Grid-scale electricity storage
using an innovative form of
Compressed Air Energy Storage

Storelectric input to Ofgem Consultation on RIIO2

This input is to be read in conjunction with the appended papers:

- A 21st Century Electricity System
- Electricity SO Forward Plan Consultation

Window for Investment

RIIO was a great improvement on the exceedingly short-term views of the market that preceded it. RIIO gave 8-year planning windows for all the players in the electricity markets to plan their strategies, plans and capital investments. However it has a number of shortfalls, including:

1. The 8-year window is not long enough, given that major capital investment has a life of 25+ years – so the framework does not provide for sufficient returns to incentivise capital investment. This is why almost all major capital investment since privatisation has been on either plants planned prior to privatisation or plants supported by special capital instruments such as ROCs, CfDs, CATOs, OFTOs and bilateral contracts.
2. The 8-year window is static, so that investments half-way into that window can only see a 4-year window for recovery of investment.
3. RIIO does not encourage innovation or clean energy: in claiming to be "technology neutral" it is in fact strongly favouring established technologies which carry no technical risk as perceived by financiers.
4. RIIO does not encourage new entrants into the market: by requiring contracts to be let only to plants that can guarantee delivery within one year (four years solely for the T-4 Capacity Market, whose prices are far too low to make a significant difference) and already have planning permission and a grid connection offer, it does in fact strongly favour incumbent providers and prevent any early stage investment in any technology that requires a new transmission grid connection – which takes more than four years to build.

Please see the enclosed report "A 21st Century Electricity System" for a proposed alternative that addresses all these issues without a penny of subsidy.

Incentivising innovation and new market entrants

One of the biggest problems with the electricity industry in particular and British industry in general is failing to support the construction of First-Of-A-Kind (FOAK) plants. This means that however innovative we are, we can't scale up and so our innovations either fail completely or are compelled to go abroad; meanwhile the country is left with outdated technology.

In the electricity industry, Ofgem and National Grid are charged with:

- Encouraging innovation
- Encouraging competition
- Not backing winners (any specific technology over the others).

However they fail to support most large scale innovation because it falls outside their mantra of not backing winners. This means that they are backing winners - they're backing incumbents over new technologies in direct violation of their regulatory duty to encourage innovation, competition and new entrants. However they could easily support such FOAK plants without favouritism if they support all of them, e.g. 10% of capex in a phased manner with stage gates, and e.g. an enforceable letter of intent to buy the power/services off a FOAK that it can offer once it is operational, within the contractual conditions and at the market prices available at the time - hence with zero subsidy. A single technology could only have two FOAKs - one at distribution scale and one at transmission scale - because the scales are so different (they may impose a requirement of, say, a factor of 10 difference in scale).

This support would be without subsidy, because it would be at the prices and subject to the contract conditions that will apply at the time. It would be without adding additional costs to operating the system, for the same reason. It is unlikely to distort any market because just one single plant of each technology will remain a minority market share. And it would bring private money into these investments by providing a bit of revenue certainty.

Investors have explained to us that there are three major categories of risk: commercial (certainty of revenues), regulatory and technical. They can invest against two of those risks, but not all three. Every FOAK has, by definition, technical risk (financiers define technical risk by whether or not it has been done before at commercial scale). And I have been told that our regulatory playing field is changing more, and more unpredictably, than any other country's, so regulatory risk is higher here than anywhere else. So the only way you can bring private investment into new technology in general and FOAKs in particular is by reducing the commercial risk - and this is as close to a zero-cost method as one can get.

And it would ensure that only cost-effective innovations are brought to market because it offers no premium. If however the country wishes to invest innovation funding into any such plant, then that is not precluded - it's an entirely separate and complementary decision.

You may wish to add a condition that any recipient of such assistance would have to build it using British resources and build their business thereafter in Britain. (Pre-Brexit, that would have to be Europe, rather than Britain.)

Regulatory Definition of Storage

These issues cannot be separated out from issues relating to the regulatory definition of storage. Storage is not generation: it takes in electricity at one time and puts it out at another, moving it in time; interconnectors just move it in location – essentially the same. Interconnectors move electricity from where it's less wanted to where it's more wanted; storage moves it from when it's less wanted to when it's more wanted – essentially the same. Therefore the regulatory definition of storage should be based on that of interconnectors.

The current proposal is to define storage as a sub-set of generation, which greatly disincentivises storage in many ways, such as but not limited to:

1. Double charging electricity for Use of System: you think that you currently double charge electricity Use of System (into and out of storage) and propose to single-charge it by charging only for so-called generation. In fact, the electricity that is purchased already has its generation UoS charges, so storage is currently triple-charged, which you propose to reduce to mere double-charging. This disadvantages storage in relation to generation (single charged), interconnectors (single charged in the electricity they buy) and Demand Side Response (no charge). A regulatory definition based on that of interconnectors would level the playing field and avoid favouring other technologies over storage.
2. Ownership and Investment: TSOs are not allowed to invest in storage at all, but are allowed to invest in interconnectors; DSOs are not allowed to invest in storage >6MW, and can also invest in interconnectors. This “backs winners” by favouring interconnectors over storage.
3. Grid code: There are many grid code requirements imposed on generation that storage is unable to provide cost-effectively, such as 15% over-generation, mandatory frequency response and the obligatory reactive power service; there are other details too that storage cannot provide cost-effectively. Defining storage as generation imposes these unreasonable costs and therefore favours generation over storage, thereby “backing winners”.
4. Innovation funding: NIC / NIA funding and support is only allowable for projects that can be commissioned by DNOs and TSOs. They are not allowed to support generation, and therefore mis-defining storage as generation prevents innovation support within the electricity system.
5. Planning: mis-defining storage as generation makes large scale storage (>50MW) subject to national planning frameworks rather than local planning, adding greatly to both time and cost.
6. Tax treatment: there are tax incentives for enterprise and innovation that explicitly ban generation on the grounds that generation is incentivised by clean energy instruments such as ROCs (expiring) and CfDs. Defining storage as generation removes any such tax incentives while storage is itself also prevented from applying for ROCs or CfDs, thereby again disincentivising storage against both generation (which can get the clean energy incentives) and interconnectors (which can get the enterprise incentives).

Poor Definitions of Services

There are many obsolete definitions of services: black start, for example, requires 6 days’ fuel to be kept at the power station, which is a legacy of the Thatcher / Scargill era. What it actually needs to do is start without power on the grid and provide enough power for enough time to start other plants. Some storage installations can do the latter but not the former; if the latter were embodied in the service definition, then more storage assets would be designed to produce it.

There is also a complete failure to take a wholesome look at the services that the system requires. Because of the loss of inertial plant, inertia diminishes, which causes problems in and of itself. Moreover, the more National Grid analyses the problem, the

more secondary effects are created by the loss of inertial systems on the grid, for example problems with phase-locked loops, with transients during the delays for switching batteries, with loss of natural reactive power, with low frequency demand disconnection etc. See https://www.nationalgrid.com/uk/publications/system-operability-framework-sof for more information. Therefore it is logical to incentivise more inertia.

Enhanced frequency response (EFR) is fake inertia, much inferior to the real thing: it needs grid monitoring, a grid signal to be generated transmitted received acknowledged and acted upon, and the plant to respond. The same thing needs to happen every time it is adjusted / switched up or down. All this currently takes ~2 seconds, during which time there is a spike on the system. Real inertia is always there, requires no monitoring or signals, and eliminates the spike. The plants that deliver it also deliver the secondary benefits such as phase-locked loops and low frequency demand disconnection support. Therefore paying for real inertia at the same rate as EFR would yield vastly greater benefits and hugely reduced costs.

Perverse activities

While claiming to do one thing, the current BEIS / Ofgem / National Grid regulations, contractual structures and practices actually often do exactly what they claim to be avoiding. Please see the appended report Electricity SO Forward Plan Consultation, which details a number of such points.

Interconnectors

In their Electricity Capacity Assessment Report 2013, Ofgem completely discounted reliance on any power from interconnectors – though they have modified their views since then. Not only do all our neighbouring countries suffer comparable shortfalls in generation capacity with Britain's, but also their demand patterns are similar. The corollary of these two factors is that if we are allowed to draw power through interconnectors when our neighbours also want it, we are likely to be paying high prices in order to do so. Nevertheless, at times when these neighbours' systems are not stressed, interconnectors provide ample electricity at reasonable marginal prices, and serve an excellent purpose in lowering Britain's overall energy prices.

As if to emphasise this point, "In February 2015 National Grid Nemo Link Limited and Elia, the Belgian Transmission System Operator, signed sign a joint venture agreement to move ahead with the Nemo Link" even though Belgium was the first country in Western Europe to be planning openly for rolling black-outs to make up for potential generation shortfalls, and Belgium's interconnection capacity is 3.5GW, or 25% of their 14GW peak demand , as compared with Britain's current 4.15GW, or under 7% of peak demand.

Yet National Grid is accelerating its reliance on interconnectors, from the current 4.15GW to 23.3GW by 2040 (Two Degrees scenario).The fact that we saw strong flows into the UK during peaks in winter 2014 is due primarily (in my opinion) to the exceptionally warm winter noted in the Winter Outlook Report 2014, rather than to their reliability when demand is high: as stated, "French and Belgian supply is expected to be relatively tight until 2020 due to closure of old fossil fuel plant and some nuclear

reactors. As conditions vary and put more stress on the market in coming years, this could lead to more volatile prices and therefore interconnector flows between GB and the continent. This is particularly the case over the peak demand of the day."

Because of their function in lowering overall energy prices and making up for domestic energy shortfalls, Storelectric's CAES does not supplant the need for interconnectors, but works with them. Indeed, CAES at either end of one could increase the energy transported by that interconnector by up to 6 times, depending on the energy profile at either end of the interconnector. Like CAES, interconnectors are therefore not the solution, but an important part of the solution.

Meanwhile interconnectors fail to offer the balancing services that National Grid is claiming and for which it is relying on them in their Future Energy Scenarios. Interconnectors carry the pre-contracted electricity in the pre-contracted direction and therefore cannot respond to short term need that are driven by rapid fluctuations in generation and/or demand.

Interconnectors and Brexit

Currently Britain is in the single market, regulated by the European Court of Justice. This ensures that if we pay enough, our neighbours have to sell us the electricity, and to do so tariff free. According to FES 2017, "our analysis currently assumes tariff free access to EU markets under all scenarios. " This is the rosiest possible scenario, which is therefore a very rash assumption – and the more so as the government has consistently said that we will leave both the single market and the jurisdiction of the ECJ. Worse, this means that all our neighbours would then be free to tell us that they prioritise their consumers at any price.

It is worth noting that this entails importing 1/6 – 1/4 (depending on scenario) of the country's peak demand by 2025, making up (by the same year) over one quarter of our total energy demand, through interconnectors from neighbouring countries. Not only does this indicate a massive domestic energy generation shortfall, but it also risks making Brexit negotiations hostage to our needs: we will be compelled to come to whatever agreement is necessary in order to be able to import these volumes, potentially weakening our opportunity to negotiate countervailing export market access such as for financial and other services.

It is also worth noting that interconnectors are part funded by the European Commission's Connecting Europe Facility (CEF), and rely on this to a greater or lesser extent for their financial viability. The innovation budget of the EU is funded by 6 countries more than the membership, including Norway, Switzerland and Azerbaijan, so it is possible for the UK to continue to use it – provided we pay into the budget, which may cause political issues in the UK. It is also possible for the UK to provide its own equivalent to CEF (and Horizon 2020 etc.) money, but that would require duplicating administration and an administrative layer to co-ordinate with the EU at both governmental and project levels.

Actions At Wrong Scales

National Grid is very proud (and rightly so) of its many innovation programmes. However every single one is directed towards actions on the distribution grid or on the distribution / transmission grid interface. There is not a single innovation programme directed towards actions on the transmission grid.

It is true that distributed generation and storage are growing very fast, and need to be dealt with. But there will always be large point sources of power input to the grid (e.g. wind farms, tidal barrages, interconnectors) and large point sources of demand (cities, industrial sites and parks, interconnectors). These cause issues on the grid, especially as most of the power sources are DC coupled and therefore have no natural inertia. These problems are growing – and doing so even faster than those for distributed energy. Therefore they need addressing.

Price Controls Out Of Control

You set many price controls, but fail to define their usage in order to achieve the goals you seek. For example, the T-4 Capacity Market auction has been subverted to be a second bite at the T-1 cherry, with over 85% of awarded contracts having a duration of two years or less, almost entirely from existing plants. It was designed to provide 15-year contracts to incentivise new build, and is therefore failing utterly in its intent. And it cannot deliver transmission connected new build because a new grid connection alone takes more than 4 years to build. As an alternative, see A 21st Century Electricity System, appended.

Your RIIO price controls incentivise DNOs and TSOs to over-estimate investment, then scrimp on it – whereas they should incentivise investment that makes the grid more robust and with greater security of supply, cleaner and with lower whole-system costs.

Your RIIO controls only evaluate the benefits of actions to the network, not to the whole system, so that (for example) encouraging storage that enhances true security of supply (rather than the partly illusory security of supply offered by interconnectors) is not incentivised.

Signed:
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