The future of regulation study: call for evidence

Storelectric response

These responses are primarily educated by the regulatory system of the electricity industry, in which we operate, though many of the statements translate into the other industries being consulted upon.

1a Regulation singularly fails to facilitate future investment needs. It does not provide sufficient contract durations for investors unless competition-distorting special instruments such as ROCs, OFTOs, CfDs, CATOs etc. are introduced. They distort competition as they only apply to specified technologies and have other technology-excluding conditions too. Such distortions are magnified by the short-term contracting framework (typically 1-2 year contracts) and made intractable by the short duration regulatory frameworks (RIIO-2 is only a static 5-year window) which prevent the regulator authorising any initiatives that require any vision beyond the close of the regulatory window to be achieved, or to earn its financial viability.

1b Regulation completely fails to facilitate innovation, and in particular the construction of commercial-scale first-of-a-kind (FOAK) plants which private finance will not fund. This leaves the country relying solely on imported technologies such as batteries and synchronous condensers because the FOAKs are built elsewhere, thereby not only undermining British innovation and industry but also denying our infrastructure the best of the world's technologies if such are developed in the UK.

1b Regulation also consistently favours incumbents over new entrants in infrastructure delivery, frequently changing regulatory and contractual frameworks to "remove market distortions" that just happen to coincide with the interests of the major incumbents. In the electricity industry, for example, half a dozen recent small "interim" changes have undermined the business cases for new storage of both large and small scale, and of clean generation; demand side response is now marginal for these same reasons despite much official encouragement.

1b Moreover there is no contract that permits start of delivery to be more than 4 years from contract award. As a new transmission grid connection takes a MINIMUM of 4 years, to which planning, design, installation and commissioning time needs to be added, this means that only well-developed proposals using existing grid connections can apply, thereby eliminating new market entrants (who cannot support the up-front costs without contractual cover to enable borrowing) and installations that are better located for need than the locations of 50-year-old grid connections.

1c Regulation fails to meet the needs of future consumers, mortgaging the future on the altar of short term expedience. For example, the regulatory system focuses on minimising cost to customers, without specifying a timescale and therefore focusing on customers over the next 2 years. The cheapest way to deliver a 2-year contract for electricity is to patch up a fully amortised power station. At the end of the contract, this is repeated; but each time it is repeated its reliability is down and its costs and emissions are up, as the power station is increasingly clapped-out. Eventually the power station dies of old age, having delivered very expensive electricity with low reliability, and no replacement has been funded. On the other hand the cheapest way to deliver electricity under a 20-year contract is by building a new power station. Over the 20-year period the average electricity price is lower (though higher for the first 6-8 years), and grid assets are renewed at a rate sufficient to maintain capacity and capability into the future.

1c Because the grid focuses on short to medium term needs, it completely fails to address the longer term. For example, in response to the de-carbonising grid it identifies the issues that will arise over the next 5 years or so, and develops fixes to those issues – sticking plasters that don't address the real problem, such as EFR contracts when the real issue is the loss of inertia.

1c This sticking-plaster approach of solving the most immediate issues first also undermines the economic case of the true solutions, and thereby makes them much more expensive. For example, if the solution relies on a stack of revenue streams A-J for its economic viability, it then finds that the sticking-plaster quick fixes take away revenue streams A-E. The consequences are either that the solution is un-viable with only revenue streams F-J, or that the bid costs of F-J (which reflect the longer-term, most fundamental needs of the system) are inflated to yield the same revenues from this curtailed revenue stack as would have been derived from the full stack. Much better would be to seek out the true solutions, identify which services they can apply cost-effectively and award all the related contracts; then, for any remaining need in any of the services, again find the technology that addresses the most important of these and make it viable by awarding the full set of contracts for all the cost-effective serves it can offer. Then repeat, until all the services are contracted.

2. Instead of the above short-sighted sticking-plaster approach, regulators should follow the radically different logic of:

1. Identify a target energy mix for 2050 (with ranges of uptake of each of many different technologies), i.e. a mix that will deliver reliable energy to all sectors while decarbonising to 2050 targets.
2. Work out how to get to such mixes from the current mix.
3. Determine policies, regulations, contractual and regulatory structures, infrastructure investment, innovation support etc. accordingly.

This would be radical because the current method is:

1. Identify the problems that will arise over the next few years.
2. Develop fixes for those problems.
3. Repeat.

This means that:

1. We have a sticking plaster approach to challenges. By the time we get to 2040 we'll have nothing but sticking plasters and be unable to solve the real, big challenges.
2. The solutions to the really big challenges take many years to implement and roll out; by the time we get round to doing them it'll be too late to achieve implementation and roll-out by 2050.
3. We are over-investing in sticking-plaster solutions, which only adds to total system costs and inefficiencies.
4. We are removing parts of the revenue stacks of the real, big solutions which means that those solutions cannot have a full revenue stack and need to amortise their costs over a smaller stack, increasing the prices in that smaller stack and adding to overall system costs.

As a first example of the consequences, over-reliance on interconnectors now means that we will be stuck when, by 2030, all our neighbours will be reliant on imports during system stress (except France which will have enough for their own use but not for export), so none of them will have surplus to export, so in times of system stress we'll have black-outs because we won't have built the required storage.

As a second example of the consequences, building synchronous condensers, black-start plants, batteries and all manner of other grid-connected solutions for the diverse challenges arising from the closure of synchronous generation (i.e. thermal power stations) is highly costly, and much more costly than building synchronous storage.

3. Currently there is a hyper-simplistic response to data. System adequacy is based on statistical analyses such as Loss of Load Expectation, for the country in isolation. It tends to ignore real scenarios such as:

- How do we power a 100% clean-energy grid after sunset on a windless winter evening?
- How can we continue to do so when that circumstance is extended by up to 2 weeks by weather patterns (e.g. the *kalte dunkel Flaute* identified by Germany and France)?

In either of these cases, interconnectors fail because the same thing is happening to our neighbours, so they have no surplus energy to export. Yet the grid is relying on imports for actual forecast demand. The consequence will therefore be black-outs, if this approach is not changed.

Worse, an analysis of the energy transition plans of 8 of the biggest economies in the EU (UK, DE, FR, IT, ES, NL, BE, DK – accounting for 85% of EU GDP) shows that all except France (in their latest draft PPE) rely on imports during times of system stress, and France's plan is to have enough dispatchable and baseload generation for domestic use alone and not for export. Therefore, if all are importing, who is exporting? (NO, AT and CH can export some, but nowhere remotely close to enough.)

Therefore regulators should be compelled not to rely on statistical measures alone, but also some real-world scenarios. And to consider neighbouring countries' plans. And, most of all, to consider the end-game of a 2050 clean grid, with all intermediate plans being consistent with ensuring that such a grid is achieved.

4. Efficiency is not achieved, because of this short-term approach of focusing on the neds of customers in the short-term future.

4. Efficiency is greatly harmed by the frequency and narrowness of contracts. For example, Storelectric's proposed CAES plants will access ~10 revenue streams, with average contractual durations of 2 years over their 40-year life. This means that they will need to bid for, negotiate and administer at least 200 contracts. Moreover the possibility that some may not be won yields two further inefficiencies: a 50% win rate would yield a doubling of the number of bids, and any possibility of loss of contracts entails an increase in the required return on capital to accommodate the risk premium.

4. Another source of inefficiency is that there are no contracts biddable (or no letters of intent) before achievement of grid connection offer and planning permission. Therefore small companies are excluded, and large ones have to undertake such development at risk, so the system will be compelled to reimburse such development risk in the prices that (eventually) consumers pay.

4. And the fact that, even with planning permission and a grid connection offer, there are no contracts whatsoever biddable with more than a 4-year notice period, means that no project with a new transmission grid connection can bid for a contract before construction is at least part complete. This forces plants to be built where there are existing 50-year-old grid connections, ossifying the grid into population / industry / supply / demand patterns that are grossly out-dated.

5. Competition destroys innovation because financiers see three types of risk: technical, regulatory and commercial: they can finance any two but not all three. The UK's regulatory risk is the highest in any democracy world-wide because our regulatory environment is changing faster and less predictably than any other. Financiers define technical risk as being anything that has never been built before. Therefore innovation requires contractual certainty – but none is available under the current regulatory system. Therefore no large-scale FOAKs are ever built. Because a FOAK, by definition, as technical risk (as defined by financiers), it is the role of the regulator to eliminate commercial risk. This can be done without distorting markets, for example by putting in place legally enforceable letters of intent to buy the output of a FOAK under the contracts (and at the prices) available at the time at which they are operational and for 15+ years thereafter; such letters should be available before planning and grid connection, and deliverable whenever the plant is ready; and only

available for a FOAK of a technology at both distribution and transmission scale – these scales to differ by at least a factor of 5 and maybe a factor of 10.

5. Competition also vastly reduces investment for the reasons stated in 1-3 above: the regulatory / contractual framework requires very high risk pricing. This explains the almost total lack of large-scale investment outside special long term contractual instruments.

6. Other countries encourage the construction of FOAKS that the UK discourages – and even prevents – by our regulatory structures and principles, as described above. This is why all new large-scale technologies introduced to the UK (e.g. batteries, interconnectors, synchronous condensers) were developed and built abroad, and why UK-developed large-scale technologies need to be bought up by foreign companies before they can break into the market – all of which benefits foreign economies and businesses at the expense of the UK economy and industry.

6. Innovation is also impeded greatly by over-rigid divisions of roles combined with a failure to provide for developments that cross between such roles. For example, although storage (especially inertial storage) is crucial to enabling renewables to power the grid, and essential for providing grid security and resilience when we cannot import energy, there is no NIA / NIC funding available because DNOs and the TSO are banned from investing in “generation”, as storage is falsely designated. This being the case, the regulator should set up an organisation / framework for financing R&D into such inconvenient technologies, but has not done so.

6. Innovation is also impeded because, unlike all other innovation funding, the innovators lose ownership and control of their innovations. This makes many of them wary of losing their IP and their future business if they accept such funding.

7. Regulation has been too slow to adapt ever since privatisation. This is not to decry privatisation, only the principles of regulation that were established then and reinforced ever since. The consequence is an old and rapidly aging fleet of power stations, and old and overloaded grids – both transmission and distribution.

7. The role of the Distribution and Transmission Network Operators should be to provide grid connections to those that need them. But the obsession with not gold-plating the grid, and with sweating the assets (termed “efficient utilisation”) means that (a) we have little resilience, (b) we don’t have suitably developed grids to which new connections can be made without enormous expenditure and lead time, (c) the DNOs’ and TSO’s role has changed from providing grid connections to rationing them, and consequently (d) developments are grossly distorted as developers know that it’s not even worthwhile discussing plans if there isn’t a vacant grid connection nearby (this is why Ofgem glibly claims that this policy is not leading to high rates of constraint / refusal / overpricing of new connections: the connections aren’t even requested because the developers know the results). Much better would be to forecast grid need in diverse scenarios, and to build for all of them. It is true that this

will lead to some unnecessary assets being built, but these will mostly be used eventually, and the much lower cost of a proactive construction programme will be much cheaper than the current reactive programme and deliver much better results for the country.

7. This focus on sweating assets is highly risky. For example if National Grid were to forecast 10,000 EVs in Warwick and the same again in Leamington Spa, and build a network accordingly (and it's failing to do even that, as it only builds reactively), then it courts disaster if 15,000 EVs are bought in Leamington and 5,000 in Warwick; and they are in an even more disastrous situation if the numbers are all doubled. Note that the current uptake of EVs is enormously faster than NG was forecasting 5 and 10 years ago.

8. The UK electricity system is the most fluid framework of any democracy in the world. Not only are all playing-fields grossly sloped (e.g. against innovations and major investment, as above), but they are also undulating and moving continuously. Recently, with little warning an justifications that are supremely narrow (as opposed to considering their effects on the whole system over the medium and longer term), the regulator has (for example)

- Accepted 85% of T-4 Capacity Market bids with one-year durations, defeating the object of T-4 and turning it into a second bite of a T-1 cherry; slashed embedded benefits by over 85% without proposing any other means to reduce peak demand without constraints;
- Created an EFR contract to provide fake inertia while simultaneously refusing to pay for the real thing even though real inertia provides innumerable other system benefits (e.g. phase-locked loops, reactive load and power…);
- Let Demand Side Response (DSR) contracts to fossil fuelled generation despite its undermining of the decarbonisation requirement;
- Failed to provide a rational and reliable means for calculating and sharing system benefits (such as deferred investment) with developers;
- Encouraged developments that artificially reduce price volatility which therefore reduce the financial case for addressing the causes of such volatility; capped the STOR market without providing alternative means of providing back-ups;
- Given free network access and zero carbon costs (instead of charging the differential between what generators pay abroad and what they pay in the UK) to interconnectors which ensures that foreign fossil fuel generators are subsidised by British consumers to reduce the national resilience of the UK's grid by forcing a reliance on artificially cheaper imported energy;
- Refused to advocate a regulatory definition of storage even though storage generates no new electricity and regulations will have to be vastly adapted in order to remove generation-related requirements that storage is ill-placed to deliver, even though this penalises storage in favour of generation (as well as grid access charges for output energy, storage must buy input energy which already includes grid access charges) and interconnectors (which pay no grid access charges, and continental access charges are considerably lower), and

even though this prevents the public tendering of “storage services” in general;

- And undertaken many other perverse initiatives.

9. Please see the appended document (below), A 21st Century Electricity System, which outlines very briefly a regulatory framework that would enable, without any subsidy or market distortion,

- Major capital investment and ongoing renewal of the system,
- Competition that restrains prices,
- Incentivisation of new technology FOAKs, and
- Incentivisation of cleanness of all technologies.

10. We see no case for a multi-utility regulator, and no benefit from it. It would probably become unwieldy.

11. The current role of regulation completely fails to mimic the outcome of a competitive market, for all the reasons above: it favours incumbents, old technologies and short-termism. Moreover, competitive markets are inadequate for national infrastructure which must be built and operated for the long term, with assets that can last a century or more. Just consider: would the current electricity (or water or telecommunications) system have been developed under purely commercial pressure? Or with today’s regulatory regimes? On the contrary, today’s regulatory regimes are living parasitically off the fat of previous strategic investments while incentivising few new ones to take the systems forward towards the 22nd century, or even the second half of the 21st. Instead, the role of regulators should be to provide:

- Long term strategic vision;
- A road map and regulatory / incentivisation framework to achieve such vision;
- Within this, competition to moderate consumer prices.

12. Government’s policy role has been lost. We have had many conversations with BEIS, Ofgem and National Grid each telling us “we don’t need lots of large-scale long-duration storage, just lots of flexibility – and we know that because the other two tell us so”. Each has lost its independence of thought and action, and the regulator and government fail utterly to challenge the assumptions and conclusions of each player. Instead, each should challenge the other two, developing entirely independent assessments. Government and Ofgem should compel NG and DNOs to build proactively a grid that will enable and encourage (rather than respond reactively to, and discourage) a future consistent with 2050 challenges and 50-year challenges beyond those.

13. There is little clarity whatsoever over strategic goals because the entire focus of regulation and grid management is on short-termism, the consumers of today and tomorrow at the expense of those of the future. This has killed investment, and prevented any large-scale FOAK being built and thereby prevented the implementation (and hence the development, as developers see no path to implementation) of large-scale innovation. The causes are described above.

14. The government's principles for economic regulation are completely and patently inadequate, as detailed above. While these should remain, some further principles needed to be added: strategic thinking, proactive development, an enabling role for investment and innovation.

15. There are many changes regulators have to make to support the country: not just public trust, but also industry trust, and the long-term needs of the country. To summarise a sub-set of them, these include:

- Take a strategic view, 2050 and 50 years hence;
- Undertake independent (of both operators and government) forecasts of the needs, and variants, in those timescales;
- Challenge operators', government and others' forecasts and actions;
- Require and incentivise proactive construction and technological development to enable all such variants;
- By such proactivity, reduce the costs of such investments to such a degree that the waste due to unnecessary developments is out-weighed by the savings of proactivity (c.f. an interconnector between South Australia and NSW cost three times as much because it was built reactively rather than proactively);
- Set in place, and police, a regulatory system that incentivises capital investment, innovation, FOAK roll-out, and cleanness without any financial subsidies and therefore with a minimisation of market distortions needed to achieve such goals;
- Give the consumers of 50, 30 and 10 years hence an equal consideration with those of 0-3 years hence.

A 21st Century Electricity System

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Introduction
The current regulatory and contractual framework is designed around a 20th century industry (baseload coal and nuclear, dispatchable gas, all other bits are add-ons). The cost of electricity is diverging increasingly from its price: already around half of commercial customers' bills consists of levies and system charges, with only around half (this being a decreasing portion) being for the electricity consumed. In a well designed system, the price of electricity should account for between 75% and 80% of its cost. Thus the headline prices may need to increase, without necessarily affecting the cost of electricity to customers.

A 21st century regulatory and contractual framework must be designed around renewables and storage (with or without nuclear) supported by distributed generation and storage, interconnectors and Demand Side Response. Features of a 21st century system would include the following.

Regulatory Framework
Until RIIO was developed, National Grid was incentivised on cheapest electricity over a 2-year period. That provided cheap headline prices but without any concern for the future of the system. When RIIO was brought in, an 8-year horizon with attendant incentives were brought in, which was a big, but insufficient, improvement.

To ensure system reliability and cost-effectiveness over 15 years requires 15-year timescales. Ditto any other period. This is because the cheapest way to deliver a 2-year contract is to patch up a clapped-out and fully amortised plant. For the next 2-year period the same is done again, and again until the plant dies of old age. But with each repeat, the plant is older, less reliable and more costly to patch up. So over 15 years the total cost of electricity would be higher than under a 15-year contract because the latter would have been delivered by building a new plant. The short term timescales alone therefore ensure that investments with long lives and long term pay-backs are penalised financially, and also are added to the commercial risks that are put against the SO's balance sheet.

Therefore, in addition to the 2- and 8-year regulatory and rewards regimes, there also need to be 15- and 30-year timescales. The shorter timescales would have greater emphasis on consumer prices and lesser emphasis on system integrity, gradually reversing as timescales extend. This will ensure that not only is the grid cost-effective now, but also that it will be both cost-effective and systematically sound in 30 years' time, with all long term investment undertaken as needed.

Another RIIO problem is that every 8 years all "base cases" are re-set. Thus at the beginning of a RIIO period, investments can be made with an 8-year amortisation life; half way through, this drops to 4 years; and towards the end of the period, significant investment is almost impossible. This should be changed to a "regulatory amortisation" of each investment over the viable life of the asset, or over a reasonable lifetime determined by the regulator. Accountants manage such amortisations for large businesses very happily even though every plant is being amortised from a different date for a different period (or one of a set of permitted periods): therefore the regulator should be able to manage "regulatory amortisation" similarly.

Contract Structure

No major investment is possible without long term contracts or other form of revenue assurance. The only capital investments in major infrastructure have come on the back of special arrangements that offer such assurances, e.g. CfDs, ROCs, OFTOs, CATOs.

Without long term contracts, a 2-year contract will appear to be the cheapest way of procuring electricity over a 2-year period. But it will be bid on marginal cost and delivered by patching up a clapped-out and fully amortised plant. On the next 2-year cycle the same will happen again, though the plant will be older, more worn, more expensive to patch up and more prone to break-downs. Over a 20-year period the country will have paid more overall for its electricity than if 20-year contracts had been let, which would have been delivered by new plant – and in the meantime no new plant is built, the old plant dies of old age and the system's capabilities plummet. Meanwhile, in order to incentivise investment there need to be special mechanisms (subsidies by another name) put in place which mean that the total cost of delivering electricity (including subsidies) is greater even in the short term than would be the case under longer term contracts.

A truly sustainable grid will engage most or all services under contracts of lengths that both encourage investment and minimise cost. Such a structure could include:

- 1/3 of energy under 15-20 year contracts, with delivery to start following grid connection, these contracts only being available for new build;
- 1/3 of energy under 5-8 year contracts, with a split between new and existing plant to be decided according to the reviews of the system from time to time;
- 1/3 of energy under contracts of up to two years, for all plant.

There is indeed some measure of uncertainty as to future demand. This can be accommodated by (a) letting such contracts in rolling annual or biennial auctions and (b) flexing the exact amount of mid- and short-duration contracts.

The entire subsidy regime and scheme of access charges need to be re-thought:

- Incentivise cleanness of technology, for example with longer contracts going to cleaner technology. An example would be full-length (as above) contracts for zero emissions generation; half-length contracts for CCGTs, with durations on a sliding scale directly proportionate to emissions between the two, that scale continuing to diminish contract length for technologies with worse emissions than CCGTs.

  - ◊ Include ancillary emissions in the calculation of the emissions of a given technology: mining, harvesting, refining or otherwise processing, manufacturing, transporting, recycling, disposing of equipment (both main and ancillary, including considerations of operational life), components, materials and fuel.
  - ◊ Ensure that imported electricity is deemed to have the emissions performance of the electricity that is delivered to the interconnector. Where that is difficult to determine, default to the average emissions performance of the source country and, if appropriate (e.g. Belgium, Netherlands) considering a proportion of the electricity to come from their neighbouring countries, at their average emissions performance. This would apply to carbon pricing and any other incentivisation scheme including contract duration.
- Incentivise dispatchability with a price premium that reflects the balancing costs avoided (or a large proportion of them, so both sides benefit).

Ensure that all capabilities can be monetised, e.g.

- Permitting real inertia to compete in the EFR market with a premium based on the fact that it is instant and requires no grid intervention, whereas EFR has milliseconds' delay and requires grid intervention. Ditto reactive power.
- There is currently no contract scheme for long term storage. If such a provision were made, then negotiated bilaterally for e.g. the first 1TWh stored (with a minimum installation size of 100GWh) prior to creating an auction for it, then this would enable the scheme to be available when the technology is developed to use it - and would thereby incentivise the development of that technology. It would also enable the contracts to be structured around the actual costs and benefits of the technology, rather than around a theoretical exercise. Similar mechanisms could be used for other services as their need is identified.
- Ensure that the various services are co-ordinated so that any plant that can deliver multiple services is able to contract to do so.
- Eliminate the Capacity Market, which is a subsidy for fossil fuelled generation.

Contract Simplicity

There are currently 15 different contracts under which balancing and ancillary services are purchased, and this number is increasing steadily. Germany, for all its faults, has 3. Large scale storage needs a stack of 8-10 contracts in order to earn full returns on investment; small scale storage stacks 6-8, and demand side response almost as many. Even generation, which used to have one contract, now has many. All except one (Capacity Market or EFR, depending on technology) of these has a duration of between 6 months and 2 years. Assuming an average duration of 1.5 years, this means that, at best, large scale storage has to fund an overhead to bid for 8-10 contracts every 1.5 years. And every contract type is different, with different terms, conditions and specifications, all of which have to be understood and juggled not only by the bidding bureaucracy but also by plant operators who have to fulfil all those contracts, and by spot traders who have to know exactly what will be surplus at what time. And it entails similar complexity and overhead in the System Operators Contracts team and control centre.

However each bid carries the risk of losing the bid. This will entail a costly hiatus in contractual cover while another (usually less remunerative) service is bid for. This can double the already huge administrative overhead of bidding. It also means that there is a financial risk, which adds to the risk premium on the investment and therefore to the capital cost of the plant. These risk premia also lead to high levels of profits when things do not go wrong, leading in turn to screaming tabloid headlines and high political risk.

The system needs simplifying. A plant should be able to tender all its services as an individual plant in one tender – or two, if demand side (DSR, demand turn-up) is included. Individual services should only be tendered if there is a specific resultant shortfall in the capabilities that have been engaged – which there shouldn't be, as there is some flexibility in capabilities, such as primary frequency response assets continuing for the duration of secondary response and even fast reserve.

Incentivising Clean Energy
All the above is regardless of energy technology. However clean energy can be incentivised, without subsidy or price premium, by superimposing cleanliness-related contract length.

To do so, the base contract lengths would need to be extended so that imperfectly clean technologies can also have sufficient contract duration to enable investment. Thus for a 100% clean / renewable technology, the longer two contract lengths would be 20 years and 10 years. For a diesel or coal (whichever is more polluting for the service being contracted) fired power station, contract lengths would be half of that for the clean technology, i.e. 10 years and 5 years. Maximum contract durations for technologies with intermediate levels of cleanliness between these two end-points would be linearly proportionate between those durations. So a new build with half the emissions of a coal fired power station could have a contract of up to 15 years, and a refurbishment up to 7.5 years. It may be politic to let contracts in steps of whole numbers of years, in which case the refurbishment would have a contract length of either 7 or 8 years depending on whether the decision is to round up, down or to the nearest integer.

The emissions performance should be calculated as a whole-system (or, in the case of storage, round-trip including all energy inputs and useful energy outputs) efficiency *for the particular duty cycle being tendered*, rather than a standard figure being applied for all duty cycles. This is because, for example, a 60% efficient gas-fired power station would be a very high performance for frequency response, but not as good for baseload.

For stand-alone storage, the calculation would take into account two factors: cleanliness and efficiency. In order to be considered on a level playing field with generation, both “inefficiency” and “dirtiness” should be factored down by 50% and then added to obtain the “undesirability factor” which is then subtracted from 100%. Thus a 60% efficient (i.e. 40% inefficient) storage system that creates 20% of the emissions of a coal/diesel fired plant would be factored down by 20% for inefficiency + 10% for dirtiness, total 30% undesirability, for a contract length equivalent to a 70% clean plant, resulting in maximum contract lengths of 17 years for new and 8.5 years for refurbishment. The justification for this factoring down is that storage provides a balancing service that maximises the efficiency of the whole system, and does so more effectively as the proportion of renewable energy in the system grows. Thus efficiency is incentivised, as well as cleanliness.

Incentivising Dispatchability

Dispatchability could be incentivised similarly to cleanliness of batteries, in that a non-dispatchability factor could be added to the dirtiness factor. Thus there could be (say) a 10% reduction for long term predictable variability (e.g. tidal lagoons and tidal flow turbines, 4 generation slots per day), 20% for only short term predictable variability (e.g. wind and solar generation). There could be an intermediate step for medium term variability such as wave power at 15% factor, if deemed appropriate.

Where dispatchability is increased by co-location, near-location or contracting with storage, then generation and storage patterns and efficiencies should be modelled to identify the forecast true output and dispatchability figures, and the dispatchability factor scaled accordingly. Where such storage is of limited capacity (e.g. less than the nameplate capacity of the generation) or limited duration (e.g. fewer than 5 hours at nameplate capacity of the storage), then the storage only partially creates dispatchability. In such cases, the storage would not be evaluated separately as stand-alone storage. One could conceive of a storage facility contracting a proportion of its capacity to a dispatchable generator and the remainder as stand-alone, in which case a compound figure could be calculated.

Non-Financially Incentivising Innovation and New Technologies

New technologies from innovative start-ups are actively prevented from developing their plant as contracts are only considered following grant of planning permission, which itself follows the study and reservation of grid connections. Therefore for a large plant, millions of pounds (which an innovative start-up does not have) are needed before the contractual cover is offered which would provide the revenue underpinning required for investors to put in the money needed for the grid connection and planning applications. It’s a Catch 22. A second Catch 22 is that many investors won’t invest without a reasonable expectation of long term contractual underpinning of revenues, which cannot be granted unless the technology is developed.

A simple way to break through these barriers and to incentivise innovation and new technologies without money (though it would best be done in conjunction with the other incentives, below) would be by early official memoranda of understanding (MOU) and letters of intent, and progress monitored to ensure that the SO understands its impact, likelihood and timing as the project develops. With these, our potential financial backers would almost certainly open their purse strings.

- For a proposal to build a first-of-a-kind plant, a letter of intent from the System Operator to state that provided certain conditions are met (those being specific to the plant being developed, e.g. FEED Study complete and supporting the previously claimed minimum performance, planning permission granted, grid connection application granted), then it is the intention of the SO to grant a 15-year contract at the rates applicable at the time.
- For such a proposal, a memorandum of understanding from the Network Operator to say that prima facie a grid connection (specified) would be available within a specified cost and timescale, unless other applications were received between the date of the MOU and that of the formal grid connection application. This helps to shorten timescales and liberate funds because currently grid connections can only be applied for following grant of planning permission which, for a transmission grid connected scheme, will cost ~£2m and take ~2-3 years. The prospect of an affordable grid connection will help liberate the private funding for the design and planning process.
  - Permitting grid connection applications to be applied for prior to grant of planning would considerably reduce the up-front risks and timescales of any project.
- For an earlier stage innovation, if it would create a technology useful to the SO, then a less binding memorandum of understanding from the SO that if the technology achieves specified milestones (demonstration on paper of technical and commercial viability), then the above letters of intent will be forthcoming. This will provide the support to the project that will show to early stage funders that the technology has a commercial future if it can be developed as claimed.

Additionally, permit system operators to invest in new generation / storage technologies and to own the consequent plant for a limited period, e.g. 5 or 10 years (possibly depending on size of plant / investment) between commissioning and sale. The proportion of the plant they can own could depend on the proportion of innovation in the plant. Any IP should have to be licensed to all who wish, but with royalty revenues accruing to the system operator as per normal commercial R&D investment.

Financially Incentivising Innovation and New Technologies
To encourage new technologies, replace ROCs and CfDs with a price supplement (pence per kW) for early stage installations of new technologies, e.g. add to all revenues 50p/kW for a first-of-a-kind plant (that is, full scale rather than experimental), diminishing linearly to zero for the 6th of a kind. If the differences from other plant types are smaller, then this premium can be reduced accordingly, but should still remain in order to incentivise innovation.

- By incentivising first-of-a-kind plant, it encourages these to be built in Britain. This incentive could be made contingent on (or proportional to) the development, engineering and manufacturing of the technology being located in Britain - which would incentivise innovative foreign companies to move in.

Create a branch of the NIA / NIC investment fund to be administered centrally by Ofgem to incentivise R&D which would benefit the electricity system as a whole but not the grid operators individually due to regulatory or commercial constraints. It should be administered to favour UK-based R&D, manufacturing etc., maybe with the proportion of costs covered being proportionate to the UK-based work (excluding installation - which is a gateway factor) as a percentage of the whole.

Other incentives for the development and introduction of new technologies should be considered, not only at the innovation stage but at the pilot and first grid connected plant stages where there is a dismal shortfall in both money and non-financial support to flex the contractual and regulatory regimes (even if only on a one-off basis to test the benefits to the grid) to enable and encourage them.

Conditional contracts would greatly assist fund raising. They could be phrased along the lines of: "if this plant can be built and deliver these services at these prices, then it is the intention of the System Operator to enter into a contract at the higher of these prices and the market prices applying at the time."

Time to Start of Delivery
Building new plants in new locations requires grid connection. Such grid connection can entail significant grid reinforcement. However the reinforcement can take 5-10 years to plan and implement, which exceeds the longest possible time allowable under the RIIO framework. Contracts for new build need to permit suitable delays to start of delivery of the multi-year contracts, in order to enable new construction.

Some discretion may be given to the System Operator as to whether or not a plant is wanted to be connected to that part of the grid. And the issue is moot for plants that use existing grid connections provided those existing connections retain their access capacity.

Grid Access
Ensure that all generation, whether UK or overseas, pays the same grid access and usage charges.

Treat storage as a grid service, not as generation or consumption – or, at worst, allow storage to pay for charges after netting generation against consumption, which would incentivise efficiency.

Instigate a methodology for ensuring that grid reinforcement costs also capture the benefits of reinforcement deferral arising from some investments (e.g. generation on a particular side of a bottleneck) and sharing those benefits with the investor, e.g. 2/3

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to the investor and 1/3 to the grid operator. Some of these benefits may be reflected by one-off payments, others by annual payments: in order to maximise the incentive to build such plant, and to reflect the timing of the benefits to the grid operator, they should be paid in advance; any adjustments can be made the following year to reflect actual usage and/or performance.

Grid Definition of Storage
Create a grid definition of storage modelled on that for interconnectors. This will permit and regulate:

- Contracting for services which are delivered off peak from storage that is replenished when market price differentials are not as high as between delivering at peak and replenishing at trough prices;
- Contracting for storage services per se;
- Ownership and investment into storage systems – maybe for only a fixed period, say 5 or 10 years from start of operation to deadline to sell the plant.

It will also eliminate:

- Over-charging for grid connections and reinforcement, indeed creating a mechanism for payments to developers to reflect a large part (2/3?) of the savings from grid upgrade deferral;
- Double charging for grid access for both charging and discharging;
- Having to pay market premia (profits, mark-ups etc.) for both buying and selling electricity.

Whole-Operation Contracting
Consideration should be given to whether System Operators (SOs) should be permitted to contract with a given storage provider / installation for "all services". This is because the number of services offered by storage far exceeds that offered by generation, and such a contract would maximise the ability of the SO to use each service from storage in the most cost-effective manner. The main issues to be considered are whether and to what extent this would make the SO into a storage system operator, and whether or not such a change would be desirable.

CAES (Compressed Air Energy Storage), for example, can offer:

1. Various embedded benefits;
2. Firm Frequency Response (Secondary, and possibly some primary);
3. Fast Reserve;
4. Short Term Operating Reserve (STOR)
5. Supplementary Balancing Reserve
6. Reactive Power MVAr
7. Demand TurnUp
8. Wholesale Peak
9. Wholesale Off-Peak
10. Balancing Mechanism
11. Capacity Mechanism
12. Black Start

While batteries cannot offer the long generation durations required by STOR and the Balancing Mechanism, they can offer Enhanced Frequency Response and Firm Frequency Response (primary).

There are various models and precedents for such contracts, including CATOs and OFTOs.

Another benefit is that SOs require such services during off-peak times as well as peak times. If required at off-peak times, then the storage would have to re-charge at higher prices while generating its revenues at lower prices, making it unprofitable. Such whole-operation contracts would enable the provision of these services at off-peak times to be profitable for the storage provider.