Oxera

# Agenda

Advancing economics in business

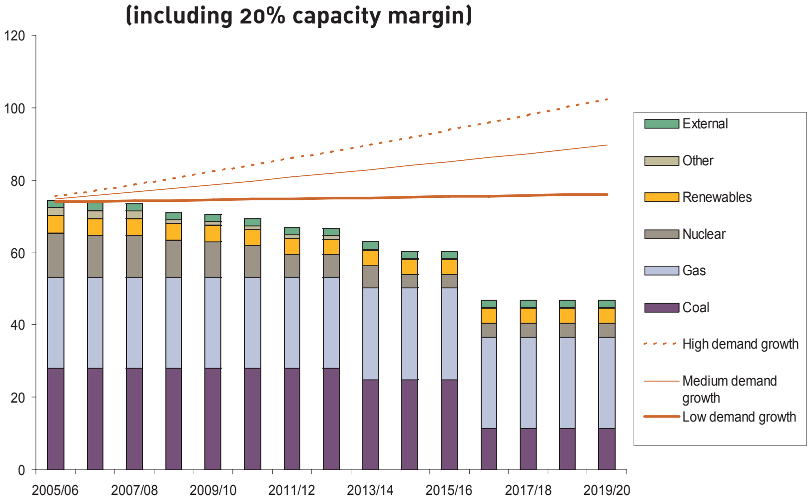
## Staying switched on: the cost of energy security

**The UK is now at the start of a new investment cycle in energy, as generation capacity retires and indigenous gas supplies decline. The level of investment required up to 2020 is high by historical standards, and creating an environment that encourages this investment to deliver energy policy objectives will be a major challenge for the ongoing Energy Review**

By 2020, the decline in UK Continental Shelf (UKCS) gas production is expected to be such that the UK will have to import over 90% of its gas consumption requirements.[1] Over the same period, 40% of the UK's electricity generation capacity is expected to have retired, such that, with no new investment, the UK will be capable of meeting only half of anticipated demand.[2]

One of the key challenges that the recently initiated Energy Review will need to address is how to establish an environment in which sufficient investment will be forthcoming to achieve the main policy goals of security of supply, tackling climate change and reducing fuel poverty.

Figure 1 Existing generation and electricity demand (including 20% capacity margin)




Source: National Grid Company (2005), 'GB Seven Year Statement 2005', May, and Oxera calculations.

This article highlights the scale of investment required in the electricity and gas sectors over the next 15 years to close the prospective energy gap. It focuses on generation investment and gas import infrastructure, and makes no judgement on whether the investment will be forthcoming in a liberalised market and through the current set of policy instruments.

### How much investment is required in the electricity industry?

#### Investment drivers

The need for investment arises from two main drivers:

– existing environmental legislation[3] and retirement will lead to the closure of 40% of current delivered[4] generation capacity by 2020;
– by 2020, peak demand is expected to be 3–36%[5] higher than today's levels.

As shown in Figure 1, assuming the maintenance of a 20% capacity margin, these drivers imply that, by 2020, the requirement for additional generation capacity will be in the range of 29.0–55.2GW, representing between 40% and 75% of current capacity.

#### Characteristics of available generation technologies

A number of generation technologies are available to meet demand—gas, nuclear, clean coal and renewable technologies being predominant. These technologies have different cost characteristics, are exposed to different risks, and benefit differentially from policy interventions or alternative market structures. For example:

– combined-cycle gas-turbine (CCGT) plants have the lowest capital cost, as shown in Table 1. Historically, this has made them the most cost-effective option.

However, high and volatile wholesale gas prices may reduce the attractiveness of this option if they persist over a sufficiently long period;

- while environmental legislation will lead to the closure of conventional coal plants, the potential for building clean-coal plants remains. Clean-coal technology, particularly integrated-gasification combined-cycle (IGCC), is a relatively new and underdeveloped technology, although there are several demonstration plants proposed. E.ON UK, for example, is undertaking studies on IGCC plants;
- there is currently a support mechanism (the Renewables Obligation, RO) for renewable technologies. However, the bias towards wind generation (since it has lower capital costs than other renewable technologies) may imply that a high level of renewable build will have an adverse impact on security of supply due to the intermittency associated with wind generation;
- like renewables, nuclear plants have the advantage of zero carbon emissions. However, the long lead times for nuclear plants, combined with uncertainty over the decommissioning liabilities, may reduce their attractiveness to private investors.

## Alternative investment scenarios

Given the available technologies, Oxera has considered a range of options depending on possible changes to the energy policy regime. With the current market scenario,[6] gas and renewables can be expected to dominate the new build, with the associated investment estimated to cost £42.0–£50.4 billion. These costs have been calculated on the basis of the capital costs of generation technologies, as set out in Table 1, and the expected energy gap as shown in Figure 1.

However, the Energy Review may to lead to a change in energy policy and therefore to the existing market environment. If direct support or market mechanisms that benefit nuclear and/or alternative technologies, such as clean-coal plants, are introduced, market prices could be affected and investment in gas and renewables may be crowded out.

If no corresponding change occurs in the RO, the largest impact is likely to be on gas investment. This is because gas plants are entirely dependent on wholesale market prices. Renewable plants, however, are less dependent on wholesale markets since they also receive support through the RO. Because the cost of gas build is lower than that of alternative technologies, the overall investment costs could rise to £45.7–£54.3 billion if new nuclear or clean-coal plants crowd out gas investment.

The bottom end of the cost range, £35 billion, will come about when demand growth is low and a high level of clean-coal plants are built instead of renewable plants. The top end of the range, £54.3 billion, will come into play when demand growth is high and alternative technologies replace gas plants.

This requirement translates into generation investment in the range of £2.3–£3.6 billion per annum over the next 15 years. This can be compared with the total electricity sector investment of £2.8 billion per annum between 1991 and 2003.[7] However, significant transmission and distribution network investment will also be required, both to renew the existing network (most of the network assets were installed in the 1960s and 1970s), and to reinforce the system to enable it to cope with the anticipated growth in renewable generation.

Over the next five years, an investment of £3.5 billion is planned in the electricity transmission network and £5.7 billion in the distribution network. Additional transmission investment for delivery of renewable generation is expected to be of the order of £561m–£766m and that for distributed generation of £274m–£427m.[8]

When the transmission and distribution investment of around £2.0–£2.1 billion per annum over the next five years is added to the generation requirement, the implied total investment required is greater than that of the £2.8 billion per annum invested in the previous 10 to 15 years.

**Table 1 Capital costs of generation technologies**

| | Reported range of costs in study (£m/GW) | Representative cost applied (£m/GW)[1] |
|---|---|---|
| Clean coal | 700–1,600 | 1,100 |
| New nuclear | – | 1,285[2] |
| CCGT | 230–344 | 320 |
| Wind | 740–919 | 850 |

Notes: These, and all subsequent costs, are assumed to be constant in real terms. [1] Point estimates rather than a range of values are used for ease of calculations. [2] This assumes that all new nuclear plants built consist of two reactors of 1GW capacity each. The cost of the first reactor is £1,600m, and that of all subsequent reactors is £1,150m.
Source: International Energy Agency (2003), 'World Energy Investment Outlook: 2003 Insights'; Royal Academy of Engineering (2004), 'The Cost of Generating Electricity'; Watson, J. (2005), 'Advanced Cleaner Coal Technologies for Power Generation: Can they Deliver?', Sussex Energy Group, SPR, University of Sussex, September; and Oxera estimates.

## How much investment is required in the gas industry?

Rising gas demand and a decline in indigenous gas supplies suggest that, by 2015, the UK will have a supply gap equal to its current demand, as illustrated in Figure 2. The supply deficit will have to be met by imports, necessitating the construction of new pipelines connecting the UK to Continental European gas markets and/or of import terminals to receive liquefied natural gas (LNG). UK gas investment is dependent on additional international infrastructure development to ensure that the gas is produced and transported to the UK.[9] The figures presented in this section therefore underestimate the scale of the challenge as they focus solely on UK infrastructure capacity.

Exploration and appraisal activity in the UKCS has increased in recent years. Capital investment in the UKCS from 2005 to 2010 is projected to total £5.85 billion.[10] Despite this investment, the UKCS is in decline, as large established fields come off plateau and new finds are relatively small in comparison.[11]

In 2004/05, the UK shifted from a position of being a net exporter of gas to one of being a net importer. Moving towards 2020, imports will have to meet a growing proportion of demand: as stated in the introduction, the UK's dependence on imports is expected to increase to over 90% by 2020. The industry is already responding to this. From 2005 to 2010, investments of £6.2 billion are planned in gas pipeline infrastructure, and £1.1 billion is planned in LNG import infrastructure, as shown in Tables 2 and 3 below.

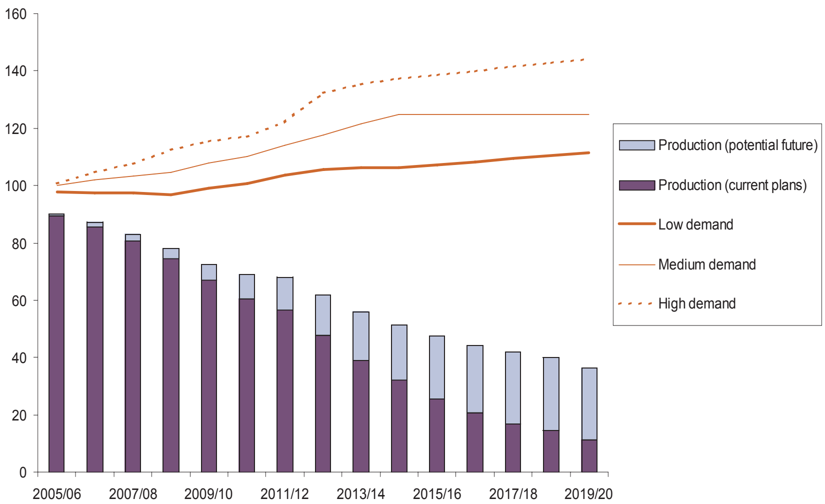
Assuming that all planned investment in import infrastructure goes ahead, the UK will be in a position of excess annual capacity. It is interesting to note that, as long as import capacity is used at a load factor of 50% each year, the UK will meet its annual gas requirements up to 2020. However, sufficient gas capacity does not imply that sufficient delivery will take place, as the UK will compete with other markets for imports. The major issue for the medium to long term will therefore be that of the volume of gas carried along these import routes.

Although LNG and pipeline imports will provide the capacity to meet annual demand, they will not have the flexibility to meet peak demand. Even when the import infrastructure has been built, there will be a shortfall in peak supply, as illustrated in Figure 3. Gas reserves held in storage facilities will be required to safeguard against any interruption in import supplies and to allow for load balancing in peak demand periods. While most investment in upcoming import infrastructure is already committed, that in gas storage is not (see Table 4 below). Considering storage facilities currently under construction alone, the UK will fail to meet its peak demand by 2012/13, even if the infrastructure is fully utilised (as noted in Figure 3). If, however, all planned storage and import infrastructure come on line, the UK will be able to meet its peak demand, provided that at least 50% of its infrastructure capacity is used.

Planned UKCS, import and storage investment over the next few years stands at £2.9 billion per annum (Oxera calculations). This is significantly higher than the £1.8 billion per annum invested in the gas industry from 1988 to 2003. More strikingly, the forecast investment delivers less security on supply delivery than the lower levels of the past 15 years. That investment covered not only pipeline delivery infrastructure, but the associated field development too, as most of it was linked to UKCS developments. The UK consumer may face higher charges to ensure that the gas itself arrives.

With the development of supply capacity in the form of new LNG terminals, import pipelines and storage facilities, and the expansion of existing capacity, comes the need for development of the UK's National Transmission System (NTS) to ensure that the increased levels of gas supplies can be transported. Investment in asset enhancement and in replacement of ageing assets is expected to be approximately £40m per year and new NTS infrastructure is expected to lie in the range of £1.0–£1.1 billion in the 2005–09 period.[12]

**Figure 2 Decline in UKCS production and rising annual gas demand (bcm)**




Source: United Kingdom Offshore Operators' Association data and National Grid (2005), 'Gas Transportation Ten Year Statement 2005', December, Tables 3.5A and 4.6B.

**Table 2 Planned gas pipeline infrastructure investment**

| Project | Capacity (bcm/year) | Operational from | Under construction | Cost |
|---|---|---|---|---|
| Langeled Pipeline | 25 | October 2007 | Yes | Ormen Lange field development: £4,045m Transport system: £1,676m |
| Increased Bacton–Zeebrugge interconnector capacity: Phase 1 | Additional 8 | November 2005 | Completed | Total project cost of both phases: £150m |
| Increased Bacton–Zeebrugge interconnector capacity: Phase 2 | Additional 7 | December 2006 | Yes | Total project cost of both phases: £150m |
| Balgzand interconnector to the Netherlands | 16 | December 2006 | Yes | £345m |
| Statfjord Later Life Project | 6 | 2007/08 | Construction contract awarded | Data not available |

Source: Department of Trade and Industry (DTI) (2005), 'Secretary of State's First Report to Parliament on Security of Gas and Electricity Supply in Great Britain', July; and National Grid Transco (2004), 'Transportation Ten Year Statement 2004', December.

**Table 3 Planned LNG infrastructure investment**

| Project | Capacity (bcm/year) | Operational from | Under construction | Cost |
|---|---|---|---|---|
| Isle of Grain: Phase 1 | 4.5 | July 2005 | Construction complete | £130m |
| Isle of Grain: Phase 2 | 9 | Q4 2008 | Yes | £335m |
| South Hook (Milford Haven): Phase 1 | 10.5 | Q4 2007 | Yes | Total project cost of both phases: £560m |
| South Hook (Milford Haven): Phase 2 | 10.5 | 2009 | Contracts awarded | Total project cost of both phases: £560m |
| Dragon (Milford Haven) | 6 | Q4 2007 | Yes | £250m |

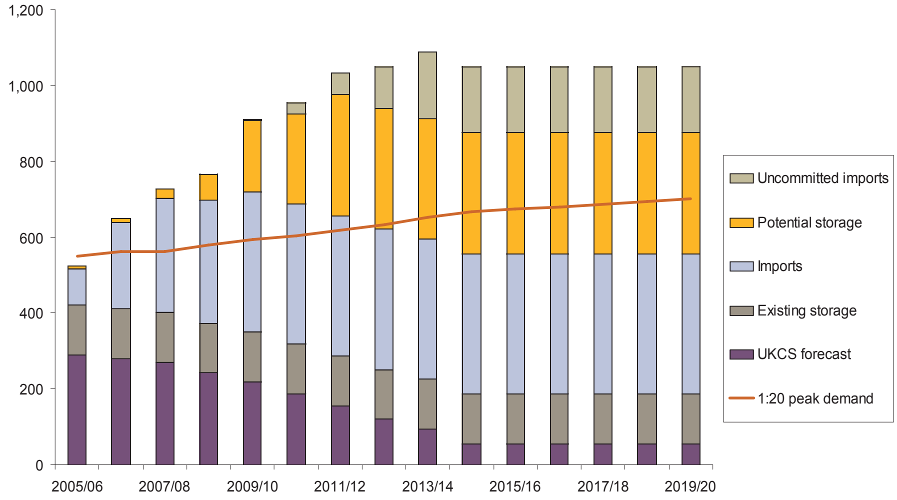
Source: DTI (2005), op. cit.; and National Grid Transco (2004), op. cit.

**Table 4 Planned storage infrastructure investment**

| Project | Size (mcm) | Operational from | Under construction | Cost |
|---|---|---|---|---|
| Aldbrough | 4,420 | Q3 2007 | Yes | £225m |
| Byley, Cheshire | 170 | Q1 2008 | Planning approved | £100m |
| Welton | 435 | 2008 | Planning application submitted | £50m |
| Preesall | 1,700 | 2009/10 | Planning permission subject to public inquiry | £333m |
| Albury: Phase 1 | 160 | 2007/08 | Pre-planning | Total project cost of both phases: £173m |
| Albury: Phase 2 | Up to 715 | 2010 | Pre-planning: drilling required | Total project cost of both phases: £173m |
| Bletchingly | 900 | 2009 | Pre-planning: drilling required | £173m |
| Saltfleetly | 600 | 2008 | Commissioning planned for 2008 | £118m |
| Caythorpe | 210 | Q2 2007 | Pre-planning | £41m |
| Cheshire (INEOS Enterprises) | Data not available | Data not available | Pre-planning | Data not available |
| Humbly Grove | 280 | 2005 | Operational | £56m |

Source: DTI (2005), op. cit.; and National Grid Transco (2004), op. cit.

**Figure 3 Peak gas demand and supply in the UK (mcm/day)**




Note: 1 in 20 peak gas demand has been assumed. This refers to peak demand on a winter day that statistically occurs once in 20 years.
Source: National Grid Company (2005), 'GB Seven Year Statement 2005', May, and Oxera calculations.

Adding on transmission investment to UKCS, import and storage investment, future gas sector investment will be £3.9–£4.0 billion per annum. This is double the historical annual investment level of £1.8 billion.[13]

## Conclusions

The UK market is about to embark on a new investment cycle, requiring a substantively greater capital commitment than has been required over the past decade or so. This in itself is challenging, but it may also be argued that the current market and policy environment are not themselves conducive to attracting the necessary funds:

- global energy commodity prices are at unprecedented levels and exhibiting historically high volatility;
- differences in the regulatory and political regimes across gas transit countries, together with an increasing concentration of supplies in higher-risk countries, add to the uncertainty over supply availability;
- neither investors nor policy-makers have experience of how a liberalised market behaves during periods of tight supply;
- significant aspects of government policy remain undecided—in particular, relating to the potential for nuclear to play a role, or the stringency of future carbon emission reduction targets.

In the gas sector, new investment is beginning to emerge—for example, the Isle of Grain LNG terminal is now in operation and the first phase of the Zeebrugge interconnector upgrade has now been completed. However, the response has been more reactive than anticipatory. In the generation market, the consequences of insufficient or delayed investment may once more lead to long periods of pricing discomfort for many consumers if these lessons are not learnt. The Energy Review provides an opportunity to re-establish the stability and certainty in energy markets that investors require.

[1] National Grid (2005), 'Gas Transportation Ten Year Statement 2005', December, Table 4.6B and Oxera calculations.
[2] Oxera calculations. The investment requirement is based on an assessment of forecast peak demand uprated by 20% to ensure the maintenance of a level of security of supply similar to that which has existed until now. There is no presumption that a 20% capacity margin is the optimal outcome (see 'Margin for Error? Security of Supply in Electricity', *Agenda*, November 2005), but this has been used for consistency with historical margins.
[3] Legislation includes the Large Combustion Plants Directive, which requires coal- and oil-fired electricity generation plants either to install flue-gas desulphurisation technology or to close down by 2016. The Directive will be implemented in 2008. The Renewables Obligation (RO) requires 10.4% of electricity sold by licensed electricity suppliers to come from renewable sources by 2010, and 15.4% by 2015. Suppliers that do not comply with the RO are asked to make a payment in lieu of their non-compliance.
[4] Oxera calculations. As the availability of on- and offshore wind plants depends on wind speed, these two types of plant will not be available to meet peak demand at all times. Therefore, the delivered capacities of on- and offshore wind have been estimated at 30% and 35% of built capacity respectively. All other technologies are considered to be fully available when determining their delivered peak generation capacities.
[5] National Grid Company's low, base and high forecasts of annual growth rates. See National Grid Company (2005), 'GB Seven Year Statement', May.
[6] This assumes that no changes in the RO take place and that support mechanisms for new nuclear and clean-coal plants are not introduced.
[7] This includes transmission and distribution investment in addition to generation investment. Source: International Energy Agency (2003), 'World Energy Investment Outlook: 2003 Insights', January.
[8] Ofgem (2004), 'Electricity Distribution Price Control Review: Final Proposals', November; (2004), 'Transmission Price Controls and BETTA: Final Proposals and Impact Assessment', December; (2004), 'DG-BPQ analysis: Final Report', March; and (2004), 'Transmission Investment for Renewable Generation: Final Proposals', December; National Grid Transco (2004), 'Transportation Ten Year Statement 2004', December; and (2005), 'Identifying and Delivering the Key Infrastructure Components to Meet the System's Strategic Needs', presentation by Nick Winser, Director UK & US Transmission to the Westminster Energy Forum, November 2nd.
[9] International investment that will aid security of supply in the UK is taking place. For example, E.ON plans to invest €3.2 billion in the upstream gas sector, transmission pipelines and storage from 2006 to2008.
[10] United Kingdom Offshore Operators' Association (2005), 'Economic Report 2005', p. 23, states that total capital investment in UKCS oil and gas is to equal £13 billion. Of this, 45% is assumed to be in gas.
[11] While considerable reserves have been found in certain areas of the UKCS, these areas currently have either no access or limited access to offshore pipeline infrastructure, increasing their cost relative to import options. National Grid (2005), 'Gas Transportation Ten Year Statement 2005', December.
[12] National Grid (2005), op. cit.
[13] International Energy Agency (2003), op. cit.

**If you have any questions regarding the issues raised in this article, please contact the editor, Derek Holt: tel +44 (0) 1865 253 000 or email d_holt@oxera.com**

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- **competing concerns: EU energy market liberalisation**
- **incentivising infrastructure investment: the role of regulators**
- **state aid and innovation: how can EU rules and practice be improved?**