April 2017

THE OXFORD INSTITUTE FOR ENERGY STUDIES

Managing Electricity Decarbonisation:

learning from experience – the cases of the UK and Spain

1 – Introduction

For most of the 20th century, electricity was a relatively straightforward industry, with secure long term assets, increasing demand and reliable revenues. It faced few risks. The basic technologies changed little and technological trends were gradual and predictable, towards ever larger, more centralised and more efficient generation, and more extensive network development. Partly as a result, there was a steady decline in unit costs and steady demand growth as electricity's share of the energy market increased, apparently inexorably. The dominant model was of a regulated monopoly. Customers were regarded largely as passive consumers, and the industry's task was simply to ensure that power was available at the flick of a switch.

Since about 1990, the industry, essentially unchanged for the previous hundred years, has undergone a rapid series of revolutions whose long term effects are only just starting to emerge. The first shock was the introduction of liberalisation and competition, initially in a few pioneer countries like the UK and Norway, but eventually across the whole EU Single Market (and much of the rest of the world). This proved traumatic enough for the industry, but before its implications had been fully digested a new wave of disruption got under way, in response to rapid technological change and the imperative of decarbonisation. The industry now faces unprecedented technological, economic and institutional change – it is truly entering a 'new era'.

Perhaps most visible are the developments in electricity generation – the growing penetration of intermittent renewable plants, driven both by reductions in cost and the policy commitment to decarbonisation. But significant shifts are also taking place elsewhere in the system with the rapid development of information and control technology, which is opening the way for new approaches to system management and more flexible demand. It is likely that we are still only seeing the beginnings of these changes.

These technological developments have been accompanied by major policy and economic changes. These include falling electricity demand in developed markets, greater use of on-site generation leading to lower network income, governments rather than markets driving investment in both renewable and fossil generation, and so on. The institutional frameworks surrounding the industry are struggling to keep up. For two decades or so after 1990, governments across the world focused on liberalisation and the extension of market forces; now there is a new emphasis on decarbonisation, but governments have not yet worked out whether decarbonisation and liberalisation can go hand in hand or whether there is a fundamental conflict. Markets have also been slow to adapt to the new era – the industry has traditionally relied on short run marginal cost (srmc) or kilowatt-hour (kWh) pricing, although a large proportion of its costs have always been fixed. With a growing penetration of zero marginal cost plants, the srmc approach looks increasingly outdated, whether at the wholesale or retail level.

David Robinson & Malcolm Keay

Regulation too needs to respond to the changes under way and the increasing decentralisation of the system. New coordination and control methods may be required to manage the rapid growth of intermittent generation, particularly wind, and of decentralised sources like solar photovoltaics. Indeed the whole basis of the industry's workings are coming into question. What ultimately are its products? How should it price them? What business models should the industry be developing? What are its resources and how do storage and demand response fit in? How to facilitate effective competition among all distributed and centralised energy resources?

This paper lists some of the ways in which two European countries – the UK and Spain – have been responding to these 'new era' challenges and what lessons can be drawn from their experiences[1]. The choice of these two countries is based on a number of factors. They are not necessarily those which come initially to mind as being in the forefront of the decarbonisation revolution – many people would think first of, say, Denmark or Germany. Those countries have indeed made significant strides in changing their electricity systems in response to the new challenges. However, among other things, this means that they have been more frequently studied and cited than the two countries which are the focus of this paper; their experiences are likely to be relatively familiar.

Furthermore, in a number of respects Denmark and Germany could be regarded as untypical, or as having faced the 'new era' challenges in less acute form than the UK or Spain. For instance:

- Both are extensively interconnected with their neighbours and in many ways this has made the task of system balancing easier. Denmark, for instance, has access to the large hydro resources of other Nordic countries and can respond to the intermittency of wind power by importing or exporting electricity as needed, rather than having to achieve balance solely within its own system. Germany, similarly, has greatly expanded its electricity trade with neighbouring countries as its wind and solar generation have grown and it also enjoys access to extensive hydro capacity in the Alps.
- In Germany, much of the impetus for the 'Energiewende' has come from the decision to phase out nuclear power after the Fukushima accident. There is wide public support for the move and wide acceptance of its consequences. Denmark has also achieved a broad policy consensus – in the words of the International Energy Agency, 'a long history of consensus-based policy making and political stability has been leveraged to develop Denmark's far-reaching and comprehensive energy policies'[2]. So in both countries political circumstances are particularly open to the changes needed.
- A linked aspect is the relative decentralisation of the industry in both countries. Germany's experience, for instance, has been described as a 'decentralised energy revolution'[3]. Much of the renewables development has been undertaken by local, communal, and municipal organisations rather than by the major utilities. In Denmark, although large scale generation is dominated by two companies - Dong and Vattenfall - the small scale wind and combined heat and power sectors are much more diverse, as is supply. In 2009 for instance, there were 84 distribution companies for only 3.2 million consumers. So in these countries, consumers often feel more directly involved in the decarbonisation process than elsewhere.
- Perhaps as a result of the political and institutional circumstances outlined above, as well as their economic prosperity, both countries' consumers seem to accept relatively high electricity prices without major political controversy, although recently there has been some resistance from smaller consumers. According to Eurostat[4], they are the two highest price countries for household consumers in Europe.

[1] A fuller discussion is available in a companion paper (EL 23)
[2] *Energy Policies of IEA Countries – 2011 Review* IEA/OECD Paris 2011
[3] Burger C and Weinmann J *Germany's decentralised energy revolution* in *Distributed Generation and its Implications for the Utility Industry* ed Sioshansi F, Elsevier 2014
[4] *Energy prices and costs in Europe* COM (2016) 769

By contrast:

- Both the UK and Spain feature in (and near the bottom of) the list of European countries which are below the EU's 10 per cent interconnection target[5]. Neither has ready access to the hydro capacity of its neighbours. To a large extent, both countries therefore have to solve the problems of intermittency at home.
- There is probably a lower level of consensus about the direction of travel in the UK and Spain. The UK has certainly achieved political agreement on the goal, in emissions terms, but many of the modalities, like nuclear and onshore wind, remain highly contentious. In Spain, other concerns – in particular the economic problems the country has encountered since 2008 – have tended to take priority.
- In both countries, the electricity industry itself, and renewable generation in particular, tends to be dominated by larger players. For instance, Iberdrola, the Spanish company, is the largest wind developer in Spain, the UK and the world in general but has little involvement in the German or Danish markets. Indeed, in Spain, decentralised renewable generation has been discouraged.
- Prices and affordability have been major topics of controversy in both countries.
- The UK was a pioneer in liberalisation and still remains committed to the principle of markets. On the other hand, it also has what are probably the world's most rigid and demanding emissions targets, enshrined in statute in the Climate Change Act 2008. Spain adopted a version of the UK's original liberalised electricity market in the late 1990's and has integrated renewables into the short-term operating regime successfully, in part because of its hydro resources and ample transmission and firm generation capacity. However, the government has intervened heavily in investment decisions and regulation, including setting tariffs that did not cover regulated costs, thereby creating a tariff deficit of over €25 billion that consumers will be paying for the next generation. Both countries face a difficult balancing act in developing their policies for electricity.

As a result of these, and other, factors, it could be argued that the UK and Spain in many ways face the 'new era' challenges in particularly acute form and that the way in which they have responded to these challenges is of significant wider interest – both for what they have done well and for their mistakes.

Clearly, a choice has to be made about which aspects of the British and Spanish response should be selected for examination. The main criteria have been:

- **Range**: the assessment below tries to cover a wide range of issues from the very highest level (institutions and governance) to the level of technical detail (for example the treatment of embedded generation).
- **Differences of approach:** In order to see what lessons can be learned, the focus has been on areas where the two countries have adopted significantly different approaches. Where the same overall approach has been taken (for instance as a result of EU harmonisation measures) there is less to be learned. Those issues are therefore not covered to any extent: the aim here is not to assess EU policy as such.
- **Relevance to other countries:** The issues examined are those of wider relevance. Some issues of undoubted importance (for example nuclear power and coal) are only touched on in passing here, as each country has its own very specific problems in these areas.
- **Links with decarbonisation policy:** The issues examined here are directly linked with decarbonisation policy. There are many other issues of a regulatory nature which are not specifically related to decarbonisation, but these are not the focus of this study.

[5] Commission Communication *Achieving the 10% Interconnection Target* COM (2015) 82

2 – Institutions and Governance

Decarbonisation creates major challenges for the governance of liberalised markets. The basic aim of liberalisation was for governments to stand back from the management of the electricity sector and allow market forces to drive developments, including investment as well as operations and consumption. With the new priority of decarbonisation (addressing the 'greatest market failure the world has ever seen'[6]) this hands-off approach is no longer tenable in its purest form. Nonetheless intervention risks distortion and inefficiency. Governments have been trying to develop arrangements which give scope for markets or regulated market mechanisms (like auctions) to operate while still ensuring the achievement of climate change objectives. The two countries have adopted different approaches:

- **Sectoral governance**. The UK has been a pioneer in this area. Its Climate Change Act insulates the decarbonisation process from short term political pressures and sets clear long term goals. Spain has a less developed institutional framework and policy development has been more erratic. There are also more specific questions of governance – for instance, on the management of networks and whether the network owner and system operator role need to be separated more clearly. The UK is moving cautiously in this direction and Spain will need to do so too.
- **Progress with decarbonisation**. Whether or not as a direct result of the differences in governance, the UK is also performing very well against its climate targets. It has already achieved reductions of around 40 per cent in greenhouse gas emissions against a 1990 base, a decade and a half ahead of the EU in general. It will face more difficult challenges in the future but the framework seems so far to have proved robust. Spain has thus far also met its climate change targets, but in part this was the result of economic recession and because these targets were much less demanding than the UK's targets – Spain's actual emissions have risen rather than fallen.
- **Role of the regulator.** Sector regulators originally had relatively defined economic functions. As decarbonisation rose to the top of the energy agenda, the UK started adding environmental responsibilities which threatened to overwhelm the regulator's core role. It now seems to be moving back to something more like the original role. In Spain, the regulator has always had more of an advisory role to the government and there has been less of an attempt to introduce environmental responsibilities. The downside is that the Spanish energy regulator has little influence on government decisions, a fact that is more important than the relative lack of independence.

3 – Costs, prices and burden-sharing

Decarbonisation inevitably involves higher costs, at any rate initially. Decisions are needed on how costs should be contained, how far they should feed through to consumer prices, and how the cost burden should be shared. Again the countries have taken very different approaches:

- **Cost containment.** The UK has experimented with various forms of cost containment, including the use of auctions for (some) low carbon generation and an overall cap on the extra costs involved. Despite some problems, the approach has on the whole worked reasonably well, though it is coming under strain. Spain meanwhile has had less success, starting off with more open-ended support schemes whose costs were not fully passed on. This led to various abrupt efforts to contain costs and a halt in new investment.
- **Price intervention.** Spain has relied heavily on price intervention to minimise the effect on consumers, leading to a huge overhang in the form of the 'tariff deficit'. The problem has been

[6] *Stern Review: the economics of climate change* HM Treasury 2006

contained in the sense that the deficit is no longer growing, but its consequences continue to distort policies and prices. Furthermore, Spain has no transparent methodology for setting regulated access tariffs (a key determinant of final prices), making it too easy for the government to influence prices for political reasons (for example to limit inflation or favour certain consumer groups). The UK has generally resisted the temptation of direct regulation of electricity prices. On the relatively rare occasions when it has not managed to do so, UK government interventions have proved counter-productive and inimical to innovation.

- **Government wedge.** This refers mainly to the extra costs included in final electricity prices due to government policy decisions rather than energy market forces and regulated network costs. The extra costs can be hidden or transparent, appear directly in electricity prices or be spread more widely, for instance in access charges. In the UK the extra costs are relatively transparent – they appear in the national accounts as 'tax and spend' – although they are not identified separately on consumer bills. In Spain the position is more complex but also more opaque – a large proportion of the final residential price (45-50 per cent) is accounted for by taxes, various levies and cross subsidies, not all of which are related to decarbonisation. This raises an important question – where should the fiscal burden be placed? At the moment it is nearly all on electricity consumers. This is arguably both unfair (given that we are dealing with a global problem rather than just an electricity issue) and distorting (as it discourages the use of electricity and the electrification of other sectors like heating and transport, where low carbon electricity should, under most scenarios, be having an increased role). There is a case for energy sector fiscal reform to spread the cost of decarbonisation in ways that are fairer and which support efficient decarbonisation in the diffuse sectors.

4 – Network regulation

Transmission and distribution networks have always been regulated, because of their monopoly nature, but the task of regulation is complicated by the process of decarbonisation. It requires the integration of numbers of new sources at both transmission and distribution levels and poses new questions for the regulators. What changes are needed to facilitate the introduction of these new sources while simultaneously avoiding the creation of distortions and inefficiencies? How can the move towards a decarbonised system be guided towards an optimal outcome, given the uncertainties about the nature of future systems? Three particular issues stand out:

- **Network pricing.** There can be a difficult trade-off between ensuring that prices cover costs and encouraging the development of the new sources. The UK has gone for a relatively open-ended system which encourages innovation and focuses on outputs in order to create appropriate incentives for the networks. The aim is to encourage development towards a more flexible system which can incorporate the large and growing number of decentralised sources (generation, storage and demand response). For instance, the UK now has nearly three quarters of a million generators (mainly solar) connected to the distribution system. Spain has a less developed regulatory approach and retains a largely traditional form of rate of return regulation, which tends to encourage the building of larger projects and excess capacity.
- **Distribution.** One of the areas where uncertainty is greatest is over the future role of distribution companies. In the past their role has been relatively passive, namely simply to distribute electricity generated from central sources. In the future their role will be much more active, but many scenarios are possible. The UK has tried to cope with the uncertainties by adopting a flexible and exploratory approach but one result is that it is only moving rather cautiously towards a more active role for the distribution companies. Spain again has seen little progress in this area.
- **Interconnectors.** As noted above, both the UK and Spain suffer from relatively limited interconnections and both want to increase the level of interconnection capacity. This should help promote competition, put downward pressure on prices, increase security and reduce the system

costs of decarbonisation. In principle, such connections could be unregulated ('merchant') projects. However, in practice, to reduce risk, a 'semi-regulated' cap-and-floor system has been introduced for the UK, while Spain still maintains a monopoly for its national transmission company in this area (which has led to challenges from the European Commission). One problem is that there is no supra-national or federal regulatory authority in Europe to regulate such links.

5 – Promoting balanced investment

Because the environmental externalities involved have not been fully internalised in prices, special support is often needed to ensure that the right sort of investment takes place. However, hitherto the process has been somewhat erratic, with more focus on building, say, a certain amount of renewable generation (to meet EU commitments), rather than considering the most effective way of getting to a low carbon system. The process has in turn created the need for new interventions, for instance:

- **Renewables.** Both countries, and especially Spain, have been successful in encouraging the growth of renewable generation. But there have been concerns over the cost and both have changed their systems of renewables support over time. In Spain's case, the change led to significant reductions in the annual revenues for existing renewable power assets and to dozens of legal challenges, including through international tribunals under the Energy Charter. There is now more emphasis on competitive approaches and less prescriptiveness about technology types. Nonetheless, the focus is still largely on intermediate targets (share of renewables) rather than the ultimate goal (an efficient low carbon system) and there have been unintended consequences, including the undermining of electricity wholesale markets.
- **Distributed generation.** It is generally agreed that distributed (embedded) generation will play a greater role in future systems because of a combination of technical developments and the need for decarbonisation. However, if governments try to force the process along by creating special incentives they risk creating new distortions. Both countries have seen over-generous support schemes for solar photovoltaics which have had to be revised. In Spain the generous support schemes focused on centralised generation and the government has been very reluctant to assist decentralised sources. The UK is currently considering whether distributed generation is being over-rewarded through the regulatory system more generally.
- **Demand response.** Again it is generally agreed that this will be an important feature of future systems and a number of experiments are under way. To date, however, tangible progress remains thin on the ground and in both countries it is unclear how to make best use of this resource. The UK has made an effort to try new formulas to promote demand response. Experience in Spain is so far limited to auctions for interruptible demand service, and these are often described as subsidies for very large industrial consumers.
- **Capacity markets.** One of the unintended consequences referred to above has been the failure to consider the impact of large amounts of intermittent plants on the system. Not least it has made investment in reliable (firm) generation less attractive, leading to the creation of capacity markets. The UK is facing tight supply margins and has created a system-wide capacity market, which has advantages in theory but has in practice not produced the results policy-makers were aiming for, namely the construction of new combined cycle gas plants. Spain has an administratively based approach to capacity payments, but this approach raises some significant issues concerning which assets are being remunerated and what service they provide. In view of the considerable reserve margin of firm capacity in Spain and the economic recession, the problems there have been less acute than in the UK. However, this could change as the Spanish economy recovers and if firm capacity is shut; in particular coal fired capacity that does not currently meet EU emission performance standards and which would require significant investment in order to meet those standards.

6 – Conclusions

No single message can emerge from the list of issues above as to the 'right' way to undertake and regulate electricity decarbonisation. All countries are different; they face different challenges and have different starting points. They need to find their own way through the difficulties.

Nonetheless, the discussion suggests some pointers in three broad areas, which are likely to be of wider relevance for any country embarking on or engaged in the process of decarbonising its electricity sector.

Overall governance

Political systems are in general not well constituted to deal with climate change. It is a very long term issue – the costs and benefits examined in the Stern Report, for instance, project centuries into the future. Emissions targets extend for decades into the mid 2000s, well beyond the lifetimes of most parliaments and indeed probably beyond the lifetimes of most parliamentarians. Furthermore, the costs and benefits of climate change are global: most of its impact will not fall on Europe and European consumers but on people in other parts of the world and on future generations. This can make it difficult to maintain a political consensus on the need for action, or to identify useful results from that action, at least in terms of direct climate impacts. It is probably also one of the reasons why intermediate targets (like penetration of renewables) have been taken as the focus of attention and treated as key indicators, particularly at the political level. Although as the comparison between the UK and Spain shows, good performance in relation to renewables is not necessarily the same thing as good performance in reducing emissions.

A further major timing issue is the long life cycle of most energy investments. Power stations have lifetimes in terms of decades or more – a nuclear station can easily take ten years or so to plan and construct, then operate for forty or fifty years. In addition, the costs can be enormous – the Hinkley C power station is possibly the most expensive constructed object on the planet[7]. Renewables investment tends not to be so 'lumpy' but it is still generally very capital intensive – that is, it involves very large sunk costs, exacerbating the risk that there will be insufficient return on investment if circumstances or government policies change. Consumer appliances tend to have shorter life cycles but consumer behaviour and energy consumption in general are slow to change – they are to a large extent a function of the housing stock, energy delivery infrastructure, urban and transport planning and so on.

Not only are the time horizons long, making change inherently slow in nature, there is also a fundamental difficulty. Because we are dealing with such a deep-rooted market failure, the incentives given by markets operating on their own are not sufficient to deliver the changes needed. In effect, investors have to commit their money on the basis of trust in government policy statements, rather than on directly analysable market factors. The credibility of governments and their commitment to policy goals is therefore crucial. The track record of most governments is not good – this study has noted a number of abrupt changes of direction and removal of particular support schemes. Furthermore, it is clear that many government policies have not been fully thought through. There are unintended consequences – collateral damage, as it were, for those who are not the immediate targets of the policies in question (for instance, the conventional generators who lost income and market share and faced higher risks as a result of government support for renewables).

A further dimension of complication is that of uncertainty – no-one, including governments, knows what the future holds. The range of options is enormous, whether for market structure, utility business models or consumer engagement with electricity[8]. Policy-making in this situation of uncertainty is

[7] Taylor S, *The Fall and Rise of Nuclear Power in Britain: A history*, UIT Cambridge 2016
[8] *Oxford Energy Forum* issue 104 (March 2016)

enormously difficult. It involves balancing the need to set out a clear sense of direction against the fact that the destination is unknown.

There can be no single route through these complications which will work for all countries. However, the UK seems to have managed the difficult balancing act more effectively than most as regards the overall emissions trajectory. While the specific solution adopted in the UK may not be suitable for all countries, the underlying principles are arguably of general application. In this light, the aim should be, so far as possible:

- To insulate climate change policy from short term political pressures.
- To set clear, binding long term goals so that investors and consumers understand the emissions trajectory the country intends to follow.
- To base decisions as far as possible on technical advice from expert bodies.

Furthermore, the need to focus clearly on these long term issues has led the UK to give more serious attention to specific consequences (like the implications for the distribution sector). Overall, the UK seems to have made more progress in meeting the decarbonisation challenges than Spain has.

System optimisation

The list above moves from topic to topic in what may seem a disconnected manner. However, it is arguable that topic-by-topic treatment is in fact an accurate description of both governments' policy-making. By and large, any overview is missing; instead governments are coming up with responses to particular challenges more or less in isolation, often creating new challenges as a result. To an extent, this is understandable. Many of the challenges are so new that governments have little idea how to handle them in themselves, much less how exactly they could be integrated into an overall strategy. But the issue-by-issue approach entails risks. At some stage a more coherent framework will certainly be needed if the countries concerned are to avoid a significant misallocation of resources.

To take a simple example. In the future, because of the increasing penetration of intermittent generating sources, it will become ever more important to find the most efficient ways of meeting demand peaks. There are at least six different options, all of which are likely to play a part, as discussed below. But to get the right balance between them, and optimise the system overall, there will need to be either efficient market signals or an optimised strategic framework. Neither exists at present in either country.

The options for meeting peaks include the following:

- Central generation – the traditional route.
- Decentralised generation – as decentralised generation grows, it becomes ever more important to ensure that it is integrated into the system and that its potential role in system balancing is exploited to the maximum.
- Network reinforcement – this is likely to take on a significant role as distributed intermittent sources grow as a proportion of the total. Networks will need to be able to make optimum use of all the sources available at any one time and these will be widely distributed across the system.
- International interconnections – this is already a key means of balancing systems on a European basis. As noted, the UK and Spain have suffered from their low levels of interconnection.
- Demand response – growing in potential both because of the supply side developments and the increasingly smart systems on the demand side.
- Storage – the technologies have been developing rapidly in recent years and costs have been coming down to near commercial levels. Both system level and consumer level storage are likely to be an important part of future systems.

However, at present, each of these options is subject to a different system of regulation and each therefore faces different incentives. Nor have they been integrated into any overall strategy.

- **Central generation –** is mainly driven by market forces as far as operation is concerned. But some systems, such as the UK, have also introduced capacity payments. There is no wider strategy underlying these capacity payments – for instance, the UK government is not clear whether it wants specific sorts of capacity, or can accept market outcomes.
- **Decentralised generation –** growth of decentralised plant is driven to a large extent by support schemes, such as the FiT payments which incentivise much embedded renewable generation. The schemes are designed to meet carbon targets, not to optimise the system and minimise overall costs. Rather, they are subject to largely arbitrary overall expenditure limits and incentives to reduce costs in specific areas. Particular forms of generation, like embedded generation, may be over-rewarded in other ways. There is at present no guarantee that it, or the policy-supported plant in general, is being built at the optimum rate from an overall system perspective.
- **Network reinforcement –** is subject to regulation. The regulation is to an extent flexible (as discussed in the networks section) but still gives a largely guaranteed return on investment. There is also some encouragement for innovation but this is explicitly experimental. There is no overall vision for the network of the future and a number of significantly different scenarios are conceivable.
- **Interconnections –** are also in practice usually subject to regulation, at least in the UK, though in a different form (mainly via the cap and floor approach, which helps underpin investment by reducing risk) and the regulator adopts a case-by-case approach to considering proposals. While there is general acceptance that more interconnection is needed, there is no overall strategy. Furthermore, like some other issues, this one requires an international approach to optimisation.
- **Demand response –** a number of experiments are under way with different approaches (some linked with capacity mechanisms, some with network regulation) and there is no clear picture of how large a role demand response will play in the future system or what form demand response will take. Nor do current wholesale or retail prices give adequate incentives for demand response, and neither government nor regulator has given a clear idea of how such price signals could be created (beyond hoping that the introduction of smart meters will enable greater resort to time-of-use pricing).
- **Storage –** little progress has been made in policy terms in considering how to realise the opportunities thrown up by the reduction in technology costs. In practice, although some experiments with storage are taking place, it remains largely a forgotten area for policy makers. Indeed, there is no clear regulatory definition of storage; it is not treated as a separate service and faces significant regulatory barriers. For instance, current treatment of storage in the UK regards it effectively as a consumer when power is flowing in and a generator when power is flowing out, leading to the risk that it has to pay twice for network use. Similarly, there are a number of solar generators who could add battery storage so as to increase their ability to provide system services, but they have little incentive to do so. Their Feed in Tariff payments apply to all exports on a flat-rate basis and they would see little or no benefit from spreading their output across the day as a whole or concentrating it on peak periods.

In short, all six routes can be used to meet the same objective of providing flexibility to mitigate the problems of intermittency, and one key challenge for the future low carbon system will be to find the right balance between them. Despite this fact, policy and incentives in each area are being developed separately and on different bases. There is no level playing field for competition, so market forces cannot be relied on to produce an optimum result. But there is also no central strategy – national or European – based on an overall economic analysis of the optimum contribution from each source. It may be premature at this stage to identify the way forward in any detail, but the lack of any mechanism to ensure the right balance between different options and deliver an optimum system

overall is increasingly problematic. It may be that some new body is needed to provide this central overview as discussed in the following section. Alternatively, governments might try to grasp the nettle of market and pricing reform in a more determined manner. But at present it is not even clear whether they intend to adopt one or other of these routes.

Integrated policy approaches

One possible conclusion from the two sub-sections above is that there is still a gap in the policy-making architecture. Some arrangement may be needed whereby:

- Particular policies can be analysed in greater detail so as to identify the possibility of unintended consequences.
- A more informed overall approach to policy can be facilitated by more attention to system issues, such as the system optimisation problems mentioned above or the sort of market reforms which will lead to a sustainable low carbon electricity market.
- Perhaps most importantly, serious examination can be given to the next stage of decarbonisation. Governments have hitherto focused on the decarbonisation of electricity, but the process has turned out to be much more than the simple substitution of one set of sources for another. As attention starts to move to the next stages – the decarbonisation of heat and transport – the issues will get even more complex in themselves. Furthermore, there will also, almost certainly, be a much greater impact on consumer options and behaviour. Hitherto, decarbonisation has largely been a matter of upstream changes (in power generation). In the future, changes will need to be made to the downstream as well (for example in residential heating options, or transport technologies). The risks of unintended consequences (for instance, the impact of electrification in these sectors on the electricity industry itself) will multiply and the need for a thorough examination of the options will increase. Fiscal reform will also be on the cards to encourage competition between decarbonised energy vectors.

At present, it is not clear that either government has access to the sort of analytical capacity described above. Even the Climate Change Committee (CCC) in the UK, generally successful though it has been, is focused mainly on emissions trajectories, rather than on energy policy making as such.

Liberalisation has in a sense compounded the difficulties of decarbonisation. With the withdrawal of governments from direct involvement in the energy sector, there has been a loss of expertise and technical knowledge, leaving policy makers ill-equipped to address the difficult problems outlined above. But in the view of the authors of this paper, the answer is not to reverse the process of liberalisation and return to a centrally managed energy market. It would not only be very difficult, in these times of austerity, to establish the depth of analytical capacity which the process would require; it would also raise new risks. Centralised systems are not good at coping with the kinds of uncertainty described above. They inevitably tend to indulge in a sort of ‘group think’, with a relatively narrow focus and an undue confidence in their view of the future. Furthermore, they are also prey to political pressures of one sort or another. So it is probably not ideal for governments to have the main analytical function, although, of course, in the end it is governments which have to make decisions. The aim would not be to change that responsibility in any way, but to ensure that government decision-making is fully informed and subject to some analytical discipline and continuity from one government to the next.

Nor do we believe that giving the task described above to an existing body, like the energy regulator, is a satisfactory solution. The regulator tends to work best when its focus is clearly on economic and competition issues; the more its functions are complicated by the conceptually distinct goal of policy analysis and delivery, the less successful it is likely to be in its primary task.

We would therefore suggest that there may be space for a new body – a sort of energy agency or system architect. The goal would be to have a body broadly similar to the UK CCC, but with a more specific focus on the policies needed to deliver the outcomes which the CCC identifies as necessary

to keep the country on track to its emissions objectives. Like the CCC, the body should be independent and outside the political process. Its recommendations should have weight and authority so that governments could not simply ignore them – for instance, they might have to justify any departure from the recommendations to national parliaments.

It is difficult to identify an exact precedent for the sort of body we have in mind, but it would be somewhere between the US Federal 'Energy Advisory Board' (which, as its name suggests, is mainly advisory in nature) and the California Energy Commission (which has a number of functions in relation to policy delivery). It would be a permanent body with its own staff and analytical capacity (like the UK CCC) and it would not directly advise government but inform the process more widely by its publications, outreach and status. Its task would be to examine the policies, institutions and market structures needed to deliver a low carbon energy system, and to make recommendations to government and parliaments. One of its key functions would be to engage consumers and communities in the process and ensure that its recommendations reflected their concerns.

In the end, however, it will be for each country to develop structures appropriate to its own constitutional arrangements and governance systems. But the main message of this study is that the 'new era' for electricity (and energy in general) has brought with it some unprecedented challenges and opportunities. There is no single way forward which can be identified for all countries; what is clear is that these challenges bring along with them a requirement for imaginative and creative policy thinking. New approaches are needed for the new era.