Reactions to:
BEIS November 2016 "A SMART, FLEXIBLE ENERGY SYSTEM: A call for evidence"

by SR Broderick (contact details at end)

With apologies for being at times repetitive and taking a view (which to me seems wholistic, but very likely is biased by position and insufficient experience).

p. 7 "Towards a smart, flexible energy system"

6. "potential to deliver lower bills" - not necessarily; there are many costs latent which may balloon appallingly if not managed. The greatest risk is to reliability

7. I am concerned that these reports do not look at the LV network, which is:
a) the single largest cost element of the power network, and
b) is known to go into saturation caused by EV rollout c. 15% (30% found by My Electric Avenue study using the Nissan Leaf - which has a 1/2 size of "present standard" power charger. Expect to see issues with network saturation from 15% EV penetration)

This implies a need to rewire the UK, from Primary stations down (ie digging up every road and relaying the cables). Where are those costs?

9. You can't do "turn up" on a saturated system. Be advised: LV cables are today being laid with an average capacity of 0.8 kW per home. DNOs are not advised to do otherwise!

You can get the power to the Primary stations, but not to domestic customers.

12. The present system is not fit to support EVs, let alone heat and turn-up.

13. Yes, DSR will help. BUT in any non-trivial scenario with electrified transport, it rapidly becomes inadequate.
FYI many studies based on US networks which do not have our constraints (their "LV systems" rewired in 1950-60s to cope with AirCon - they are already equipped with extra capacity; we are not)

14. Markets cannot flourish when they cannot deliver OR they will be limited to what can be delivered (basically re commercial premises)

15. IFF the enablers (such as a useful net system) are in place; ICT alone will not work.

16. It is a fantasy to suggest that most domestic customers (today) have movable loads of significance. This point was put at CIRED recently "What in a normal UK/EU home can be turned off?" The consensus was - nothing significant. With EVs, that will change.

17. The sentiment is agreed, but ICT for several reasons cannot step into this role immediately:
a) culture. Power industry is happy with 50 yo equipment; in the ICT world that is ancient and totally unmaintainable

b) complexity. ICT is an order of magnitude more complex then the power industry is used to or skilled to work with.

Example:
It becomes necessary to maintain an ICT system from 1995 for security reasons. It is written in something popular then (like BCPL or MODULA-II).

a) no-one is trained to write in that nowadays - never heard of it!
b) the supplier has gone, so the hardware and OS became unsupported
c) there are no compiler or software tools available
d) 20 years is at the edge of the life of digital media. It is found that the media with the original code is damaged due to deterioration.

How would this system be maintained? By replacement, the norm for ICT.

** ICT expects short-lived systems maintained by replacement. Talk to a programmer and ask how they would design a system to last 20 years - they will be amused at the concept! **

Moving to an ICT dependant power system may put the network in peril - the above scenario may be writ large and acted out as the years go by. A real-life example from my experience:

In the late 1990's I was part of 160 staff working on a novel automated exchange for BT; I was on that project for just under 4 years. The project cost c. £250 million, had a design life of 20 years and went live in 2000. It was a cracking system and we were proud of it. It was scrapped in 2006.

This was due to (b) above - and the risk of security breaches.

Can you afford to do that if the company who installed key / major SG network components goes bust and the thing is unmaintainable? Who pays for the replacement?

By going ICT the power industry is at risk of undefinable, ongoing non-trivial costs. How does this improve reliability and lower costs?

30. There is a Chinese wall between Smart Meter data and service providers (Data Protection Act). What is being done about that?

Example: DNOs do not have access to Smart Meter data in real-time; but they can buy often weeks-old data from the retailer (who owns it).

** You cannot have a functional Smart Grid with this in place **

33. Customer participation rates are likely to be very very low; saving pennies a day is of no interest to a family of teens. It MUST be automated - but, to control what? We are back to the lack of sensible significant loads to turn off. The TV? The lights?

35. The case for benefit to the customer has not been shown; again savings vs. lifestyle.

37. This is my specialist area - the impact of EVs on the local network. This must be actively managed, so a Smart Grid will be needed within the next 5 years.

38. One way forward is for a sealed local controller, sited at the local substation, which only reports net feeder load. DNO does not bother with household SM's.
Further, the unit could provide feeder balancing services and other management - of the EVs, heat pumps etc. Note that phase balancing is needed to minimise losses (it is common for a 130A feeder to see 30A on two phases and say 90A on the third. This exacerbates Joule losses.).

40. This needs to be upgradable. Back to a local control box... add such a feature to that and let it control the local SM's by a commercial protocol?

The DNO network would be sealed and talk to the control box. That would limit the affected range of issues and break-ins. Without having to regularly upgrade the SM software. The DNO would own the box and to be responsible for its "fitness for purpose".

41. Don't forget net system stability; the proposed system is almost unknowable ahead of time (and we have less and less inertia).

44. Funding, skills building and help with integration of new technology is needed.
Plus the providers of new significant loads, on whom reasonable regulations may be applied. Example: DNOs are being obliged to reduce losses (2020 transformers and the like). Yet, are the losses on inverter (eg Leaf, over 300W inverter losses) regulated? Not to my knowledge.

But the losses in a low-loss substation transformer (some less then 300W) **are** regulated!

What is the point in saving Watts in one place, whilst they are carelessly discarded elsewhere?

50.

ii) without a useful LV network of capacity, dynamically managing the EV's to support a market may not be feasible.

iV) Having looked at V2G for several years, I am not convinced that there will ever be a market. Why? (other than network issues above)

The profit turn must exceed the cost of damage (ageing) of the EV battery. Even with batteries at a quarter of the low costs today - this is unlikely.

Suppose the battery cost is £40 per kWh, and has a life of 1,000 cycles. Owner income of at least 4p for every kWh trade is needed for cost parity.

This is unlikely, for it suggests a larger apparent income. As an EV owner I would want 6p - and if run by an aggregator, we are looking at more as they would want a cut. Soon that becomes 10p.

Given that EVs may be around in 10's millions (2040? 2050?) - is there a market that has those pockets and demands the service of say 7 kWh * 10^6 = 7 GWh?

This is not generation, this is load shifting; the 10p is a turn per kWh - i.e. £100 MWh... over the market rate. Is there such a market, of such a size? I don't see it.

What I do see is a smaller market (which will bid itself through the floor, resulting in zero players as they cannot meet costs). Remember, this is with super-cheap batteries.

Where there is scope - is charging on sunshine signals (which of course with a local controller can do freq. response and some DSR) - if you can get the power to them.

// how do you do FR with non-V2G charging EVs? Such a large population must be planned into a generation schedule, complete with start and end charging times. En-masse leading or lagging planned times gives FFR opportunities, on both edges. This has been studied 3 times to my knowledge and made to work.

But what if the batteries were not just cheap but very very cheap? Is that likely?

There is more profit on selling a car with a £5000 battery vs. one with a £500 unit. The £500 battery will loose margin.

Restated: At some point in battery development the next major improvement will reduce forward profits. And there battery technology development will slow to a stop, so to avoid that calamity.

Question from myself: Is not the power industry being mugged by the IT industry, desperately casting around for new markets? Please be sure SG is workable at all levels.

Most other sectors have learnt the hard way that IT is a bottomless pit of cost (most major IT initiatives about the world have been failures).

Yes, there will be problems. Somehow I suspect the answer to every problem will be - more time, more spend, more time, more spend...

*** What measures are in place that this entire modernisation adventure will not come back and drive costs far over what is sensible?

Please - maintain a fall-back position, one which works without an extensive SG / ICT.
==========

<u>Main document body</u>

1.1.8 Beware the word "efficient". Different people use it to mean different things - and, some admittedly possible efficiency measures may not pay for themselves (in any reckoning).

Whole system impacts and metrics / quantifications are needed!

2.1.2 Network Charges for storage

A possible method: Loss impact charging

1. charge for network use depending on impact on losses. The connection and a major "through-limb" of the supply network is monitored.

2. If losses in the limb are increased by the action of the storage system, the storage operators pay a use charge. At other times they do not.

Hence, payment occurs on charging but not on support (as the sample point currents are lowered). However if the losses are raised e.g. charging during a peak, the storage system is charged disproportionately more.

4.1 Smart Appliances

See CIRED 2016 Paper 0122 “Are People as smart as their smart meters are?” - Study found (paraphrased): No.

Questions:
28: I am not pro 3rd parties controlling my equipment at home, even if it will same me 20p a day. £20 would be different.

29: Option A (then I could tell not to buy it)

30: No evidence, but would not want 3rd parties to control any load which impacts my comfort or lifestyle. Control over things I am NOT immediately using is OK; this could stretch to the EV and storage and perhaps fridges (with a time limit).

31: DNO Insurance. People who have all their food spoilt / temperature controlled drugs spoilt / then die / fail to get their kid to hospital etc. etc - because some third party control cut power - will demand recourse to sue that party.

32: For vulnerable parties there should be guaranteed supplies.

4.2 UL Emission Vehicles

10: My Electric Avenue is obsolescent and not representative of modern and forthcoming systems; the EV batteries are very low capacity and the charge 3.3 kW vs the standard 7 kW (today's norm). So HALVE their stats / conclusions.

11: This observation is driven by monitoring people will range anxiety (Leaf could only do 90 miles on a "I must charge *all* overnight" charge).

Today's EVs (eg Renault Zoe, on sale in UK from the end of 2016 @ under £16 k) do not have to be plugged in all the time. From full charge they might be used for 2 days of commuting and still have over 100 miles range left.

Why plug in? People won't; they are likely to treat them as a normal fossil fuel car and charge / refuel as necessary.

Expect the future to **not** match MEA conclusions.

12: Beware the Sky effect. In the 1990's Sky (then BSkyB) went to satellite control of software updates, sending the Skyboxes a "check for a new update" signal. The update was via telephone landline.

This synchronised hundreds of thousands of Sky boxes to simultaneously check for software updates. The telecos discovered this on the first Sky update; the command focussed dial-ins from around the country onto one exchange, en-route to the update server (zero to > 10^5 connections in a few milliseconds). The exchange became unstable.

Do you want a version of this for the power system? All those EVs might well be timed to switch as one, easily within 1 cycle. Is there a random scatter? A 100 second scatter would be good.

Q33:Cause incorporation of "passive" management systems by law i.e. which act to guarantee charge X on the EV at a set time, but don't say when / how that will happen - as long as charge X is in the battery at the right time the user won't care.

Q34:Full electrification of vehicles faces 2 major issues:

a) my contact at TRL says 40% of all car owners would be incapable of charging an EV at home (no means to connect e.g. terraced houses, tower blocks, flats)

b) DSM / DR for domestic feeders is inadequate - EVs will not work without major / pervasive system replacement for the LV networks. Really.

Electric heating makes it worse (it brings in secondary effects - like homes without gas must now cook electric, use water heaters, room heaters. And impose a massive load (lasting half a day?) recovering from long-duration power-loss in winter.

** There will be raised correlation between hard winters and outages **

Imagine a blacked-out => cold estate - all that thermal mass. And on power restoration: 3kW heaters going in every room! And the HP, EV, cooking... will this work over 1 kW ADMD system?

I can't alas track a reference (have looked) but in last 6 months have had sight of a WPD estimate of c. £53 billion for LV refurb. My own estimate was a bit higher; I suggest this is formally investigated.

It's commercially and politically impossible to do all these works at once (esp. digging up all the roads) but this must:

a) be expected,
b) be planned,
c) be financed.

4.4 Consumer Protection

29: a) I wish to reiterate that DSM / DSR is not enough; all they do is move load to unloaded times. Once the point is reached when the total energy load exceeds continuous LV cable ratings then juggling timing will not help. You are forced into laying new cables; any savings are transitory.

Much of the country is equipped with 1 - 2 kW ADMD per household feeders. These, and their transformers, will need wholesale replacement. It is misleading to customers and to managers to encourage the belief that any savings are long-term. "Savings" are just kicking the can down the road.

4.5 Cyber security

- is all about time and cost. No cypher is securable in the long-term; all that can be done is to make penetrating security unreasonably difficult. But what about in 10 years time? It is perhaps likely that by then the security is "vulnerable" - and a laughing-stock 10 years after that.

I strongly recommend defence in depth, to NOT use any public Internet services and to have a black-hat team (penetration testers).

Then, social hacking. People are easy to attack; they will inadvertently (in kindness, just doing their job) unknowingly breach security.

Talk to BT who are very big on this stuff. I suggest calling up BT Innovate & Design Research Labs at Adastral Park, near Ipswich. The only name I have in the security area - this is a few years old now:

> Colin Blanchard M.Inst.ISP | CISSP | IEng MIET
> BT Innovate & Design

:) that was fun!

Not forgetting the need to boost power / energy engineering skills training. We need to up UK skills, esp. for DSO's.

I note with amusement that the UK Government skills projections (UKCES report "Working Futures 2014-2024", p.8) expects a 9% drop in demand for power engineers, due to "efficiency".

Given that this is what the Government thinks, what fate funding for UK training?

I suspect that the UK may not be able to get enough suitable people to work on power systems, as every country in world will be demanding such skills (plus ongoing ageing-off of existing staff).

Steve Broderick

EngD Research Engineer
(now in year 4 of a Engineering Doctorate re V2G EVs on the UK LV system)

University of Southampton
srb3g13@soton.ac.uk

LinkedIn: uk.linkedin.com/in/steve-broderick-8509a817