PIU Energy Project

ELECTRICITY AND GAS NETWORKS – INITIAL SCOPING NOTE

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1. PURPOSE OF THIS NOTE AND WAY FORWARD

1.1 This note explores the key issues associated with electricity and gas networks – the wires and pipelines. These networks, which form the means of delivering electricity and gas to consumers, present a different and more complex range of issues than the transport systems used to deliver other forms of energy such as oil and coal.

1.2 This is one of a series of initial scoping notes that have been prepared by the PIU Energy Review Team on a series of topics. The team will not be producing scoping notes on every aspect of the Review. Some areas relevant to the Review have already been explored in depth by the PIU Resource Productivity and Renewables Review Team which has been working since January 2000 and which has been merged into the Energy Review Team.

Readers should not assume that the PIU has in any respect closed its mind. Propositions are made, and questions are put, in order to draw responses.

1.3 We will be taking forward discussion of the questions and propositions raised in this note over the next two months.

1.4 This will be done via a series of bi-lateral meetings with key stakeholders. We are also likely to arrange a workshop involving all key stakeholders where views on the key issues can be exchanged and debated, probably during October.

1.5 The PIU has already invited all interested parties to put submissions to it by 10th September on all aspects of the PIU Energy Review. Interested parties are invited to respond in their submissions to the questions and propositions raised in this scoping note.

1.6 We would also be grateful if interested parties could let us know as soon as possible if they consider this note overlooks key questions, if any of the questions posed, or propositions put, are fundamentally mis-conceived, or if the note contains any factual errors.

2. GENERAL BACKGROUND

2.1 Networks of wires and pipelines for the transportation of electricity and gas have been built up over many decades. Change has tended to be incremental and the networks, while vital, were subject to relatively little debate. However, liberalisation of both electricity and gas markets has increased the complexity of the issues surrounding the networks and independent regulation has stimulated wider discussion of these issues.

2.2 In the case of electricity networks, the evolution over the last 50 years has been towards bulk transport of electricity from large remote sites to often distant consumers. However, new kinds of network are now a real possibility and a long term review of energy is an excellent opportunity to consider them. Put simply, the model of one-way flows from large power stations to consumers may be challenged. Smaller scale sources of power, renewable and non-renewable offer the possibility that electricity systems may change radically, with much more power generated at community or even household level. Such a model has environmental attractions but is not inevitable and would require large changes to the nature of the networks. Asking questions about the feasibility, cost and desirability of such a change, which could take decades to implement, is an important ingredient of the present review.

2.3 This note focuses mainly on the following networks[1]:

- The high-voltage electricity transmission networks owned and operated by National Grid Company, (NGC), Scottish Power and Scottish & Southern Energy;
- The lower-voltage regional electricity distribution networks of which there are 14 in Great Britain, each owned and operated by a Distribution Network Operator (DNO);
- The gas network owned and operated by Transco, which includes a high-pressure National Transmission System (NTS) and lower-pressure local distribution zones (LDZs).

2.4 These networks are generally regarded as natural monopolies because, given their characteristics of high fixed costs, low variable costs and economies of scale, it would be inefficient or impractical to have competing sets of wires and pipelines. For that reason, they are subject to regulation to ensure that they do not abuse their monopoly positions to the detriment of consumers, either by overcharging or by discrimination between different user groups. In some countries gas pipelines, especially long distance trunk lines, are not regarded as natural monopolies and pipeline owners and operators compete with each other.

Questions:

Is the concept of natural monopoly a useful one to apply to these networks? Is it likely to remain so for the foreseeable future?

[1] This note does not explicitly consider networks in Northern Ireland, although the issues affecting those networks will generally be similar to those raised in this note.

2.5 The networks are set in the context of liberalised and competitive markets for electricity and gas. This means that the networks carry electricity and gas for a range of competing users.

2.6 In the UK, network ownership is generally vested in companies that are not also users of the networks and network access is on the basis of “Common Carriage” (CC) under which the operator sets out network access terms and conditions equally applicable to *all* users and approved by a regulatory authority[2]. This approach to regulation may be contrasted with “Negotiated Third Party Access” (NTPA) in which the network owner may also be a user, and in which network access terms are negotiated with individual users, with users having rights of appeal to some form of regulatory authority or the courts. NTPA continues to be used in some European, and other, countries in which the process of market liberalisation is underway, although the European Commission believes that the CC approach is preferable.

2.7 The networks listed in Paragraph 2.3 are not the only electricity wires or gas pipelines in Great Britain. Other wires and pipelines are owned and operated by a variety of players and mostly feed into or out of the main networks. An important example is the network of offshore gas pipelines bringing gas from the producing fields to the Transco system. The rules governing the building and operation of such wires and pipelines vary but, with the exception of very small systems, in general terms they are subject to NTPA with actual or potential users able to appeal to one or another regulatory body if they consider they have not been offered satisfactory terms.

Questions:

Is it appropriate to apply Common Carriage access to the main networks and NTPA to other wires and pipelines?

Where do the natural monopolies end and how can the boundaries be justified:

(a) in respect of offshore gas pipelines?

(b) in respect of smaller onshore gas and electricity systems?

2.8 In competitive electricity and gas markets it is necessary to have a set of mandatory commercial arrangements with which all market participants have to comply if they wish to use the networks. These arrangements are necessary to enable competing users of the system to trade with each other whilst keeping the whole network balanced, and are known as “trading arrangements”. Examples of these arrangements include the old electricity Pool and its replacement, the New Electricity Trading Arrangements (NETA). These arrangements have an important influence on the operation of and demand for the networks, even though the bulk of actual trade is bi-lateral.

[2] This does not mean that all users pay the same charges but that users in similar situations pay the same charges. In some cases, network owners are subsidiaries of other companies that are also network users.

2.9 A crucial characteristic of electricity is that it cannot be stored[3]. Gas can be stored, although to do so in large quantities is generally expensive, not least because of the need to minimise the risks of fire and explosions. Because of the difficulties with storage the amount of electricity put onto the network (generated) needs to match the amount taken off (load) on a minute by minute basis. This process is often referred to as "system balancing". System balancing is also required in gas networks to ensure the gas in the pipelines is maintained within a certain pressure range[4]. However, because some gas is effectively stored in the pipeline network itself, system balancing for gas can take place over longer intervals than for electricity. At present gas system balancing in Great Britain takes place on a daily basis.

2.10 When considering the operation of electricity and gas networks it is useful to distinguish between certain functions that can in principle be carried out by different parties even though in practice they are often carried out by the same party[5]:

- The Network Operator (NO). The NO is generally the recipient of payments from users for use of the system and the party that makes decisions on new investment in the system and carries out the physical maintenance of the existing system. The NO is usually the system owner, although this need not be the case;

- The System Operator (SO). The SO is the party that is responsible for carrying out system balancing. This activity is likely to involve buying and selling of electricity or gas through the trading arrangements. The extent of system balancing actions required, and the options open to the SO, depend in part on the condition of the networks.

2.11 In Great Britain, NGC, Scottish Power and Scottish & Southern Energy act as both NO and SO for the electricity transmission systems in their respective areas. To a considerable extent they also act as SO for the distribution networks attached to those transmission networks[6]. Transco acts as NO and SO for the gas network.

2.12 Effective operation of the networks is a crucial element of security of supply of electricity and gas. Furthermore, the increasing use of gas for electricity generation means that the effective operation of the gas network is now crucial to electricity security as well as gas security and vice versa – gas generators ramping up and down rapidly could endanger gas network security.

2.13 Network costs currently account for approximately 40% of the total prices of electricity and gas to domestic consumers. The proportion for commercial and industrial consumers varies considerably according to their individual characteristics, but is generally less than 40% and can be as little as 20%. These differences broadly reflect the extent to which consumers take a steady flow of electricity or gas at all times or vary their consumption by time of day or year, and the proportionally higher costs of serving smaller consumers at lower voltages.

[3] Very limited storage of the potential to produce electricity is currently possible, in batteries, reversible fuel cells or flywheels. Other energy sources such as fossil fuels or hydrogen can also be stored.
[4] Pressure ranges for gas networks are prescribed to minimise the dangers of leaks and explosions.
[5] Further sub-division of roles is possible but is beyond the scope of this note.
[6] Although DNOs may also take some actions to despatch plant or load reduction.

3. BACKGROUND ON EXISTING NETWORKS

Electricity Networks in General

3.1 The main electricity network in Great Britain, like most networks in other countries, operates on Alternating Current (AC). Electricity networks can also be operated on Direct Current (DC) and some small networks are operated in this manner. The main advantages of AC are that its voltage can be transformed easily and, at any given voltage, it is safer. High voltage is suitable for long distance transmission with low losses whilst most consumers require lower voltages. The main disadvantage is that AC networks require all generators to be synchronised at the same frequency right across the network. This requires more active management, in addition to system balancing, in order to keep the power frequency within a tightly defined range suitable for both generating plant and load and to avoid power disturbances.

3.2 The main electricity network in Great Britain is a single AC network. The distinction between the transmission and distribution parts of the network is in some respects arbitrary. NGC has the responsibility for ensuring the maintenance of system frequency across the whole system in Great Britain[7].

Electricity Transmission Networks

3.3 The transmission networks carry electricity at high voltage. There is one network covering England and Wales owned and operated by the National Grid Company. There are other networks in Scotland and there are AC links between these transmission networks. The England and Wales network is also linked to the French network by a DC cross channel link, thus avoiding the need for the GB system to be synchronised with that of western Europe. Most large power stations are directly connected to the transmission networks and power is taken off the networks at grid supply points (GSPs), from where it flows into distribution networks and on to customers[8].

3.4 Total capital employed in the transmission businesses is about £10 billion, and annual investment has been running at some £0.3 billion[9].

3.5 Each of the transmission networks has its own SO, ensuring a continuous balancing of supply and demand on the system, and the distribution networks feeding from it, by issuing instructions to generators and consumers to adjust their generation or load in accordance with bids and offers that they post in the Balancing Mechanism, which is an important part of NETA.

3.6 At present the transmission network is paid for by use of system (UOS) charges on electricity suppliers taking power through GSPs and on generators connected to the transmission network. These charges vary from region to region to reflect the estimated costs of accommodating extra generation or demand at different points on the network. In general there is more generation than demand in the north of England and vice versa in the south, so UOS charges on generators are higher in the

[7] Under the British Grid Systems Agreement between NGC and the Scottish grid operators. Scottish operators agree to maintain pre-determined flows across the links into England through actions in their own areas.
[8] There are some 100 GSPs in England and Wales.
[9] CRI – Financial and Operating Review of UK Electricity Industry 1999/2000.

north and UOS charges on suppliers are higher in the south. The UOS charges are set by the network operator, after approval by Ofgem, and are designed to raise the amount of revenue that Ofgem considered appropriate, under the price control, to meet the costs of maintaining and renewing the network.

3.7 There are separate incentives on the SO, to encourage it to minimise the costs associated with system balancing[10]. These currently take the form of one or two year agreements between the SO and the regulator under which the SO retains a share of any reduction in system balancing costs below a target level, or has to meet a share if the costs exceed the target. The rewards and penalties on the SO are subject to absolute cash limits. This is known as "cap and collar profit sharing". The incentives on the SO encourage it to agree with the NO (which is often the same company) strategies for network investment and maintenance that will facilitate reductions in system balancing costs.

3.8 Ofgem are currently considering the creation of firm, tradable, access rights for transmission capacity, together with improved ways to measure network quality and incentivise its provision.

Electricity Distribution Networks

3.9 The distribution networks carry electricity at lower voltage from GSPs to individual customers. Smaller generating stations are directly connected to distribution networks. There are 12 networks in England and Wales and 2 in Scotland. Each network is operated by a DNO but some companies own more than one DNO.

3.10 The operation of distribution networks is largely passive. DNOs do not issue instructions to generators or consumers in order to balance supply and demand on their networks, but the networks do contain some automatic adjustment devices.

3.11 The combined capital employed in the distribution networks is some £15 billion with annual investment of the order of £1.5 billion[11].

3.12 The allowed revenue for DNOs, under their price controls, is currently met by UOS charges levied only on suppliers. The UOS charges do not vary by locality within a network, although they do vary by voltage level. Unlike the situation with the transmission networks, where generators also face UOS charges, generation directly connected to distribution networks does not presently pay UOS charges. Instead it has to pay for the costs of reinforcement on any part of the network that may be required as a consequence of its connection. There is clearly scope for considerable judgement over the level of reinforcement needed and the cost thereof in each individual case. Generator connection to distribution networks has more in common with NTPA than CC.

3.13 Following the work of the Embedded Generation Working Group, see Paragraph 4.14 below, Ofgem are currently considering changes to DNO regulation to make it more cost reflective and remove regulatory barriers to generator connection to local

[10] System balancing costs are passed on to system users through mechanisms contained in the trading arrangements.
[11] CRI – op cit.

networks. Ofgem are also considering better ways to monitor and incentivise network quality through their Information and Incentives Project.

The Gas Network

3.14 The onshore gas pipeline network in Great Britain is owned and operated by Transco. Gas pipelines connecting offshore gas fields to shore are not part of the regulated natural monopoly. There is a gas link between England and Belgium capable of handling 20% of current UK production levels or meeting 10% of current UK demand[12]. There are also gas links between Scotland and Ireland.

3.15 The gas network is divided into a National Transmission System (NTS) and a series of local distribution zones (LDZs). In general, gas from offshore fields and imported gas flows into the NTS, from which it flows into the LDZs and on to consumers.

3.16 Capital employed in the gas network is about £14 billion and annual investment has been running at about £500 million in recent years.

3.17 Transco also act as SO for the gas network, buying and selling gas in an "On the day Commodity Market" (OCM) which forms a key part of the gas trading arrangements, and also using bi-lateral contracts and its own liquified natural gas storage facilities.

3.18 At present, a single price control covers both the NTS and the LDZs. Under this control, Transco are allowed a pre-determined amount of revenue each year for network maintenance and investment. Until recently, this revenue was raised from entry charges on shippers and exit charges on suppliers that were uniform across the country. However, exit charges could be firm or interruptible, depending on the customer's choice. Those choosing interruptible terms would pay less, but could find their supply interrupted by Transco as part of its system balancing action. Since October 1999, entry charges have been replaced by capacity auctions and tradable access rights. The auction system has led to variations in entry costs by location and by time of year, depending on the extent of network capacity at various points and times.

3.19 There are powerful safety reasons for ensuring that the gas network is adequately maintained. Ensuring the safety of the gas network is the responsibility of the Health and Safety Executive (HSE) which has the ability to take enforcement action against Transco, requiring it to undertake certain actions, or, in extreme cases, close parts of the network. HSE maintain regular contact with both Transco and Ofgem and there is a Memorandum of Understanding between HSE and Ofgem which addresses the inevitable tension between the HSE's duty to ensure safety and Ofgem's responsibility to maintain downward pressure on the costs of system operation[13].

3.20 Ofgem are currently considering the creation of longer term, tradable, access rights, reform of the capacity arrangements at NTS exit points, separate regulation of the NTS and LDZs and reducing the system balancing period for gas from 24 hours to 1 hour.

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[12] The existing compression facilities on the link mean that more gas can be exported from the UK than imported to the UK.

[13] Similar arrangements between HSE and Ofgem are in place in respect of the NGC system.

4. KEY ISSUES FOR NETWORK REGULATION

4.1 Many of the key issues affecting networks are the same in principle for electricity and gas, although the details will of course differ. They are issues that surround the regulation of any monopoly activity. The function of the regulator is twofold: (a) to ensure the provision of a suitably sized network, operated efficiently, and priced at a level to recover costs without excessive profit; (b) to act as an umpire for the market to prevent discrimination in trading and network access.

4.2 Key issues for the networks are how to determine the level and structure of prices charged for use of the system, the appropriate level and type of investment and the incentives for the system to be operated in the most efficient manner whilst maintaining safety and the quality of service. These are complex issues for which there are no easy solutions

4.3 The broad approach that has been followed by Ofgem is that prices and charges should reflect as far as reasonably practicable the costs that different network users place on the system. In practice, given the costs of precise measurement of all consumers' loads, the need for pricing transparency, and the difficulties in allocating costs of long lived assets, there is always going to be a degree of cost "smearing". Nonetheless, pursuit of a policy of prices reflecting costs could have distributional consequences, with users who currently face the same prices facing increasingly differentiated prices in future.

> **Question**:
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> Is it appropriate that, where practicable, network users should pay different prices depending on the costs they impose on the networks? If not, why not and what could be an alternative approach?

4.4 Fundamental to the problem of monopoly regulation is that of information asymmetry. This has two aspects. The first is that the company being regulated has more information about its costs and activity than the regulator. Two approaches have been deployed to address this problem. The first is extended price control periods. By setting price controls for longer periods (typically 5 years) the company is encouraged to increase its short term profits by increasing efficiency to an extent greater than expected by the regulator. By doing so, it reveals information to the regulator which can be used in the next price review. The other approach is comparative analysis. This has been useful for the electricity distribution networks where comparisons can be drawn between the different networks, but is harder for the electricity transmission and gas networks where the only comparators available are international and where relevant information may be scarce.

4.5 The risk with encouraging cost reduction is that costs may be cut at the expense of quality of service. Ofgem have been working to improve ways to monitor quality and are considering ways in which regulation can be amended to reward the NO for improvements in quality and penalise it for reductions in quality. However, effective monitoring of network performance is complicated by the fact that weather conditions can lead to very significant year to year variation in performance.

4.6 A further risk is that the NO will reduce short term investment, in order to pocket the profits, although the ability to do so is limited by the regulator's ability to claw back capital underspend in certain cases *within* a price control period. Short term quality of service might not suffer but the increasing backlog of investment could either push longer term prices up or put the security of the network in jeopardy. Ownership of networks by companies based outside the UK could exacerbate the risk of short term profit-taking. A related risk is that the regulator may not allow certain investments to qualify for the future regulated asset base, thus raising the issue of "stranded assets". These risks are a particular feature of the gas and electricity networks where most equipment is very long lived (50 years or more is not untypical) and where the need for and timing of replacement is very much a matter of judgement.

4.7 It could be argued that the degree of information asymmetry between regulator and regulated is now much less than it was when the networks were first converted to privately owned regulated businesses and that most of the efficiency improvements available have already been realised.

Questions

Are the approaches used by Ofgem to tackle information asymmetry between regulator and regulated appropriate? Are there better ones?

Is Ofgem striking the right balance between seeking cost (and hence price) reduction and investment and maintenance of the quality of service?

If not, what are the implications for the approach to network regulation?

Is Ofgem's approach to measuring network quality in terms of numbers and duration of involuntary interruptions appropriate?

4.8 The second area of information asymmetry is that between network users on the one hand and the regulator and the NO on the other. In competitive markets, consumers convey information about their preferences in terms of price and quality by switching between different providers offering different products or price-quality combinations. With a monopoly provider, this is not possible.

4.9 Historically, the main way in which this asymmetry has been addressed is through dialogue between users, the regulator and the NO. However, dialogue is not well suited to revealing users' willingness to pay. In order better to understand users' demands for network services, Ofgem have suggested more widespread use of market based instruments, such as auctions and tradable access rights, to allocate capacity in the short term, to inform and influence network investment plans for the longer term and to influence siting decisions for new generation, gas sourcing or load. Auctions have already been introduced for entry to the gas NTS.

4.10 As the configuration of the networks changes over time, cost-reflective access charges would also change. Lack of predictability in these changes could be a deterrent to new investment in both electricity and gas producing and consuming facilities. Long term tradable access rights could help companies manage these uncertainties.

4.11 There could be trade-offs between approaches designed to reveal users' demands for the network, that could require significant administrative and transaction costs, and more broad-brush approaches in which the regulator, on behalf of consumers in general, determines appropriate standards and investment needs and in which at least some costs are broadly "smeared" across users[14]. There is also a potential trade off between the certainty of an adequate if imperfect approach and the uncertainty of continued changes in pursuit of an optimal approach.

Questions:

Is there a need for more market-based instruments to allocate existing capacity and improve investment decisions and if so how could they be introduced?

Are the costs of introducing such measures likely to outweigh their potential benefits?

Are capacity auctions and tradable access rights appropriate instruments – and if not, what other instruments might be used?

4.12 An inherent quality of networks is that they enable electricity and gas to be transported from one place to another. Over time, the spatial distribution of electricity and gas production and demand can be expected to change. One aspect of cost reflective pricing is that network charges are likely to vary by location. This encourages efficient decisions for new plant siting and closure of existing plant. For example, an electricity generator proposing to locate in an area where fuel and land are cheap but which is remote from electricity demand, should be encouraged to consider the alternative of location in a more expensive site but closer to the electricity load.

4.13 There is a view that network access charges during most of the 1990s have tended, in comparison with cost reflective charges, to advantage electricity and gas producers based in Scotland and Northern England and disadvantage consumers in those regions, with the reverse being the case for the south of England[15].

Questions:

Has the balance of network charges tended to favour producers in Scotland and Northern England to a greater extent than warranted by variations in cost?

If so, should this situation be corrected?

4.14 There has been widespread concern that electricity DNOs do not have the right incentives to encourage generation plant to be connected to their networks. In particular, they may prefer to reinforce their networks rather than encourage additional local generation or greater energy efficiency at potentially lower overall cost. This issue has been examined in depth by the Joint Government Industry

[14] It has also been suggested that greater use of market instruments for network access could segment the bulk energy markets, thereby reducing market liquidity and effective competition.

[15] Aspects of the electricity trading arrangements, particularly the way transmission and distribution losses are allocated, may have similar effects.

Working Group on Embedded Generation which reported in January 2001. The main recommendations of this report were:

- Ofgem should review the structure of regulatory incentives on DNOs in the light of the new statutory duty on DNOs to facilitate competition;

- A Group should be established under Government leadership to co-ordinate and take forward the implementation of the present Group's recommendations for the longer term;

- The report, which can be found on the DTI website at www.dti.gov.uk/energy/egwg/index.htm, also contained a substantial number of more detailed recommendations.

The work of this group is being taken forward by a Co-ordinating Group, established in July 2001 and chaired jointly by Ofgem and DTI. DTI's draft Social and Environmental Guidance to Ofgem[16] says that embedded generation should be able to access the network on fair and transparent terms.

Questions:

Are the recommendations of the Working Group consistent with a general approach of cost-reflective pricing for networks?

Do they address the key problems identified with embedded generation?

Is reform of distribution network regulation the most important network issue at present?

5. NETWORKS AND SECURITY

5.1 It is clear that gas and electricity networks play a crucial role in delivering security of supply for these energy sources. In practice, the vast majority of supply interruptions experienced by consumers over the last 25 years or more have been due to failures in networks and especially in local electricity distribution networks. They have not been due to shortages of fuel or generating capacity. The networks are also subject to systemic risk in that circumstances on one part of the network will affect what is happening elsewhere.

5.2 Given the risks of network failure, many consumers, especially in industry, commerce and public services, have back-up arrangements which can be used in the event of supply interruptions. Consumers who are willing to have their supplies interrupted are able to obtain lower prices, since their actions reduce the need for network capacity. Examples of these approaches are:

- Industrial gas consumers who can use oil instead of gas if necessary;

- Hospitals or IT companies with back-up generators able to run on oil or gas;

[16] DTI Consultation Document of May 2001.

> **Question**:
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> Should consumers of all kinds be given further encouragement to consider their own security requirements and if so how?

5.3 A key concern for network security is that there should be adequate ongoing investment in network replacement and, where necessary, reinforcement. Lack of network capacity has been quoted as one of the reasons behind the current electricity shortages in California.

5.4 There are currently a number of substantial changes to network regulation being considered (see Paragraphs 3.8, 3.13 and 3.20). Some concerns have been expressed that the current pace of regulatory change is excessive, with interested parties having to focus on several significant regulatory proposals at once and with too little time for analysis and discussion of what are inevitably complex proposals with significant costs of implementation. It is possible that the regulatory uncertainty created by these proposals, taken together, could mean that network operators and users are unwilling to make new investments until they have been resolved. This in turn could create security problems in the medium term, especially where significant investments might be necessary now to meet medium term needs.

> **Questions**:
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> Is there a risk that current and proposed regulatory approaches would lead to inadequate investment in the networks?
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> If so, why and what is the appropriate means of securing adequate investment?
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> Is there a case for a deliberate regulatory policy to encourage over-sizing of networks on precautionary grounds?
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> If so, how should this be done, to what extent, and who should bear the costs?
>
> Is uncertainty created by regulatory changes currently being considered causing medium term security risks? If so, how can these risks best be dealt with?

5.5 Links between networks, including international links, can contribute to energy security by enabling supplies from one network to be shared between both in the event of a supply shortage in the other. Alternatively, such links can enable a given degree of security to be achieved at lower cost, perhaps by reducing the margin of spare generating capacity[17]. The commercial value of these benefits may encourage more international links to be built. For example, we are aware that NGC are in discussion with a range of parties to build new links with Norway and Holland. These links would not be part of NGC's regulated monopoly network. There are also proposals to increase the capacity of the existing gas link to transmit gas to the UK.

5.6 On the other hand, there can be disadvantages from additional links, particularly when the security problems are on one side of the link but the existence of the link causes prices on the other side to rise. For example, there have been concerns that

[17] This is true so long as there is not a strong positive correlation between plant outages on the two networks.

electricity links have caused high prices in California to spill over into other states of western USA. Export of gas to Europe via the UK-Belgium gas link has led to higher gas prices in the UK, even if the root cause was not a security problem on the European side but high gas prices there reflecting in part a lack of market liberalisation.

Questions:

Can market forces be relied on to provide the appropriate number and capacity of international links, especially if energy market competition is less well developed outside the UK?

Is there a case for government or regulatory intervention to promote new links and if so, what form should this take?

5.7 With the recent increase in gas use for electricity generation, and possibility of further increases, it is important that the trading and network arrangements for the two fuels fit together. It is important to avoid perverse arbitrage incentives between the two markets whilst facilitating arbitrage that leads to gas being used where it is of most value to consumers, with corresponding adjustments in electricity markets.

Question:

What, if any, further steps need to be taken to ensure that trading and network arrangements for gas and electricity provide appropriate incentives for arbitrage between the two markets?

5.8 In view of the complexities of network regulation, systems of access charging and trading arrangements, and the need for widespread consultation before changes can be implemented, it is possible that network operators and users might be unwilling to make investments that are necessary to maintain security of supply in the medium term

5.9 Liberalised electricity and gas markets are a relatively recent development, both in the UK and elsewhere and the UK has probably reached a more advanced stage of liberalisation than most other countries.

Question:

What further lessons can the UK learn from network regulation in other countries with liberalised energy markets?

6. NETWORKS AND THE ENVIRONMENT

6.1 At present, electricity trading and network access arrangements are "technology blind". The price that a generator is able to command in the wholesale electricity market, and the costs it has to pay for network access, are entirely independent of the fuel used for generation or the amount of environmentally damaging emissions from that generation[18].

6.2 Network configurations and access costs can have a significant impact on the environment. For example, it is widely recognised that Scotland contains a substantial part of the UK's onshore wind generation resource. However, Scotland currently has more generation capacity than demand. It is possible that if network links with England (or other countries) were not expanded, then additional wind generation in Scotland could displace other zero-carbon generation sources in Scotland, such as hydro or nuclear, instead of contributing, as expected, to the reduction of emissions and diversification from fossil fuels.

6.3 It can be argued that network access terms for electricity and electricity trading arrangements should take explicit account of environmental considerations, with environmentally benign forms of generation being given preferential treatment relative to less benign forms. For example, the EU Directive on Renewable Energy suggests that renewables could be given priority access to networks. However, it is not clear how this might be accomplished, what forms of environmental impact should be taken into account, and how they should be weighted.

6.4 An alternative approach might be for environmental regulation to be separate from network access terms and trading arrangements and managed instead through regulations on power stations or through market based instruments such as taxes or tradable emission rights. In this way, generators would be faced directly with the environmental consequences of their actions and those with lower costs on account of their lack of emissions would be better placed to compete in the market and able to pay higher network charges if necessary because of their location.

6.5 Another area in which Ofgem is considering significant changes to electricity trading arrangements is the attribution of transmission and distribution losses. Network operators already face regulatory incentives to reduce these losses and in general reduction of losses should be environmentally beneficial. Ofgem are considering proposals that would put stronger incentives on generators to reduce losses, but this could adversely affect some low carbon generation in areas where generation exceeds demand, particularly renewables in Scotland.

6.6 Draft DTI guidance to Ofgem suggests that consideration of environmental implications should form an integral part of any major initiatives. It also suggests that renewable electricity generation should be given access to the networks on reasonable and proportionate terms. Ofgem's view, as set out in their Environmental Action Plan[19], is that it looks to Government to lead on environmental policies with significant financial implications and that Ofgem should act to ensure that long term

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[18] Enviromental issues may be less significant for gas networks and trading arrangements since all gas has similar environmental impacts.

[19] Published on 20th August 2001.

network development, access and operation appropriately reflects the needs of network users on a non-discriminatory basis.

6.7 Some of the changes currently being considered by Ofgem, including those for auctions of electricity network capacity and for loss attribution, could well be described as major initiatives and could have significant environmental implications.

Questions:

Should network access and trading arrangements be "technology blind"?

If not, why not, and how could environmental considerations be incorporated in a fair and transparent manner?

6.8 Networks themselves can have adverse environmental impacts. Overhead electricity transmission lines in particular have significant visual impacts and are considered by some to adversely affect the health of those living nearby[20]. These impacts are not taken into account under the current system of network regulation, but are dealt with through the planning process.

Questions:

How should the local environmental impacts of networks, and in particular of overhead electricity transmission lines, be taken into account in network regulation and investment plans?

Is there a role for a designated independent expert, perhaps Ofgem, to advise local planners on the wider benefits of proposed new lines, so these can be weighed against local considerations?

7. LONGER TERM NETWORK CHANGES

7.1 This section concentrates on electricity networks, since there would appear to be less scope for fundamental changes to the broad structure of gas networks, given the location of gas reserves.

7.2 It has been suggested that electricity networks will need to undergo fundamental changes in future in order to be compatible with sustainable development. Technical changes may be undermining the economic advantages of large scale generating plant with smaller plant such as micro gas turbines becoming more competitive. A lot of zero emission renewables plant is better suited to small-scale generation. Much renewables generation, particularly from wind and solar, is likely to be unpredictable and intermittent. Such developments could lead to much greater generation of electricity at the level of individual households or small communities and this process could also facilitate greater use of small scale combined heat and power with its associated energy savings.

[20] Putting these lines underground is generally reckoned to increase costs some 20 fold.

7.3 Increasing competitiveness of small-scale generation would not necessarily mean that networks would become redundant. Some zero emission plant such as nuclear and offshore wind are more suited to large scale facilities in remote areas, with possible need for new wires to bring their output to market. A key efficiency advantage of networks is that generation capacity can be sized to meet peak demand on the network as a whole. This system peak will be lower, perhaps much lower, than the sum of each consumer's maximum demand because individual maximum demands occur at different times of day or year. For somewhat similar reasons, networks can help to deal with intermittent generation sources, so long as there is not a strong correlation between such generation in different parts of the country, although other means of handling increased intermittency, including availability of fossil-fuelled plant for back-up, is likely to be necessary. Networks could therefore still offer efficiency benefits even if the generating plant attached to them were smaller in scale.

7.4 However, their role could change radically. Instead of mainly distributing power from large generating stations to consumers in a one-way flow, local networks might become much more active and the direction of power flows might change frequently according to local circumstances. While the extent of energy flows might decrease, the network would still have important security and back-up roles.

7.5 On the other hand if new, cheap and small-scale ways to store electricity, or fuel that could readily to be converted to electricity, were to be found then the efficiency and security benefits of networks could be significantly reduced. Smaller areas and even individual consumers could perhaps meet their electricity needs cost effectively from small-scale local generation.

7.6 Compatibility with the above developments might suggest that the existing electricity network was progressively broken up into smaller scale AC, or even DC, networks, each with its own SO. This could be combined with some use of high voltage DC links between networks and to bring larger power sources such as offshore wind farms to market, new metering and control systems, partly to accommodate increasing proportions of intermittent generation, and updated trading systems to accommodate the increased blurring of the distinction between electricity producers and consumers.

Questions:

Does the above vision of electricity networks seem plausible? If so, over what period might it evolve?

What might be the costs of moving to networks of this kind?

Would current approaches to network regulation, based on cost reflective pricing and investment to meet user requirements, be able to deliver the non-marginal changes required? Would it be able to do so if the costs of carbon abatement were internalised in electricity prices?

If not, what does this suggest for approaches to network regulation and investment and in particular for any urgent changes to these approaches?

7.7 An aspect of the above vision for electricity is that with generation closer to the point of use, any local environmental costs of generation would more likely be borne by those using the electricity. This would contrast with the current position in which large generating stations are often remote from the load they serve leading to local opposition to new plant and difficulties in obtaining planning permission. The latter issue has often been cited as a major contributory factor behind recent problems in California.

Questions:

Should network reinforcement to accommodate large, remote sources of power be discouraged in order to provide stronger incentives for local generation?

How might such discouragement work?

Would it have unacceptable implications for generation costs and network security?

7.8 There would seem to be two key longer term issues for the gas network. The first is how the network can adjust to cope with new sources of gas as existing UK fields move into decline. This process could be quite rapid in a few years time and the adjustment required significant.

7.9 The second issue affecting gas networks is whether and how they might be expanded to cover all areas of the UK. At present, about 80% of consumers are actually connected to gas supplies. The Government has announced its intention to set up a working group to examine extension of the gas network, producing an initial report by October 2001. Ofgem will be participating in that working group.

Questions:

Would current approaches to network regulation, based on cost reflective pricing and investment to meet user requirements be able to deliver the changes needed to accommodate significant new sources of gas and expand the gas network to more consumers?

If not, what does this suggest for approaches to network regulation and investment and in particular for any urgent changes to these approaches?