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Regulatory frameworks for decentralised energy ☆

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ABSTRACT

This paper considers aspects of the current regulatory frameworks for markets and infrastructure which can inhibit the deployment of decentralised energy. The government has stated that decentralised energy can make a positive contribution to reducing the UK's carbon emissions, but recognises that at the moment the technologies face market and regulatory barriers. If it is to become a viable alternative to centralised generation, energy market design and the regulation of energy infrastructure will have to evolve to ensure that decentralised options are no longer locked out.

1. Introduction

We have been asked to respond to the following questions:

What is the role of and challenges for an energy regulatory framework, with regards to:

(a) decentralised energy generation and distribution model; and
(b) an energy system that includes significant contributions from both centralised and decentralised energy generation and distribution?

There is some confusion about what is meant by decentralised energy, and definitions have shifted over time and in different contexts. We have taken 'decentralised energy' to mean the same as 'distributed energy', which the government defined in its recent consultation on Renewable Energy Strategy as: '…the local supply of electricity and heat which is generated on or near the site where it is used. In practice it is often delivered as a package of energy efficiency and energy supply measures and covers a range of technologies, at varying scales from the household to the community, which can generate electricity and heat from renewable or fossil fuel energy sources' (BERR, 2008a, para 5.1.1).

This definition emphasises decentralised energy's proximity to its point of use. The size of a distributed energy project can range from a few kilowatts in the case of microgeneration to many megawatts in the case of community schemes, which often use combined heat and power (CHP) technologies.

However, this definition is arguably too narrow to answer the questions adequately. It does not incorporate schemes whose primary intention is to export their output rather than to provide energy mainly or wholly to local consumers. In this context, ownership is not limited to individuals or community projects, but is extended to private companies which seek to make commercial returns on their investments.

An Ofgem/BERR document published at around the same time as the Renewable Energy Strategy defines distributed energy as 'renewable electricity generation which is connected directly into the local distribution network, as opposed to connecting to the transmission network, as well as combined heat and power schemes of any scale' (Ofgem/BERR, 2008a, p. 1). Unlike the previous definition, this covers only electricity generation from projects connected to distribution lines and excludes both heat and the energy-efficiency dimension—in other words, it corresponds to the general definition of distributed generation. It also broadens the definition to one that implicitly recognises that the main purpose of a distributed energy scheme can be to export electricity rather than providing it to a specific locality.

Given the lack of clarity about what constitutes distributed energy, we have adopted elements of both definitions in this paper, and assume it to include small-scale electricity and heat technologies using renewable sources or fossil fuel CHP. This covers both microgeneration technologies and larger-scale community or commercial projects. It may be sited on distribution lines, or on the consumer's side of a metre. Its output may be produced exclusively or primarily for specific locations, output may be intermittent or irregular, and it is not necessarily owned by large incumbent energy companies. Its widespread use does not remove the need for transmission networks but it does change the emphasis of their roles to one of balancing flows across the system rather than purely delivery.

As the UK's energy systems became increasingly centralised from the 1950s onwards, technical approaches to network design and operation, embodied in various engineering standards and

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codes, were developed to reflect the characteristics of centralised generation. Following privatisation, the energy system also influenced the way in which electricity markets were designed to reward large-scale, flexible and predictable generation, and the design of regulations to govern the financial operations of monopoly network operators. In economic theory, these two trends can be seen as centralised generation becoming 'locked in' to the system (Arthur, 1989). The technology gradually influenced the design of institutional and economic aspects of the system, and excluded other, increasingly less viable alternatives. The 'increasing returns of adoption' enjoyed by centralised plant acted as a disincentive to invest in smaller projects, which became locked out by the economic, political, social and legal support for locked in, centralised generation.

The development of the heat system followed much the same pattern, characterised by long-distance gas networks developed to transport fuel to most households, or the provision of centralised electricity for heat. There are very few district heating networks designed to provide heat to a number of houses or commercial buildings in the UK, in contrast to many other European countries.

Both the lock in to current systems and increasing returns of adoption can act as disincentives to invest in decentralised energy (DTI, 2007, p. 98; DTI/Ofgem, 2006). Encouraging the deployment of more decentralised energy, however, is only part of the picture. Decentralised energy may offer carbon and energy intensity advantages over the traditional centralised model of electricity and gas provision, but a degree of centralisation and the provision of transmission networks are still likely to be necessary to ensure overall system security. The challenge is both to increase the level of decentralised energy in the UK, and also to make sure that centralised and decentralised systems can co-exist, economically as well as technically.

There is now a new policy interest in decentralised energy, driven in part by the need to reduce carbon emissions, and partly by its perceived potential to contribute to other policy goals such as reducing fuel poverty and increased security through greater fuel diversity (BERR, 2007). Some barriers to deployment have already been addressed or removed, notably some engineering standards for distribution lines which have been revised to allow for distributed energy. But the systemic nature of lock in means that shifting the system towards a degree of decentralisation must also be systemic: there is no single magic bullet.

2. Current conditions

This paper concentrates on aspects of economic regulation, which plays an important role in the rate of decentralised energy deployment because the market and network rules can have a direct and indirect impact on the economic performance of projects. As in other areas, the rules governing energy markets and infrastructure can be seen as enhancing the lock in of conventional energy configurations.

While Ofgem is responsible for the regulation of electricity markets and infrastructure, there is currently no body responsible for regulating heat. The following section on current conditions therefore concentrates on electricity, while the section on future advances raises some possible models for heat as well as electricity regulation.

2.1. Electricity markets

Market arrangements for distributed energy will dictate the extent to which small-scale technologies are deployed. The market directly affects the prices at which the energy they produce can be sold. Less directly, the market allows for risks such as price volatility and the availability and cost of financing for new projects. This in turn reflects on the economics of a project and often the level of financial support necessary to make it viable (Gross et al., 2007).

The current market arrangements—known as British Electricity Trading and Transmission Arrangements (BETTA)—were designed to reflect the characteristics of conventional generation and to reward predictable, flexible output. The design of BETTA can disadvantage small-scale generation relative to centralised generation (DTI, 2007; Ofgem/BERR, 2007), in part because the emphasis on costs creates incentives to pursue economies of scale in both generation and trading. Transaction costs associated with market participation can be reduced per unit for bulk sales.

In addition, BETTA requires generators to predict output in advance. Many renewable and CHP projects generate or export power intermittently or irregularly, meaning that they face financial penalties if they are unable to guarantee a certain level of output. If a small project is owned by one of the large, vertically integrated energy companies, these risks can be balanced within its generating portfolio. However, independently owned projects face high transaction costs and imbalance risks, and therefore tend to sell output to a third party, usually an electricity supplier. This does not necessarily remove the risk of imbalance penalties, as the third party is likely to offer a price that factors in the impact of imbalance changes on its own market participation (Ofgem/BERR, 2008a). There are concerns that distributed energy may be undervalued by suppliers, who may overcompensate for these risks, while at the same time undervaluing the benefits that it may offer including avoided transmission costs (Ofgem, 2008a; Ofgem/BERR, 2008a).

Even where export is not the primary purpose of a project, the impact of incumbents' valuation of exported power can have a significant impact on a project's economics. The disparity of suppliers' valuations of renewable microgeneration has been highlighted by a recent Ofgem study (Ofgem, 2008b). Prices offered for power exported from microgeneration installations range from 4.25 (Scottish Power) to 18 p/kWh (Scottish and Southern), with each supplier treating the exporters' entitlement to Renewable Obligation Certificates in a different way.

The 2007 Energy White Paper committed the government to ensuring that regulatory arrangements do not raise unnecessary barriers to the wider uptake of distributed energy (DTI, 2007). A subsequent review of market and licensing arrangements led to proposals for simplifying market participation and supply licensing for small generators, and suggestions for mitigating the impact of imbalance risks (Ofgem/BERR, 2008a). However, this work will not be completed until the end of 2008 at the earliest, and the implementation of any final decisions may take some time after that. So, while there are signs that market conditions may be shifted in future, they will not provide a quick solution to the barriers that small-scale generation faces in the market.

2.2. Electricity infrastructure

Currently, distribution networks are operated passively, transporting power from transmission networks to final consumers with little need for management beyond ensuring that the networks stay within technical limits. As more distributed energy is deployed, distribution networks will have to become more active participants in the electricity system. This will require a degree of upgrading, reinforcement or replacement of the networks. This, however, is not necessarily as forbidding an issue as it might appear. The Energy Networks Association (2005) estimates that around 70% of the UK's network assets are now reaching the end of their design lives, and there is a general consensus that

Box 1–Distribution price control measures for distributed energy

- *Innovation Funding Incentive*: DNOs are allowed to spend a limited amount of turnover (up to 0.5%) on projects designed to enhance network design and operation. The incentive covers any aspect of distribution system asset management from design to decommissioning as long as the focus is on providing value for end customers by enhancing efficiency in operating costs and capital expenditure. This can include measures to manage networks more actively.
- *Distributed Generation* (*DG*) *Incentive*: This is designed to encourage DNOs to connect more DG by reducing the amount that DG developers pay to connect to a network and imposing Use of System charges instead ('shallow-ish' connection charges). This reduces the upfront costs of connection for the developer while giving the DNO a level of income over the lifetime of the project. Applications for connection are assessed on a case by case basis, rather than as one of a potential group of new projects, meaning that the mechanism does not encourage DNOs' strategic development of networks.
- *Registered Power Zones* (*RPZs*): RPZs do have a more strategic approach. They are a sector of a distribution network (either geographic or defined by electrical connections) in which the DNO can demonstrate innovative solutions to the connection of new distributed generation. The DNO will be able to charge the DG developer an additional £3/kW/year on top of the DG Incentive premium for five years if the proposed scheme is approved.

provision has to be made to finance a programme of network upgrades and replacements. There is therefore an opportunity to substitute 'like for like' replacement of infrastructure with new technologies which could enable more active management.

However, there is little incentive within the present regulatory framework for distribution network operators (DNOs) to undertake this work or to think about the longer-term strategic development of their networks. The regulations governing DNOs have not yet adapted to encourage the deployment of distributed energy (EA Technology, 2006). For example, although DNOs can earn some revenue from Use of System charges from distributed energy connected to their networks, and a small proportion is related to performance standards reflecting network efficiency, most of their revenue comes from charging consumers. This can create a Catch 22 situation where DNOs accord a low priority to connecting distributed energy to their networks.

Some measures designed to encourage network innovation and the connection of distributed generation were established for the current price control period (2005–2010) (Box 1). These measures have met with limited success. Most DNOs are well short of the target of 0.5% of turnover for investing in R&D, indicating that innovation is a low priority in their businesses. The Distributed Generation (DG) Incentive does not appear to have encouraged the connection of greater levels of distributed generation. While more distributed generation may be connected to the networks, there is also a noticeable decline in projects asking DNOs for a future connection, indicating that the DG Incentive is not acting as a significant driver for new projects.[1] Although Ofgem imposed a limit of two Registered Power Zones (RPZs) a year for each DNO, in the event only four have been implemented in the three years since the introduction of the price control (Ofgem, 2008a).

Developing a distributed energy project at a specific site can allow the DNO to avoid network reinforcement. A DNOs capital expenditure on equipment increases its regulatory asset base, and therefore the level of returns that it is eligible for in future. Spending on its own infrastructure will therefore be more attractive for a DNO than avoiding expenditure by connecting a distributed generation project to part of the network and potentially avoiding reinforcement costs. The potential contribution of distributed generation to avoiding investment has, however, now been recognised in network Engineering Standards (ER P2/6), which allow projects to be considered an acceptable alternative to investment in new network infrastructure. The degree to which this opportunity has been taken up so far is questionable. One RPZ is based on the connection of new wind generation that can be 'constrained off' if the thermal capacity of the line is reached, but this appears to be the only example of avoided investment so far.

The provision of adequate transmission capacity will play a role in the development of a more decentralised electricity system. At the moment, arrangements for expanding or renewing transmission infrastructure are acting as a 'significant barrier' to renewable and other low carbon generation reaching the market (Ofgem/BERR, 2008b, p. 1). For example, the delay in upgrading the transmission network in Scotland is acting as a brake on connecting renewable generation to transmission and distribution lines there, and so prevents projects from exporting power towards centres of demand in England and Wales. New arrangements have been devised to try to overcome this blockage in the short term, but longer-term arrangements to ensure that transmission operators can invest in timely upgrades have yet to be developed.

As with markets, the design of regulation for infrastructure can act as a disincentive to invest in distributed energy. However, this issue has been recognised, and changes are being put in place, both as part of the next distribution price control for DNOs (2010–2015), and under new transmission arrangements. It remains to be seen whether these changes will be sufficient to drive the deployment of more distributed energy.

At a broader level, the construction of energy markets and a presumption in favour of competition and choice for all consumers creates problems for developers seeking to construct private networks for electricity or heat from distributed energy. While developers will want to know that they will have a firm customer base to recoup the costs of network construction, consumers will need to be protected from overcharging from the monopoly operator. Ofgem and BERR are actively considering how to resolve this dilemma for electricity networks, but progress appears to be slow (Ofgem/BERR, 2008a). Given that heat is currently unregulated, the regulatory dilemma does not arise here to the same extent. The construction of heat networks may in some cases be enabled by government grants, but these are by their nature relatively uncertain in the longer term. More certain ways of financing high capital cost projects will need to be developed if heat networks are to become a viable choice.

But it would be wrong to identify problems with the market and networks as the sole reason why there is not more interest in distributed energy. Delays and inconsistencies in the planning

[1] It is difficult to identify a single reason for the decline: it may be because of the design of BETTA discouraging new small-scale projects, difficulties with planning arrangements, design problems with the Renewables Obligation, uncertainty about future government energy policy, or a combination of these together with a range of other factors. The point that the DPCR 4 measures to encourage more distributed generation are not sufficient to overcome these barriers remains valid.

system also play a role, as do problems with support mechanisms such as the Renewables Obligation. However, providing a viable commercial environment and access to adequate networks for small-scale projects will be vital if there is to be a significant expansion of distributed energy in the longer term.

3. Future advances

Achieving long-term government targets for reductions in CO_2 emissions and increasing the use of renewable energy are drivers for the increased deployment of distributed energy. However, given the long lead times for policy formation and project development, and the long-lived nature of energy system assets, changes to address the lock in of centralised technologies will have to be established in the relatively short term.

There are suggestions that the regulatory environment is beginning to change, and that this change will continue, for example with the requirement to facilitate the connection of small-scale generation to distribution networks, and moves to simplify market participation. In the context of the long-term development of distributed energy, the question is whether this evolution is enough, or whether change has to be either faster or more radical.

This section considers some of the issues that will need to be resolved to allow increased distributed energy deployment as well as the longer-term strategic development of energy systems. It is beyond the scope of this paper to make detailed specific recommendations about individual technologies. However, it is possible to set out a range of more generic suggestions for where changes in current arrangements might encourage the deployment of distributed energy.

3.1. Regulation

The role and performance of distributed energy are directly influenced by the regulatory frameworks for electricity put in place by Ofgem. When the regulator was set up to oversee the operation of the privatised electricity and gas industries, it was designed to drive cuts in costs for consumers, not to create an environment in which energy systems could undergo radical changes in response to the need to reduce emissions of carbon dioxide. The regulatory structures which Ofgem put in place reflect the conditions of the 1990s, rather than the 21st century desire to encourage the deployment of alternative technologies and practices.

Ofgem is primarily required to promote competition. Social and environmental considerations are less central in the exercise of its duties. The Sustainable Development Commission (2007) has recently recommended that the duties which frame Ofgem's activities should be amended to ensure that the sustainability implications of its actions are given more emphasis. Such reframing may not be adequate, as Ofgem exercises a considerable degree of discretion in balancing its duty to consider sustainable development with its overarching duty to promote competition where appropriate (Ofgem, 2006). This implies that stronger political direction may be necessary if the environmental advantages associated with distributed energy are to be given more emphasis. The government is currently consulting on guidance to Ofgem on how it addresses environmental and social issues, and is specifically targeting the removal of barriers to distributed energy (BERR, 2008b). It is not yet clear whether this attempt to prioritise specific activities within Ofgem will address the problems identified by the Sustainable Development Commission.

The UK's energy systems include the transport system as well as electricity and gas, which is mainly used as a source of heat. In the past, they have been treated as entirely separate entities in policy and regulatory terms, and little direct attention has been given to heat policy or regulation. Distributed energy offers the opportunity to bring the provision of services within these three sectors closer together, realising efficiency gains and carbon reductions. Distributed energy can be used to provide both heat and electricity from the same process, while renewably produced electricity can be used to provide power for transport, again reducing emissions. Current regulatory structures have not adapted to reflect these technological changes, or the business opportunities for energy options which can help reduce carbon and energy use. The regulatory framework will have to evolve to enable rather than restrict the deployment of small-scale, sustainable technologies and to permit new business models which reward increased carbon or energy efficiency.

3.2. Market

A new market framework to encourage distributed energy should emphasise the role that demand reduction and the provision of energy services can play in increasing energy efficiency and reducing emissions. They are playing an increasing role in energy policy through measures such as the Carbon Emissions Reduction Target and the Zero Carbon Homes scheme. A broader regulatory approach to designing the markets for energy would encourage the eventual integration of such approaches into the market, rather than relying on them taking place through legislative action outside the market. So, for example, as more decentralised energy is deployed on distribution networks, and the networks become increasingly actively managed, the role of DNOs in the market could change to allow them to act as aggregators and active participants in the trading mechanisms for buying and selling power.

3.3. Infrastructure

This paper has identified a number of issues within the regulation of distribution networks which can act as a disincentive to distributed energy. Some could be relatively easily addressed—for example by increasing the penalties for losses on distribution networks to create an incentive to consider connecting more generation. Other measures will prove more complex. Ensuring that the interests of developers and DNOs coincide for distributed energy projects will prove a challenge, given that developers require a connection to the network where they can best exploit a renewable resource or ensure a market for their heat output, while DNOs would prefer projects to be sited where they can best make a contribution to the stability and operation of the network. Balancing these interests is inevitably difficult. The current performance of measures in the current price control intended to encourage distributed energy suggests that they are not working. The new emphasis on enabling distributed energy in the development of the next price control regime is therefore welcome.

Transmission will continue to play a key role even in a more decentralised electricity system. But its role may shift from being the main transporter of power to one where its main roles are to balance power flows produced on distribution networks and to transport energy from remotely connected renewable generation. Regulatory changes are needed to ensure that transmission operators have incentives to construct adequate capacity in time for generators to connect. Renewables should be given priority access to transmission to enable centralised fossil fuel based generation to be displaced, a measure foreseen in the current draft of the new EU Renewables Directive (European Commission, 2008).

Table 1
Policy initiatives

Initiative	Responsible	Status	Purpose
Renewable energy strategy	BERR	Consultation under way—final strategy expected spring 2009	To develop a strategy for renewable energy deployment to meet the UK's allocation of the EU renewable energy target (15% by 2020)
Strategy for heat	BERR	Spring 2009?	Development of and potential heat policies for low-carbon heat
DE market and licensing arrangements	BERR/Ofgem	Final plans expected to be implemented by end 2008	To ensure that regulatory arrangements for electricity markets do not raise any unnecessary barriers to the wider uptake of DE
Transmission access review	BERR/Ofgem	Implementation early 2010? Interim arrangements in place for connect and manage	A review of the current technical, commercial and regulatory framework for new transmission infrastructure and grid management for increased renewables generation
Distribution price control 5	Ofgem	Under way—final arrangements 2009?	Sets regulatory framework for DNOs from 2010 to 2015
Social and environmental guidance to the gas and electricity markets authority	BERR	No timetable for completion	Consultation on revising ministerial guidance to GEMA (Ofgem) on the exercise of its duties

3.4. Decentralising heat

Encouraging the emergence of heat networks for community projects presents a new problem for policy makers, particularly if it is decided to establish a regulatory framework around them. So far, the construction of heat networks has tended to be supported by the provision of government grants. This is unlikely to remain tenable if such networks become commonplace. Regulation should ensure both returns for investors and protection for consumers. Care will be needed to ensure that the regulator is able to balance competitiveness with the environmental advantages of distributed energy and so avoid questions which might be directed at Ofgem about balance in the exercise of its duties.

3.5. Future opportunities

The UK energy system's lock in to centralised generation must be addressed to ensure that decentralised energy is no longer locked out by the increasing returns of adoption associated with larger systems. Regulation which makes distributed energy a viable alternative to investing in conventional energy options should go some way towards enabling this and could be guided by a number of general principles:

- The regulatory framework for markets and infrastructure should be geared towards the long-term strategic development of energy and guided by the need to reduce CO_2 emissions, rather than relatively short-term concerns emphasising competition.
- Regulation should enable the integration of heat and power provision as a way of reducing CO_2 emissions.
- Recognition that not all technologies are equal in scale or performance. It is inappropriate to expect them all to perform under uniform market and regulatory conditions.
- Recognition that distributed energy could enable new patterns of ownership and operation in energy markets, and that market rules should change to allow this.

A number of relevant high level policy and regulatory initiatives are under way (Table 1). These can provide the vehicle for the necessary fundamental revisions to both market and infrastructure regulation to allow greater deployment of distributed energy technologies, based on the broad principles outlined above.

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