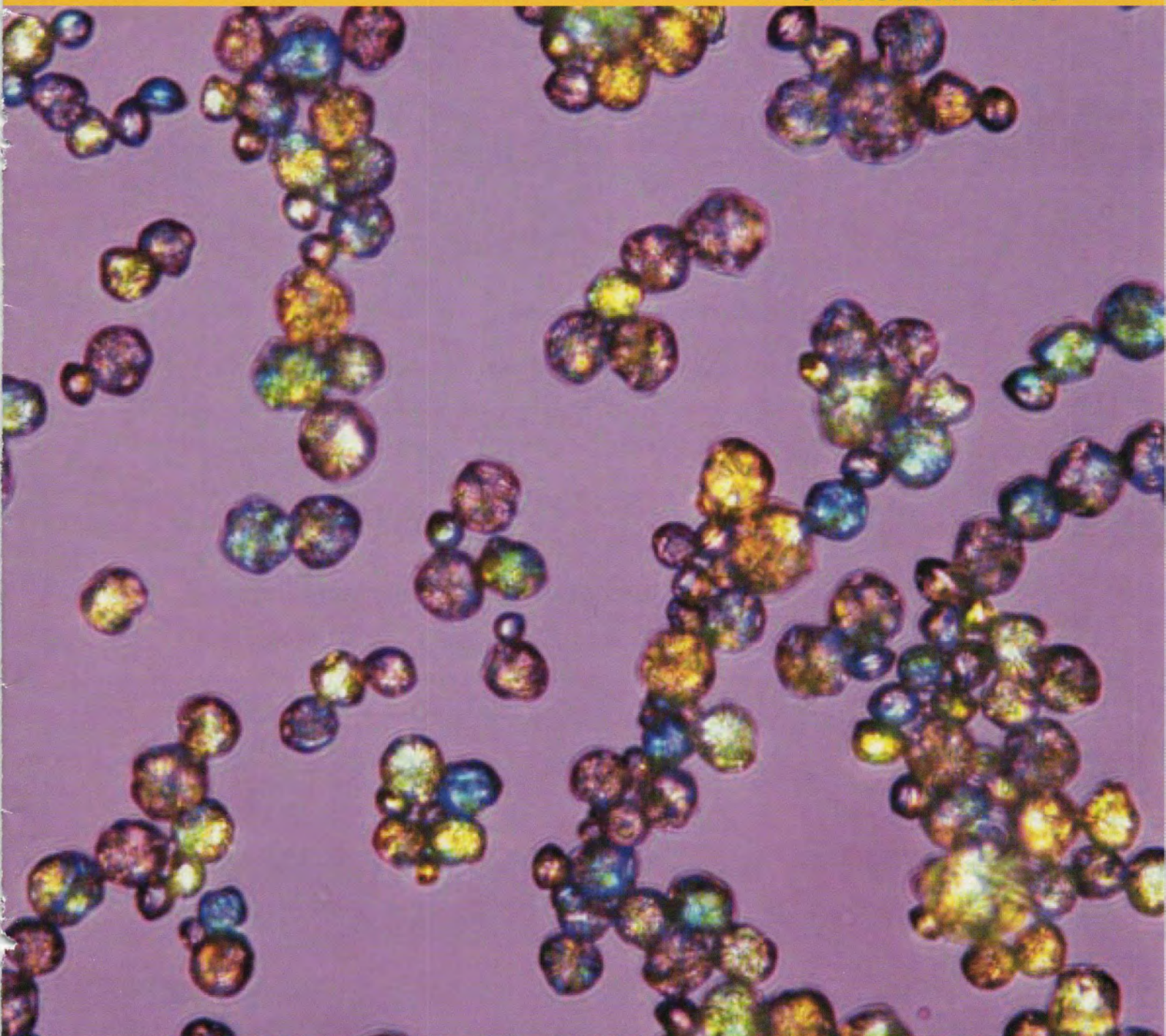


energy world

JANUARY 2005



Heat storage in buildings

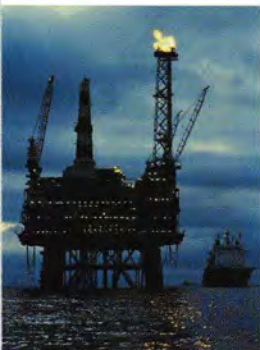
Emissions trading in Europe

'Verbund' CHP in Germany

published by



El Oil and Gas Training 2005



NEW COURSE

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8 February 2005, London

El member: £550 (£646.25 inc VAT) Non-member: £650 (£763.75 inc VAT)

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Who should attend?

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For more information please contact Nick Wilkinson

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Cover

Microcapsules of paraffin wax (pictured here through a microscope) can be incorporated into building structures and used as latent heat stores, as chemicals company BASF demonstrates on page 17. The addition of heat storage can help a lightweight building perform more like a heavyweight structure, smoothing out temperature peaks and reducing the need for heating and air conditioning. The company makes extensive use of CHP plants to fuel its manufacturing plants in Germany.



Published by

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Printed by

Thanet Press Ltd, Margate, Kent

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Opinions expressed in *Energy World* are those of the authors individually and do not necessarily express the views of the Energy Institute as a corporate body.

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Energy World is circulated free of charge to all paid-up members of the Energy Institute.

To libraries, organisations and persons not in membership, it is available on a single subscription of £115 for 10 issues in the UK and £135 for overseas subscribers. Agency Commission – 10%. ISSN 0307-7942

Energy World is printed on wood-free, chlorine-free pulp sourced from a sustainable forest.

Energy Institute
Registered Charity No. 1097899
61 New Cavendish Street, London
W1G 7AR, UK

Is the UK on track to meet energy efficiency targets?



*Philip Sellwood,
Chief Executive,
Energy Saving Trust*

In 2003, the Government published the Energy White Paper. For the first time, energy efficiency was placed at the heart of the UK's energy and climate change policies. Ambitious targets were set to reduce carbon dioxide emissions by 60% by 2050. The Government's existing goal of reducing carbon dioxide emissions by 20% by 2010 remains in place.

At the Energy Saving Trust (EST), we were greatly encouraged by the targets set and by many of the policies put in place to deliver them. But there are clearly doubts that the Government will reach its near term 20% emission reduction target by 2010. A report published by the Environmental Audit Committee earlier this year found that the Government's environmental policies were progressing somewhat slower than hoped. Of course, this target will be reached (or missed) through activity in every sector – business, transport, households – and by looking at households alone we can identify the areas of real weakness.

The domestic sector

In the household sector, Government plans to cut carbon dioxide emissions by 4.2 million tonnes of carbon per year by 2010 and we are fully supportive of this goal. However, despite the comprehensive policies and activities outlined, we know there is a considerable job to be done (by EST and others) to persuade consumers to make sustainable choices in all of their energy related behaviours.

The major policy for encouraging consumers to take up energy efficiency measures, like insulating their cavity walls and lofts and installing condensing boilers, low energy kitchen appliances and lighting, is through the Energy Efficiency Commitment (EEC). The EEC requires energy suppliers to offer consumers discounted energy saving measures, but the success of this policy depends on consumer willingness to take them up.

The EEC has been in place since 2002 and some elements of it have been extraordinarily successful. For example energy A-rated appliances (fridges and washing machines) have flown off the shelves as suppliers have reduced the costs to a point where it would make no sense to buy anything else. But the offers on cavity wall insulation have not been so successful, even at half price. So why is this, when cavity wall insulation saves the most energy and carbon dioxide per home? Put simply, householders don't think of it as something they need. It is so optional as not to be a real option for many people.

We therefore need to do something that will make householders want to install it. Marketing is important, but we know consumers are suspicious of energy saving messages from energy supply companies, so that is where EST has an increasing role. We have run a series of local marketing pilots in areas of high density cavity wall housing which have shown some

success. But, with 15 million homes still with unfilled cavities, we need more than this, and we believe it should be on a national scale. That is where fiscal incentives come in.

Fiscal incentives

There have been some encouraging measures introduced in the last few Budgets which have offered reduced VAT on a range of technologies, and have particularly helped reduce the costs of the Government funded Warm Front programme, which installs energy efficiency measures into fuel poor homes. In the last Budget the Chancellor announced a commitment to reduce VAT on ground source heat pumps. These use the warmth of the ground to heat the home, thereby making energy and carbon dioxide savings as homes replace part of their fossil fuel energy supply with a renewable one.

The Treasury also announced that private landlords would be offered upfront relief on capital expenditure on energy efficiency. This will lead to reduced fuel bills and improved comfort for tenants. But what we haven't seen is an incentive that takes a 'whole house' approach, offering all householders an incentive to take a good look at the total structure of their property and install invisible energy saving measures like cavity wall insulation.

EST believes that an incentive on Stamp Duty to refund money to householders who introduce energy saving measures in their home would be highly effective. Three million people move home annually in the UK, so this market has real potential. A welcome development has been the new Housing Act, passed in November 2004. Under the provisions both of the Act and of European law, all homes will require an energy performance assessment when sold. This will include recommendations on cost-effective energy efficiency improvements and is likely to form part of the proposed Home Condition Report, which comes into force in 2007. We believe that linking this advice to a Stamp Duty rebate would be a very powerful encouragement for householders to make those energy saving improvements.

With a combination of more advice to consumers and fiscal measures to complement EEC, we believe that the Government could achieve the household emission reduction target of 4.2 million tonnes of carbon per year by 2010, but without them it will be a struggle.

The Energy White Paper targets are achievable and we should continue to strive for them, but we – consumers, energy suppliers and Government – must work together to reduce the effects that reckless energy use is having on our environment. ●

For free, impartial advice on how to make your home or car more energy efficient and save money on fuel bills, visit www.est.org.uk

Kyoto Protocol becomes legally binding on 16 February

The European Environment Agency (EEA) The Kyoto Protocol will become legally binding on its 128 Parties on 16 February, following the receipt by the United Nations Secretary-General in November of the Russian Federation's instrument of ratification.

"A period of uncertainty has closed. Climate change is ready to take its place again at the top of the global agenda," said Joke Waller-Hunter, Executive Secretary of the Climate Change Secretariat, which services the UN Climate Change Convention and its Kyoto Protocol. The Protocol's entry into force means that, from 16 February:

The Arctic is warming much more rapidly than previously known, at nearly twice the rate as the rest of the globe, according to the results of a four-year study of the region conducted by a team of 300 scientists. At least half the summer sea ice in the Arctic is projected to melt by the end of this century, along with a significant portion of the Greenland Ice Sheet, as the region is projected to warm an additional 4–7°C by 2100. These changes will have major global impacts, such as contributing to global sea-level rise, according to the final report of the Arctic Climate Impact Assessment (ACIA).

The assessment was commissioned by the Arctic Council (a ministerial intergovernmental forum comprised of the eight

- 30 industrialised countries will be legally bound to meet quantitative targets for reducing or limiting their greenhouse gas emissions;
- the international carbon trading market will become a legal and practical reality – the Protocol's emissions trading regime enables industrialised countries to buy and sell emissions credits amongst themselves; this market-based approach will improve the efficiency and cost effectiveness of emissions cuts;
- the Clean Development Mechanism (CDM) will move from an early implementation phase to full operation –

Arctic countries and six indigenous peoples' organisations) and the International Arctic Science Committee.

The projections are based on a moderate estimate of future emissions of carbon dioxide and other greenhouse gases, and incorporate results from five major global climate models used by the IPCC.

Warming over Greenland is projected to lead to substantial melting of the Greenland Ice Sheet, contributing to global sea-level rise at increasing rates. Over the long term, Greenland contains enough melt water to eventually raise sea level by about 7 m. Should the Arctic Ocean become ice-free in summer, it is likely that polar bears and some seal species would be driven toward extinction.

the CDM will encourage investments in developing country projects that limit emissions while promoting sustainable development; and

- the Protocol's Adaptation Fund, established in 2001, will start preparing itself for assisting developing countries to cope with the negative effects of climate change.

Under the Protocol, industrialised countries are to reduce their combined emissions of six major greenhouse gases during the five-year period 2008–2012 to below 1990 levels. The European Union, for example, is to cut its combined emissions by 8%, while Japan should reduce emissions by 6%. For many countries, achieving the Kyoto targets will be a major challenge that will require new policies and new approaches.

Only four industrialised countries have not yet ratified Kyoto: Australia, Liechtenstein, Monaco and the United States. Australia and the US have stated that they do not plan to do so; together they account for over one third of the greenhouse gases emitted by the industrialised world. Developing countries, including Brazil, China, India and Indonesia, are also 'Parties to the Protocol' but do not have emission reduction targets, says the UN, but many developing countries have already demonstrated success in addressing climate change.

According to the Intergovernmental Panel on Climate Change (IPCC), the most up-to-date scientific research suggests that humanity's emissions of carbon dioxide and other greenhouse gases will raise global average temperatures by 1.4–5.8°C by the end of the century. They will also affect weather patterns, water resources, the cycling of the seasons, ecosystems and extreme climate events. Scientists have already detected many early signals of global warming, including the shrinking of mountain glaciers and Arctic (see box) and Antarctic sea-ice, reduced ice cover on lakes and rivers and longer summer growing seasons.



The first dual fuel 'HotModule' fuel cell unit from Germany's MTU CFC Solutions has gone into demonstration service at a CHP district heating plant in Berlin. The plant, which can run on natural gas and methanol, should demonstrate that the technology is not dependent on existing gas networks, but can also operate on liquid fuels, in this case derived from wastes generated in the city. The plant, based on technology from the US-based FuelCell Energy Inc, can produce 230 kW of electricity and 180 kW of heat at 400°C.

Current unsustainable energy trends 'deeply troubling' – IEA

The earth contains more than enough energy resources to meet demand for many decades to come. The world is not running out of oil just yet. Moreover, there is more than enough money globally to finance the large expansion of energy infrastructure that will be needed. But soaring oil and gas prices, the increasing vulnerability of energy supply routes and ever-increasing emissions of climate-destabilising carbon dioxide are "symptoms of a considerable malaise in the world of energy." So said Claude Mandil, executive director of the International Energy Agency (IEA) as he presented the *World Energy Outlook 2004*, which contains the IEA's latest energy projections to 2030.

Mandil called for more vigorous action to "steer the global energy system onto a

more sustainable path."

He described the inexorable increase in global energy demand from now till 2030 that the WEO predicts – as well as our continuing heavy reliance on carbon-emitting fossil fuels – as "deeply troubling."

In the Outlook's reference scenario, which projects energy trends in the absence of new government policies or accelerated deployment of new technology, world primary energy demand is set to rise by 59% from now till 2030. Some 85% of that increase would be in the form of carbon-emitting fossil fuels: coal, oil and natural gas. Two-thirds of the new demand would come from the developing world, especially China and India.

Demand for oil would continue to expand, at 1.6% a year, from 82 million barrels per day (mb/d) today to 121 mb/d in 2030, and inter-regional trade in oil would double to 65 mb/d. Most of that additional trade would have to pass through vital chokepoints, sharply increasing the possibilities of a supply disruption. More and more oil would come from fewer and fewer countries, primarily the Middle East members of Opec.

Gas use is projected to double by 2030, largely because it will be the fuel of choice for electric power generation. Coal would continue to supply a fifth of world energy needs, mostly in power generation and

increasingly concentrated in China and India.

Nuclear power would grow very slightly, decreasing in Europe while advancing in Asia. Use of non-carbon-emitting renewable energy sources would triple, but would still account for only 6% of world electricity production in 2030.

"These trends are, however, not unalterable. Our analysis shows that more vigorous government action could steer the world onto a markedly different energy path", said Mandil. World energy demand is 10% lower and carbon-dioxide emissions 16% lower in an 'alternative policy' scenario. The world's reliance on Middle East oil and gas are also much reduced. "Yet, even in this alternative scenario, energy imports and emissions would still be higher in 2030 than today and would still be growing."

"What this analysis shows very clearly", he added, "is that achieving a truly sustainable energy system will depend on technological breakthroughs that radically alter how we produce and use energy." He called on governments to take the lead in accelerating the development and deployment of new technologies "that allow us to meet our growing energy needs without compromising our energy security and the environment."

Order a copy of *The World Energy Outlook 2004* from IEA Books, www.iea.org/books

First wind project for Pakistan, new farms for Italy, Spain and Canada

The US-based Wind turbine supplier GE Energy has announced major new contracts to develop wind farms in Italy and Spain, and to launch the first commercial wind farm project in Pakistan.

In Pakistan, New Park Energy Phase 1, a 45 MW installation will be the first phase of a 400 MW wind project, has been approved by the government through its Alternative Energy Development Board (AEDB). GE has been selected to provide 30 of its 1.5 MW wind turbines for phase 1 and NPE has committed to work with the company eventually to reach a goal of 1,000 MW of generating capacity.

Pakistan's government has set a goal to have 10% of the country's energy produced from renewable sources by the year 2015. AEDB has forecast the installation of 1800–2700 MW of wind power capacity by 2015. The New Park project will be located near Port Qasim and will provide electricity to the Karachi Electric Supply Company to help support residential and industrial expansion in the Karachi area.

Meanwhile, GE Energy is also to supply forty-two 1.5 MW wind turbines for five

wind projects in southern Italy that will add 63 MW of capacity for the Italian power grid. All of the projects are in Troia, 180 km northeast of Naples and is one of the windiest areas of Italy. In addition to supplying and installing the wind turbines, GE will perform operation and maintenance services for five years. All five projects are expected to be completed by the beginning of 2006.

GE Energy has also completed the installation of 198 of its 1.5 MW wind turbines for projects across the Castilla La Mancha region of central Spain. The turbines were installed in groups of 33 units at each of six sites in Cuenca, a province of the Castilla La Mancha region. The wind turbines were supplied by GE under an agreement with Energía Hidroeléctrica de Navarra, S.A. (EHN), a Spanish renewable energy developer that is responsible for the turnkey construction of the wind farms and their operation and maintenance. EHN's original stake in these wind projects subsequently was transferred to Iberdrola S.A., Spain's second largest power company.

The Castilla La Mancha wind energy projects support the country's goal to increase its wind power capacity to 20,000 MW of capacity by year 2010.

Last, wind turbine erection is underway at the Bodenaya Wind Plant, an 18 MW wind project being built in the Spanish coastal principality of Asturias – GE Energy was chosen to supply 12 of its 1.5 MW wind turbines for the project.

Meanwhile, Denmark's Vestas Group has received an order for 83 of its 1.8 MW

wind turbines from SaskPower International in Canada. The turbines will be installed at a wind farm being built in southwestern Saskatchewan.

In a separate development, Germany's Siemens Power Generation (PG) has entered the international wind industry with the acquisition of one of the five major suppliers of wind energy systems worldwide: Danish turbine supplier Bonus Energy A/S. Bonus, which has installed more than 5,000 turbines with an aggregate capacity above 3 GW in twenty countries, also supplied the world's largest offshore wind farm to date, with a capacity of 166 MW, located at Nysted in Denmark.

Energy Manager of the Year

Entries are now being accepted for the NEMEX Energy Manager of the Year award – see insert for more details.

Nominees can propose themselves or a colleague, and should submit a 300-word synopsis entitled 'Why I should be Energy Manager of the Year', to highlight their achievements.

The winner will be announced at the annual NEMEX gala dinner, to be held in Birmingham on 24 May 2005.

The deadline for nominations is 4 March 2005. Submissions should be sent to Gill Haben at the E.I. t: +44 (0)20 7467 7135 e: ghaben@energyinst.org.uk

Alstom, Siemens build hydropower plants in China

Alstom has signed four contracts with a combined value of €357 million to provide power generating equipment for three pumped storage projects in China. The three projects cover the design, manufacturing and supervision of building and commissioning of sixteen 306 MW reversible pump-turbine/motor-generator units and auxiliaries. Equipment will be manufactured in Alstom's facilities in Brazil, China, France and Switzerland.

The first contract is for the supply of eight 306 MW units for the Huizhou Pumped-Storage Power Station, located in China's southern Guangdong Province, for Guangdong Pumped Storage Co, Ltd. The second covers the supply of four units for the Bailianhe Pumped-Storage Power Station, located in central Hubei Province. In the third contract, the State Grid Henan Baoquan Pumped Storage Co, Ltd has ordered four 306 MW units for the underground powerhouse of the Baoquan Pumped-Storage Power Station located on the Yuhe River in central Henan Province. The fourth contract concerns the



Artist's impression of China's Laxiwa hydropower project – the largest on the Yellow River transfer of technology.

Alstom has also been awarded two contracts worth around €37 million for Francis turbine/generator units in the Hunan Province in southern China.

Meanwhile, Voith Siemens Hydro Power Generation Shanghai has been awarded a contract to supply five Francis turbines rated at 711 MW each for the Laxiwa hydropower project. The Laxiwa hydropower project, located at the upper stream of Yellow River in Qinghai Province, is part of the National Hydro Power Development Program to utilize the hydropower resources in the western region of China and transmit the energy to the eastern areas. After completion in

2011, the project will be the biggest hydropower station along the Yellow River.

The Chinese government has expressed its support for Tidal Electric's proposed 300 MW offshore tidal lagoon in the waters near the mouth of the Yalu River by signing an agreement pledging to cooperate with the development. At 300 MW, the project would be the largest tidal power project in the world, topping the 240 MW French tidal power plant in LaRance, Brittany. The next steps for the project are to conduct engineering feasibility studies similar to those that were recently concluded in the UK for Tidal Electric's Swansea Bay project.

Four new CCGTs for China

In a consortium with Shanghai Electric Group Corporation (SEC), Siemens Power Generation (PG) has secured orders from four Chinese utilities to supply nine gas turbines for four gas-

fired combined cycle power plants in China.

PG will supply six V94.3A-gas turbines for three combined cycle power plants at the Zhengzhou, Xiaoshan and Zhongyuan locations. Each of the plants, comprising two gas turbine engines, will have a capacity of 700 MW. In Shidongkou, three turbines will be deployed in three combined-cycle units. The capacity of this plant will be 1,050 MW.

Worldwide, China is the power plant market with the highest growth rate, says Siemens, which has equipped 17 power plants in China in the last ten years.

Largest PV system in Thailand

Shell Solar has installed Asia Pacific's largest (460 kWp) rooftop solar photovoltaic system at TESCO-Lotus' latest supermarket, in Bangkok, Thailand. Occupying nearly 8,000 m² of the total roof area, the system will feed power to the Metropolitan Electricity Authority (MEA) grid via three 150 kVA inverters, as well as supplying the on-site load. The system will supply around 12% of the buildings' annual consumption.

Sakhalin to supply LNG to Japan and west coast US

The Sakhalin Energy Investment Company Ltd (Sakhalin Energy), developer of Russia's Sakhalin II project, has signed an agreement for the supply of 1.5 million tonnes of LNG per year for 22 years to Tokyo Electric Power Company – Japan's largest power company.

LNG will be supplied to Tokyo Electric from Sakhalin Energy's major new LNG plant, which is under construction at Prigorodnoye on Aniva Bay on the

southern tip of Sakhalin, just two and a half day's sailing from Tokyo Bay in Japan. It is the first LNG plant to be built in Russia and will have a total capacity of 9.6 million tonnes per annum.

Previously, Sakhalin Energy signed an agreement to supply 37 million tonnes of LNG over a 20 year period to Shell Eastern Trading Ltd (Shell) for the North American natural gas market. This represents the

first sales of Russian natural gas to North America.

The landmark deal also marks the beginning of Sakhalin Island as a strategic new source of natural gas for both Mexico and the US West Coast markets, says Shell. It confirms Sakhalin Energy as a world-class player in the LNG market, and firmly places Russia in a new strategic position as a global supplier of natural gas.

LNG from Sakhalin Energy will be purchased by Shell to supply the new Energia Costa Azul plant that will be constructed in Baja California, Mexico. Sakhalin Energy will also provide the ships to deliver the LNG to the Baja California terminal.

Brown announces new moves to improve energy efficiency

Secretary of State for the Environment, Margaret Beckett, has welcomed Chancellor Gordon Brown's December Pre-Budget Report, which emphasised the need to tackle climate change as a key pri-

ority among several global challenges. The Report included two new initiatives designed to help deliver the increase in energy efficiency discussed in the *Viewpoint* article on page 2.

Announcements included:

- a new Energy Efficiency Innovation Review to examine how technological, policy, financial and organisational innovation can best contribute to a step change in national energy efficiency performance;
- a new, £20 million fund to accelerate energy efficient technology managed by the Carbon Trust and designed to help focus the growing public and private investment in this area, by fostering new partnerships to accelerate energy efficient technology;
- a package of measures to support the development of biofuels, including a feasibility study and consultative process on a 'Renewable Transport Fuels Obligation'; and
- reforms to make the system of company

car tax more environmentally sensitive.

The Energy Efficiency Innovation Review, to be undertaken jointly by Defra and the Treasury, will examine how innovation, by Government, business or consumers, can best contribute to a longer-term step-change in energy efficiency. Results will feed into the review of the UK Climate Change Programme, says Defra.

Meanwhile, the new £20 million fund will provide a focus for public and private investment in energy efficiency, and will help to build new partnerships between experts from business, research and policy-making. Trade and Industry Secretary Patricia Hewitt said: "The UK has world class research strengths in the science underpinning energy efficient technology. This fund will help us capitalise on those strengths and continue the transition to a low carbon economy."

John Healey, Economic Secretary to the Treasury, said: "The innovation review and R&D fund will help deliver the step change in energy efficiency we need."

Record year for UK wind industry

Last year (2004) should prove to have been a record year for the UK wind industry, and expansion out to 2010 should result in some £7 billion of new investment into the sector, according to data released by the British Wind Energy Association in November. BWEA records showed that:

- 10 new wind projects were commissioned by November 2004, totalling 240 MW of new capacity, with two more to be commissioned by the end of the year – representing almost three times last year's build;
- 18 wind projects were under construction, totalling over 600 MW – this new capacity is all scheduled to be commissioned in 2005;
- in 2004, some 33 new wind projects were approved through the planning system, totalling 800 MW of new capacity – this represents an 83% approval rate for projects determined the year; and



Eight 2 MW wind turbines from Germany's REpower Systems AG are to replace ten 300 kW machines currently installed at the Caton Moore wind farm near Lancaster, northern England, following a successful planning appeal. The new turbines, which had to come in beneath a 90 m tip-height restriction, will increase the rated output of the farm from 3 MW to 16 MW. The installation contract is the second multiple-turbine awarded to REpower UK Ltd, the joint venture between engineering company Peter Brotherhood Ltd and REpower Systems AG, since its formation a year ago.

- 94 onshore projects were in planning, representing 4,767 MW of capacity, equal to 5% of the nation's electricity needs.

Looking forward to 2010, BWEA released new findings following a survey of six major companies at the centre of the development of wind power. The survey showed that, by 2010 it is predicted that there will be some 7,500 MW of wind power installed in the UK; half onshore and half offshore. This represents some 7.5% of the nation's electricity needs, and approximately three-quarters of the Government's 2010 renew-

able energy target.

Marcus Rand, BWEA Chief Executive said: "These are exciting times for the wind industry. At long last we are developing a healthy and vibrant market here in the UK, the windiest nation in Europe. This year has been a record breaking one for the industry and the indications are that next year will be even bigger."

In one 24 hour period in October, over 300 MW of new wind power capacity was approved in Scotland and Wales, three times as much as was built during the whole of 2003.

First gas production from Goldeneye

Gas production from the Goldeneye gas condensate field in the Outer Moray Firth, 100 km north of St Fergus on the North-east coast of Scotland commenced in October, says Shell U.K. Limited (Shell) on behalf of co-venturers Esso Exploration and Production UK Ltd, Paladin Resources plc and Centrica Energy.

Kieron McFadyen, Technical Director for Shell Exploration & Production in Europe said: "The £300 million Goldeneye project

has commenced production safely, on time and on budget, demonstrating world class project delivery. Goldeneye will provide around 3% of the gas for the UK, so will make a significant contribution to securing energy for the UK in the future, as the country becomes a net importer of gas. Plateau gas production is estimated to be some 300 million standard cubic feet of gas and associated liquids a day."

The Goldeneye field was initially

regarded as economically marginal, mainly due to the distance from more existing infrastructure. However, Shell engineers came up with an innovative solution of transferring gas and condensate at reservoir pressure from an unmanned platform to the onshore processing Shell/Esso facility at St Fergus. The pipeline is 105 km in length, making it the longest such pipeline in the UK Continental Shelf.

Home condition reports will include energy efficiency

Energy efficiency campaigners have been celebrating the passage of the Housing Bill through the House of Lords – particularly as an amendment that calls for a 20% improvement in the energy efficiency of UK homes by 2010 was included at the last moment. The Bill will now go forward for Royal Assent and is almost certain to become law.

The Bill includes the compulsory requirement for a 'Home Information Pack' to be prepared before a home is put up for sale. Home Information Packs will include a range of information for potential purchasers, including a Home Condition Report which is designed to be an objective survey of the condition of the property that can be relied upon by buyers, sellers and mortgage lenders. Home Condition Reports will include information on the energy efficiency of the building.

The breakthrough was welcomed by SAVA, the organisation that promotes higher standards in residential surveying and is leading the way in the training, assessment and development of

services for the emerging Home Inspector market.

Managing Director Brian Scannell said: "This is excellent news and means that all of the work that has been done over the past two years is now going to bear fruit. The icing on the cake was that the Government introduced an amendment that calls for a 20% improvement in the energy efficiency of the residential sector by 2010. This indicates that, at the very least, the Energy Efficiency Commitment (EEC) scheme will continue past 2008 at a reasonable level. Similarly, through the introduction of energy reports within Home Condition Reports, the UK will fulfill its legal obligations under the EC directive on the energy performance of buildings and we will at last be able to measure and start to improve the energy efficiency of our existing housing stock."

The Government has stated that it needs over 7,500 Home Inspectors in place by 2007 to support the production of Home Information Packs.

Clear Skies ahead to 2006

The Government's Clear Skies scheme for funding renewable energy technology for communities, not-for-profit organisations and households, has been extended to March 2006 with £2.5 million of additional funding. This brings total funding for the scheme, which is funded by the DTI and managed by the BRE, to £12.5 million.

Cornwall's Eden Project has joined the hundreds of not-for-profit organisations – local authorities, housing associations, schools, hospitals and many others – to successfully apply for Clear Skies grant support for installing renewable energy technology. The scheme is supporting the installation of biomass technology to provide energy for the Eden Project's new education resource centre.

A hydro turbine at Derwentwater YHA Hostel, and solar thermal systems for 53 social housing units in the London borough of Sutton, are two other examples of the 42 projects offered support following the latest (sixth) round of applications. Projects from round six were awarded a total of nearly £700,000.



The last of more than 71,000 fuel elements has been removed from the two reactors at Hinkley Point A nuclear power station and transported to Sellafield in Cumbria for reprocessing. Completion of the defuelling project, which was completed four months ahead of schedule, marks a significant milestone in the decommissioning the Magnox station that closed in 2000. Defuelling started in December 2001.

The despatch of the final flask means that around 99% of the radioactivity has now gone from the site, says the British Nuclear Group

Companies move to keep UK trading scheme on track

Six companies involved in the much criticised UK Emissions Trading Scheme have offered to provide an additional 8.9 million tonnes of carbon dioxide equivalent emissions reductions as a way to keep the UK scheme on track. (The EU's own emissions trading scheme started this month.)

The voluntary UK Scheme began in 2002 with 32 companies pledging to cut emissions of greenhouse gases by 11.9 million tonnes of carbon dioxide equivalent before the end of 2006. But, says Defra, in the first two years, many participants were able to achieve emissions cuts beyond initial expectations. This has resulted in a surplus of low value emissions reductions allowances in the UK emissions market. Six companies: Ineos Fluor, Rhodia Organique Fine, INVISTA Textiles, BP, British Airways and Lafarge Cement – have now offered to increase their collective emission reductions by almost 280%.

The move follows recent criticism of the

UK Scheme by the Public accounts Committee. Chairman Edward Leigh MP said that, although the Scheme had led to substantial reductions in emissions of greenhouse gases, it was disappointing to find that this could have been achieved at lower cost to the taxpayer.

The Committee said that some participants had been rewarded with incentive funding from Defra for emissions reductions which they had achieved before the Scheme began, and that Defra should seek concessions from Scheme participants who have benefited unduly – to deliver additional emissions reductions and maintain confidence in the Scheme.

The Committee added that only 34 companies participated in the Scheme in the end, although Defra had originally estimated that up to around 3,000 companies might benefit. Despite the small number of participants, Defra did not reduce the amount of planned incentive funding from £215 million.

Production ends at giant Selby coalfield

Coal production at the giant Selby coalfield in North Yorkshire ended in October last year as the last of over 260 faces to be worked during the past 21 years ran out of coal, says owner UK Coal. Riccall was the last of the original five mines to cease production, its remaining workforce of 160 people is now being progressively reduced as work on salvaging equipment, sealing off old workings and capping the two shafts is completed. Operations are also being phased out at Gascoigne Wood, the surface location that has processed and despatched Selby mine output to customers. About 90 employees are affected by the cessation of operations there.

It took a decade and £1.4 billion of investment to get the Selby Complex into full production, but only once in its 21 year history did the complex achieved the 12 million tonne annual output it was designed to produce, says UK Coal. Nevertheless, more than 121 million tonnes of coal, accessed by 460 miles of underground roadway have been recovered since the Selby complex began production in June 1983.

But, after accumulating losses of around £100 million over three years, the owners announced in July 2002 that mining operations were to be phased out.

Of the 1,900 people who worked at the complex at that time, around 300 have or will be transferred to other collieries, principally Kellingley in West Yorkshire. Others, having opted for redundancy or early retirement, have taken advantage of the biggest re-training programme ever launched to assist in the regeneration of an area affected by job losses and the closure of an industry. More than 1,530 employees have received assistance ranging from skills analysis to retraining.

The six Selby sites could become small business parks, encouraging new employment opportunities in the area if plans for the re-use of offices, stores and workshops are agreed by the local authority. UK Coal

remains Britain's biggest coal producer. With the cessation of production at Riccall, the company will have eight deep mines in operation – in the North East, Yorkshire and the East and West Midlands



Artist's impression of Manchester's Co-operative Insurance Society's HQ building as it will be once covered in solar photovoltaic (PV) panels. The CIS Tower, the tallest office building outside of London and a dominant feature on the Manchester skyline, will be host to the largest vertical solar cladding project in Europe and the largest solar power system in the UK.

PV company solarcentury has provided the design expertise for the project from the outset and will supply the technology and advise the project team on the integration of the solar array into the building. The solar modules will be manufactured by Sharp, a solarcentury technology partner. At 391 kW of installed power covering 3,200 m² and generating 180,000 units of electricity per year, this will be solarcentury's largest installation to date.

The £5.5 million project is being supported by grants from the Northwest Regional Development Agency and the DTI.

ConocoPhillips opens major CHP plant at Immingham

ConocoPhillips European Power Limited, a division of oil major ConocoPhillips, has inaugurated its new, 730 MW Immingham CHP plant in North Lincolnshire. The £350 million plant, said to be the largest and most technologically advanced facility of its kind in Europe, will reduce the company's utility cost at the Humber refinery by around 30%.

The Immingham plant has been developed very much 'against the run of play' that has seen the development of large-scale industrial CHP plants come to halt in

the last 3-4 years due to unfavourable gas versus electricity prices and market arrangements to sell excess power. CHP Association Director David Green said: "The ConocoPhillips CHP team are to be congratulated for their tenacity and ingenuity in bringing forward this development which, as they have said, they would not even have considered in the market conditions which the Government has now created. The start of this plant also brings with it the news that, for the first time, no other such industrial CHP developments are being either planned, developed or commissioned in the UK."

The new plant nevertheless represents 14% of the remaining CHP capacity needed for the Government to meet its target of 10 GW of 'good quality' CHP by 2010.

Immingham CHP also helps set the stage for continuing industrial development of the South Humber Bank, adjoining one the best deep water ports in Europe, says ConocoPhillips, which has



One of the biggest in Europe – ConocoPhillips' 730 MW Immingham CHP

committed £10 million of capital to connect new industrial customers with steam and electricity locally.

Winter energy supplies 'sufficient' – NGT

Energy consumers can rest assured that there will be enough gas and electricity available to meet customers' needs for this winter, according to annual energy forecasts from National Grid Transco (NGT) published by Ofgem. A preliminary forecast, with very similar conclusions, was published last May.

For gas, the report says that, despite declining UK gas reserves, supplies can be maintained – even in a 'Siberian-style' winter expected only once in every 50 years – using a combination of UK supplies, gas imports, storage and, where necessary, demand-side response from large gas customers. Gas fired generators

alone could provide more than two thirds of the response required under severe winter conditions.

In electricity, NGT continues to forecast that it will meet winter peak electricity demand, with the return of some moth-balled plant in time for winter. The forecast 'safety cushion' stands at 20% and could rise to 22% if other available plant returns to the system. This compares with a margin of 16% at the same time last year.

Fewer, shorter power cuts, on average

Both the number and duration of power cuts continues to fall, according to energy regulator Ofgem's latest report on the quality of service performance of the 14 electricity distribution companies in Great Britain. The report covers the period between April 2003 and March 2004.

Since a quality of service incentive

scheme was introduced in April 2002, the average number of power cuts has fallen by 7%, and the duration of power cuts has reduced by 6%, says the report. There has also been an improvement in the quality of distribution companies' customer telephone response service which, on average, is rated by customers as 4.4 out of five. However, while standards overall have improved, performance varies across the country, leaving room for further improvements, says Ofgem.

In 2003/04, the best overall performer was Western Power Distribution (WPD). In recognition of WPD's strong performance

they will be rewarded with a 1% increase in revenues during the next distribution price control, due to take effect in April 2005. Scottish and Southern Energy and CE Electric also performed better than average overall.

Elsewhere, performance was more mixed, with all companies performing better in some areas and less well in others. This mixed performance is exemplified by EDF Energy Networks which improved performance in their EPN (Eastern) and LPN (London) areas, but whose SPN (South East) network was the weakest overall performer, says Ofgem.

Didcot power station to burn locally-grown biomass

ESD Biomass, the biomass-for-energy business, has launched its first commercial farmer's contract, called the 'Power Plant Contract', to secure specifically grown crops for power generation. Meanwhile, RWE npower has signed the first letter of intent for the use of willow as a fuel feedstock, along with coal, at Didcot power station in Oxfordshire.

Biomass is increasingly being trialled and fired in existing oil and coal-fire power stations to contribute to meeting the UK's obligations under the Kyoto agreement.

Power Plant Contracts will be issued to growers and landowners to ensure the supply of at least 30,000 tonnes per year of short rotation coppice willow for

renewable electricity generation, a figure requiring the cultivation of approximately 3,000 hectares of land.

Neil Bryson, Chairman of ESD Biomass, commented: "The long term agreement with RWE npower is a logical and timely step for the emerging biomass industry. It is economically efficient to use existing coal-fired capacity in this way rather than building dedicated facilities now – and helps to establish the fuel supply infrastructure for the future. Not only does the use of renewable sources such as willow have a significant impact on reducing carbon dioxide emissions, assisting energy suppliers to meet the renewable energy obligation, but

it also creates the opportunity to extend the life of existing conventional power plant."

Kevin McCullough, director of npower renewables said, "By March 2009, generators will have to make sure that an increasing proportion of the biomass they use comes from purposely grown energy crops including willow. This is the first time producers and a large energy generator have agreed a long term relationship to co-fire specifically grown energy crops within existing power stations, rather than just making use of biofuels that happen to be around."

Growers and landowners wishing to discuss contracts should visit www.esdbiomass.co.uk

Emissions trading: a new, carbon-constrained world order?

The carbon-constrained future is here now. The world's largest greenhouse gas emissions trading system comes into force this month and, while the extra red tape and cost that this will bring could pose a threat to business – particularly so against a background of significant increases in gas and electricity prices during 2004 – it also presents an opportunity to re-focus on energy and utilities management, in order to deliver ongoing improvements in efficiency and costs reduction. Here, Gareth Jones, Director of Organisational Carbon Management, ESD, considers what companies need to do to participate in the new world order.

Greenhouse gas emissions from human activities have an impact on the environment but, since they are a by-product of industrial processes and energy production, the costs of these impacts have not been borne by the polluter. In the language of economists such costs are 'externalities', implying that they lie outside conventional market structures.

The Kyoto protocol attempts to address this by agreeing national targets for emissions reduction by 2008-2012 and emissions trading is one of the 'flexible mechanisms' allowed under the protocol to help countries achieve these goals. The Kyoto protocol provides a framework for requiring systematic emissions reductions over time; emissions trading enables the market structures to place a price on carbon emissions reduction.

The protocol requires a critical mass of countries to ratify for its commitments to become binding – the aggregate greenhouse gas emissions of all Kyoto signatories must be at least 55% of the world total – but now that Russia has ratified, the threshold has been reached and the protocol will come into force in February this year.

Emissions trading in Europe

The EU, with 15% of global carbon dioxide emissions, has signed up to Kyoto but pre-empted the protocol by setting up its own emissions trading scheme. The EU Emissions Trading Scheme (EU ETS) starts this month, and would still have applied even if the protocol itself did not achieve enough signatures. Covering all 25 member states, the EU ETS will require an estimated 12,000 installations, across a range of energy-intensive industry sectors, to reduce emissions to a government-set level or else pay for additional EU carbon allowances (EUAs) to cover emissions in excess of this level. It looks like constraints on carbon emissions are here to stay.

In its first phase (2005-2007), the EU ETS will cover carbon dioxide emissions from combustion installations with greater than 20 MW thermal input, oil refineries, coke ovens, iron and steel plants, and factories making cement, glass, lime, brick, ceramics, pulp and paper. These sectors are responsible for around 45% of current EU carbon dioxide emissions.

The range of greenhouse gases, and sectors covered, may be extended in the second phase of the scheme (2008-2012). With the ratification of the Kyoto protocol, the EU ETS will in all likelihood continue beyond 2012 in subsequent five-year phases, aligned with the five-year Kyoto commitment periods during which ongoing national greenhouse gas reduction targets must be achieved.

As with all EU directives, the EU ETS must be implemented within each mem-

ber state through national legislation or new regulations. Each country must produce a National Allocation Plan, which sets out the quantity of carbon dioxide emissions allowances that will be provided to each installation. At the end of each compliance year – 2005 is the first one – the installation must have enough EUAs to equal its actual carbon dioxide emissions during the year; if it does not, additional allowances must be purchased from the emerging EU carbon market to cover the shortfall.

If the installation fails to do this by the compliance deadline, then it will face penalties of up to €40 for each tonne of carbon dioxide of shortfall, *in addition* to having to purchase the necessary allowances from the market. This penalty rises to €100/t in Phase 2 of the scheme.

In theory a liquid, transparent and accessible market for carbon emissions allowances will enable a least-cost path to compliance with reduction targets. Companies who are able to reduce emissions at relatively low cost will have an incentive to exceed their reduction target, since any excess reduction can be sold into the market. Companies with higher abatement costs can look to the market to buy the required allowances instead of investing to reduce emissions internally. The overall outcome is the same – in terms of the total emissions reduction achieved – but with a lower total cost compared to a no-trading scenario.

Threat or opportunity

Businesses now need to assess the extent to which this is a threat or an opportunity. On the face of it, additional costs squeeze margins, and more regulations puts pressure on already stretched management time. But if carbon constraints are here to stay, business processes and management systems must adapt to accommodate them.

This will be just as true for companies not included within the scope of the EU ETS as those that are: quite apart from the fact that the scheme can be extended in 2008 to include additional sectors and greenhouse gases, there will be indirect impacts on energy prices and the cost of materials manufactured by sectors with carbon reduction targets.

Electricity costs, already increasing as a result of rising oil and gas prices, will increase further as the cost of complying with carbon caps is borne by the power sector. Gas prices may also rise as the power sector shifts from using coal to using lower carbon gas, increasing demand. In addition, the knock-on effects of carbon costs on other utilities – such as steam, compressed air, water or refrigeration – means that there will be a strong case for a wider re-examination of utilities management and procure-

Carbon management self assessment tool

ESD Edinburgh Centre for Carbon Management (ECCM) has launched a 'Carbon Management Self Assessment Tool', CAMSAT. The tool provides a simple and quick assessment of the quality of a businesses' systems for responding to climate change, and an area-by-area evaluation of how carbon management could be improved to maximise opportunity and minimise risk.

Commissioned from ECCM by UNEP and the Bioclimate Research & Development Trust, CAMSAT focuses, says ESD, on current business processes in four critical areas:

- *greenhouse gas assessment and monitoring* – exploring current means of assessment, quality and regularity of monitoring and verification standards;
- *greenhouse gas emissions reductions planning* – reviewing breadth and depth of activity, knowledge of relative cost and returns on reductions in different business areas and the potential impacts of greenhouse gas reduction technologies;
- *greenhouse gas offsetting actions* – evaluating processes for offset, transmission of offset options through the

supply chain and the quality of offsets used; and

- *communications and reporting* – assessing quality of internal and external communications, allocation and communication of responsibility, external reporting processes, context of communication and stakeholder and customer engagement.

CAMSAT is available free and can be obtained via the UNEP Climate Change website:

www.unep.org/themes/climatechange/Focus_Areas/index.asp

ment systems.

In principle, emissions trading provides a simple route to meeting caps on carbon emissions. The emergence of an EU-wide network of emissions brokers, traders and trading platforms means that a company facing a shortfall of allowances can easily purchase the necessary quantity to achieve compliance.

But since buying EUAs brings no other benefit than satisfying the required compliance, the company must know when it is appropriate to do this, as opposed to reducing emissions internally through improved energy management, or investing in low carbon technology such as combined heat and power, energy efficiency or renewable energy projects. Internal measures can bring other benefits, such as reduced energy costs, improved product quality as well as lowered emissions, whereas selling excess carbon allowances could bring in extra revenue.

Certified emissions reductions from low carbon projects will also be tradable into the EU market. The Clean Development Mechanism provides a framework for creating tradable carbon emissions reductions from projects in the developing world. CDM project credits will be accepted into the EU scheme from 2005 and could form a lower cost route to compliance with reduction targets.

Emissions reductions from Joint Implementation projects (low carbon projects in one country with joint investment from another) could provide another route. JI credits from eastern Europe and elsewhere will be accepted from in the EU ETS from 2008. Such 'carbon finance' could thus become a valuable secondary income stream for low carbon projects, encouraging investment in clean energy technologies in the developing world, eastern Europe, Russia and other countries of the former Soviet Union.

Add to this the development of more sophisticated EUA deals such as options, forward trades or hedges and the deci-

sion on how best to integrate internal emissions reduction measures with a trading strategy becomes even more complex. Whilst simply trading to compliance is a quick fix for a company without sufficient allowances, it is also a pure cost; decisions need to be made on how best to balance trading with other options in order to protect profitability in the long term. A strategic approach is required.

Reliable, accurate data

For a multi-site, multi-national business, the cost of reducing carbon dioxide emissions through internal measures needs to be evaluated and compared with the site-specific caps set by the country NAPs. This also applies to sites outside the EU, since certified emissions reductions from qualifying projects in non-EU locations can be traded into the scheme. Such potential assets should not be overlooked.

The availability of reliable, accurate data will be essential for this to happen. Since emissions data must be provided in a form capable of being checked by external verification agencies, the data collection chain, from meters through to the data management software, must be capable of meeting a defined standard of verifiability. As penalties apply for getting it wrong, verification agencies will be cautious about signing off company emission statements without being very sure that they are correct.

This may require investment in secondary metering and enhancement of existing energy and emissions databases, as well as the development of common procedures for data management applied consistently across all sites.

But the consistent approach to data collection, management and reporting across sites and business units to meet the needs of verifiers can also be used to develop more reliable energy consumption benchmarks, allowing good practices to be identified at better perform-

ing sites and transferred to poorer performers, providing the basis for an ongoing programme of performance improvement linked to ongoing monitoring and targeting.

This in turn can help the company as a whole to decide on how best to balance any investment in ongoing emissions reductions and a programme of emissions trading. Investing in internal emissions reductions may well yield reduced energy costs which far outweigh the value of the avoided carbon compliance cost.

Renewable generation can be used as a hedge against rising fossil fuel costs. For example, the financing of a wind turbine project can be structured so that the price of delivered electricity is not linked to grid power costs; as these rise the cost-effectiveness of wind electricity improves. In a market with rising fossil fuel costs – and associated carbon costs – renewable energy projects could be a good way of managing utilities cost risk, quite apart from other, less tangible benefits such as brand enhancement, demonstration of corporate responsibility and motivating staff by showing a commitment to take action on climate change.

Many businesses are now looking seriously at renewable energy projects as a means to reduce their exposure to rising fossil fuel prices.

With the advent of the EU ETS and the imminent ratification of the Kyoto protocol, climate change issues now need to be addressed seriously by business. For many companies, this will require a root-and-branch evaluation of their commercial strategies, and the investment, business planning, utilities management and financial processes that underpin them. Those that succeed in adapting to a low carbon economy will be able to sustain profitability and competitiveness into the future.

Contact ESD on +44 (0)1225 812102 or at www.esd.co.uk

Emissions trading 'will harm UK industry'

As currently set-up, at least the first phase of the EU Emissions Trading Scheme will damage UK industry, says Director of the UK Energy Intensive Users' Group Jeremy Nicholson. This is because the UK Government is playing fair and has thus set tough emissions targets while several other countries have allowed complacency to dominate their national plans. There is room for improvement in the second phase, though.

The Energy Intensive Users Group represents industrial sectors in the UK for whom secure, internationally competitive energy supplies are a matter of commercial necessity. Energy intensive industries have always had a powerful commercial incentive to minimise their energy costs, so it is not surprising that they have the best record in improving energy efficiency (and reducing greenhouse gas emissions) of any sector of the economy. In contrast, emissions from other sectors – especially transport – continue to rise. Yet the energy intensive sectors are the ones that will be hardest hit by costs arising from the EU Emissions Trading Scheme (ETS) scheduled to start on 1 January 2005.

EIUG endorses the principle of emissions trading as a means of achieving emissions reductions at least cost. The ETS was conceived as a means of helping states trade imbalances in their emissions relative to their national targets under the Kyoto protocol, rewarding states that over-achieve at the expense of those that fail to achieve their targets.

The UK is on track to meet its Kyoto target, a 12.5% reduction in a basket of greenhouse gases below 1990 levels, largely as a result of the 'dash for gas' in power generation and the continuing improvements in industrial energy efficiency. The government intends that the UK will go well beyond this to meet a self imposed target of reducing carbon dioxide emissions by 20% by 2010 – requiring twice as much carbon dioxide to be cut from our emissions as needed to meet our Kyoto target – and this ambition is reflected in our emissions allocation plan for the ETS.

Rising emissions in Europe

In contrast with the UK, the emissions plans of our principal EU competitors show they are not yet serious about achieving their Kyoto targets, let alone going beyond them. Indeed, many plan to allow their emissions to carry on rising until 2008. Germany, for example, plans to

carry on subsidising its coal and lignite industries and to stick with its policy of prematurely retiring the nuclear generation that provides nearly a third of their power, which will necessarily cause emissions from power generation to rise.

The original 15 EU states are set to find themselves so far adrift from their overall Kyoto cap by 2008 that they will not be able to meet it by internal means – see Figure 1. States will be exposed to the cost of buying emissions credits from those with surpluses (i.e. the accession countries) but also from outside the EU (e.g. by funding 'Joint Implementation' and 'Clean Development Mechanism' schemes in developing countries and/or carbon trading with Russia).

The UK Government has recently revised its ETS allocation plan (see box), responding to the latest data showing that industrial emissions in 2005 will be 7.5% higher than assumed in their earlier draft. Allowances for manufacturing sectors have been altered accordingly, but an even heavier burden appears to fall on electricity generators. The revisions do nothing to lessen the impact on consumers of raised electricity prices. In fact, the overall reduction in emissions under the revised plan is much greater than was initially proposed and the UK will retain one of the toughest emissions caps anywhere in the EU. Industry is now faced with the uncertainty of not knowing whether the Commission will approve the revised UK plan – something that cannot be guaranteed and will in any case take until February 2005 to be confirmed.

UK energy prices will rise

Industrial sectors like steel, glass and ceramics will be affected by the ETS as direct participants, but also because of the impact of increased electricity costs. Early in 2004, the DTI published a report by ILEX, the energy consultant, assessing the impact of EU emissions trading on electricity generation in the UK. ILEX concluded that the price of electricity would rise by 10–30% depending whether gas or

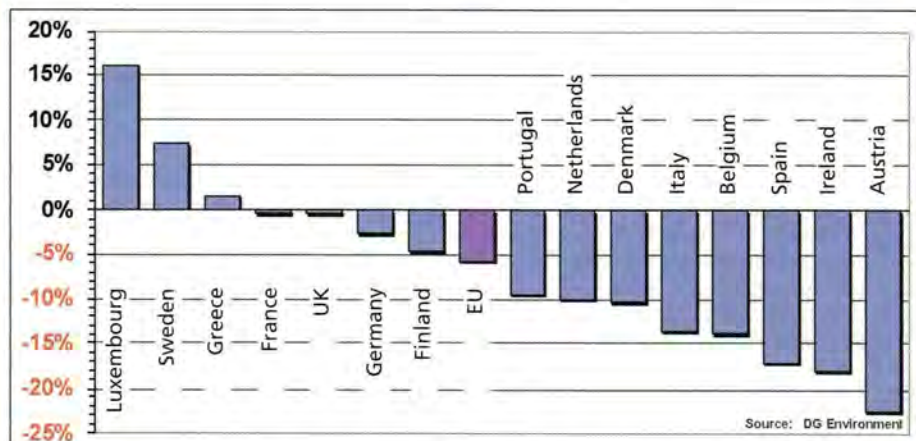


Figure 1. EU emissions 2001: changes required to meet 2008-12 Kyoto targets

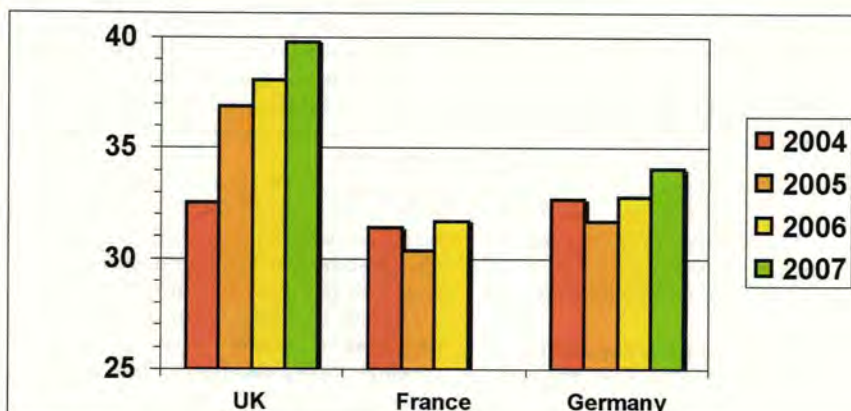


Figure 2. Projected UK electricity prices (£/MWh)

coal is the marginal generating plant. The actual impact will depend on the traded price of carbon, currently around €8–9/t CO₂, which reflects the scarcity of carbon, a function of how far the EU remains adrift from its overall Kyoto target. The wider this gap is, the higher the price of carbon will be and hence the bigger the impact on electricity prices.

The price of carbon may well increase in the second phase of the ETS starting in 2008, as the Commission is expected to insist on member states adopting tighter and more consistent allocation plans fully in line with their Kyoto commitments.

ILEX's predictions are broadly consistent with forward wholesale market data for the next three years which shows dramatic increases in wholesale electricity prices (on which industrial contracts are based) in the UK and some other states. However, the cost of carbon is not set to be passed on through higher electricity prices in states like France and Germany to anything like the extent as in the UK, due to a combination of over-generous emissions plans and unliberalised energy markets (the latter may take many years to sort out). An unintended result of ETS, as things stand, is that there will be a significant competitive distortion in power prices – to the disadvantage of UK industry – see Figure 2.

A European symbol

It is important to remember that reducing emissions in Europe is merely symbolic without global participation. The USA, responsible for 25% of industrial emissions in 1997, has rejected the Kyoto Protocol with Australia following suit – so neither are committed to reducing emissions. Russia is now ratifying the treaty, which will at last bring it into force internationally, but has substantial scope to carry on letting its emissions rise. Developing countries were never obliged to constrain their emissions at all, yet are becoming major emitters in their own right. Chinese emissions, for example, will reach the level of those from the USA by around 2020 if current growth rates are maintained – see Figure 3.

EIUG wants to see an environmentally credible ETS that does not distort trade or unduly damage our economies – the ideal model to which other countries might in time be persuaded to subscribe. But the ETS, based on current national allocation plans, does not meet these criteria. We fear that a botched scheme will hamper efforts to persuade the USA and developing countries to embrace emissions trading as the centrepiece of an international response to curb global emissions. Let us hope the EU gets its act together by the time phase II of the scheme starts in 2008.

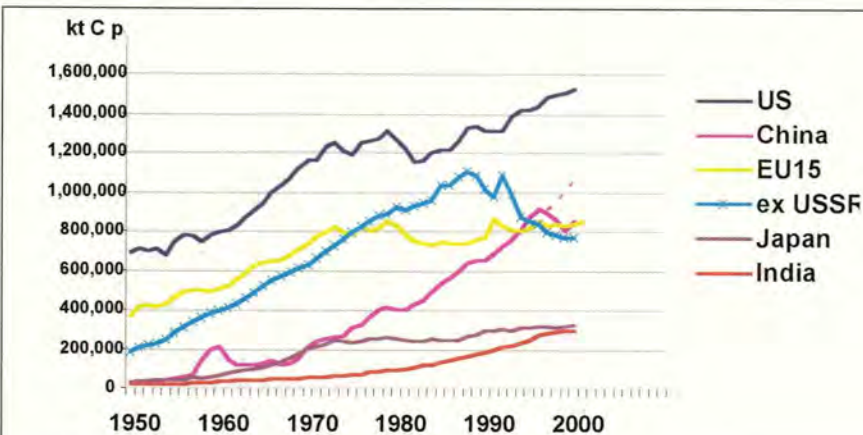


Figure 3. Carbon dioxide output by region

UK's revised allocations plan

Below is an extract from a note issued by the DTI in October to explain why it planned to alter the numbers in the UK's National Allocation Plan for the EU ETS.

"In our draft National Allocation Plan submitted to the Commission in April, it was explained that the number of allowances would be reviewed at the time of submitting the final plan, in the light of the ongoing work on the energy projections, the review of Climate Change Agreement targets for 2006, any potential changes in fuel intensity for the Iron and Steel sector and the receipt of verified data from operators. The changes in energy projections set out above, together with changes in fuel intensity for the iron and steel sector and the finalisation of the Climate Change Agreement targets leads to an increase in projected emissions from the UK installations covered by the EU ETS for the period 2005–7 of 15.3 MtC (56.1 MtCO₂) compared to the position in April.

The Government has considered how to reflect this increase in emissions in allocations under the National Allocation Plan. The Government is proposing to increase the total number of UK allowances for the period 2005–7 by 5.4 MtC (19.8 MtCO₂) allowances."

The move met with predictable reactions. Friends of the Earth said: "Tony Blair is going back on his promise to address global warming and is allowing industry to create even more pollution which will directly lead to climate change. By significantly increasing the amount of carbon dioxide pollution that industry is allowed to emit he is undermining the UK's international credibility and sending a very poor signal to the rest of Europe." The organization said it will be urging the European Commission to be tough on the UK and to reject the new plan.

The CBI took a different tack, saying: "It's vital the European Commission approves the 3% increase in allowances proposed by the UK Government. Without this extra headroom business would not be able to cope with the more ambitious targets, which result from the increased projections for future emissions announced today. Frankly the Government's earlier figures were wrong."

As well as directing the Energy Intensive Users Group, Jeremy Nicholson is also a board member of the International Federation of Industrial Energy Consumers and a member of Ofgem's Environmental Advisory Group. Contact him at jnicholson@eef-fed.org.uk

Two views on the next generation

Balancing energy generation, economics and the environment is a highly complex business, particularly with climate change at the top of the Government agenda. It requires the assessment of the trade-offs between the economically rational choice of electricity generation versus the environmentally friendly option – and then the development a realistic strategy. Here, Business Development Manager Mike Coulten and Market Analyst Veronica Smart, both with the Energy Information Centre, debate the issues, one supporting renewables; the other more use of gas.

It is now nearly universally accepted that climate change is happening. The headline figures that global average surface temperature have increased over the 20th century by around 0.6°C and that sea levels are expected to rise by 13 cm by 2020 and 41 cm by 2050 are nothing new. And, just recently the Russia Government agreed to ratify the Kyoto protocol making participating countries emissions targets legally binding. But is this enough?

The UK government has committed to more stringent targets than those it agreed to under Kyoto in an effort to lead the way in combating climate change. These were laid out in its Energy White Paper published in 2003 covering carbon dioxide emissions and the development of renewables, pledging to:

- increase renewable generation to 10% of total electricity supplied by 2010;
- reduce carbon dioxide emissions by 20% by 2010 compared to 1990 levels; and
- aspire to cut carbon dioxide emissions by 60% by 2050.

These are very ambitious targets bearing in mind that, currently, renewable generation only accounts for around 3% of supply and that, in 2003, carbon dioxide emissions actually increased. Problems with gaining planning consent have been one of the main issues behind the slow build of renewable generation plant, whilst the recent rises in emission levels were the result of the increased use of coal-fired generation in 2003, due to the high price of gas. This clearly shows economics winning over the environment.

The generation solution

So what energy strategy should the Government adopt to ensure that its targets for 2010 are met? High gas prices are expected until new infrastructure is built, allowing the UK to import more gas, but the first of these projects is not due for completion until 2006/2007. This may postpone the build of new combined cycle gas turbines (CCGT) power plants for the next few years.

It is estimated that the spark spread (the difference between the cost of gas used to produce one unit of electricity and the price of electricity) needs to increase to over £10/MWh for a consistent period to provide generators with the price signals required to invest in new build gas-fired generation. However, despite electricity prices rising by over £12/MWh in the last eighteen months, the spark spread is only £7 to £8/MWh, still short of levels required to encourage new build.

Security of supply in relation to the UK's growing dependency on gas imports, has also become an issue with regard to gas-fired generation. However, concerns

regarding the interruption of gas supplies to the UK are largely unfounded. There is enough gas storage to cover the loss of a significant supply source for 30 days in the EU and sources of gas imports are well diversified.

Russia will remain the single most significant importer to the EU; in 2010 it will be the provider of only around 30% of EU gas consumption, compared with 20% last year. This gas, however, enters the EU via a number of routes, with three separate pipelines currently in place. Further pipeline routes will be in place by 2010, ensuring that the loss of a single pipeline will have little effect.

So let's turn to nuclear. The advantages are that it is a carbon dioxide-free form of generation, it is reliable, diversified and has a secure fuel source. However, one of the main disadvantages of using new nuclear to help meet our 2010 target is the very long lead time for new build with an estimated 5–10 years of planning and 5–10 years to build the power station. Nuclear currently does not feature in UK energy policy, but indications are the door is not closed with regard to nuclear generation.

The environmental view

So, what are the views on what should happen to the future generation mix? Should we go for gas, nuclear, renewables or a mixture? Veronica Smart offers her opinion: 'I strongly believe that we need to head towards a renewable future. There are a number of advantages for opting for renewable generation, not least that it is carbon dioxide free. The fuel source is free, sustainable and reliable, there is no waste issue and the generating stations are easily decommissioned.'

'Wind power is currently one of the most important forms of renewable generation in the UK. Unfortunately, wind power is associated with a number of negative aspects, the main one being that the wind does not necessarily blow when power is needed. This essentially means that wind power cannot be used as base-load generation, and back-up generation is required. However, with wind farms spread around the UK, the chances of the wind stopping blowing throughout the whole country is highly unlikely. Therefore, the level of standby generation is substantially less than estimated by anti-wind campaigners.'

Smart states: 'One of the other negative aspects of wind power is its perceived impact on the landscape, visually and audibly. My answers to these are simple, new technology means that the sound of a turbine is no more than the of background noise so even on a windy day you hardly notice the sound. As for the visual impact, this is likely to diminish as they become more common. When electricity pylons were first erected there was strong objections to their impact on the countryside

Technology

Cost of generation

(p/kWh)

CCGT	2.6
New coal	3.2
Nuclear	2.3
Onshore wind	3.8
Offshore wind	5.5

Source: The Royal Academy of Engineering

Table 1. Cost of generation

landscape, but now you hardly notice them. It will be the same with wind turbines.'

Table 1 represents the Royal Academy of Engineering's view on the cost of generation from different sources. This suggests that wind power is uneconomic compared to gas and coal. However, it has to be remembered that renewable generation is subsidised through the Renewables Obligation. Currently Renewable Obligation Certificates (ROCs) for the third compliance period are trading at £42.50/MWh, making wind generation competitive with gas and coal.

Wind power is perceived as the most common form of renewable generation, but there are others out there. Landfill gas, for example, also makes a sound contribution to the overall renewable portfolio and, looking to the future, tidal, solar and wave generation are all lauded as the next big thing. Admittedly, these may not be commonplace for a few years, but in order to ensure they receive the adequate funding we need to give renewable power all the support it needs. If wind technology can be shown to work and make a significant contribution to UK generation, it will remove any remaining barriers to other renewable technologies. Wind power may not be the Holy Grail when it comes to renewable generation, but its development is essential for the UK to meet its stringent emissions targets.

So what is Mike Coulten's answer to the issues surrounding generation?

Climate doubts

'Well, whilst we can all observe that climate is changing rapidly, we cannot say why with any certainty, although environmentalists would have you believe that carbon dioxide has been conclusively tried and found solely culpable. If only it were that simple.'

'In fact, though we can observe that carbon dioxide in the atmosphere is at historically record high levels and can calculate that we have put a lot of it there, we cannot state that this has 'caused' the observed warming of the atmosphere. So, reducing carbon emissions could be a good thing if carbon dioxide does turn out to be the causal factor and if we can make significant enough reductions to have an effect. Or it could turn out to be the wrong target and/or a hopelessly

small response that will not affect future climate paths. Perhaps we should humbly consider the possibility that the path of future global climate is not controllable by mankind?'

Coulten continues: 'The UK has already massively reduced its emissions of greenhouse gases as a result of the switch from coal to gas in its electricity generation. This switch has not only delivered cleaner generation, but also lower cost power to UK business. Many now say that the UK's 'dependence' on gas imports should constrain further CCGT build as security of supply issues arise. The UK actually exported record volumes of gas in 2003 and our import dependence is likely to only grow slowly. We see again that resource depletion pessimists have underestimated future supply and overestimated future demand.'

'Other European countries have relied almost wholly on imported gas from Russia for the past 30 years and security of supply has never been an issue. The UK sits next to Norway where gas reserves are sufficient to meet UK demand for gas imports for at least 20 years and LNG gas supplies are now competitive with pipeline gas and available from numerous supply sources. Finally, UK gas import infrastructure, whilst only just adequate for a 5% probability cold winter event in 2004/05, will be vastly oversupplied by 2007 as a plethora of new import capacity is built in response to current sky-high prices.'

'Environmental generation, in general and wind power in particular, is considerably more expensive than fossil fuel-fired or nuclear generation. If this were not so then the ROC subsidy to renewable generators would not be required. In fact, due to planning constraints, the ROC value is high and giving super normal returns to wind farm operators. So what is constraining the build of more wind turbines? The answer is planning restrictions. As such, the RO scheme could be seen as a formal government reward for gaining planning consent.'

'It is largely because of the need for a back-up supply if wind generation fails, since peak demands are regularly associated with high pressure sitting over the UK during mid-winter. In such conditions some wind turbine somewhere would still be generating but overall output would be way down. A full, 100% backup would

not be required, but more than 50% and perhaps higher until we get a widely dispersed wind resource.'

Coulten continues again: 'Gas clearly offers the cheapest path to future carbon dioxide reductions, with renewable generation an expensive administered solution to the issue of climate change. Nuclear may well become more competitive with gas as new technology reduces costs throughout the generation process. Renewable generation is clearly the most expensive option. It seems clear to me that whilst we will tilt at windmills and fret about nuclear, we will build gas, which will be securely and efficiently supplied from multiple sources at low relative cost to other fuels.'

My only concern is that we sacrifice UK competitiveness at the alter of environmental monsters under your bed. In my experience, without intervention things usually turn out pretty well.'

In conclusion

It is clear that there are a large number of issues surrounding the future generation mix for the UK. What is best for the environment may not be the most economic option and there are also the opinions of the UK public to consider. Would they prefer a nuclear power station or a wind turbine in their back yard? If the Government is committed to renewable generation it needs to eliminate the uncertainty with regard to long-term funding, in order to increase investment. The problems with planning also play a major role in preventing the construction of wind farms and, if the Government is determined to meet the targets it has imposed upon itself, the barriers to construction need to be eliminated.

Whatever avenue the Government decides to take will mean an increase in electricity costs for industrial and commercial consumers. Renewables are expensive and unless gas prices crash by 10 pence per therm, electricity prices are going to have to rise to encourage the build of gas-fired plant. The cost of new nuclear build is uncertain and there is also the issue of disposing of waste, and the costs incurred. These will probably be passed on to electricity consumers, adding further upside to prices.

So are the days of cheap electricity behind us? Well, evidence would suggest that the days of prices of £16/MWh are well and truly in the past.

The Energy Information Centre (EIC) has almost 30 years experience of the energy markets and delivers a comprehensive portfolio of services to industrial, commercial and public sector organisations. Services offered include market intelligence, energy procurement, data accounting, energy management and strategic consulting.

Contact the EIC at www.eic.co.uk

Optimising energy with 'Verbund' CHP

Giant chemicals and energy company BASF held a 'dialogue on energy management' with journalists last October in Germany. The main subject was the company's extensive use of CHP to fuel its major manufacturing plant at Ludwigshafen. The company also gave a presentation on its encapsulation technology, which allows the incorporation of latent heat stores into the very fabric of buildings

Energy is enormously important for the Ludwigshafen site, as the following statistics clearly show: 250 production units on the 7 km² site need an uninterrupted supply of power day and night. The electricity consumed last year – 6.2 million MWh at the last check – would be sufficient to supply 2 million households. Steam demand is also massive, enough to heat 500,000 homes. There is 180 km of pipes for steam transport installed on the plant premises, and as much as 3,400 km of power lines. Moreover, there are other systems supplying cooling water, deionised or demineralised water, compressed air, natural gas and nitrogen.

Energy is essential for manufacturing chemical products, accounting for 10–15% of manufacturing costs on average, and occasionally as much as 50%, in the case of electrolysis, for example. It is imperative, therefore, to conserve as much energy as possible. This relatively banal observation forms the starting point for the 'Verbund' philosophy, which embraces both energy and products. (Developed in the early 1980s, Verbund – also known as 'pinch technology and 'heat integration' – seeks to optimize heat flows at a manufacturing site. Exothermic, or heat-producing, reactions supply heat to endothermic processes in as efficient a manner as possible.)

A dependable general environment, in both economic and political terms, for energy production and energy supplies is a prerequisite to ensuring that sites such as Ludwigshafen can maintain their competitiveness.

Moreover, a reliable energy supply is crucial. This applies especially to plants that require days to start up and begin producing to specification, as well as to

unplanned shutdowns, which can lead not just to money being lost, but ultimately to market shares being lost as well. Consequently, tried and tested components that have already proven their worth in continuous commercial operations need to be used. Conversely, it also means some restraint when using the latest developments. Take gas turbines as an example: In the new combined heat and power (CHP) plant, a manufacturer's standard production gas turbine is installed; the turbine is then downgraded, allowing close to 40% longer production cycles between service intervals. BASF's energy experts are convinced that this solution is more economical than using new developments offering a few tenths of a percentage point in improved efficiency, but which have yet to prove themselves in practice.

The chemical industry pursues an 'n-1 philosophy'. This means that measures are taken to ensure that the largest unit used to generate steam or electricity can fail without jeopardising the supply. Though this principle does not come free of charge, it does significantly increase the availability of the production units supplied. The company's own expertise in quality assurance is extremely important when engineering and constructing new plants, and when operating and repairing existing power plants. This is demonstrated at the construction site of the new power plant in Ludwigshafen and in the modifications being made at the Nord power plant. Because pipes in the steam generator were inadequately welded, extensive maintenance work is required here. Early detection and swift action help to cut costs and reduce delays because it is much easier to make alterations to drawings than to make

Existing CHP plant at BASF's Ludwigshafen site in Germany



Heat storage capsules smooth out temperature peaks

Phase change materials (PCMs) or latent heat storage systems can play a major role in helping to smooth out temperature fluctuations in buildings.

Many materials and systems currently on the market are designed to keep building interiors warm by virtue of their insulating properties. Insulation also reduces the rate at which buildings are heated up through the walls in summer, although most of the heat enters the building through the windows in the form of solar radiation. In fact, once the heat has entered the rooms, good insulation will actually prevent the building from cooling down at night.

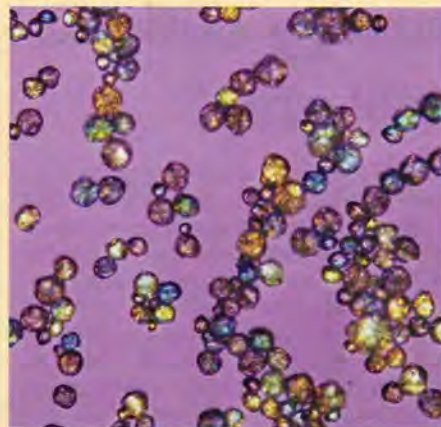
The building's mass plays an important part in determining the temperature. A heavy building is able to smooth out temperature peaks by virtue of its mass. As an example, consider the difference between a shack made of corrugated iron and a cathedral. Any building's thermal properties would lie somewhere between these two extremes. When the sun is shining, temperatures in the shack would become quite unbearable. On the other hand, due to its thick walls a cathedral stays pleasantly cool even at the height of summer. A typical single-family massive construction-style

house would lie somewhere in the middle.

BASF's solution for safely inserting latent heat stores right into building materials themselves is micro-encapsulation. Tiny globules of wax 2 to 20 microns in diameter are coated with a layer of extremely hard plastic. These microcapsules are completely sealed, safe to process and free of formaldehyde. In addition, the resultant materials are well suited for further treatment – they are impervious to grinding, drilling, cutting, etc. since their small size makes them virtually indestructible.

The encapsulation process also protects the wax in its very pure form, meaning the high heat storage capacity of 110 kJ/kg is permanently guaranteed. In principle it can be manufactured to any switching temperature. BASF's 'Micronal' DS 5000 X absorbs the ambient heat energy at around 26°C. This temperature has been confirmed by computer simulations to be optimal for passive summer heat insulation in buildings. A material with a switching temperature of 23°C is also available.

Shifting temperature peaks to nighttime is not only more convenient, it also results in significant cost savings. Air conditioning can be avoided, or at the very least designed for lower peak loads.



Seen through a microscope, BASF's microcapsules make efficient latent heat stores

Maxit, based in Merdingen, Germany, offers 'maxit clima', a PCM plaster that is used like normal plaster. This 'intelligent' plaster was first used in the new administrative building of Badenova, an energy supply company based in Offenburg, Germany. Here the plaster's performance completely satisfied the architect's requirements for a higher thermal storage mass without adding more weight to the building.

changes to steel and concrete. Although personnel resources are tight, BASF is striving to preserve this important knowledge for the future as well.

A further requirement that energy supplies must meet is low cost. The tools we can use to achieve this are low investment costs and thus a smaller debt service. At €400 to €450 per kilowatt, CHP plants are relatively cheap. Hard coal plants, by comparison, cost €800 to €850 per kW and optimised lignite plants €1,000 per kW. Other performance indicators are lower operating costs through the use of reliable components and optimum automation, resulting in lower personnel costs.

More than 50% of the steam supply for Ludwigshafen is already covered, and will continue to be provided, by the use of process heat. The Süd CHP plant (pictured) has been on-stream since 1997, and will be complemented by the new plant in 2005. When this additional unit goes into operation, more than 80% of the steam demand will be covered by BASF's own production. The situation is similar with regard to the development of electricity generation, the majority of which will also be produced directly on site once the new power plant has gone into operation. However, it should be noted that the Süd power plant belongs to the supplier RWE.

Some 2,100 tonnes of steam are required per hour, 56% of which is provided by the energy Verbund of exothermic and endothermic processes. The supply of surplus steam extends beyond the confines

of the particular business unit to supply other business units as well. The natural gas-based CHP plant supplies a further 20% steam. Substitute fuels derived from our own petrochemicals provide an additional contribution. For example, fuels similar to natural gas or heating oil are collected in the plants and burned centrally. This segment of the energy supply has further potential for optimisation, particularly since the existing facilities of the Nord power plant are almost 40 years old.

The total electricity demand at the Ludwigshafen site comes to 710 MW. We produce a mere 15% of this ourselves, with most of the rest coming from the RWE power plant at the site (just under 40%) and from the national grid (more than 45%). The new power plant will change the situation at the Ludwigshafen site in that it will enable more electricity to be produced while using practically the same amount of steam.

Thus, the new plant will significantly reduce the amount of bought-in electricity for the site in Ludwigshafen. A new power plant, the CHP plant on the Rhine River, will help to substantially develop the energy supply structure. This plant has been designed for an output of 650 tonnes of process steam per hour and 450 MW electricity. The gas turbine used belongs to the well-known Siemens 3A series, which notched up its millionth hour of operation in mid-2003, proving its re-liability. As a result, starting 2006, the amount of steam generated at BASF will increase from 80%

to 83%, while the amount of electricity we generate ourselves will go from 15 to 63%.

In addition to the Ludwigshafen site, CHP plants generate the necessary quantities of steam and electricity at practically all of BASF's major production sites. These are primarily Schwarzeheide in Brandenburg (Germany), Antwerp in Belgium, Tarragona in Spain, Seal Sands in Great Britain, Freeport, Geismar and Port Arthur in the US, Altamira in Mexico, Nanjing in China and Kuantan in Malaysia. The gas turbines have an electricity generating capacity totaling 1,760 MW. Of the 12 plants, five are operated on contract by regional energy-producing companies.

Industrial energy supplies have to be based on efficient, proven and economical supply technologies. In the chemical industry the focus is on using cogeneration, as this sector requires process steam and electricity. Our objective here is to achieve optimum fuel usage with maximum electricity yield. This will automatically result in low emissions. Moreover, we are monitoring and analysing innovations in the area of steam and electricity production to see to what extent they can be used for industrial applications and how proven they are. With innovations, efficiency and economic viability are ultimately the crucial issues – because, as an energy supplier that produces electricity and steam, BASF itself provides the means to the end of production.

Contact BASF at www.basf.com

UK green energy outlook 'still grey'

BT has signed the UK's largest green electricity contract with RWE npower and Centrica – a deal that represents an important step forward and a strong piece of PR for the renewables lobby. However, as independent market analyst Datamonitor's Alex Solomon explains, recent Datamonitor research indicates that just 15% of industrial and commercial companies have a set target for procuring green energy.

British Telecom (BT) has publicized the contract as the world's largest purchase of green electricity, with the volume (2.1 TWh) set to cover almost all of BT's UK

demand over three years. In recognising the importance of the deal for the green power sector, the UK government has described it as 'globally significant'. While clearly a step forward for the renewable industry, Datamonitor suggests that the move cannot mask the fact that British companies still have a long way to go in terms of both setting and hitting targets on green energy and carbon emissions.

BT, one of the UK's largest companies, has an impressive history in the area of environmental responsibility, having reduced energy related carbon dioxide emissions by 80% since 1991 through investment in energy management and more energy efficient equipment. The contracts secured with npower and Centrica, for 1 TWh of renewable power and 1.1 TWh of energy from CHP will see a further reduction of 325,000 tons of carbon dioxide emissions per year – the equivalent of taking 100,000 cars off the road.

However, the contracts do not mean that the amount of green power generation in the UK will see a corresponding increase. Although npower has some small interests in wind and hydropower, together with CHP these sources still accounted for less than 10% of its 2003 production, says Datamonitor. Centrica currently has no renewable generation, although it has committed £750 million to new renewable projects over the next three years.

This means that in reality the companies, particularly Centrica, will be sourcing the power through the use of renewables obligation certificates (ROCs), which allow suppliers to purchase green electricity produced by renewable generators through a traded system. As a result, there are no guarantees that the BT contract will increase the total renewable generation capacity of the UK as a whole, although it is likely to drive further liquidity in ROC trading, adds Datamonitor.

npower supplies Westminster and Sainsbury's

Energy supplier npower business has signed a two-year contract to supply Westminster City Council's entire portfolio of 1,563 sites with 118 GWh of electricity and 255 GWh of gas.

The council's portfolio is split into two parts; 'non-housing' and 'housing'. The former includes all major council buildings, car parks, offices, schools and public conveniences, while the latter is looked after by CityWest Homes – Westminster's arm's length management organisation – and includes all communal elements such as estate lighting and

communal heating schemes.

The Council is strongly committed to promoting energy efficiency and the use of renewable energy so, as part of the deal, npower will supply 28 major Council buildings with 100% renewable electricity. Additionally, the same sites will benefit from npower's 'Half Hourly Online' service that enables organisations to monitor their energy efficiency levels and keep track of energy consumption via key consumption data.

Meanwhile, Sainsbury's has signed a five year contract with npower business to

supply 1,500 GWh of energy to all stores across the UK. Around 150 GWh of this energy will be from renewable sources, including 15 GWh to its head office in London. The deal forms part of Sainsbury's energy efficiency initiative, whereby it has allocated £14 million to reducing its energy consumption by 11% over two years.

Since renewable energy is currently in short supply, Sainsbury's has also taken 650 GWh of 'good quality' CHP, which also qualifies for Climate Change Levy exemption.

Another try at 'added value' contracts

Recent research from Datamonitor suggests that between 10 and 20% of the UK industrial and commercial customers are willing to buy energy under contracts that fully integrate commodity supply of power and gas with 'added-value' demand management services. 'Performance Partnerships', the new marketing initiative from London Energy (a subsidiary of Electricité de France) and Dalkia UK, aims to corner this niche segment with a product that overcomes some of the usual reservations about extra services.

Datamonitor's report author Mikhail Masokin says that utility outsourcing could rival the IT outsourcing market in a few years' time, but it is currently suffering from considerable barriers to higher take-up.

'Added-value' demand management

services are an attractive growth market for companies in the energy sector, with a potential for 25% annual growth rates and double-digit profit margins. However, service providers find it difficult to win customers and secure deals, as benefits are difficult to quantify and payback periods can be viewed as too long, Masokin says. "In particular, demonstrating return on investment is difficult, both by service providers to energy buyers and by energy buyers themselves to their companies' decision makers."

Even where benefits can be clearly demonstrated, raising the finance can be difficult as most companies operate on thin margins, Masokin says. "The internal structures of would-be customers are often not amenable to buying in energy services, due to conflicts of interest between energy buyers and chief financial officers."

The new initiative from Dalkia UK and London Energy is an attempt to overcome this and other obstacles to greater take-up, by combining energy supply and demand management services into a fully integrated proposition.

Energy partnership cuts costs for BT

A major programme to provide remote meter reading services for BT is enabling the telecoms giant to improve its energy efficiency programme and reduce costs. Data management specialist, IMServ Europe, has installed half hourly meters at over 5,000 BT sites up and down the country to deliver accurate meter readings and do away with manual reads.

The move means half hourly electricity consumption data can now be collected remotely, either over BT lines or via BT's own internal network. The data can be used to improve energy management across BT's buildings and puts the organisation in a stronger position when negotiating with electricity suppliers.

Previously, the sites had non half hourly meters installed, but as these sites were generally unmanned and secure, access problems meant that bills were often estimated and data was inaccurate.

El awards extended to wider energy industry

The annual El Awards used to be the Energy Institute's recognition for excellence and innovation in the world of oil and gas. This year they have been extended to the wider energy industry. The Awards offer both major and smaller companies the opportunity to showcase their groundbreaking initiatives in an international arena.

The Energy Institute received some 100 entries for the eight award categories. Judging for each category is based on the achievements deemed to have had the most impact or potential impact on the industry. Matthew Pinsent, CBE was the guest of honour at London's Savoy Hotel in November for the Awards dinner and presentation.

communication

Sponsored by ABN-Amro

Winner: IT Power – Enthuse

The 'Enthuse' project provides relevant and easily accessible information about renewable energy through presentations and workshops, which enables local authorities to be more effective in implementing renewable energy schemes.

A format has been developed which includes the 'Renewable Energy Matrix', an interactive tool that helps attendees to identify the way forward for local authority. The 'Enthuse Toolkit' includes leaflets on policies, planning and projects, together with example case studies. Over 1,100 local authority representatives have participated in 30 Enthuse events held as part of the project to date.

community initiative

Sponsored by BG Group

Winner: npower Health – Health

through warmth

The 'Health through warmth' initiative aims to help tackle the issue of fuel poverty, associated cold-related illnesses and winter deaths. It targets and assists vulnerable people to improve their health and living conditions, with energy efficiency and heating measures installed where they are most needed. This ensures that people who are ineligible for other assistance can get much needed support.

The scheme was established by npower in 2000, in partnership with National Energy Action (NEA), the NHS and other local interests.

environment

Sponsored by KPMG

Winner: Walsh Ecuador – Reducing the footprint of 3D seismic in the tropical rainforest of Ecuador

Multiple seismic exploration programmes have been conducted in the Ecuadorian Amazon without re-using areas previously cleared for heliports, resulting in unnecessary damage to forests. Walsh Ecuador and Encana have developed a remote sensing technique to accurately identify historic heliports in mature tropical rainforest, for re-use in 3D seismic exploration surveys.

The Walsh GIS team analysed satellite images from the 1980s and 1990s for historic heliports which had reforested naturally. A total of 324 locations were identified, representing about three times the required heliports for the programme.

innovation

Sponsored by ExxonMobil

Winner: Halliburton Energy Services – DepthStar tubing retrieval subsurface safety valve

The DepthStar tubing-retrievable safety valve (TRSV) is a new development in well completion equipment, providing improvements in reliability, safety and cost of overall offshore infrastructure and valve placement.

With operators moving in to deeper water, Halliburton found a need to develop a TRSV capable of operating at greater hydrostatic pressures. The DepthStar TRSV is claimed to be the first surface-controlled subsurface safety valve that eliminates the potential for well fluids inside the production tubing from migrating into the TRSV actuation and hydraulic control system.

international platinum

Sponsored by Total

Winner: Shell Exploration & Production – Goldeneye: World class technology
Shell Expro drilled the Goldeneye discovery well in October 1996. Recoverable reserves from the reservoir are in excess of 500 billion cubic feet (bcf) of gas and 17 million barrels of condensate.

Rather than deploying a conventional, manned processing platform to separate the gas and liquids offshore, the company selected a simple platform, not normally

manned, at the field location, linked by a single new 105 km multiphase pipeline to St Fergus, with hydrocarbon processing being performed onshore and remote operation and monitoring of the offshore facilities by satellite link.

safety

Sponsored by Shell

Winner: BG Exploration and Production India – Investing for a safer future

BG launched 'Zero LTIF' (lost time injury frequency) in 2003, a behaviour based safety project designed to cut the number of hours lost through workplace injuries.

BG Exploration and Production India was the first business in the BG Group to implement the LTIF safety procedures and has set the standard for other operations around the world. Of the 2.8 million man-hours worked between 1 January 2003 and 31 May 2004, not one hour was lost through lost time injury at the company.

technology

Sponsored by Eni

Winner: Shell UK – Deployment of high horsepower ESPs to extend Brent field life
The North Sea Brent field, first discovered in 1971, is enjoying extended life due to the largest reservoir depressurisation scheme yet undertaken.

Electrical submersible pumps have been installed to back-produce water from the reservoir in order to replenish the gas cap, ensuring delivery of gas. The operating environment is particularly harsh due to a combination of heat, wellbore solids and gas. To meet this challenge, a range of specially designed centrifugal pumps was developed. Currently, 12 systems are being deployed. Each uses the largest power cable, plus the highest rated motor used to date offshore.

outstanding individual achievement

Sponsored by Norman Broadbent

Winner: Dr Wolfgang Schollnberger

Recently retired as Technology Vice President for BP, Dr Wolfgang Schollnberger is a visionary leader, an effective ambassador for the energy industry, a tireless innovator and a prolific oil and gas explorer.

His career began at Royal Dutch/Shell in 1972. He moved to Amoco in 1979, where he served as a Senior Geologist holding several positions. He served as Chairman of the International Association of Oil and Gas Producers Management Committee from 1999 to 2003 and been active in the American Association of Petroleum Geologists. He has recently been helping to set up an El Branch in Houston.

To find out more about next year's El Awards contact Laura Viscione, El Events Department, t: +44 (0)20 7467 7105; e: lviscione@energyinst.org.uk

Integrating distributed generation into the grid – a T&D company view

Energy World regularly publishes articles on distributed electricity generation – whether renewables or on-site CHP – but rather less on how electricity networks might and are accommodating new, 'embedded' plant. Here, electricity transmission and distribution company AREVA T&D considers the problems associated with distributed energy sources – and discusses some of the solutions.

As a result of the ongoing trend towards privatisation and decentralisation, the worldwide electrical power industry has seen a major transformation in recent years. To a large extent, what was once a vertically integrated industry with single entities owning generation, transmission and distribution systems in a geographic region has become an industry based on dispersed ownership, with separation of generation, transmission and distribution.

Furthermore, increasing pressure to secure the supply of electrical power and to meet the requirements of the Kyoto agreement have led to the proliferation of distributed energy sources, including renewable energy, embedded anywhere in the distribution network – all leading to technical, operational and commercial challenges.

The distribution grid is inherently weaker than the transmission grid because of its limited power capacity, so the failure of a single system can affect its entire balance. As a result, the multiplication of small embedded energy generation sources, continuously stressing the network, has significantly increased the potential risk of disturbing its stability.

This is becoming increasingly true as CHP, solar and wind energy sources emerge to play an important part of our energy mix. While development of these green energy sources is to be encouraged, the power they generate fluctuates more rapidly and can cause power quality and power balance problems. Consequently, utilities have established minimum connection requirements in terms of system operating constraints, power quality and supply stability that each independent power producer must comply with in order to safeguard the distribution grid and its customers.

Power imbalances

With wind farms, for example, power imbalances and voltage fluctuations can occur because wind is an intermittent source of energy. Wind may not be available when demand requirements are high, causing energy imbalances and resulting in penalty charges. These power imbalance issues can be minimised in terms of cost impact by more accurate wind predictions, as can be provided by AREVA T&D's 'e-terrawind' software package.

The software offers an end-to-end IT solution covering the reporting of the wind farm's real-time critical data from both the turbine and the electrical system. The same software can also be used for a large wind farm to improve its voltage and VAR controllability, enabling it to react (from a network perspective) in a similar manner to conventional generation plants.

In addition, e-terrawind includes innovative generation scheduling and optimisation tools, which allow network operators (or generation portfolio players in a dereg-

ulated environment) to optimise the efficiency of their overall generation strategies. For network operators it also includes a very detailed dispatcher training simulator utilising wind generation models, which can precisely assess the impact of the wind farm on their network security.

To compensate for wind power's unpredictable electricity production in deregulated environments, wind farm operators usually combine other generation capacities such as coal or hydro. With higher costs and environmental constraints, the challenge is to achieve better controllability and energy optimisation to define the most profitable energy mix at any instant.

In this particular case, e-terrawind extends to the level of an adapted trading functionality, including integration of weather-based generation forecast, generation portfolio scheduling and dispatch monitoring. It also provides interfaces to the trading market places so that wind operators can maximise their revenue.

Another scenario to be considered is the emergence of large offshore wind farm projects, such as those proposed for the UK. Here, the market system offers generation players various trading opportunities between long-term contracts, day-ahead energy or in combination with other generation or industrial load assets. In this case, e-terrawind is totally integrated with AREVA's 'e-terramarket' electronic market place systems and 'e-terratrade' participant trading systems.

Power quality and grid stability

Managing power balance issues is not the only challenge faced by distribution network operators. Power quality and grid stability problems also exist but can be avoided. By carrying out simulation studies and modelling at the beginning of a distributed energy project, engineers can help determine ways to ensure the secure and stable connection of distributed generation sources into the grid in compliance with grid codes.

For wind farms, AREVA T&D can simulate the respective dynamic behaviour of the turbines according to the developer's control strategy and wind speed fluctuations. Steady state and dynamic studies of a distributed energy installation, from its equipment through to the grid connection and beyond, can be performed to provide a cost-effective and technically compliant system design, which meets new and emerging grid connection requirements.

Power electronics solutions such as high voltage direct current (HVDC) schemes or Flexible AC Transmission System (FACTS) applications can also provide effective grid compliant solutions when connecting distributed generation sources to the grid. For generation sources located far from the load centre, HVDC solutions can offer many advantages, ranging from higher transmis-

sion capacity, lower losses, precise and rapid control of power flow and fewer disturbances during network faults. AREVA T&D's HVDC solutions are in operation around the world and, for example are implemented for the Konti-Skan project linking the power systems of Denmark and Sweden.

For distributed generation sources connected with a traditional AC connection, FACTS solutions such as Static Var Compensators (SVC) represent effective power quality solutions and ensure the steady state and dynamic performance of the AC system in compliance with grid connection standards and requirements.

Moreover, some wind farms do not ride through a local fault scenario. For example, if there is a short circuit fault near to the wind farm and the fault is cleared, the wind farm itself may not recover. This primarily depends on the type of turbine being used. A solution to this problem can be implemented at the turbine level. A system solution is also available by using coordinated protection and control strategies in combination with compact dynamic reactive power support devices.

Harmonic emissions are another power quality issue to be aware of. They can result from some distributed generation sources because of the use of power electronic devices. These devices normally form part of the overall distributed generation resource and have been introduced mainly to optimise the effective overall generation plant design. Inherently, power electronic devices do an enormous amount of 'switching' which, by their very nature, introduce distorted waveforms onto the supply.

Besides containing the fundamental 50/60 Hz waveform, distorted waveforms also contain a large amount of harmonics, dependent on the level of switching and distortion introduced. Quality power electronic devices contain filters which limit the amount of harmonics (distortion) introduced on to the supply.

Unfortunately the amount of filtering impacts on the cost-effectiveness of the power electronic devices in question. As a result the cost and quality of such devices, implemented as part of the distributed generation resource, vary widely depending on market and supplier.

Harmonic pollution of the supply, introduced by distributed embedded generation resources, is not a new problem to distribution networks and systems have been required to address power quality issues for decades. As we move further into the digital age, away from electromechanical devices, system loads include more and more power electronic devices. The move from typewriters to PCs is just one example of this. AREVA T&D has provided system operators with not only the tools to measure, protect and control the system against non-linearity and distorted waveforms, but also the primary plant AC filters to eliminate harmonics that are present.

Other power quality issues that need



to be addressed by system operators include power factor and voltage flicker. A poor power factor is a symptom of an inefficient network, indicating that a large amount of generation is being consumed ineffectively by the supply of reactive power. Real power is the 'useful power' available to consumers and the consumption of reactive power is wasteful for all parties in the supply chain, from the consumer to the transmission operator.

Voltage flicker is a symptom of inefficient network support. It is more prominent in developing networks but can also occur on established networks when these are subjected to a large amount of contingencies. The strength of a network is dictated by its resilience to contingencies but, unfortunately, network strength is only brought about by the investment in plant (lines, transformers, etc) available. The level of transmission and distribution investment dictates the level of voltage flicker that can occur.

Safety

When a part of the utility system that contains both loads and a generation source is isolated from the rest of the system but remains energised, a phenomenon known as islanding, there are safety issues that must be addressed. This is because this islanded distributed energy source is not within the control of the utility and it may not be possible to shut it down or isolate it from an area that needs work in the event of breakdown. Consequently, utility line workers can be exposed to risk from energised lines that should have been shut down.

Clearly it is important to be aware when islanding has occurred, which requires investment in effective monitoring, protection and control. Given the safety implications, this is an area that should be given the highest priority.

From a commercial and managerial

standpoint, distributed energy sources can be very challenging. Here, there is a major contrast with large generators, because distribution network operators do not have the same level of control over these distributed energy sources and cannot always match generation levels to consumption needs. The result is that electricity surpluses and shortages can occur, causing the network's frequency to either increase or decrease – resulting in a potential shutdown.

To ensure a balance of electrical flow on the grid and to enable real-time buying, trading and selling of electricity, a high degree of communication is needed. AREVA T&D uses highly sophisticated SCADA systems to enable the supervisory control of entire distributed power installations. This enables small generators and network operators to monitor the installation's performance and to adjust its production according to real-time load requirements. Within its range of products, AREVA T&D offers teleprotection and some network telecommunication facilities. It also offers network operators a variety of remote terminal unit (RTU) solutions.

Through its system study support, backed by a wide range of systems and products, AREVA T&D can provide grid connection solutions that meet the new and emerging grid connection codes. Through its energy management systems, the company can also provide the capability for wind farms to be integrated into the power system and its associated market systems.

The company has a long history of providing network operators with equipment and services for the transmission and distribution sectors. As these sectors evolve, AREVA T&D is committed to maintaining and enhancing this level of support in line with the new challenges that transmission and distribution operators will face. ●

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Oil depletion – crisis, concern or no problem?

Eighty people gathered at the Energy Institute's lecture theatre on 10 November to once again debate the existence, timing and significance of an impending 'peak' to global oil production. Opinions on this subject are very divided, from those convinced that peak production – and thus the onset of constrained supplies and rising (even further) energy prices – is almost upon us; to those who believe that technological advances, 'non-conventional' oil sources and economic fundamentals will combine to ensure that any supply problems will remain well into the future.

Report by Petroleum Review.

Opening the conference, Vice President of the Energy Institute Professor Martin Fry noted the importance of the subject, particularly at a time of high oil prices. He stressed the increasing importance of energy efficiency as a way to lessen the impact of both high prices and potential resource constraints caused by depletion.

Chris Skrebowski, the editor of the EI's *Petroleum Review*, made the first presentation. He set the scene by asking a series of questions that he hoped the other speakers would answer over the course of the day. He started off by noting the variable quality of the available data, which, he claimed, was one of the reasons that the interpretations of the situation were both variable and ambiguous. It was this that enabled some to conclude there was concern, even crisis, while others were able to conclude that there was no problem.

Skrebowski went on to suggest that the reason so many had come to listen to the day's proceedings was that prices were at their highest levels since the 1978/1985 price plateau, which produced the early 1980's recession; there was little or no immediate spare capacity; and economic growth was potentially threatened. After noting the economic importance to all aspects of contemporary life and the extended time required to find and develop new fields, he suggested that the question the speakers had to answer was very simple: 'Are future oil supplies primarily determined by investment levels or are they now being constrained by geology?' In short, lack of financial incentives and why, or lack of good rocks?

Data discrepancies

Dr Roger Bentley of the University of Reading gave a comprehensive review entitled: 'Global oil depletion: viewpoints in collision'. He began by noting the way that geologists generally saw peak oil as being relatively close, while economists either had it way in the future or denied the possibility of peak.

According to Bentley the main reason for this was the generally poor quality of the reserves data and the large discrepancies between the industry data (principally the IHS database) often accessible by the geologists, and the public databases usually used by the economists.

He further noted there were four key, unresolved issues which had an enormous impact on the analyses:

- the real size of Middle East reserves;
- the size and significance of discovery growth;
- the size and significance of reserves growth; and
- the speed of development of non-conventional oil and oil substitutes.

Detailing the enormous size of the overall resource base in terms of currently unrecovered oil-in-place, heavy oil, tar sands

and oil shales, Bentley then contrasted this apparent abundance with Colin Campbell's latest production forecasts, which indicate peak oil and liquids production around 2012. He then showed a wide range of peak production dates from various authors (mainly geologists) ranging from 2005 to 2025, followed by a further listing of forecasts (mainly economists) which either had no peak or one after 2030.

Bentley then presented a series of graphs derived from the IHS database and suggested these indicate an all oil peak around 2010. He noted that the economists' counter to this scenario was that it failed to credit human ingenuity, that higher prices increased supply and decreased demand, and that there was a large technology gain.

Regretting that geologists and economists were reluctant to talk, and suggesting that both could gain from greater dialogue, Bentley concluded his presentation with his own peak estimates:

- non-Opec conventional oil now–2007
- global conventional oil peak 2010–2015
- global all oil 2010–2020
- global oil and gas 2015–2020
- global gas 2020–2025

A geologist's view

Speaking for the geologists, Francis Harper of BP started by showing the production profile for current reserves based on a number of assumptions. He confirmed that discovery had been on a declining trend since the 1960s, but noted an upturn in discovery in the late 1990s that was associated with deepwater finds and the 'super-giant' Kashagan field in the Caspian. Asking if these were anomalies or a new trend, he went on to evaluate the successes and failures of the deepwater basins around the world.

He noted that some 1,500 wells had now been drilled in 120 offshore basins. Of these, 30 were productive and around 20 had commercial discoveries. Using IHS database numbers, Harper showed that the creaming curve of discovery was still rising in the four most prolific basins – Gulf of Mexico, Campos Basin, Congo Basin and the Niger Basin – indicating that further discovery is likely, even though around 55 billion barrels has already been discovered.

In contrast to this optimism, Harper then noted that Kashagan was the only super-giant field discovered in the last 25 years and that the North Sea was the last major province to be opened up. Average discovery size had fallen to around 50 million barrels of oil equivalent (boe) by 1980 and had stayed at this level ever since – apart from a temporary jump to 100 million boe around 2000, which was associat-

ed with the impact of Kashagan and deepwater discovery. However, the success rate for wells had increased steadily from the one-in-six of the 1950s to the current one-in-three.

While conceding that exploration performance was somewhat disappointing, Harper explained that the major positive change was the way that discovery estimates grow with time. Contrasting IHS data in their 1997 and 2003 reports covering the period 1950 to 1996, he showed that the reserves estimate had increased by 200 billion barrels – although he did concede that most of the gain was in the larger older fields. He also showed that during the 11 years to 2003, the IHS estimate of cumulative discovered volumes to 1990 has increased by an average of 40 billion b/y. He explained that field estimates grow either by increases in hydrocarbons-in-place (extensions, additions) or by increases in recovery factor (revisions, improved recovery). This growth in reserves more than compensates for production and disappointing discovery.

The remainder of the presentation examined the potential for the various alternatives – heavy oil, bitumen (tar sands), shale oil, gas-to-liquids and biofuels.

His overall conclusions were that:

- existing discovered reserves are unlikely to sustain demand for more than about 15 years;
- exploration cannot be expected to replace production and its contribution may continue to decline;
- reserves growth is likely to continue as the dominant form of reserve additions, but much of it will only slow post-peak production decline;
- non-conventional oil will become increasingly important – there is a very large resource but converting it into reserves has significant financial and environmental costs; and
- non-Opec is likely to reach a resource-constrained production peak from conventional oil in the next 10 years – thereafter, production capacity will be concentrated in progressively fewer countries.

Long-term future

Professor Peter Odell followed, with a presentation entitled 'Oil's long term future – 85% yet to be exploited'. He started by noting that concerns about future oil supply have been a recurring theme – as encapsulated in the pamphlet: Oil Crisis... Again? (BP, 1979), which foresaw oil production outside the Soviet bloc peaking in 1985. Professor Odell then explained that such analysis failed because of the rigidity of the assumptions about discovery and the "absurd notion that oil had a perfectly inelastic supply price curve." He then went on to explain that, using the publicly available reserves databases, discovery had handsomely

exceeded consumption – meaning that the world was 'running into oil' rather than 'running out of it'.

Odell also commented that the application of new technology was still largely confined to Europe and the US and that, once its impact was fully felt in areas such as the Middle East and the former Soviet Union, there would be a major uplift in production and reserves.

He contrasted this dynamic analysis with that of those who saw supply constraints emerging in the near term. He developed this dynamic approach (financial incentives drawing forth incremental supply) further, by presenting a plot of ultimate reserve assessments over time, which showed the way the estimates' trend towards an ultimate of 2,700–3,400 billion barrels. Odell then went on to look at the potential contribution of non-conventional oil, showing graphs in which conventional oil production peaks around 2025–2030 and non-conventional peaks around 2090. Combined, this gives an overall peak in 2060 of around 6.8 billion toe.

By showing the range of additional supply sources and establishing the economic response to the price signals, Odell stated that he felt confident in saying that future oil supplies presented "no problem" for the foreseeable future. He also noted that all the current analysis tended to be done on the basis that oil had an organic origin. He drew attention to the Russian-Ukrainian theory of oil's abyssal, abiotic origin, pointing out that this could remove the remaining constraint on oil supply if it proved correct.

Middle East dramatics

In what was in many ways the most dramatic presentation of the day, Dr Michael Smith of EnergyFiles spoke to the title: 'Middle East miracle or mirage?' He started with a series of slides showing the way recent peak production of 22.5 million b/d came from 11 producers, with the Middle East five (ME5) – Iran, Iraq, Kuwait, UAE and Saudi Arabia – accounting for 20 million b/d. In succeeding slides he showed how, despite the growth in offshore production, total world oil production, excluding production from the ME5, would peak by 2010 and then move into decline. He then showed the volumes needed to be produced from the ME5 to meet demand growth of 1.5% and to offset the decline in all other producers after 2010. Extrapolation of this showed that the ME5 needed to produce over 75 million b/d by 2030 to meet 1.5% growth.

Smith then explained that he would "believe" the stated production expansion targets of the ME5 and proceeded to graph them. The graphs showed that 1.5% demand growth would produce a peak in 2013, with some potential excess production capacity in the run up to 2013. However, if demand growth was at 2.5%, the peak production occurred in 2010. And, most dramatically of all, if demand growth

proceeds at 3.5%, then global peak is now.

He pointed out that ME5 reserves and capacity can be endlessly debated, but, even taking their own ambitious capacity estimates, the sort of demand growth known for the last 30 years cannot be sustained for another decade.

Smith's summary was equally dramatic: "Before peak, supply has moved to meet demand. After peak, demand will drop to meet supply."

Exaggerated concerns

Dr Rob Arnott of the Oxford Institute for Energy Studies spoke next, on 'Oil depletion or depleted policies'. He explained that he saw four reasons for the failure of the oil companies to develop new production capacity in time to avoid the recent tightness and high prices. These were lack of exploration activity caused by inappropriate oil price assumptions, manpower constraints caused by an ageing workforce and overeager downsizing, corporate strategies that set unrealistically high rate of return requirements and, lastly, working with legacy assets designed to optimise returns rather than production. His view was that more appropriate policies would largely ameliorate the situation.

Optimistic outlook

The final presentation of the day was from Dr Ken Chew, Vice President-Industry Performance and Strategy for IHS Energy. In the course of his presentation Dr Chew presented a large number of slides drawing on IHS database information. While this broadly confirmed the pattern of declining discovery and lack of recent large field discoveries, data providing a rather more optimistic outlook was also shown.

A detailed analysis of the non-conventional resource plays was given, showing the sheer size of the potential heavy oil, tar sand and shale oil resource base. Details were presented of the way both Orinoco heavy oil and Canadian tar sands production was building up and their future trajectory. Detailed analysis of both oil and gas reserves were also given, with comparisons made to the public databases. One of the most important slides showed how discovery in the 1995–2003 period of 144 billion barrels was exceeded by consumption of 236 billion barrels. However, revisions and reassessments of pre-1995 discoveries had added 457 billion barrels of reserves (over half in the Middle East). Of this total, around 190 billion barrels was resource growth/reserves growth/field growth, while the balance was new data/under-reporting/missing data.

Chew's conclusion was that, if all of the resource base was included and the high estimate for yet-to-find used, global oil resources were only 25%–30% depleted and gas resources only 20% depleted. ●

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8 North West England	67	177	223
9 Borders	76	160	226
10 North East England	76	172	244
11 East Pennines	51	148	235
12 East Anglia	56	136	244
13 West Scotland	87	198	236
14 East Scotland	85	183	250
15 North East Scotland	90	186	253
16 Wales	47	151	194
17 Northern Ireland	68	201	215
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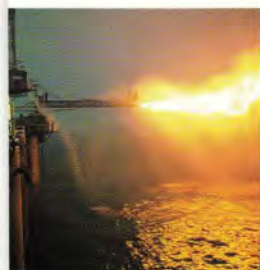
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