National Grid and Distributed Generation

Facilitating the Future

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If you would like to discuss the contents further please contact:

Charles Davies
Commercial Director
National Grid Company
Kirby Corner Road
Coventry
CV4 8JY
Tel + 44 (0) 2476 423103

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National Grid

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Summary

National Grid is committed to assisting the development of the electricity industry to support the Government's 2010 targets and beyond in respect of the proportion of electricity to be provided by renewable energy and combined heat and power. The transmission network has a distinct and enduring role to play in facilitating the future development of distributed generation.

The electricity transmission network in England and Wales - owned and operated by National Grid - provides a highly responsive way of transporting power and balancing the overall electricity system. Over the past ten years, the system has experienced radical change with the liberalisation of generation and supply, coupled with a widespread shift from coal to gas-fired plant.

The UK Government aims to have 10% of electricity supply produced by renewables by 2010 - a proportion set to rise considerably thereafter. 2010 also brings a target for the doubling of combined heat and power (CHP) plant from 2000 levels. Looking further forwards, the Government is considering how longer term environmental and security of supply issues might best be addressed.

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Many renewables and CHP developments will connect to local distribution networks rather than to the high voltage transmission network.

Responsive Transmission, see page 7

The electricity system remains, by its nature, an integrated entity. Transmission has an important role to play in co-ordinating the operation of this system so that it supports the successful introduction of these new forms of generation.

Bulk Transfers, see page 10

One of National Grid's main tasks - to enable bulk transfers of power around the country - is likely to remain largely unchanged. The likely siting and nature of new plant will continue to require the flow of power from areas of most generation to areas of most demand. Some development of the transmission network will take place to accommodate the changing nature of power flows.

Security of Supply, see page 13

A challenge for the long term is the generally intermittent output of some renewables. This involves National Grid's other main task - to ensure security of supply by balancing generation with demand. As the proportion of renewable and CHP generation increases over the long-term, so the proportion of both steady baseload and fast response output will decrease. This will not present difficulties for the 2010 targets. But in the long term, it will become more necessary to develop new ways to manage the balancing tasks of the system. In so doing, it may well be possible to create new markets for these security mechanisms, known as ancillary services, to which distributed generation can contribute and which would offer further sources of revenue to them.

Encouraging Distributed Plant, see page 16

Since most renewables connect to their distribution network, their viability depends in large part on resolving technical and commercial issues at the distribution level. Nevertheless, National Grid can support this process in a number of ways: by simplifying the contractual requirements for new types of generator, by ensuring a non-discriminatory approach to connection and charging, and by working with distributors to develop local markets in ancillary services.

The Long-Term, see page 19

No-one can predict with certainty what shape the energy sector will take in the long-term. The proportion of renewable and low-emission generation is likely to increase significantly - and this will accelerate the need to find new mechanisms and markets for providing system security. But the speed and nature of development, particularly from new technologies such as fuel-cell and solar photovoltaics, might potentially direct the industry in different ways. National Grid is committed to facilitating this future industry, however it develops.

The changing mix of generating plant in the UK
The UK Government has set ambitious targets for reducing greenhouse emissions and increasing the proportion of new forms of electricity generation.

Kyoto commitment
Although the 1997 Kyoto Protocol still awaits ratification, the UK is committed, as part of the EU sharing agreement, to reducing greenhouse emissions by 12.5% on a base level of 1990 by the years 2008-2012. In addition, the UK has set a domestic goal of reducing emissions of CO^2 - by far the most prevalent greenhouse gas - by 20% by 2010.

Target for renewable generation
The UK Government has targeted 10% of electricity to be supplied from renewable sources by 2010. The amount of generation required to achieve this will depend on the type of technology used. It is forecast that the total capacity of renewable plant will need to increase from 2,300MW in 2000 to at least 7,500MW by 2010 - and quite possibly much more.

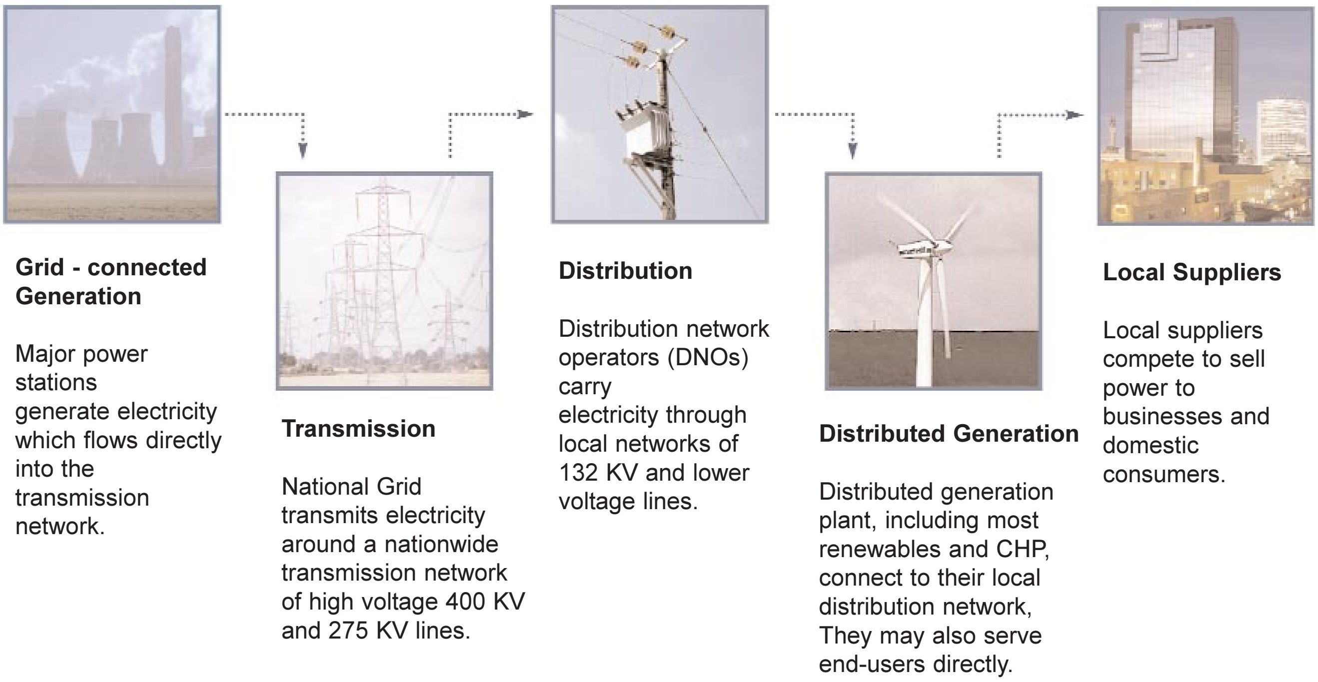
Target for combined heat and power (CHP) generation
The target for CHP is an installed capacity of at least 10,000MW by 2010, more than double the 2000 capacity of 4,300MW.

Overall change to generation
The proportion of new forms of plant - both renewable and CHP - within the UK's overall generating capacity is estimated to rise from 8.6% in 2001 to 20% in 2010. This proportion is likely to increase further in subsequent decades.

Networks and Distributed Generation

The electricity system will adapt to the arrival of new forms of generating plant, many of which are small and connected to their local distribution network rather than to the transmission system.

Key Elements Within The Electricity Industry



The bulk of electricity in England and Wales is generated by large generating plant, each with an output of at least 100MW. Currently in mid-2001 there is 67,000MW of such plant, 94% of which is directly connected to the high voltage transmission network. But many of the new types of plant, whether renewables or CHP, produce much less than 100MW output. Their smaller size makes it uneconomic for them to connect directly to the transmission system. Instead they generally connect to their local distribution network, hence they are described as distributed plant. Most presently do not participate in the national electricity market such as the short-term balancing mechanism operated by National Grid to match supply with demand across England and Wales as a whole.

The development of renewable energy sources such as wind, wave, biomass plant, and CHP, over the next decade will increase the amount of generation connected to distribution networks. Looking further ahead, widespread development of micro-CHP, photovoltaic and fuel cells will also, by their nature, connect to distribution systems. As a generic term to describe all these types of generation, we have used the term “distributed generation.”

Certainly there is a growing need to incentivise distribution systems to cater for distributed plant, to develop market mechanisms and to ensure continued security of supply while enabling new forms of generation to flourish.

But it is important to remember the overall objectives of any electricity system - to produce power as efficiently as possible while supplying it to customers as cheaply and securely as possible. By these criteria, the co-ordinating role of the transmission system remains essential, both to the system overall and to encouraging the growth of renewables.

> *"We do not accept … that the grid and centralised generation will ever become superfluous or even the junior partner. The necessary stabilising role of the grid must remain."*
>
> House of Lords Select Committee on the European Communities Session 1998-9. 'Electricity from Renewables' June 1999.

To understand the continuing importance of the transmission network, it is useful to consider the fundamental role of transmission within the electricity system.

Responsive Transmission

The electricity system is, by its nature, an integrated entity. Transmission has a crucial role to play in co-ordinating the operation of this system so that it supports the successful introduction of new forms of generation.

National Grid

Owns and operates the network of high voltage 400 and 275 kV transmission lines and substations in England and Wales, connecting large-scale generation and local distribution networks.

Controls the system to balance generation with demand and maintain security and quality of electricity supply.

Balancing Generation and Demand

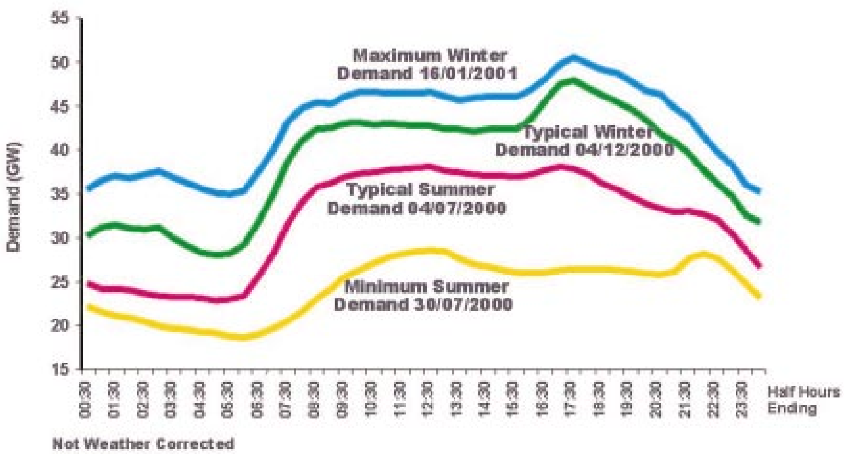
Electricity cannot yet be stored in bulk, so the output of generation against demand must be constantly balanced. Some capacity is necessary on stand-by as a cushion to maintain security.

Several factors complicate this balancing act. Demand for electricity fluctuates according to the season, the weather, the time of day and even on what happens to be on television. Lightning can cause faults on the transmission system by striking overhead lines and, as with any complex machinery, major plant can break down, so leading to a rapid drop in generating capacity.

At present, demand can only be adjusted in limited ways, so generation must respond to demand, increasing and decreasing its output as required. When managing such variations, it is generally more efficient to operate a large system rather than a small system. Such scale enables responsive generation capability and standby reserves to be shared across the system. Furthermore, it enables demand at each moment to be met by the most economic generation, largely irrespective of where it is located.

Hence National Grid has two roles as transmission operator. On the one hand it manages the network of high voltage lines which links large generators and connects local distributors and on the other hand it controls the system, balancing generation with demand on a minute-by-minute basis.

Balancing Dramatic Fluctuations in Demand



On any day of the year electricity demand in England and Wales fluctuates significantly - with particularly sharp rises each morning. In winter this pattern is even more pronounced. Aside from seasons and weather, other events can cause sudden surges in demand. One notable episode of the BBC soap Eastenders created a sudden 2,300MW surge in demand. To balance such fluctuating demand with consistent supply, National Grid must have access to a significant amount of fast response and reserve generation.

Flexibility

In today's electricity system in England and Wales, generators compete to sell energy to suppliers. They also compete to provide the ancillary services needed for fine balancing of the network, such as being on stand-by to provide power at short notice. Electricity suppliers compete to sell power to the majority of end-users.

Within this structure, National Grid manages the network and controls the system. Like the local distribution networks, it has a natural monopoly, which is highly regulated and incentivised to operate efficiently. National Grid's Licence requires it to provide a level playing field for anyone wishing to make use of the transmission network. This involves providing transparent information on charges, network capability and opportunities for future use.

Further market transparency, and some complexity, has come with the New Electricity Trading Arrangements (NETA). Introduced in March 2001, NETA requires generators and suppliers to enter bilateral contracts for energy and allows generators to self-despatch, ie to choose how they operate their plant to fulfil their contracts. National Grid retains its role in balancing the overall system, and is incentivised to achieve this for the lowest cost.

Technological Developments

Technological changes have also transformed the transmission system. The shift from coal and oil to gas-fired generation, for example, has entailed the connection of 25,000MW of new plant and the disconnection of 23,000MW of old plant in the past 10 years alone. Over a third of the total generation in England and Wales has changed within one decade, which inevitably adds considerable complexity to network planning.

Investment in technically advanced equipment has enabled National Grid to improve the capacity and flexibility of the network, so enhancing its ability to incorporate new forms of generation. New types of devices such as quad boosters enable power to be shared more evenly over the existing system. Improved compensation equipment, such as mechanically switched capacitors (MSCs) and static var compensators (SVCs), allows electricity to be transmitted over long distances without unacceptable drops in voltage, and improved conductor design has helped capacity on the 400 KV system to be trebled since its introduction.

An already flexible transmission system

Over the last 10 years, National Grid has developed the transmission network into a flexible and responsive system. In the past decade it has:

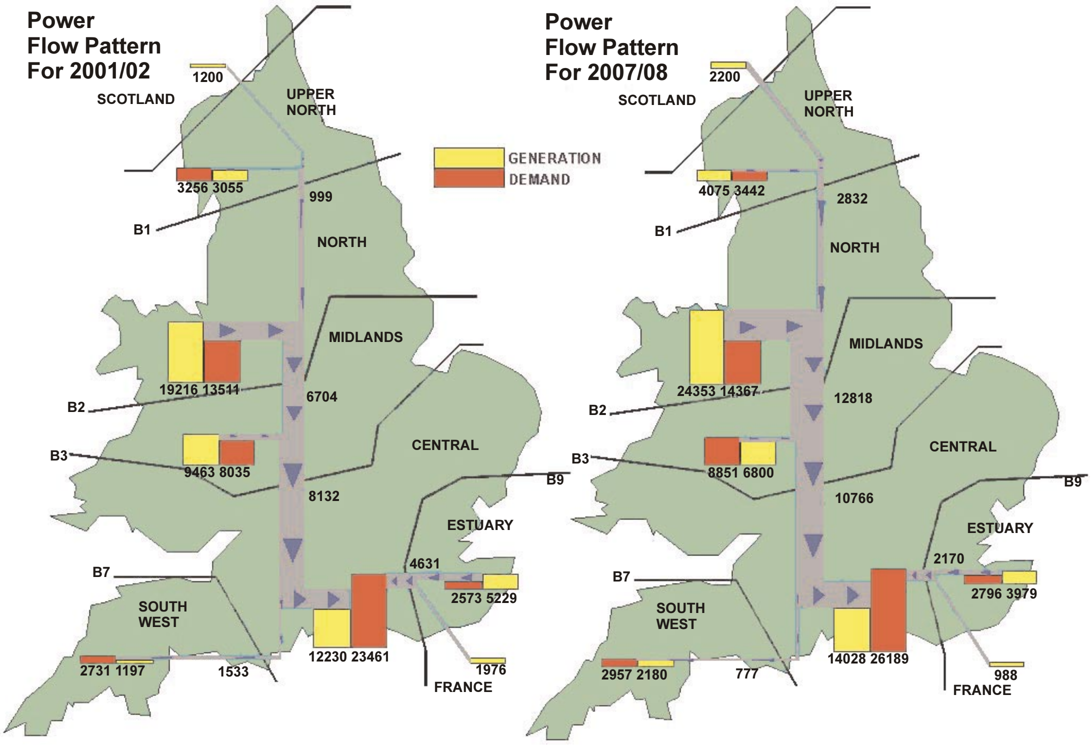
- Connected nearly 25,000 MW of new generation and disconnected 23,000 MW of plant. This represents 37% of all generation plant.
- Increased network capability by over 20%.
- Pioneered new markets for ancillary services within the electricity system which enable major electricity users and other parties to contribute commercially to system operation.

Such flexibility in managing both commercial and technical change gives National Grid confidence for handling the arrival of widespread distributed plant.

Bulk Transfers

The likely siting and nature of new plant will continue to cause a general flow of power from areas of generation surplus to areas of demand. Hence bulk transfers of power around the country will continue. With some development of the transmission network, National Grid will accommodate the changing nature of power flows.

Projected Power Flows from North to South



This chart illustrates the regional balance of projected power flows on a typically cold winter's day, marking generation in yellow and demand in red. The grey pipe shows the bulk transfer of power from areas of generation surplus to generation deficit. This pattern of surplus flow from north to south persists throughout the year. As demand drops, output first reduces from more expensive generation in the south, so maintaining the transfer. The need for such bulk transfers is very likely to continue with the introduction of renewables and other distributed plant.

Managing Regional Imbalance

As network operator, National Grid must enable any generation, wherever located, to be used to meet national demand. Typically there is a significant surplus of generation in the north and a significant surplus of demand in the south. This pattern of southward flow continues throughout the year, peaking at up to 10,000MW.

Proximity to coal and gas-fuel supplies were a major reason why power plants were sited in the north, away from the nation's demand centres in the south. The question today is whether the advent of new renewables and other distributed plant will even-out this regional imbalance and so reduce the need for bulk transfers.

Why bulk transfers require a high voltage network

Bulk transfer of electricity is most efficient at high voltage. A 400kV transmission line carries up to ten-times more capacity than the 132kV line - the highest voltage used in distribution networks. Capital cost is up to four-times less per MW of capacity, while relative heat losses are at least nine-times less for the same power flow. Hence bulk transfer at high voltage is both cost-effective and minimises environmental impact.

The Impact of Renewables and CHP on Bulk Transfers

Perhaps surprisingly, it is unlikely that the new distributed plant will radically reduce the need for overall flows from north to south. This is due to both geographical and commercial reasons.

Distributed generation which connects in the north could displace generation in the south which historically has had higher generation costs, and so could actually increase system transfers from north to south. Distributed generation locating in the south will also tend to displace the older and more expensive southern generation and so could leave power north - south flows unchanged.

To give a cost-signal to power stations and demand, transmission charges provide a financial incentive for generators of all sizes to locate in the south. Transmission-connected generators receive a payment through their contract with National Grid if they locate in areas which reduce the need for network reinforcement. Smaller generators receive an indirect incentive because they can enable suppliers to avoid payments of National Grid demand-related use of system charges, which are higher in areas requiring reinforcement for imports.

Of course many smaller types of distributed plant will, by their nature, be sited close to areas of demand, wherever that may be. These include micro, small and district CHP, fuel-cells and possibly photovoltaics. New gas-fired generators may also even-out the regional balance of generation and demand. But, as has already been pointed out, there would need to be a very large volume of new connection predominantly in the south to change the current balance, radically.

Perhaps more significantly, some forms of renewables and larger CHP installations will often have to locate away from the main areas of demand. Wind power is strongest in the north and west, as is wave power. Biomass plant may be more southern but its need to be near agricultural or forestry fuel sources will distance it from major cities. New hydro and geothermal resources may also contribute to bulk transfers by entering the transmission system via new interconnectors.

In short, National Grid foresees that bulk transfers of power will continue through the transmission network.

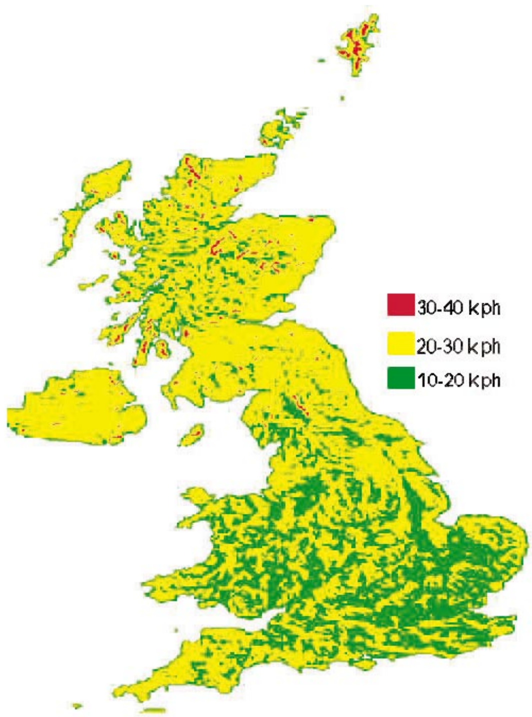
Managing Power Flows Between Transmission and Distribution

Although the regional imbalance between total output and demand will continue into the foreseeable future, local power flows are likely to change with the arrival of distributed plant. National Grid expects to see a reduction in the flow across the interfaces between the transmission and distribution networks.

While these lower flows will possibly delay the need for these parts of the transmission network to be reinforced, it is unlikely to remove the need for substations at the interfaces. These substations will still be needed to balance the fluctuation between generation and demand within the distribution networks.

In some areas the output of distributed plant may cause exports from distribution to the transmission network. Existing transmission capability should support such exports with ease. If not, then relevant interfaces could be reinforced. National Grid already actively co-ordinates transmission developments with distributed generation developments to ensure that the system operates smoothly and efficiently, and will continue to do so.

Wind Speed and Existing Wind Turbine Sites in the UK



Harnessing natural forms of energy, particularly wind, will require generators to be located far from the main areas of demand and so increase the need for bulk transfers of power.

The arrival of renewables and other distributed generation may not alter the regional imbalance which requires bulk transfers of power along the transmission network. The effect of such plant could even be to increase these bulk flows. National Grid is ready to accommodate the new generation sources required to meet the UK Government's 2010 targets.

Security of Supply

National Grid is confident that in the near term it can manage the increase in renewable energy output, some of which will be of an intermittent nature. In decades to come, as the penetration of renewables increases, it may become necessary to adapt the mechanisms for maintaining technical and commercial system security.

Security of Supply

National Grid achieves a secure system by constantly balancing generation and demand. Scale counts: the larger the system, so the wider variety of generation and the greater scope for averaging out fluctuations in demand and generation. Also, a larger system offers more scope for competition between the providers of services that the system operator can call upon. There are commercial markets for providing reserve generation, based on the different type of response that plant can deliver.

The transmission system ensures that demand in any one part of the country does not depend solely on the availability of local generating plant. By connecting generation throughout the system, National Grid can enable most efficient use to be made of what is available - while also giving access to the market for reserve services to as many generators as possible.

Intermittency

No generating plant operates constantly at full capacity. However, some renewables and CHP have much more unpredictable and variable output than traditional generation. Wind and sun, for example, are naturally intermittent sources of energy. This impacts on system security in two ways: it may bring more fluctuation to output and it offers such plant limited scope for providing reserve capacity.

The reduction in the proportion of large generation does not present great concern to overall security in the foreseeable future. As we have shown, the interconnected nature of the transmission system tends to average out fluctuations across the system. There are also sophisticated mechanisms for obtaining reserve and response services from whoever can provide it at lowest price. National Grid believes that sufficient fast response and reserve services will be available for a situation in which the entire 2010 renewables target is met by wind-powered plant - perhaps the most variable generation of all.

Nevertheless, extensive penetration of renewables will eventually require changes to the way that the system is secured. Several factors should become clearer over the next few years: the mix of new generation technology, particularly the amount of large-scale wind generation; the development of system control frameworks on distribution networks; and the operating experience of system-balancing after the introduction of NETA; including the way that demand customers respond to NETA prices. These factors will determine how National Grid will need to develop new commercial approaches to ancillary services.

Rather than reduce the need for central system operation renewables might increase it

The unpredictable output of many renewables highlights National Grid's role as system operator in maintaining security of supply.

Renewables tend to generate only a small proportion of their installed capacity. Photovoltaic cells depending on daylight are expected on average to produce around 10% of capacity. For wave and tidal power it is 15-25% and for wind turbines the figure is 25-35%.

Output can be predicted to some extent from, for example, weather forecasts and tide timetables. Also, the likely geographical spread of renewables will help average out local conditions. However in winter, when demand peaks, the UK sometimes experiences bouts of cold, still and overcast conditions. At such times, security of supply could depend particularly on plant which can offer steady output (currently nuclear and fossil-fuelled plant) and on overall co-ordination of the system by National Grid.

"A system heavily dependent on intermittent renewable sources would have to contain a correspondingly large capacity of back-up plants using fossil fuels."

Royal Commission on Environmental Pollution, 'Energy - The Changing Climate' June 2000, 8.41

Renewables and Ancillary Services

In the short-term, it is possible to develop ancillary services market arrangements so that renewables and other distributed generation can participate.

While the small size of renewables and other distributed generation means they cannot be used individually by the system operator, combining their capability will enable them to contribute to system balancing and security. National Grid has already set a precedent for this in creating a market for major electricity users to contribute to overall energy balance.

To enable small players to compete, National Grid encourages the use of aggregator agents. These combine the capacity of separate, similar providers, such as steelworks, to provide a single, significant offering to the system. As a result, the market for ancillary services is wider, competition is greater and the system operator has more flexibility.

In the future, similar markets will be developed for renewables. The aggregating agent could be their local distribution network operator (DNO), who is connected to both the plant and the transmission network. Creating such markets would be likely to entail significant amendment to existing arrangements between DNOs, transmission operations and service providers.

There is a further area in which renewables can potentially contribute to ancillary services - by providing reactive power services to maintain quality of supply. Voltage is mostly controlled by the generation and absorption of reactive power. As voltage cannot be carried very well on the transmission network, this task is performed largely by generators as a local activity. Hence there is a strong local need for reactive power which, given the creation of appropriate distribution markets, renewables would be able to provide and so gain a further income stream.

Aggregation enables small players to contribute to system security

Just as a medium-sized steel manufacturer can now compete commercially within the vast market for balancing security across the network, so small distributed renewables may be able to compete in the future. The means for this is aggregation. Many small players of similar operation combine their contributions through an aggregating agent. The resulting accumulation of power (or voluntarily withheld demand as in the case of steelworks) is significant enough to be marketable to the system controller. Creating such an ancillary services market for distributed generation will support the economic viability of renewables.

National Grid will help develop new mechanisms to maintain system security as the proportion of renewable generation increases.

Encouraging Distributed Plant

Widespread distributed plant is a new development for the electricity system in England and Wales. Initially the focus will be on distribution networks, but there is an important role that the transmission network can play.

Technically

From a technical viewpoint, we have already discussed the possible impact of distributed plant on bulk transfers of power across the transmission network and between the distribution networks and the grid. Changes in the short to medium term will be managed within National Grid's existing procedures for network planning.

But there are several technical and practical issues at the distribution level. These include capacity restrictions, particularly as a result of the network in rural areas, and fault level restrictions resulting from the historic optimisation of networks in urban areas. Technical liaison between National Grid and Distribution Network Operators will ensure that development of both transmission and distribution networks is co-ordinated to facilitate the emerging requirements from new generation.

Commercially

The Department of Trade and Industry / Ofgem Embedded Generation Working Group in May 2001 highlighted several key factors in facilitating the development of distributed generation. These include accessible processes for market entry, effective information flows, and transparent terms for connection and use of networks.

Presently generators wishing to connect to the distribution network pay the full cost of reinforcing that local network to accommodate their connection, often before they connect. Moreover, they may find it difficult to share this cost with other generators who follow once the capacity has been established. Such so-called 'deep' connection charges can be a barrier to new generators. An alternative now being considered would be the introduction of 'shallow' connection charges - like those already offered by National Grid - whereby the costs of reinforcing infrastructure are shared between all connectees.

Developers require access to network information so that they can better evaluate siting options. The Working Group liked National Grid's approach to providing information on transmission system opportunities through its Seven Year Statement, its charging policy on connection and use of system, and its general approach to facilitating new entry. These present a useful model for addressing generation issues emerging at the distribution level.

National Grid is actively working to assist the connection of new forms of generation. It is, for example, revising its contracts with distributors to incorporate information about distributed plant, so that distributed generators need only have a single point of contact with their host network - and not with the transmission system operator as well. This will reduce red-tape for small generators.

In any case, National Grid's Licence prohibits discrimination between parties who make use of the transmission network. Hence there is a central principle of transparency in the charges it makes and the information it gives about the network.

National Grid recognises the benefits brought by distributed generators to the transmission system. The charging arrangements for Transmission Network Use of System (TNUoS) and Balancing Services Use of System (BSUoS), by which suppliers effectively contribute to the cost of the transmission network, encourage suppliers to use distributed plant: they receive a 100% credit against their charges for the output they take from distributed plant.

There will, of course, be occasions when larger installations of more than 300MW will find it economic to connect directly to the high voltage transmission network. National Grid aims to provide whatever economic and technical information it can in helping developers of such plant to make their decision.

Most renewables connect to their distribution network. Their viability depends largely on resolving technical and commercial issues at the distribution level. Nevertheless, National Grid can support this process. One way is by simplifying contractual requirements for new types of generator. Another is to ensure a non-discriminatory approach to connection and charging. National Grid will also work with distributors to develop local markets in ancillary services.

National Grid's charges can benefit renewables indirectly

Even though distributed generators do not connect to the transmission network, they can still benefit indirectly from National Grid's charging structure. This structure is based on the principle of providing equal access to any party seeking to connect. There are three types of charges for customers who use the transmission system. These charges cover the costs of building, maintaining and operating the network.

Connection charges

When a generator or large demand customer connects directly to the transmission network, it pays connection charges to cover the cost of installing and maintaining assets required for the connection. These charges are 'shallow' - they only cover those assets at or very near to the connection site. Distributed generators pay connection charges to their local DNO instead. These distribution connection charges are currently 'deep' - whereby generators pay the full cost of reinforcing the distribution network to accommodate their connection. DNOs may reduce their transmission connection charges if they feel the new distributed generation will reduce the DNO's overall demand on the transmission system.

Transmission Network Use of System (TNUoS) charges

Generators exporting more than 100MW and suppliers pay TNUoS charges each year. These cover the regulated cost of the transmission network infrastructure assets and their maintenance. Generators pay according to where they are located. In those areas where National Grid must reinforce the network to accommodate increased exports, generally in the north, the charges are higher. In areas, generally in the south, where new generation actually reduces the need for transmission investment, the charges become positive - ie National Grid pays the customer. Smaller generators do not pay TNUoS charges. But their connection may reduce the liability of their local electricity supplier to pay TNUoS charges - and their supplier may give them an 'embedded benefit' which reflects this reduced liability. Such benefits tend to be larger in the south.

Balancing Services Use of System (BSUoS) charges

These charges are paid by generators and electricity suppliers who participate in the national electricity market. They cover the costs of system operation including ancillary services, such as fast response and reserve. Smaller generators can, if they wish, participate in the national market without incurring these charges. Normally small generators will help an electricity supplier avoid BSUoS charges and so may be able to negotiate a 'distributed benefit' from the supplier.

The Long-Term

By the middle of this century, renewables and CHP are likely to represent a much larger proportion of generation in England and Wales. National Grid will play its part in facilitating this change.

The development of distribution network operators into local system operators is likely to be an emerging feature of the next decade. This will make possible the evolution of new markets for ancillary services through which renewables and CHP can contribute to system security. It will also influence the way today's potential energy sources become economic reality - which in turn will determine the technical implications on both distribution and transmission networks.

The Royal Commission on Environmental Pollution (RCEP) suggested in its 2000 report that up to 17,000 MW of wind power (both onshore and offshore) could be developed by 2050. The siting of such plant would impact on network design through connections and power flows, while the intermittency of such generation would necessitate the development of new security mechanisms for sourcing reserve and fast response capacity. It might also impact on the long-term delivery of baseload electricity.

The RCEP report also suggested that by 2050 some 15 million houses might each have 4KW of solar photovoltaic capability. This represents some 60,000 MW of capacity, which is just short of today's total generation capacity. Similarly, micro-CHP and CHP district heating systems would help bring generation much closer to demand. Such developments would radically affect power flows by reducing the demand on distribution networks. However, a transmission network would still be needed to transport bulk flows and maintain system security, even if the nature of the transmission network would probably change.

There are other long term developments offering potentially radical change. Hydrogen and regenerative fuel cells present exciting possibilities for the storage and transportation of energy. Energy storage would considerably ease the problems of incorporating intermittent sources into electricity networks.

Facilitating the Future

In the near term

National Grid can ably assist, both technically and commercially, in delivering the Government's 2010 targets - and beyond.

National Grid is keen to contribute, wherever possible, to tackling issues that emerge.

Committed to flexible, transparent and non-discriminatory operations, National Grid is essentially commercial in its attitude to solving problems.

In the long-term

However the industry develops, there will be a long-term and enduring need for a high voltage network.

Bulk transfers of power will remain essential across the network - and may increase with the arrival of more offshore and large scale wind generation.

As the penetration of renewables becomes much higher, it may be necessary to develop new ways to ensure stability and security with this more intermittent generation base. These will depend on a flexible and efficient high voltage network.

The energy sector will evolve according to a complex array of technological, commercial and political forces. National Grid brings practical experience of operating within a continually evolving environment. The transmission system will support the development of distributed generation in the near term, while preparing at the same time to facilitate the changes of the future.

National Grid
September 2001

Printed on 100% Post Consumer Waste Paper