Reforming the FiTs and capacity mechanisms: the 2-stage capacity auction

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1. Introduction

Back in 2010, as Energy Market Reform (EMR) was getting going, I proposed a 2-stage auction as a way of combining mechanisms for meeting the carbon targets with the maintenance of a sufficient security margin. The first stage would be open to all, and the second constrained to meet the carbon budget if necessary, and if the carbon price is insufficient[1].

Instead, EMR followed a complex path, with Feed-in-Tariffs (FiTs) to replace the Renewable Obligation Certificates, limited by the Levy Control Mechanism (LCM) as an overall cap on the subsidies and, in addition, five separate capacity mechanisms have been developed and implemented. The result has been a very high cost, deeply interventionist "picking winners" approach to energy investments.

It has not proved successful. The LCM is in danger of being breached, there has been popular opposition to electricity prices and ministers have found that despite introducing some auction elements, they are encouraged – and forced – to repeatedly intervene on a technology-by-technology basis. We now have very

[1] Helm, D.R. (2010) Market Reform: rationale, options and implementation. http://www.dieterhelm.co.uk/sites/default/files/Market%20reform%20October%20paper.pdf

expensive offshore wind, a FiT for Hinkley, and even possible support for a tidal lagoon project.

These messy outcomes are partially the result of the utter conviction by Miliband, Huhne and Davey that the oil and gas prices would keep going up, and hence intervention on renewables would be temporary and would by around 2020 largely wither away. That now looks fanciful (and indeed it always did). The result is that the temporary support has become permanent, and a rethink is required.

The 2-stage auction is a way to: simplify the myriad of interventions; concentrate on the core market failures; and maximise the use of the market to break the stranglehold of lobbyists and misguided and captured politicians and civil servants.

This paper sets out in more detail the case for 2-stage auctions, the key features of the design, and the practical transition measures away from the current complex and inefficient interventions.

2. The case for a 2-stage auction

The case for 2-stage auctions breaks down into two main parts: the general case for auctions and markets; and the specific case for dealing with security and carbon market failures through auctions.

(i) the general case for auctions and markets generally

In the enthusiasm for picking winners on a case-by-case basis, and more generally for planning the electricity systems, sight is typically lost as to why command-and-control, state ownership, statutory monopoly and detailed regulation did not produced the results its advocates typically advance.

In directly allocating resources, the state suffers too related disadvantages. First, it is at an informational disadvantage; and second, it is wide open to capture by lobbyists and vested interests. In a state allocation process, the government needs to know all the consumer demands and all the costs of supply, whereas in a market process each participant needs only to know their specific circumstances – their own costs and their own demands. The market therefore has an extraordinary advantage over the state. No amount of detailed Gosplans, no amount of Chinese 5-year plans, and no amount of detailed prescriptions of specific technologies can overcome this basic asymmetry. The market is – in generic terms – massively more informationally efficient than the state.

This leads on to the second advantage of markets and competitive bidding. Markets "cut through the crap" of lobbyists and vested interests. In a state allocation system, the challenge for companies is to bias and capture the decisions in favour of the interests of their specific technologies. The asymmetry of information is what makes this possible. Given the lack of information by government, lobbyists present "studies", "reports" and "analyses" to support their preferred outcome.

This is very apparent in the British energy market. As the shift towards specific banding of the Renewables Obligation and then the technology-specific FiTs took effect, the number and budgets for lobbying boomed. New trade bodies sprang up. Major energy companies moved their offices to be close to government departments, and consultants and PR companies flourished.

None of this is new or surprising. Energy was simply following a well-worn path. The NFU has blazed a trail on the back of state subsidies and the Common Agriculture Policy. The oil industry has been refining its lobbying techniques for over a century, and the nuclear industry has invested heavily in the "arts of persuasion". Wherever there are subsidies in play, the rational response is to focus on ministers, officials and the media. The US is riddled with a corporate

"pork-barrel" culture. In Britain, Renewables UK is a very rationale and effective response to the cornucopia of subsidies on offer through renewables subsidies.

These two related arguments have a further twist. To the extent that governments intervene, the more complex the mechanisms, the greater the scope for both lobbying and unintended consequences. Both of these flows from the informational asymmetry. Complexity increases the power of lobbyists, and complexity begets lots of interfaces with other policies and interventions. These considerations put an enormous premium on simplicity – and a key advantage of the 2-stage auction proposal advanced here. Complexities make policies less efficient.

A final advantage of markets is "surprises". Markets invite competitive bids, without prescribing who or what can bid. Innovation is a continuous process, and entrepreneurs continually try out new ideas and new products. To incentivise them, they have to have access to markets. The outcomes of auctions so far for capacity illustrate this point: none of the government's predictions turned out to be remotely fulfilled – not the expected price, and not the expected technologies. It is worth recalling that as recently as late 2014, DECC predicted that the wholesale price was on a path to £92 mWh by the early 2020s (which just happened to be the same number as the FiT for the Hinkley project), and that the clearing price in the first capacity auction would be around £40 kW. In the former case the wholesale price has fallen sharply, and in the latter case, the price turned out to less that £20kW.

Markets are far from perfect. They have many failures. Bidders make mistakes. But so too do governments, and government failures have to be balanced against those of the market participants. These market failures have to be so big as to outweigh the informational problems that ministers and officials face, and the phalanx of lobbyists and vested interests with a direct stake in biasing the outcomes in their favour. Where there are obvious and clear market failures, the choice of process then shifts to the precision of the interventions, and the use of

the state or the market to allocate the resources to meet the government objectives. Again simplicity is at a premium. There needs to be as many policy instruments as there are policy objectives – and no more.

(ii) the specific case for addressing security and carbon market failures

There are two main market failures in electricity: security of supply and carbon. They require two policy instruments.

Security of supply is a system property, and as such a public good. It is not met by simply aggregating up the individual decisions of consumers and suppliers. This was the fundamental design error in NETA and then BETTA. Though security has lots of components – dependency on imports; the margin of capacity over demand at particular times of day and night; and the exposure to a generic fault in a particular technology, such as nuclear – most of these are beyond the scope of micro management. This does not stop the lobbyists: the NFU repeatedly assert that we need national food security and hence national food self sufficiency; and Renewables UK is rather keen on avoiding gas imports, preferring self sufficiency too. In both cases such policies would result in more money for their members, and more costs to the customers. They are rent-transfer policies.

Getting the overall capacity exactly right is impossible, and spurious precision is at best pointless. The level of demand in five years' time is very uncertain, and over a decade it can be very different from forecast. For example, back in 2006, it would have been reasonable to forecast GDP growing at 2-3% a year going forward. But then GDP would today be more than 20% higher than it has actually turned out to be.

The best that can be done is to set a rough margin, and build in a flexibility mechanism. In other words, having a target of say a 10% margin does not mean auctioning all the capacity for all future years now to met the predicted demand now. Having flexibility has a further advantage: new technologies on the demand and supply sides may reduce the need to have large capacity margins. Auctions reveal information, which central planners do not have. It is a further advantage of market mechanisms that future auctions can be adjusted accordingly.

On carbon, the government has unilateral targets for the reduction of carbon production (but not consumption) through to 2050, with 5-year rolling carbon budgets for the first 20 years. The relevance of these to tackling climate change is questionable, but for the purposes of this paper, the targets can be taken as given.

What is the economically most efficient way of meeting the carbon targets? There is a very powerful argument to suggest that a carbon price would dominate all the other alternatives, and if the carbon price was credibly set and adjusted to meet the target, almost all the other interventions (apart from R&D) could be abolished. Such a carbon price has several advantages. There would be no need for any "winners" to be picked, and lobbyists would find themselves redundant. It is very hard to argue with a carbon price.

If there were a single carbon price, then a 1-stage single auction would suffice. There would be an auction of capacity contracts, and the bidders would internalise the carbon price in their bids. It would be very simple, and both policy objectives would be met. The complex architecture of the RO and FiTs could be simply abolished.

The case for a 2-stage auction arises only because the government is not prepared to take the carbon price-only route. It is committed to the Renewables Directive and therefore has to ensure that a proportion of electricity comes from specific technologies, irrespective of whether they are the least cost ways of

meeting the targets (which they almost certainly are not). In addition, the government is committed to a new build nuclear programme. This in both cases, it is forced to have a technology-biased policy, and this means that a simple auction will not suffice.

The 2-stage auction attempts to minimise the consequences of this technology-specific selection. The mechanism again puts the emphasis on simplicity and information revelation. Stage 1 remains a simple, general auction of capacity open to all. It is unconstrained. The auction reveals the costs of each technology. The second stage adds in the carbon technology constraint. Once the information is revealed in stage 1, the government then compares the supply schedule from the bids with the carbon budget and the renewables targets. A second constrained auction may then be required, focussing on a narrower range of auctions.

Consider the advantages. The government knows from the market information in stage 1 bids what the additional costs of its technology-specific (inefficient) policies on renewables and carbon targets will be. It can compare the alternatives from stage 1, and this informs it as to the time profile for meeting the targets. It still makes the renewables bid against each other – there is no banding or renewables technology differentiation.

Consider too the form of the bids. Capacity auctions are about the availability of plant to meet demand. They are *firm* power bids. They do not allow bidders to offer capacity intermittently. *This puts all the technologies on a level capacity playing field.* For intermittent technologies, they will need to subcontract to peakers, demand side responses, and other mechanisms for meeting their intermittency. In turn, there are two further advantages: a secondary market in intermittency-management is created; and there are powerful incentives to develop new technologies to address intermittency, such as localised storage and batteries.

The 2-stage auction is the minimum distortion to meet the two policy objectives, in the face of a political reluctance to take the most efficient option – a single carbon price.

(iii) the case against the current inefficient forms of intervention

There is much merit in the old adage: "if it ain't broke, don't fix it". In this case, it is hard to think of a more inefficient and expensive way of meeting both the overall carbon target and the Renewables Directive than the current one, and the complexity of the existing capacity mechanisms makes the outcomes inefficient too.

The obvious place to start on the carbon side is to focus on reducing emissions associated with coal. It is terrible stuff, with multiple pollutants – from methane in mines and from coal stocks, to water pollution, through to transport emissions, and then carbon dioxide, nitrogen oxide and sulphur dioxide, and then the low thermal efficiencies of coal power stations and the waste disposals. Switching from coal to gas avoids many of these other pollutants, and also has around half the carbon emissions. It is a "no brainer" that the cheapest way to meet the overall carbon targets in the next decade or so is to switch from coal to gas. Remarkably in Britain (and even more so in Germany) the opposite has been the case over the last five years.

In terms of the low carbon technologies that have been selected as "winners", Britain has a record of picking amongst the most expensive. Politicians claim that Britain is the world leader in offshore wind – in effect, it is a world leader in picking one of the most expensive technologies. The current government now apparently favours tidal lagoons in the Severn estuary. In rough order, tidal lagoons make offshore wind look cheap by comparison, and offshore wind makes nuclear look cheap, and nuclear makes onshore wind and recent solar panels look cheap. In other words, the efficient supply curve has been *inverted.* This is

what happens when government pick winners. The lobbyists win at the expense of customers and the climate.

The power of auctions has already been seen in limited FiT and first round capacity auctions. As noted above, the price in the first capacity auction was roughly half what government had predicted. Consider what would have happened in the absence of the auction – the government would presumably have allocated contracts at £40 kW, rather than less than £20. It is not hard to work out the scale of the inefficiency.

3. The design of the 2-stage auction

The 2-stage auction outlined above is deliberately very simple. Stage 1 is the easy bit. The System Operator (SO) in conjunction with DECC has to make a decision about how many contracts to offer. This requires a forecast, and this in turn requires a model of demand and supply.

The model and the forecast do not have to be very sophisticated. Recall, accuracy is spurious for two reasons: the world will turn out differently; and there is a process of rolling auctions so adjustments can be made as these surprises materialise – on both the demand and the supply side.

Having formed an initial picture of the possible supply and demand, the system operator does not need to consider the balance of intermittent renewables and base load (as it does at the moment). The reason is that all the technologies bid into the single auction – there are no separate FiTs, or even FiT auctions. All bidders have to base their offers on firm power. *The problem of intermittency is therefore decentralised onto those technologies and suppliers who cause it* – and its system costs. If FiTs are retained, then the system operator has to take a view about the mix of generation between base load, peakers and others. This is a very powerful reason for having a single auction process.

The renewables lobby will no doubt object that its investments are solutions not to the capacity issue, but rather to the carbon one. This argument should be dismissed. Renewables are part of the capacity, and those that are intermittent do cause serious system problems and costs. They contribute to and cause problems to the public good of secure supplies of electricity because they are an integral part of the system.

The renewables lobby might also argue that they require subsidies and the appropriate subsidy should be dictated by the relationship between their costs and the wholesale market. They therefore require a FiT based upon the wholesale cost of mWh and not the capacity element of kW. Yet again this is mistaken. All bidders in the capacity market are bidding for a capacity fixed price contract to be on the system, on the basis of their assumed wholesale revenues. The fixed priced capacity contract is the amount of additional monies they need to cover their costs. Some capacity is more expensive than others. Offshore wind is more expensive than CCGTs. These are simply facts.

No new investment is likely to be able to recover its costs in the current wholesale market, and there are good reasons for thinking they probably never will. The current wholesale price is below the entry price even with a capacity margin prediction of perhaps as low as 2%. Why? Because in part zero marginal cost renewables are coming onto the system. Over time more and more new technologies will reflect the economics of the internet – zero marginal costs – and the market therefore moves increasingly towards a fixed priced world. This is a capacity not energy market: energy from units of zero marginal cost technologies is effectively costless (by definition), as is use of broadband networks most of the time. In such a world everyone needs fixed priced capacity contracts, and the fact that renewables need higher priced contracts simply reflects the fact that they are more expensive.

In moving all technologies into a single auction process, much of the paraphernalia of the current FiT regime can be dismantled. This includes the Contracts-for-Differences (CfDs). They were invented to make sure that the renewables would not benefit on the upside from the assumed doubling of oil and gas prices, and hence the assumed much higher wholesale prices. It was all part of the illusion of assuming that ministers and officials knew that fossil fuel prices were going to go up and hence the renewables would all soon be in the market.

CfDs have their own costs, and they appeal to a particular interest – traders. CfDs are not cost free, and they create a secondary market, but without any obvious significant benefit to customers. The argument mounted in their defence is that they incentivise the generators to produce as much as possible. However this is spurious: in a world where generators get the wholesale price, unless it is negative (in the case of 100% renewables generation for specific periods) or below the energy costs (in the case of gas, coal and biomass) the companies maximise profits by maximising output. The merit order remains, and the wholesale market rations production accordingly above the zero boundary.

Stage 1 is open to all comers. It will include the demand side and storage as well as generation. Anyone who can meet the capacity requirement can join in, and all will have to handle their own peculiarities – intermittency, demand profiling and use of storage sites – through the secondary markets. They all bid for the right to a revenue in exchange to committing to having power available. It is up to them as to how they deliver this outcome. Indeed it is possible that financial and other aggregators might enter this market, leaving it up to them to subcontract.

The objection is that the system operator might fear that bankruptcy or other problems might limit the ability to rely on the power actually being available. This brings in contract law. Across markets, companies and individuals are repeatedly making commitments where there is a risk of failure to deliver. Contract law provides a penalty regime – damages and compensation can be

claimed through the courts for failure to honour contractual commitments. The problem in electricity is that a failure on the part of one party has potential system consequences. This gives rise to considerations of enhanced penalties. Again markets give lots of examples: the posting of bonds; demonstration of financial resources; and the availability of a secondary market to make good shortfalls are examples of mechanisms used in commercial contexts.

Two special cases might be advanced – nuclear; and small-scale projects. In the case of nuclear, it could reasonably be argued that it is not certain when the capacity may be available. The recent examples in Finland and France of new European PWRs suggest that they can be late as well as over-budget. They might therefore argue that they cannot commit. But this does not escape the costs of this uncertainty. In the case of Hinkley, whether or not 3.2 GWs is available on a specific date is a very big factor in the system security of supply. It is more additional capacity than the actual margin in the coming winters. Therefore the failure to deliver on time imposes costs on all the rest of the system. The obvious answer, as with the intermittency of renewables, is that the nuclear project needs to commit to firm power, and put in place subcontracts if it fails to deliver on time, thus protecting others from the consequences of its failure to meet the timetable for bringing the new plant on stream.

Once the system operator has received the stage 1 bids, the informational position is transformed. The system operator now has a supply curve to work from. The next task is to compare this supply schedule against the carbon budgets and the carbon targets. This is not an exact science – some judgement is required. The targets are not for next year but further out. The Climate Change Committee (CCC) has been created as the expert body to advise government, and it could have a role in assisting the system operator in its assessment of progress towards the targets.

Note that there is nothing new here. This is already part of the process of deciding how many FiTs to offer, and to which technologies. But under the

assessment on receipt of the Stage 1 bids, there are only two questions to answer: is the carbon target being met? And: is the Renewables Directive being met? In answering these questions, the stage 1 bids reveal how expensive it is to achieve the targets early rather than later. It might even inform whether the targets themselves are affordable, since there is also the possibility of renegotiating the 2020 directive, and of negotiating the rollover into the next period (particularly in the context of the EU referendum and because other member countries share similar issues, costs and concerns). Finally, it is unlikely that over the next three decades there will not be some resetting of the unilateral carbon target for 2050. It would be extraordinary if the information from the auctions were not relevant.

Having decided whether to constrain the auction for stage 2, there is then a question about whether and in what form re-bidding might take place. In theory, it could simply be a matter of awarding to the stage 1 bids that fit the targets. However in practice there are several reasons why a stage 2 auction might be appropriate. First, different technologies might have different carbon implications, and this might be made explicit against a shadow carbon price. In phase 1 carbon does not matter (if no full carbon price to integrate): in phase 2 the bids might be weighted by the carbon saved multiplied by the shadow carbon price. Second, more information would have become available to the bidders. For example, by constraining the bids, it might be that there would be more zero marginal cost plant on the system, and hence the expected wholesale price might be lower, and bidders might want to take this into account. They may still be held to the key assumptions in their stage 1 bids, subject to the specific and identified changes.

These complications are the result of a second-best carbon policy – choosing not to have a carbon price set at the level to meet the targets. The challenge for the stage 2 bids is to only add in the extra information that is relevant to the carbon targets – and nothing else. Thus, there is no discrimination between different

types of low carbon technology, bids are all firm (and hence no account is included for intermittency), and there are no CfDs.

It remains for the government to decide if it wants to override the auctions in very specific cases. Some have argued that this applies to nuclear, and that it is not practical to auction 35-year contracts. But before exemptions further complicate the picture, two factors should be borne in mind. First, nuclear is a non-marginal investment. Adding 3.2 GWs at Hinkley has major market and system implications *for everyone else*. Adding 3 or 4 more nuclear plants like Hinkley is a game changer. Second, auctions are valuable even if the number of bidders is small – indeed even if it is only one. Why? Because that is what happens implicitly behind closed doors in the case of negotiated contracts like Hinckley's FiT. It is almost always better to have a contract open to challenge even if the challenges do not emerge, and transparency is a key requirement for both good government and to enhance public confidence in the process and the eventual price. It might also be added that it is not impossible that some institution might take a 35 year contract at less than £92 mWh, share out the risk across pension and other funds, and then parcel it up into discrete bits. It is at least worth knowing whether and at what price others might take this up.

4. The transition and simplification process

It would be good to switch to the 2-stage auction immediately, but there are practical problems, not least that the current FiT and capacity auctions are already in place. But a neat feature of the 2-stage auction is that it can be gradually introduced, by gradually simplifying and unifying the current auctions.

The starting point is in respect of the future FiT auctions. The CfDs can be cut away almost immediately, for the reasons set out above. This in turn would require some reform of the Levy Control Mechanism, but this is a matter for government to decide the amount of total subsidy available, and in any event

with FiTs and capacity contracts already in place the LCM is tied to only one element of the electricity price. The LCM implies that the carbon and renewable targets are not binding constraints – otherwise the subsidy would be whatever is necessary to meet the targets.

Next, in the FiT auctions, all bidders can and should be required to bid firm power – now. This has several merits. It identifies the true costs of some of the intermittent technologies, and it essentially takes over quite a lot of the requirements of short-term capacity auctions into the secondary market. It is the intermittent renewables that, to a considerable extent, cause the need for peakers.

Without the CfDs and with firm power, the two key requirements for convergence with the capacity auctions would be in place. Convergence is further enhanced by starting at the other end - the current complex capacity auctions. There are, as noted, five of these. The evolutionary path takes these down to just two, reflecting two different problems. The first is to manage demand and supply at very short-term intervals – by days or hours – with very short-term fluctuations. These will be much less problematic if the intermittent renewables bid firm power – "when the wind doesn't blow" or when "the sun has got his hat on", these wind and solar technologies will be providing the back up power directly from their sub-contractors in the secondary market.

Yet there will still be genuine demand fluctuations and there will be unanticipated outages and shortfalls. In the absence of storage, this balancing needs to happen, and the System Operator needs to be able to call on very short term demand and supply responses. In theory, this will follow in response to the incentives created by the wholesale price: shortages will prompt prices to rise, inducing demand and supply responses. Yet even in the most perfect market, there will be genuine uncertainty, and since the costs of interruption of supply are asymmetrically large, it is sensible to have a very short-term balancing mechanism.

At present, the system operator has two auctions for the very short-term markets: a demand side and a supply side mechanism. The rationale is that the demand side is still in its infancy, in the absence of smart technology. Yet this infancy is also part of the problem: it is far from clear what the counterfactual to a bid to interrupt demand is. What would the company have done anyway, particularly since at points of system stress the price would be rising sharply, thus incentivising the companies to switch off or turn down anyway? There is a strong case for an early simplification and merger of these two short-term mechanisms.

The second is all about investment – the bringing onto the system of sufficient capacity in a timely fashion. At present, the system operator divides this into three separate auctions – 1, 3 and 15 years. These periods were designed to match the different system operator requirements – and, in effect, called forward respectively: peakers; plant life extensions; and gas CCGTs. However trying to be too clever was a costly mistake: the auctions produced lots and lots of very small "car-park generators", rewarded the AGR nuclear power stations which arguably already have great incentives to stay on the system (to delay the costs of decommissioning), and produced only one CCGT. The costs were over £1 billion.

It is inevitable that the system operator will want to have a view about the time dimensions of investments. It need not concern itself about intermittency if the FiTs are for firm power – and this simplifies the existing capacity auctions. It is no longer necessary to take a view about the flexibility of plant if all plant is on a firm supply basis. This all happens in the secondary market.

On the time dimension, there are two ways of simplifying the existing auctions. The first is to merge the three investment auctions into one. All bids are then in the same auction. The second is to reduce them to two: a one-year peakers market, and then an open period for everything else. The argument for keeping the one-year auction separate is that it takes time for the FiTs to become on a

firm power basis. The transitionary simplifications in the FiTs and the capacity mechanisms need to be carefully coordinated.

To recap the immediate simplifications are:

(i) abolish the CfD elements
(ii) move all FiTs to a firm power basis
(iii) merge the three capacity mechanisms (1,3, 15 years) into two (1, and any time period)
(iv) merge the two very short term capacity mechanisms into one.

This sets the scene for the eventual merger of FiTs and capacity mechanisms into a single auction process. In order to speed this transition, the SO could create a virtual auction, publishing the results of its calculation of what the bids in a single auction would look like. This can be done by simply merging the bid data from the simplified FiTs and the capacity mechanisms into a single framework, and then publishing the supply curve that would have resulted. This would not only help iron out the practicalities but also enable all to see the inefficiency of the choices currently being made in the complex mess which has grown out of the Miliband-Huhne-Davey EMR programme.

5. Conclusions

As the government tries to extricate itself from the complex morass of interventions it has inherited, the two key drivers should be: simplification; and the use of competitive tendering through auctions.

Energy policy is not rocket science. There are just two main overriding objectives when it comes to investment: security of supply; and meeting the carbon targets. In principle, all that is required for the first is a *capacity margin*; and for the second, a *carbon price*. Given the uncertainties and the asymmetric risks and costs of too much versus too little capacity, a crude 10% margin is

probably as good as any benchmark to aim for. This is a margin of excess supply that a competitive market will never deliver except by accident. It requires that the overall system capacity is centrally determined, and a capacity mechanism to reward companies for this excess supply margin. On carbon, politicians have been reluctant to confront voters explicitly with the costs of the targets they have adopted, and have tried to disguise the costs by "picking winners" amongst the technologies, and then doctoring the market to favour those chosen. The costs are now readily apparent: the lobbyists and vested interests have comprehensively captured DECC and ministers.

The way out of this mess is to auction contracts for new generation on a rolling basis. It requires simplification to achieve this: to simplify the FiTs by making all bids firm power (and hence place the obligation to contract for back-up on the technologies which cause the systems problems through their intermittency) and to get rid of the CfDs (which are of limited if any value). It also requires reducing the capacity mechanisms to two investment vehicles (for 1 year and anytime) and the very short-term mechanisms to one.

This paves the way for full integration into a single mechanism – a capacity auction for all new investment. To the extent that ministers and DECC still wish to avoid the most efficient solution to carbon, and therefore avoid a proper carbon price, the single auction mechanism can be a 2-stage bidding process, with the first stage open to all and any technology, and the second stage adjusted once the carbon budgets and targets have been considered.

The prize for these reforms would be great. Gone would be all the costs associated with multiple auctions and mechanisms. Gone would be all the arguments about the true costs of intermittency. Gone would be much of the informational requirements on the system operator. The market would reveal a great deal of information in a much more credible (because committed) way. And above all else, gone would be the deadweight burden imposed by the lobbying and vested interests that a "picking winners" regime generates. Ministers could concentrate

on the big political decisions – how big a capacity margin is needed and how fast to decarbonise, without worrying about the relative costs of offshore wind or the latest solar panel.

That would then leave the field free to concentrate on what really matters in terms of market failures - *R&D and the next generation of low carbon technologies.* Policy is this area is primitive, and the waste and inefficiency of current renewables policies have absorbed money some of which could have been spent to considerably greater benefit on research. Whilst there is nothing that is really "immature" about roof top solar, onshore and onshore wind and PWRs, there is a lot that needs to be done to help open up the light spectrum, develop new solar film and other applications, develop new battery and storage technologies, get smart technologies in place and electrify transport. That is where scarce monies should go, and that is where the policy development exercise should concentrate. It would help if the associated technological transformations are borne in mind too – new materials like graphene, and new processes like robotics and 3D printing. As the *Electrification-of-Everything* gathers pace, energy policy needs to keep up with these exciting new opportunities and the better ways they may offer for decarbonisation.