E3G

Creating New Electricity Markets to Meet Energy Policy Challenges

Explaining the Electricity Market Reform landscape

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Executive summary

Liberalised electricity markets have now been established around the world for over two decades and have delivered many benefits to consumers. However, there are now increasing calls for these markets to be reformed. This is in part based on a desire to learn from existing operational experience and in part based on the belief that existing market designs will not be able to support delivery of energy policy challenges going forward.

There is an emerging consensus that electricity markets have, as yet, failed to deliver competition, efficient investment and innovation in technologies, products and services, particularly on the demand side of the market. Electricity markets therefore need to be re-focused going forward if they are to deliver best value to consumers at a time when the extent of the energy policy challenge is particularly significant. Four key issues appear central to this transformation:

1. Attracting sufficient efficiently financed investment to support decarbonisation and security of supply objectives.

2. Ensuring that system operators can maintain security of supply with increasing volumes of intermittent renewable electricity.

3. Creating retail electricity markets that command the trust of customers who are facing increasing electricity prices.

4. Maximising the potential for cost-effective investments in the demand side of the market to reduce overall demand and provide balancing services.

All liberalised electricity markets are likely to face these challenges at some point in the future, although the timing and order in which they need to be addressed will vary. Indeed, many countries have already initiated electricity market reform (EMR) processes to address one or more of these concerns. Also, in many situations, this reform agenda will need to be pursued against a background of increasing physical interconnection between power systems that will inevitably drive a convergence in market design.

Various solutions to these challenges are beginning to emerge, although it is too early to describe any as 'best practise'. However, the EMR agenda is often characterised as 're-regulation' and, therefore, treated with suspicion by policy makers who have spent many years promoting market-based approaches. This characterisation is over-simplistic and, whilst the investment challenge does indeed demand a re-balancing of risk between investors and customer which in turn will expand the role of regulation, the opportunities to stimulate a genuinely competitive and fast moving retail market in consumer facing products and services are significant. Therefore, the electricity market reform process represents a re-focusing for markets and competition on those areas such as energy efficiency that have the potential to deliver more tangible benefits for electricity consumers and deliver best value outcomes across the system as a whole.

This paper sets out the flaws with current market designs that need to be addressed by EMR along with some of the emerging solutions. Policy makers will need to consider how and when this reform agenda is tackled within their own electricity markets.

1. Liberalised electricity markets

The process of electricity market liberalisation is now well established in many countries around the world. Over the past few decades, large state owned entities have been re-structured and often sold into private ownership, new market rules have been devised and implemented to allow electricity to be bought and sold whilst enabling a system operator to maintain reliable power supplies, and end consumers can choose from a number of competing electricity providers. The extent of the change has been immense and it has delivered many of the intended benefits. These have included significant improvements in the efficiency of electricity production and transmission and the attraction of new private sector investment into the sector. However, other potential benefits have proved more elusive. In particular, dynamic customer facing markets in electricity products and services have not developed and, in consequence, major improvements in consumption efficiency have not materialised. These customer facing markets tend to remain highly consolidated with little evidence of significant new entrants or the emergence of business models built around innovative new products and services.

There is, therefore, much to learn about the design of liberalised electricity markets from the experience of the past few decades. Moreover, the policy and technological context of electricity markets has also moved on significantly. They can no longer be viewed merely as a means to reduce costs of energy whilst preserving secure supplies. Decarbonisation of the electricity sector is now viewed as the critical first step in the decarbonisation of the wider economy, presenting credible technology pathways for early reductions in greenhouse gas emissions and, thereby, presenting options for the subsequent decarbonisation of other sectors through electrification.

The twin desire to learn from the experience of operating electricity markets and to support the decarbonisation of the sector going forward has given rise to numerous market reform initiatives around the world. These have ranged from incremental 'tinkering' with existing frameworks through to fundamental overhauls of the key design elements. This paper sets out the electricity market reform landscape and explains those elements that are emerging as the most important changes that need to be pursued to deliver against future policy challenges. In particular, this analysis illustrates that market reform should not be considered as an exercise in re-regulation but rather the removal of barriers that have prevented competition and innovation reaching those areas of the market that can deliver maximum benefits to consumers.

2. The electricity market reform landscape

Electricity markets are subject to constant review and revision to cope with evolving circumstances. Generally, the changes can be managed by market participants and regulators and are of a detailed technical nature. However, a number of major challenges have emerged over recent years that have commanded high level political attention. These can be grouped as follows:

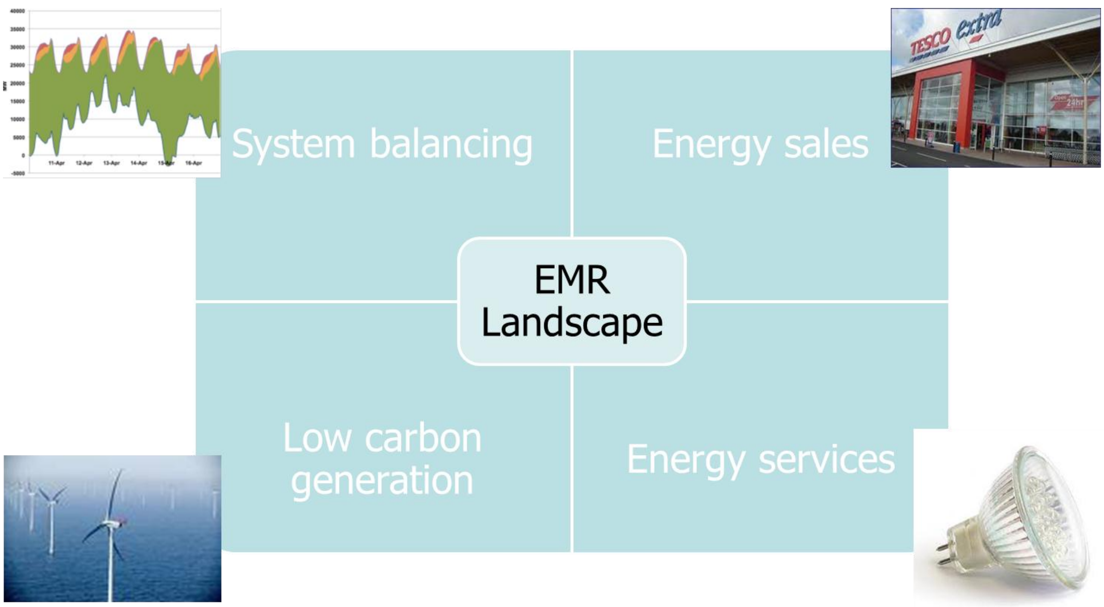
1. Attracting sufficient investment to replace and enhance the existing infrastructure consistent with decarbonisation and security of supply objectives and to do so in a way that allows for these investments to be financed efficiently.

2. Ensuring that the move towards more intermittent forms of generation will not compromise security of supply and that sufficient resources of the right type will be available to allow system operators to maintain the real-time balance between supply and demand.

3. Creating retail electricity markets that are genuinely competitive and that command the trust of customers who are facing increasing electricity prices.

4. Maximising the potential for cost-effective investments in the demand side of the market to reduce overall demand and provide balancing services.

These four challenges represent the critical issues that now need to be addressed by electricity market designers. They comprise the electricity market reform (EMR) landscape and are illustrated in the following diagram:

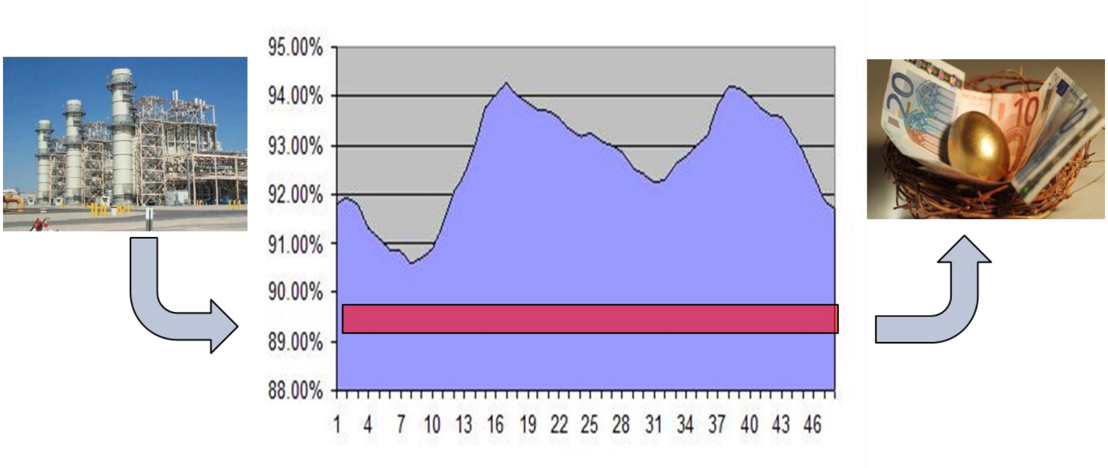


Different countries and regions will need to tackle these issues at different times and in different orders over the coming years. However, it is likely that each issue will need to be addressed at some stage if electricity markets are going to be able to support delivery of long term energy policy objectives.

The following sections explain the deficiencies in existing market designs that have given rise to this reform agenda and sets out some of the potential reform solutions that are emerging.

3. Low carbon generation

Electricity markets have successfully stimulated considerable investment in new power generation capacity. The principles underpinning these investments are illustrated in the following diagram:



New power plant will be more efficient than existing power plant and will therefore be able to operate a lower cost. This efficiency advantage will enable the new power plant to operate at, or near, base load and throughout the day earn market prices set by older and higher cost plant. Moreover, the technology of fossil-fired power plant is relatively mature and investors can confidently expect that a construction project will be completed to time and budget and the power station will, thereafter, work reliably. The new power plant will, therefore, be continually earning an operating profit, or ‘energy credit’, that can be relied upon to recoup financing costs and deliver project returns.

The decarbonisation agenda presents new challenges for generation investment since significant reductions in the carbon intensity of electricity will require some combination of renewables, nuclear and fossil-fired plant fitted with carbon capture and storage (CCS) technology. These technologies tend to have greater construction and performance risks than conventional alternatives and are often considerably more expensive. The existing principles underpinning generation investment will, therefore, no longer apply and new administered mechanisms are required to deliver project returns for investors.

Part of the solution involves establishing a cost of carbon, either through taxation or a cap and trade scheme. This has the effect of increasing the operating costs of high carbon emitting plant, and thereby the power price, to the level at which low carbon emitting plant, that often has very low operational costs, can earn sufficient energy credit to recover capital costs and deliver a project return. Carbon pricing has proved effective in reducing the output from higher carbon emitting plant in favour of lower carbon alternatives that have already been built. However, carbon pricing in itself is not effective in driving significant levels of investment in low carbon assets. This is for a number of reasons:

1. Carbon prices are administered by politicians and, therefore, subject to on-going adjustment as political circumstances dictate. Investors require a high level of confidence in the future of these prices over many years and, sometimes, over several decades since they are vital in delivering project returns. The long term value of the carbon therefore tends to be discounted in an investment appraisal as a result of the risk of future policy change.

2. More immature low carbon technologies that might ultimately be required in large amounts, such as offshore wind or CCS, would require an extremely high carbon price to deliver project returns. Such carbon prices applied across the whole market would lead to significant increases in energy prices for consumers, as well as windfall profits for cheaper low carbon plant. These distributional effects are generally regarded as unsustainable from a political perspective.

3. As the power system progressively decarbonises, the proportion of the time in which carbon emitting plant will be operating will progressively decrease. This will, therefore, decrease the proportion of time in which low carbon plant is able to earn an energy credit and potentially lead to extremely volatile prices.

It is, therefore, necessary to introduce additional mechanisms to encourage investment in low carbon emitting plant. This usually involves establishing a fixed price, or fixed price premium, payment for such plant, or through establishing an obligation on electricity suppliers to purchase a proportion of their electricity from particular low carbon sources. These so-called feed-in-tariff or quota schemes are an increasingly important element of electricity market design and this level of importance is likely to continue to increase over the next few decades as more low carbon capacity is built. Key design questions facing policy makers include:

1. Should these payments for low carbon generators be embodied within a market regulation, which may be changed and may not give sufficient certainty to investors, or through a contract, which is likely to be complex to implement?

2. How should policy makers balance the need for long term technology targets that support the development of efficient supply chains with flexibility to adapt to new technology options?

3. What approach should be adopted to ensure that future reductions in technology costs will be passed through to consumers without introducing changes to the mechanism that undermine investment confidence?

4. Is it sensible to entirely insulate low carbon generators from short term market price signals or should they retain some exposure such that they maximise their potential to respond to market need?

The UK Government is in the process of reforming its electricity market in light of the need to meet challenging carbon reduction targets. It is proposing to introduce a new mechanism to support low carbon investment based on long term contracts, primarily aimed at attracting sufficient levels of low cost finance to the sector, accompanied by significant changes to industry institutions and governance arrangements. The implementation of these proposals represents a major overhaul of the existing market design framework.

4. System balancing

Integrated power systems require that supply and demand continuously balance to maintain a stable system frequency and reliable supply for system users. This continuous balance is achieved through ensuring that there are sufficient resources on the system to meet total demand (resource adequacy) and adjusting the output of these resources in line with real time changes in the level of demand (dispatch).

Historically, power systems have been operated on the basis that output from generation assets can be controlled to follow changes in consumer demand. Under these circumstances, if sufficient capacity is available from those generators to meet system peak demand, it is assumed that they can be dispatched to meet total demand at all times. Therefore, the resource adequacy challenge is met by delivering a total amount of firm capacity to the system sufficient to meet the relatively few hours of system peak demand. There has been continual debate since electricity markets were first introduced as to whether the energy price signal alone would be sufficient to deliver an appropriate level of firm capacity or whether an additional 'capacity mechanism' should be included. No consensus on this issue has been achieved and both approaches have been widely adopted.

However, the increase in the share of supply from intermittent renewable generation will change the nature of the system and the associated reliability challenges. The principle change is that it will no longer be possible to control the availability of a significant proportion of the generation capacity. Moreover, these assets tend to have the lowest operating costs on the system and the least cost approach is to utilise as much as possible of the energy produced when these resources are available before turning to supply resources with much higher production costs.

The challenge for the dispatchable resources on the system is, therefore, no longer to follow changes in overall consumer demand, but rather to follow changes in the residual 'net demand' not already served by intermittent renewable generation. The result of this change is illustrated in a recent National Renewable Energy Laboratory/GE Energy report that modelled 35% energy penetration of wind, photovoltaics (PVs), and concentrating solar power (CSP) on the power system operated by the WestConnect group of utilities in Arizona, Colorado, Nevada, New Mexico, and Wyoming.[1] The charts below show a relatively benign week, when the 'net' demand follows a repeatable pattern that is not dissimilar to the overall system demand, along with a more challenging week where the profile of net demand is much more volatile than overall demand and does not follow a repeatable pattern.

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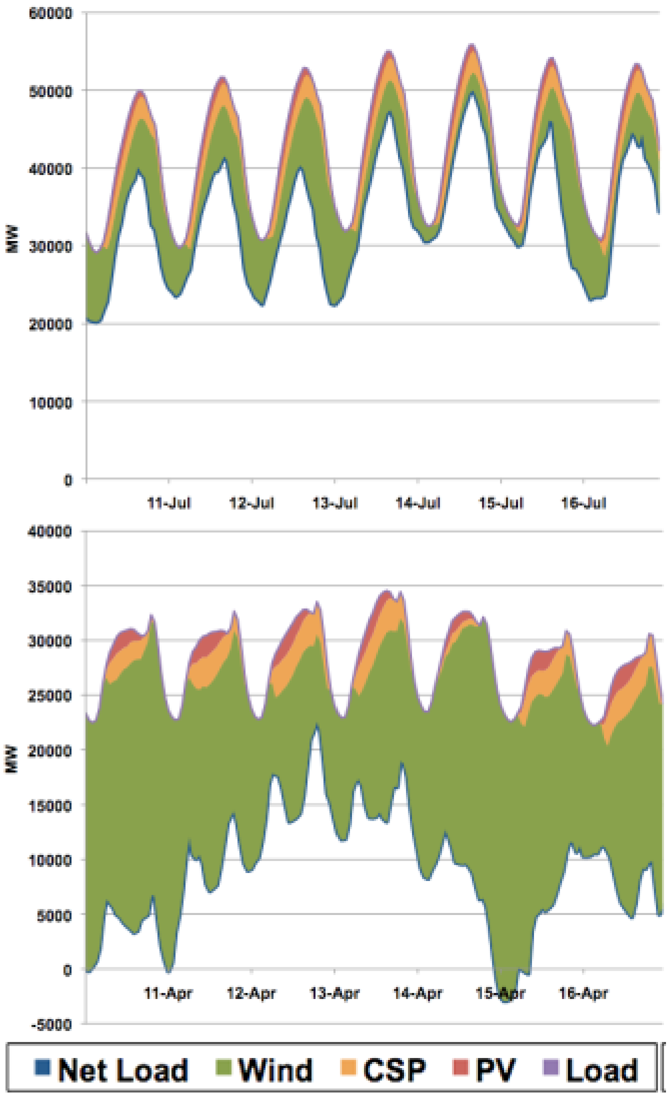
[1] Lew et al., 2010: How Do High Levels of Wind and Solar Impact the Grid? The Western Wind and Solar Integration Study, NREL/TP-5500-50057, December 2010



There has recently been much debate as to whether or not these new power system characteristics increase the need for a separate capacity mechanism or not. However, an analysis of net demand highlights that, whilst having sufficient firm capacity to meet peak system demand remains necessary, it is no longer sufficient to deliver reliability at least cost and, therefore, the quantity of firm capacity no longer constitutes the sole basis upon which resource adequacy should be determined. The most challenging threat to reliability is not the overall level of peak system demand. Instead, the biggest challenge arises when consumer demand and the availability of intermittent renewable generation are changing in opposite directions, something that can happen any day, every day, at any time during the day, and even several times a day. It will occur to the greatest extent in two situations:

1. When demand is increasing to system peak whilst the availability of partially dispatchable renewables is reducing to a minimum, and

2. When demand is falling to system minimum levels whilst the availability of partially dispatchable renewables is increasing to a maximum.

This highlight that the ability of resources to respond to a rapidly changing level of net demand will be as important as the overall quantity of firm capacity in delivering system reliability.

Policy makers are only now beginning to consider how to integrate the concept of a capacity payment with mechanisms to encourage resources that are sufficiently flexible to meet the future system balancing challenge.

5. Energy sales

A key objective of electricity market liberalisation was to introduce consumer choice and allow a variety of supply companies to purchase power from the wholesale markets for onward sales to customers. This has generally worked well from a mechanical perspective with many markets exhibiting relatively high rates of supplier switching. However, some markets still retain regulated tariffs and in those markets where prices are unregulated there has often been on-going concerns about the extent of competition between suppliers and, thereby, whether consumers really do have a meaningful choice. One key source of concern is the absence of new entrants to the market that have established and grown on a sustainable basis to become significant competitors to incumbent suppliers. These concerns are exacerbated by the perceived similarity in the prices and products offered by existing players.

Apart from the political desire to control retail electricity prices and retain regulated tariffs, there are two key challenges that have served to constrain the development of competition in retail electricity markets:

1. Arcane billing and metering infrastructure

2. Wholesale market price risks

The first of these has presented a particular challenge for established brands that may wish to enter the energy retail markets. It has proved notoriously difficult to produce accurate and reliable bills and provide high standards of customer service using existing metering infrastructure. This creates a significant risk of brand damage that acts as a deterrent to major retailers.

However, the second challenge is the most significant and affects all players in the retail electricity markets. Prices in forward electricity markets are often highly volatile and suppliers need to decide when to purchase the power they need to sell to customers. Significant fluctuations in these costs have the potential to lead to some suppliers having a substantial cost advantage or disadvantage compared with other suppliers. Although this presents the opportunity for lower cost suppliers to increase market share, such moves are unsustainable as price fluctuation favour different suppliers over time. This has led to suppliers adopting very similar hedging strategies that avoid significant swings in market share. These hedging concerns can be reduced to some extent where wholesale markets are highly liquid since this allows suppliers to avoid major wholesale price exposures and this is particularly important for smaller suppliers. However, liquidity in these markets is often relatively low, particularly where a high degree of vertical integration exists. Indeed, the inherent riskiness of the wholesale markets creates drivers for consolidation, both vertical and horizontal, as suppliers try to manage the risks through diversification and scale, thereby reducing the liquidity required by smaller and independent suppliers.

The situation in which a small number of dominant suppliers serve the overwhelming majority of customers is now a common feature of electricity markets. Indeed, many Governments take advantage of this situation and use these suppliers as delivery agents for a range of social and environmental objectives (e.g. social tariffs, energy efficiency). The introduction of these so-called 'supplier obligations' further reinforces the drivers for consolidation by increasing the complexity and risk of supplier business models.

Nevertheless, the expectation amongst consumers for competition and choice in electricity supply is now widely established, often leading to frustration and concern with the reality that presents itself. In particular, at times of increasing energy prices, consumers are looking to politicians to provide assurance that prices are fair and are not the result of anti-competitive practises by suppliers. These political pressures inevitably lead Governments into two responses:

1. Impose increased regulation over electricity prices – thereby reversing one of the key objectives of liberalisation.

2. Attempt to introduce changes that promote new entry and competition in electricity supply.

The first approach is easy to implement and is likely to be the immediate reaction of many Governments. However, the second approach, although more challenging to pursue, has many long term advantages. This third element of EMR has three key strands:

1. Eliminate or simplify supplier obligations such that they do not have a significant impact on the business model of electricity suppliers. This may involve transferring delivery responsibility to some central authority.

2. Pursue replacement of legacy metering systems with new smart meters, along with the associated network infrastructure. This will introduce many attractions for major non-energy retailers to enter the market by improving the quality of customer service and providing a deeper customer relationship. The benefits of smart metering run beyond the impact on market entry as explained in the next section on energy services.

3. Focus on improvements to market liquidity. There are many options available to force generators to sell their output on the open market, including mandatory auctions or release programmes. However, liquidity in short term markets ultimately depends on well-designed cash-out mechanisms that allow market participants to forecast, and therefore respond to, contractual imbalance.

These issues are often not categorised as 'EMR'. However, they represent a critical challenge for market designers and will have a huge impact on the nature of electricity markets in future.

6. Energy services

There is no dispute that investment in the demand side of the market, to reduce demand or provide balancing services, is not only likely to be significantly cheaper than providing supply side alternatives, but is probably essential if energy policy challenges are to be met. However, existing electricity market designs have not proved successful in attracting such investment at scale. There are many reasons why a pure energy price signal has not proved successful in creating a market for investment in demand side services and a combination of remedies will inevitably be required if such a market is to emerge. However, one key factor is that the value of the investment will depend on the avoided cost of future energy purchases or the short run value of balancing services. Both of these parameters are highly uncertain and difficult to predict and this inevitably gives rise to a significant investment risk. Those businesses which have, or are capable of developing, new products to help consumers manage energy consumption, along with those that have the project delivery capability, are unlikely themselves to be experts in energy markets and will generally require the customer to evaluate the investment return. It is not just small customers that are likely to be wary of taking such risks. Even large energy intensive industries may reject such investments unless the business case is overwhelming.

Policy makers have therefore resorted to delivery agents to drive investment in the demand side. System operators are responsible for maintaining system balance at least cost and obligations are now commonly placed on electricity suppliers to promote demand reduction. However, both of these delivery routes have limitations that have constrained the development of demand side markets. Apart from the potential adverse implications for retail competition, supplier obligations drive a least cost compliance response and the bulk deployment of low cost measures (primarily insulation), often through large national contractors. Although this can be extremely useful in capturing the 'low hanging fruit' of efficiency improvement, it has not been successful in stimulating a dynamic market for products and services that harnesses the innovation potential of smaller providers. Similarly, the system operation function is extremely complicated and it has not proved easy to regulate or incentivise system operators to seek out innovative new ways to balance the system. They have, therefore, generally been able to rely on tried and tested approaches, usually employing power plant to provide balancing services.

The objective of electricity market design should be to ensure that equal value is available for equivalent investments on both the supply and demand sides of the market. This is necessary for the power system to deliver the set of best-value investments for consumers. Many demand side technology options are immature but are not afforded the same level of support given to immature low carbon generation technologies. For example, renewable generation benefits from deployment targets and revenue support mechanisms that eliminate much of the future energy price risk. Policy makers are beginning to consider if such approaches may be required to drive the development of demand side markets. If successful, this has to potential to trigger the most fundamental transformation of electricity markets of all the EMR initiatives, leading to the development of dynamic new markets that will provide real choice and benefits for electricity consumers.

7. Conclusion

Electricity market liberalisation has delivered many benefits for consumers and market designs have continued to evolve in light of experience. However, existing designs have major limitations that are likely to require further reform if they are to be able to support the delivery of challenging energy policy objectives going forward. The four areas discussed in this paper represent the key issues that will need to be tackled at some point in all liberalised markets. It would be a mistake to describe the thrust of this reform agenda as a 're-regulation' process that is stepping back from market principles. Indeed, it is a mistake to assume that existing market designs are giving rise to competitive and efficient outcomes given that the demand side of the market has failed to develop and the inherent risks have led to consolidated market structures. The level of investment needed will require a rebalancing of risks between customers and investors and this, by definition, will involve an expanded regulatory regime. However, a well-designed package of reforms has the potential to increase the overall levels of competition and innovation though placing the demand side of the market at the centre of the reform agenda, leading to the development of new dynamic markets in customer facing products and services.

It is important that policy makers throughout the world now consider how and when the challenges described in this paper will affect their electricity markets and, therefore, what programme of EMR might be appropriate in their jurisdiction. In particular, the benefits of increased physical interconnection between markets is now widely appreciated and the timescales and nature of the reform programme may be driven as much by the need to harmonise rules between markets as by the specific circumstances within an individual power system.