycle/Gas Turbine Technology* (DTI, 1998), 12pp

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NOTE: Most Foresight publications are available at *www.foresight.gov.uk/publications*, UK Government publications at *www.dti.gov.uk*

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Back Cover: Meri-Pori, Finland – Advanced Supercritical Pulverised Fuel Plant (courtesy Mitsui Babcock Energy Ltd)

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ADVANCED POWER GENERATION TASK FORCE

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