

Resource Adequacy and Renewable Energy in Competitive Wholesale Electricity Markets

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Introduction

Governments in developed economies have always been concerned about having enough electricity generation capacity available to avoid frequent or unacceptably long power outages.¹ We refer to this as the “resource adequacy” objective. By contrast, governments have only relatively recently begun to address the challenge of reducing carbon emissions in the electricity sector. We refer to this as the “low carbon” objective. A fundamental policy goal today is to meet both objectives efficiently.

How should electricity markets be structured and regulated to meet these two policy objectives? The options analysed herein assume that the aim is to reform existing competitive wholesale electricity markets. All such markets were initially designed with the goal of ensuring resource adequacy (either as a formal requirement or simply as a target), but none were designed to reduce carbon emissions.

It is therefore not surprising that Great Britain (GB) and most other countries with competitive wholesale electricity markets are now considering revising the design of their markets to ensure that both policy objectives can be met efficiently.

This paper draws on international experience to analyse how different wholesale market models deal with both the resource adequacy and low carbon objectives.² Section 1 introduces the analytical framework, including the market models studied. Section 2 discusses the challenges of resource adequacy under various market models. Section 3 examines how these models deal with the low carbon objective, specifically with the requirement to build renewable capacity. The final section presents two case studies from Spain and GB, based on the findings from the preceding sections. ■



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Section 1 ANALYTICAL FRAMEWORK

1.1 CRITERIA FOR ASSESSMENT

In order to compare different market models, we have chosen three criteria against which to measure their relative strengths and weaknesses. The first criterion is how well the model meets the resource adequacy objective, whether this is a formal obligation or simply a target. The second criterion is the model's ability to meet directives or legislative quotas for low carbon power, and in particular for power from renewable sources. The third criterion is how *efficiently* the models meet these two objectives. In particular, we focus on the efficiency of generation investment decisions.

A central argument in favour of competitive markets is that they promote innovation. We favour competitive models that are as technology neutral as possible because they encourage innovation. For instance, to meet the low carbon objective, where innovation is critical, we favour models that encourage competition among renewable power of different kinds. Such options include carbon capture and storage (CCS), nuclear, demand reduction and other low carbon alternatives. More generally, although the paper focuses on the incentives for generation investment under different wholesale market models, demand reduction should always be considered as an alternative to generation, and can be built into these models.

1.2 CHOICE OF MODELS

We have chosen to study competitive wholesale markets where investors are free to select the technology, timing and location of their generation investment. It is these markets where the competing objectives of resource adequacy and low carbon emissions are most likely to cause problems.

We have evaluated a wide range of wholesale competitive market models and have categorised them in Table 1 by reference to whether or not they have formal resource adequacy requirements.

For this paper, we distinguish between "energy-only" markets, like the British Electricity Trading and Transmission Arrangements (BETTA), and alternative "energy and capacity" markets.

In addition to GB, energy-only markets have been implemented in wholesale power markets around the world, including in many European markets, in Canada's Alberta Electric System Operator (Alberta), in Australia's National Electricity Market (NEM) and in the U.S. with the Electric Reliability Council of Texas (ERCOT). They have no explicit payments for making capacity available, although they generally will include ancillary service markets (e.g., for operating reserves), which provide a revenue stream in addition to that from producing energy.

From a theoretical perspective, an important requirement of energy-only markets is that they allow for sufficiently high and frequent price "spikes" to enable peaking plants to recover their capital costs. Such markets do not include any formal resource adequacy standards or guarantees, although there may be targets, such as indicative reserve margin targets.

The "energy and capacity" models provide separate revenue streams for energy and capacity (also along with ancillary service markets). They fall into two broad groups:

- ◆ *Payment-based models*: these aim to achieve resource adequacy targets through administratively-determined *payments for capacity*. Whether or not the target is met will depend on how attractive the capacity-based payments are to existing and potential generators.
- ◆ *Quantity-based models*: these set explicit *resource adequacy obligations*, normally as a percentage over the peak demand of a retail supplier's customers. This model has, in various forms, been adopted by most of the deregulated U.S. markets. ■

Table 1 Examples of Market Designs for Resource Adequacy

Without resource adequacy requirement		With resource adequacy requirement	
Energy-only model	Energy + capacity model		
ERCOT, AESO, Australia's NEM, NordPool, GB and other EU markets	Capacity payments	Capacity requirements	
	Argentina, Chile, Columbia, Peru, Ireland, Spain, South Korea and Ontario	U.S. (CAISO, SPP, NYPP, PJM, NEPOOL, MISO, NYISO, ISO-NE), Australia's SWIS and Brazil	

Section 2 THE RESOURCE ADEQUACY OBJECTIVE

2.1 ENERGY-ONLY MODELS

In energy-only models, customers theoretically choose their desired level of reliability through their willingness to pay for price spikes. The design of energy-only markets should enable investors to recover the cost of investment in generation capacity that is consistent with these market preferences and mechanisms. Investors must be confident that energy prices will be allowed to rise under conditions of shortage, enabling them to recover their investment over the life of the plant. Faced with these price signals, investors are free to choose the technology, timing and location of their investments.

Advantages of the Model

This model is simple and does not rely on regulatory mandates to ensure resource adequacy, letting the market decide on the acceptable level of reliability and investment. Provided energy prices are not capped at levels below the value of lost load (VOLL), the model should deliver the amount and type of

capacity that market participants choose. The model can, therefore, meet the resource adequacy criterion and do so efficiently, also allowing for choice of technology.

Disadvantages of the Model

The concerns are mainly political and practical implementation issues. One concern is that policy-makers will not allow price spikes that are sufficiently high and occur frequently enough to deliver revenue streams that justify adequate investment in generation, which would solve what has been referred to as the “missing money” problem. Many energy-only markets have imposed price caps at levels set below the likely VOLL and therefore fall into this missing money trap. More generally, power system operators and regulators have struggled to find mechanisms for setting scarcity prices at efficient levels, which is a particular challenge in the absence of significant demand response.³

Even where there are no explicit price caps, investors will be concerned about political intervention to avoid prices rising to the level necessary to recover investments. This concern is particularly acute for highly capital intensive and long-lived investments, such as nuclear power.

For example, there are concerns in a number of European countries that an increase in wholesale prices driven by the impact of CO₂ prices will lead to increased political pressure to introduce a limit on energy prices or a windfall profits tax on existing infra-marginal units (e.g., nuclear and hydro). Even in GB, where there is relatively little pressure to introduce price caps, political risk of this sort will nevertheless be a concern for investors.

A second, related concern is the greater price volatility of energy-only markets, which introduces investment risks that can increase the cost of capital, which in turn raise overall costs to consumers. These concerns become more acute as the share of intermittent renewable energy in a market increases.

A third concern is that most consumers (except the largest ones) are unlikely to be exposed to spot prices and so cannot express their resource adequacy preferences. Even if they could do so, it is currently not possible to disconnect only those customers who do not wish to pay prices above a particular level. However, smart meters and smart grids should provide the tools necessary to mitigate this problem over time. Moreover, in this new “smarter” world, aggregators of load may be able to control their customers’ demand in a way that introduces a large, new source of supply (i.e., reduced demand) at times when the system needs it.

A fourth concern is the reliance on “out of market” payments in many energy-only markets. These include extra payments — determined administratively rather than via markets — to relieve congestion costs, purchase capacity or guarantee the availability of operating reserves. These transactions may reveal inefficiencies in the existing market design and can often lead to further inefficiency since they distort the energy prices that are the basis for investment decisions.

2.2 PAYMENT-BASED CAPACITY MODELS

Payment-based capacity models involve an administratively-determined capacity payment, in addition to energy market payments. There are many different approaches to determining such payments, some of which are very systematic and predictable and others that are not.

Some models provide long-term certainty of capacity payments, such as Spain’s fixed payment to new plants for 10 years reflective of the need for capacity when they come on-stream.⁴ Whilst others, such as in Ireland, determine capacity payments over shorter periods, even down to an hour.⁵ The essential feature of all these “payment-based” approaches is that they focus on providing administratively-set capacity payments in an attempt to achieve resource adequacy targets.

Advantages of the Model

First, regulators can use capacity payments to encourage a desired level of capacity investment, while imposing mitigation measures on the energy market to avoid severe price spikes. This approach does not directly impose reserve requirements on suppliers; rather, the achieved reliability level is the result of the investment response of generators to the administratively-set capacity payments.

The capacity payments are designed to reflect the remuneration that the regulator estimates will be required to deliver the targeted reserve margin. They may be adjusted in a systematic way to reflect changes in real reserve margins.

Second, this is the only market design that readily allows for differentiation of capacity payments to new and existing resources or by technology type. This flexibility enables the regulator to change the payments to reflect changing circumstances and is often attractive to regulators and policy-makers.

Third, to the extent that capacity payments provide a steady payment stream and lead to lower and more stable energy prices, they reduce the investor’s risk and thereby may lower the costs of supply.

Disadvantages of the Model

The capacity payments model has several potential problems. First, by definition, this approach does not provide any guarantee of generation investments. If capacity payments are too low, investment will be inadequate. Conversely, if payments are too generous, excess investment will occur, which is equally inefficient.

Second, this approach has the potential to introduce and perpetuate significant market price distortions with quickly expanding scope. While the system may begin by paying only a few new plants, the scope of payments may expand to all new (and many existing) plants. Payments to existing plants are likely to be necessary and can be significant because the all-in net costs of retaining existing plants can be high: they often are close to (or even in excess of) the cost of new plants.

Another distortion is introduced when capacity payments are not available to demand-side resources. When the costs of capacity payments are recovered based on energy consumed rather than peak loads, demand response is also undermined.

Finally, the administrative flexibility in setting capacity payments introduces risk for potential investors. If governments can change the capacity payments, abolish them altogether or not implement the rules as they are defined in the legislation, this will increase investment costs and reduce or distort investment choices. However, this concern says more about investor perceptions of a government than it does about the model itself.

2.3 QUANTITY-BASED CAPACITY MODELS

These models impose a requirement on retail suppliers to demonstrate that they have purchased a sufficient quantity of capacity to meet the demand of their customers, including a target reserve margin (say 12 percent). The simplest models involve suppliers using their own generation assets (if they are vertically integrated) or signing bilateral contracts. Failure to meet capacity requirements is penalised. Imposing this requirement necessarily creates a (at least bilateral) capacity market with market-based pricing of capacity resources.

The U.S. experience shows that there are many possible variations. At its simplest, satisfying resource adequacy requirements only involves bilateral trading or vertical integration. Adding a centralised capacity market can increase pricing transparency over a purely bilateral capacity market, provide a backstop procurement mechanism for the system operator in case of deficiencies and offer suppliers another option for satisfying or adjusting their mandated reserve requirements.

A centralised capacity market also standardises the capacity product and facilitates market monitoring. Furthermore, the resource requirement can be imposed on a multi-year forward basis (e.g., suppliers show in 2011 that they will have sufficient capacity to meet projected 2014 loads), which increases competition and further reduces price volatility. These features can be particularly valuable in markets with many small suppliers, retail competition and migrating customer loads.

The U.S. provides examples of all these approaches. California satisfies its resource adequacy requirement for the next year through a bilateral market. New York relies on a centralised market to help facilitate a next-season resource adequacy requirement. PJM and New England rely on a centralised capacity market with a three-year forward looking resource adequacy requirement.

Advantages of the Model

The main attraction of this approach, when well designed, is that it almost guarantees that the desired level of reliability is achieved. Similar to product safety regulations (such as car safety standards), this model encourages innovation and allows market participants to find most the efficient way (e.g., with different supply and demand-side technologies) to satisfy the requirement.

Disadvantages of the Model

First, quantity-based models allocate the same capacity value to all capacity. This does not allow for differentiation between new and existing capacity, which may be a drawback for some policy-makers. It is of course possible to differentiate between technology types by setting separate capacity targets – a point to which we return later.

Second, quantity-based capacity markets that rely solely on bilateral contracts can impose significant transaction costs on smaller participants. They are also more difficult to monitor for the exercise of market power.

Third, adding centralised markets or forward requirements is a complex undertaking that carries a non-trivial risk of design flaws. Transparent, centralised capacity markets also have the “dis-

advantage” that the clearly visible capacity price draws attention to the high cost of maintaining reliability requirements.

All three of these models can, in principle, deliver resource adequacy. They have differing advantages and disadvantages but perceived failures are usually associated either with flawed implementation or excessive government intervention. ■

Section 3 THE LOW CARBON OBJECTIVE

None of the wholesale market models were designed to support the goal of reducing carbon emissions. We examine whether, and how well, each of the models described above (energy-only, payment-based and quantity-based capacity models) can support this new objective. However, we start by considering the general issues raised by the use of mechanisms to support renewable power.

3.1 RENEWABLE SUPPORT MECHANISMS

Just as the resource adequacy problem has been tackled with both price- and capacity-based approaches, so has the problem of encouraging renewable generation. Payment-based mechanisms for dealing with carbon normally involve introducing feed-in tariffs or tax credits. Quantity-based mechanisms usually rely on requiring retail or distribution companies to purchase specified quantities of “green” power.

While CO₂ prices also provide support for renewables, they will almost certainly not be high enough to elicit on their own the investment in renewable power that is needed to meet current policy requirements. Setting a quota for renewable power that is well above what would be built under competitive markets (including CO₂ costs) makes it more difficult to achieve broader low carbon objectives since the renewable obligation depresses both CO₂ and energy prices. This is because the subsidisation of renewable energy⁶ reduces the residual demand for CO₂ permits (and conventional sources of energy) and thus postpones the date when renewable power will be financially viable without subsidies.

Advantages of Feed-In Tariffs & Tax Credits

Feed-in tariffs have been successful in promoting investment in renewable power, most notably in Germany and Spain, whilst tax credits are commonly used in the U.S. Governments find feed-in tariffs and tax credits attractive because of the flexibility they offer to vary payments for different technologies (type and vintage) and to promote faster or slower growth. Investors find them attractive because, at least in principle, they provide certainty of cash flow,⁷ particularly in the case of tax credits, which are usually locked-in when the investment is made.

Disadvantages of Feed-In Tariffs & Tax Credits

Feed-in tariffs and tax credits suffer from a basic problem of any payment-based system that aims to achieve a quantity objective: namely the problem of setting payments that are too high (and elicit too much supply) or too low (and elicit too little). There are many ways to fine-tune feed-in tariffs to overcome the problems, but as is evident from the experience in Spain and Germany, these mechanisms can become very expensive. Also, feed-in tariffs generally do not provide incentives to renewable generators to run at times of high value because they usually do not vary by time of production.

Any payment approach that sets subsidies on the basis of specific technologies risks reducing innovation. Although the renewable quota itself limits the range of low carbon alternatives (to renewables), feed-in tariffs for specific renewable energies further limits competition among renewable options.

Advantages of Quantity-Based Approaches

Quantity-based approaches to meeting low carbon objectives are potentially an attractive way of securing investment in renewable energy capacity. These models include the UK Renewable Obligations Certificate (ROC), the Italian green certificate scheme and the U.S. Renewable Portfolio Standards (RPS). Each of these involves an obligation on retail suppliers or distributors to purchase a specified quantity of renewable energy or certificates.

In theory, a quantity-based approach should ensure that low carbon targets are met because suppliers will be penalised if they do not meet their obligations. However, the experience in both GB and the U.S. has shown that this is not always the case – problems in obtaining planning permission and concerns regarding the duration and structure of the scheme have meant that the volume of renewable generation available to suppliers can be less than the targets that have been set for them.

However, there is little risk of the expensive overshooting that has occurred in countries where feed-in tariffs were higher than needed. Suppliers will be compensated only for the renewable power that is within the limits of their quota. There is also a logical connection between imposing renewable quota obligations on suppliers and the development of contracts between suppliers and renewable developers. In this way, both parties reduce their exposure to volatile energy prices, which lowers costs.

Quantity-based approaches also have the potential to encourage innovation in carbon-saving technologies, including different renewable energies, CCS, nuclear power and energy-saving options. This potential depends on the degree to which retail suppliers can choose how to meet the carbon target: if all low carbon supply- and demand-side technologies are treated in the same way, innovation is encouraged the most.⁸

Disadvantages of Quantity-Based Approaches

Some investors argue that quantity-based approaches on their own do not provide sufficient revenue certainty. In addition, to obtain financing investors usually need to enter into long-term

power purchase agreements (PPAs). Compared to the relative ease of securing revenue stability through a feed-in tariff, PPAs are difficult and costly to negotiate.

In practice, innovation is also dampened because technology “carve-outs”⁹ account for a significant share of the renewable capacity. Furthermore, like feed-in tariffs, capacity requirements concentrate on renewable energy rather than broader means of lowering CO₂. They also do not usually include demand-side (energy efficiency) alternatives, nor do they typically include nuclear, CCS¹⁰ or other means.

We conclude that no single approach to meeting carbon constraints and renewable energy targets is optimal. Payment-based approaches to renewable energy offer no guarantees on quantities and can be very expensive. They also offer relatively little room for innovation across different technologies.

Quantity-based approaches offer greater certainty of meeting a target and may allow for greater innovation if they have very limited carve-outs. However, prices (as well as costs to consumers) are more uncertain. Investors generally prefer the feed-in tariffs because of the lower transactions costs associated with obtaining the revenue stability that is important for the often highly leveraged financing of renewable power projects.

Both of these approaches are problematic to the extent that they focus only on renewable power and do not include a full range of demand- and supply-side alternatives for lowering emissions.

3.2 ENERGY-ONLY POWER MARKETS***Advantages of Energy-Only Models***

Energy-only markets do not have any obvious advantages when it comes to the low carbon objective. However, this does not necessarily mean that they are likely to fail to deliver low carbon outcomes. The lack of an advantage does not automatically imply a disadvantage.

Disadvantages of Energy-Only Models

Whilst energy-only markets may successfully meet the low carbon objective, there is the risk that in doing so, they will fail to meet the resource

adequacy requirement. This is because of the impact that renewables can have on the incentives to build conventional plants.

In addition, as discussed above, some form of subsidy for renewable power will be required to meet renewable objectives. Both payment- and quantity-based approaches to supporting renewables are likely to weaken the incentive to invest in new conventional generating capacity in an energy-only market since the low dispatch costs of many renewables will depress energy prices.¹¹

New conventional power plants will be required as the need for operating reserves increases with the share of intermittent renewable energy production. In an energy-only market it will be particularly important that, as energy prices fall, ancillary service prices rise to provide adequate compensation to the plants required to provide these services, which might otherwise face stranded costs and choose to retire. If the ancillary service markets do not work efficiently, or prices in them are constrained in some way, then achieving resource adequacy will be even less likely.

3.3 CAPACITY PAYMENT MODELS

Advantages of Capacity Payment Models

In markets with capacity payments, some of the concerns that a low carbon objective raises in relation to an energy-only market are alleviated. This is because conventional plants receive payments for being available as well as for producing electricity. However, the level of capacity payments will need to be adapted to address changing market conditions under low carbon requirements.

Disadvantages of Capacity Payment Models

If the wholesale electricity market relies on payment-based mechanisms to ensure both resource adequacy and to meet renewable energy quotas, this introduces significant discretion and a heavy burden on regulators. While the two objectives may well be met, it is not clear that they will be met efficiently.

One or more elements of the market may need to be adjusted on an almost continuous basis to ensure that the two elements work efficiently together. This will increase the regulatory risk to which generators are exposed, especially if there is the potential for the government to get involved in the process and use it to achieve wider political goals such as providing low and stable prices to domestic consumers.

3.4 QUANTITY-BASED CAPACITY MODELS

Advantages of Quantity-Based Models

By definition, imposing a resource adequacy requirement on retail suppliers should maintain resource adequacy irrespective of the carbon objective. Hence, a quantity-based approach to resource adequacy provides better guarantees regarding the availability of sufficient operating reserve capacity to back up the intermittent renewable power. Importantly, there is no need to adjust resource adequacy requirements over time in response to changing carbon policies.

Disadvantages of Quantity-Based Models

The inclusion of intermittent low carbon generators within a resource adequacy market makes it important to determine how much the resources can be expected to contribute during peak load conditions, which strongly varies by technology and location. Moreover, if low carbon generators are supported by feed-in tariffs, it will also be important that the tariffs take account of the revenues that they can earn from selling their capacity in the resource adequacy market to avoid over-compensation.

If resource adequacy and the low carbon objectives are both addressed through quantity-based approaches, this can add significant design complexity. This is the case particularly if technology carve-outs are included and increase the likelihood that a flawed implementation leads to unforeseen and inefficient outcomes.

3.5 IN SUMMARY

In the face of low carbon requirements, energy-only markets may face increasing difficulty in achieving resource adequacy due to the depressing impact of growing renewable generation on energy prices. For such markets to succeed, investors will need to be confident that energy prices will be allowed to spike and ancillary service markets are well designed to provide the necessary compensation to conventional plants providing operating reserves.

Capacity payments overcome some of the problems associated with energy-only markets and low carbon requirements in that they provide an independent stream of revenues for conventional generation. However, they may impose an unduly heavy burden on regulators, interact strongly with feed-in tariffs for low carbon options and tend to

reduce innovation. They also may not provide the revenue certainty¹² sought by generators since they may need regular adjustments to ensure that both the resource adequacy and low carbon objectives are met. Imposing explicit capacity requirements provides better guarantees concerning the overall resource adequacy. However they provide less pricing certainty and can be more complicated to implement.

Under all three models, encouraging the development of demand-side response may well prove a more cost-effective method of meeting both the resource adequacy and low carbon objectives. It is important, therefore, that any capacity-related payments made to generators are also available to the demand-side. ■

Section 4 CASE STUDIES

We provide two case studies on how the above framework could be applied: Spain and GB. In Spain, the current problem is excess capacity and low energy prices. By contrast, in GB the main concern relates to conventional capacity shortages that are projected to emerge over the next few years. However, both markets need to continue building renewable generation to meet their EU requirements, and therefore, will face an increasing need for operating reserves.

In Figure 1 we consider how the existing models in these two countries should be revised to ensure sufficient investment to meet the resource adequacy and renewable targets, and also to provide the necessary ancillary services to back up intermittent renewable sources of power.

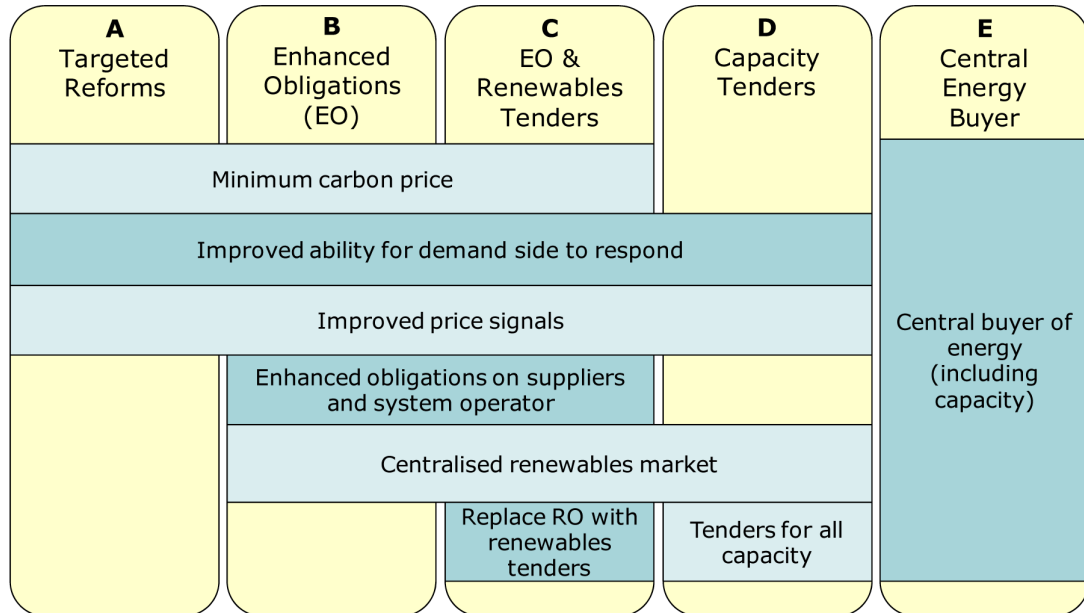
4.1 SPAIN

Spain has an energy and capacity payment model, with an administratively set capacity payment for new conventional plants (in practice, combined cycle gas turbines or CCGTs) and a feed-in tariff for each type of renewable technology.¹³ Due to

very generous feed-in tariffs, renewable power in Spain can now account for more than 50 percent of generation output on some days.¹⁴

At the same time, there has been a rapid increase in CCGT capacity, some of which is supplied under long-term gas contracts with take or pay clauses that encourage the plants to run even when energy prices are too low to cover the short-run cost of the fuel.¹⁵ These factors, combined with low demand due to the economic recession, have significantly depressed energy prices.

There are two main short-term policy challenges related to renewable power and resource adequacy. The first is how to cope with the high costs (estimated at over €6 billion for 2010 alone) of subsidies to existing renewable power plants. A significant share of the subsidies accumulated over the past years have not yet been passed through to consumers; this has contributed to a growing and unsustainable "tariff deficit". Many solutions to this are on the table, including recovering the cost from taxpayers or from all carbon-emitting energy sales, not just from electricity. But the central point

Figure 1 Ofgem's "Project Discovery" Policy Options¹⁶

Source: "Project Discovery: Options for delivering secure and sustainable energy supplies," Ref 16/10, Ofgem, February 2010.

is that Spain set feed-in tariffs far too generously and now needs to change its renewables model without losing the confidence of investors.

Second, Spain is faced with a problem related to the impact of renewable energy on CCGT plants. Prices in the energy market have been so low that, even when generous capacity payments are taken into account, the sensible economic solution may be to mothball some of these plants.

However, the system operator argues that the plants are required to provide back-up to the renewable energy and wants to encourage the owners of these plants to invest to make them even more flexible. Meanwhile, the regulator is threatening to reduce the revenues of CCGTs further by limiting payments for resolving transmission constraints. In short, Spain's wholesale electricity markets are facing serious challenges, especially due to the need to continue increasing investment in renewable power.

4.2 GREAT BRITAIN

GB is in a very different position than Spain. It has an energy-only wholesale market without capacity payments or requirements. It also faces the challenge of major generation investment

needs over the next ten years to avoid shortages. Thus far, GB has lagged behind on its delivery of renewable power, despite having a quantity-based approach to most forms of renewable energy (the ROC scheme). In recognition of these issues, the Office of Gas and Electricity Markets (Ofgem) published a consultation document in February 2010, which outlined a number of possible changes to the market arrangements that might address these issues, as illustrated in Figure 1.

In the context of this paper, the most interesting proposals from Ofgem relate to (i) "enhanced obligations" on suppliers and the system operator (SO) and (ii) capacity "tenders" for renewables or all capacity.¹⁷ Ofgem envisages that retail suppliers would be required to demonstrate that they had sufficient contracted supply to cover the energy demand of their customers over the next three to five years. Similarly, the enhanced obligation on the SO would be a requirement to forward purchase sufficient back-up and flexible generation to meet future requirements.

The tender options described by Ofgem would involve a central body determining the level and timing of needed investment and inviting generators to submit bids to deliver additional

capacity in return for receiving some form of capacity-related payments. These capacity tenders would probably apply separately to different technology types (as might the length of support provided) and be location specific. If the tenders applied to all capacity, then consumers capable of providing demand-side response would also be able to bid to receive (short-term) support.

4.3 POSSIBLE REFORMS TO THE MARKETS IN SPAIN AND GREAT BRITAIN

In both markets, we believe that there would be advantages to moving to a system of obligations on retail suppliers as a way of ensuring resource adequacy. This is more urgent in the GB market, due to the potential for capacity shortfalls over the medium term. Yet it would also have advantages for Spain, since its current surplus capacity problem could be rapidly eroded by generation retirements or if demand growth returned to its pre-recession levels.

In view of the renewable obligations imposed by the EU, it is our view that both markets would benefit from introducing an integrated quantity-based capacity requirement on retail suppliers, supported by organised capacity auctions, covering both overall resource requirements and low carbon/renewable objectives. It would then be for retail suppliers and generators to determine what types of capacity, including demand-side options, would best meet these objectives.¹⁸ We would not be supportive of proposals (such as Ofgem's capacity tenders and central energy buyer options) that centralised the decisions over the choice of technology for capacity additions.

We recognise that such an approach might pose difficulties for emerging technologies, but we consider that these would be more appropriately addressed by tax credits, since this approach would minimise market distortions. We agree that there is a strong case for support at the national or EU level for basic research into new low carbon technologies.

We also acknowledge the concern that supporters of high capital cost options, such as nuclear and CCS, might not consider that such an approach would

provide sufficiently long-term revenue certainty to justify investment. However, we believe that the introduction of a resource adequacy requirement would provide a more stable planning environment and hence alleviate such concerns.

For both markets, we would also support placing longer-term obligations on the SO, such as those put forward by Ofgem. This should go some way in addressing the need to ensure that there are adequate operating reserves to cope with intermittent generation – an important issue we identified with low carbon objectives under all market models. It would, of course, be necessary to ensure that plants are not being paid twice for the same service. Consequently, the SO obligation could not involve availability payments if plants were already receiving capacity-related payments via a resource adequacy mechanism.

While the general approach outlined above should enable the resource adequacy and low carbon objectives to be met in an efficient manner, we recognise that it would entail quite radical reforms to the existing markets, with Spain and GB starting from very different designs. This means that the way in which the general approach is implemented could vary between the two markets, and there would probably be a need for transitional phases.

For example, as a first step in Spain, where feed-in tariffs already exist, it might be appropriate to introduce centralised renewable auctions (to limit quantities) with the feed-in tariff for new plants successful in the auction being set by the auction clearing price. In GB, it would be more straightforward to move directly to a capacity requirement, because this would not be too different from the current ROC mechanism. But the central thrust of the reforms would be the same, namely the importance of introducing quantity-based obligations.

We consider that the very different problems facing the electricity markets in Spain and GB could be solved by broadly similar market-based approaches. We recommend that regulators and governments resist the urge to impose highly centralised, non-market-based solutions to these problems. ■

Conclusion

We conclude that all market models face a growing challenge to ensure resource adequacy in the presence of low carbon policy objectives. In addition, market models need to ensure adequate operating reserves (including demand response) to cope with the intermittency of increasing wind and solar generation.

These challenges may be particularly acute for energy-only markets, such as BETTA because of the depressing effect on energy prices that low marginal cost renewables can exert. In an EU context, the way forward likely involves introducing quantity-based market mechanisms to ensure sufficient entry by new resources, both conventional and renewable (and demand-side options), as well as refining ancillary services markets.

As illustrated in our case studies of Spain and GB, however, both markets still need to keep building renewables to meet their EU targets. We conclude that in the long run, the introduction of integrated resource adequacy markets, i.e., covering both conventional and renewable capacity options, would be the most appropriate way forward.

We acknowledge that there may need to be transitional steps in reaching this goal and that these transitional steps may vary between the two markets. In addition, we advocate the introduction of longer term obligations on the system operator to ensure that sufficient operating reserves are available to cope with an increasing share of intermittent generation. ■

The Brattle Group's Experience in European Energy Markets

The Brattle Group provides advice to private and public sector clients on the full range of competitive, regulatory and commercial issues that arise in EU energy markets. Our experience working with regulators and regulated and unregulated companies provides us with a unique breadth of perspective, and allows us to address the most complex problems on behalf of our clients.

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- ◆ *Forecasting of prices and energy flows*
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- ◆ *Gas portfolio optimisation*
- ◆ *Tariff-setting for regulated networks*

We have provided energy economic consulting on the impacts of almost every major European energy merger since the mid 1990's, including the mergers (or attempted mergers) of Gas Natural/Endesa, GdF/Suez, Nuon/Essent, E.ON/MOL, and Gas Natural/Unión Fenosa.

We also advise regulators and companies on a range of regulatory consulting issues such as market design and integration, unbundling and ISO design, and exemptions from Third Party Access for new infrastructure. On the commercial side, we provide price forecasting and risk analysis tools and advise on complex strategic investments in new infrastructure and long-term contracts.

An important aspect of our energy work is our perspective in climate and carbon policy. We advise clients on the design of policy and regulations related to CO₂ emission targets and the allocation of emission permits, as well as on the promotion of energy efficiency, renewable energy, carbon capture and storage and smart grids.

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Endnotes

¹ Although a very large percentage of power outages in developed countries are caused by problems on the transmission and distribution networks, a fundamental requirement of any electricity system is the adequacy of generation capacity.

² It draws on Pfeifenberger, Spees and Schumacher, "A Comparison of PJM's RPM with Alternative Energy and Capacity Market Designs," *The Brattle Group, Inc.*, September 2009. Refer to this report for a discussion and bibliography of existing research in this area. Available at: http://www.hks.harvard.edu/hepg/Papers/2009/Brattle%20RPM%20Comparison%20Whitepaper_Sept09.pdf.

³ The introduction of smart metering and smart grid technologies may, however, alleviate this problem if retail services take advantage of this capability and sufficient demand response by customers can be achieved. See Faruqui and Harris, "Unlocking the €53 Billion Savings from Smart Meters in the EU," *Energy Policy*, October 2010.

⁴ This mechanism has been enacted in Spanish legislation, however it has not yet been implemented as designed.

⁵ Ireland determines the overall "pot" of money available for capacity payments annually, but half-hourly payments to generators depend, in part, on the actual supply-demand balance in that period.

⁶ There are sound policy reasons to subsidise renewable power (energy security and industrial policy, specifically in infant industries), but we do not discuss them here.

⁷ Spain is debating whether to reduce feed-in tariffs for existing solar PV plants. Note also that governments, for instance the federal government in the U.S., sometimes change the level of tax support for renewable power, which adds uncertainty for developers of renewable power.

⁸ There is, however, a case for public funding of basic research in new low carbon technologies that are not currently economically viable. This funding is needed to overcome the well-known market failures that lead to underinvestment in R&D by the private sector.

⁹ Retail suppliers are required to obtain at least a minimum percentage of their energy from specified technologies, e.g., wind and solar.

¹⁰ Some schemes in the U.S. do include clean coal and hydro, but not nuclear plants.

¹¹ It may still be possible to recover investment costs, but the risk of falling into the missing money trap increases.

¹² A reduction in wholesale energy prices due to increased output by renewable energy sources is also a potential source of difficulty in these payment models.

¹³ See the reports by García and Robinson on the design of the Spanish renewable regulatory regime. "New Spanish Regime for Solar Photovoltaic Sector," prepared for UK Trade & Investment, *The Brattle Group, Ltd*, May 2009; and "Renewable Power in Spain," prepared for UK Trade & Investment, *The Brattle Group, Ltd*, April 2008.

¹⁴ At the end of 2009, there were 19,150 MW of wind capacity and 3,400 MW of solar capacity.

¹⁵ The absence of efficient and liquid secondary markets for wholesale gas and for gas network access contributes to this problem. There are regulatory proposals on the table to address these issues.

¹⁶ This figure is taken from Ofgem's consultation document, "Project Discovery: Options for delivering secure and sustainable energy supplies," Ref 16/10, *Ofgem*, February 2010.

¹⁷ We do not discuss the central energy buyer option here because, as discussed earlier, it represents too radical a move away from a competitive wholesale market to fit readily into a discussion on design options.

¹⁸ We note that achieving the EU target of a 20 percent increase in energy efficiency from a "business as usual" scenario would enable both markets to limit investment in renewable energy whilst still meeting their low carbon targets.

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