1. Distributed Flexibility

Before considering Distributed Flexibility, please consider why Flexibility is needed in the first place; it is not to match Supply and Demand, though necessary, that is not sufficient. The primary reason is that any commodity, and any product, including Electricity, is sold on Price, Quality, and Delivery. Flexibility is needed to meet all three objectives:-

1) Ofgem is the recognized authority on **Price**, but that is not the subject of this Call.
2) If the Industry fails on **Delivery**, or Availability, they will get Hell from the Politicians. This shows a distinct lack of leadership; for "keeping the lights on" is a simple Party Trick, called Synchronization, learned by the Industry in the 1850's; besides it is in the Industry's best commercial interest to keep the power on. - In order to achieve Flexibility, Politicians need to prepare the consumer to accept that Load Shedding is the norm. (President Cyril Ramaphosa of South Africa said that he had no constitutional obligation to "keep the lights on". Now, that was brave! It's the sort of fearless action that is needed. It will be interesting to see how long he lasts?) – A refund of the standing charge for any day for which the power is cut for 10 seconds or more, should be a *sine qua non* and a minimum deterrent.
3) Having travelled around the world a bit, I feel confident enough to say that Britain has one of the worst **Quality** of Electrical Supply in the World. Quality can be characterized by three parameters:-
    I. **Frequency**. This is over managed centrally by the National Grid.
    II. **Voltage**. We are under performing on Voltage for three reason:-
        - ***Joining the EU***. The EU runs at 230V, the UK used to run at 240V, and a lot of the infrastructure still does. – We are in a transitional phase operating to both standards; there is no going back because market forces will prevail. I reckon the transitional phase has another 40 years or so to run.
        - ***Greening the Grid.*** As we Green the Grid by adding Roof-top Solar and Embedded Generation, the usage of the Grid Changes leading to Higher Distribution Voltages and higher Volatility, which also need to be controlled to regain Voltage Quality.
        - ***On Demand Devices.*** The profile of consumer appliances and devices is slowly changing from inefficient continuous use devices, to high-power on-demand devices. This too increases consumption volatility.
    III. **THD** (or Total Harmonic Distortion) is catch-all for a plethora of wave-form issues. The following image (Figure 1) shows how the delivered waveform deviates from a sine. This not only leads to a loss of efficiency in the home, but also indicates terrible waste by over-saturation of the Distribution Transformers.

Clearly, Voltage and THD can only be managed locally and they cannot differentiate one consumer from their neighbouring consumer; and this is the primary reason why Flexibility needs to be distributed, and Distributed locally (not centrally).

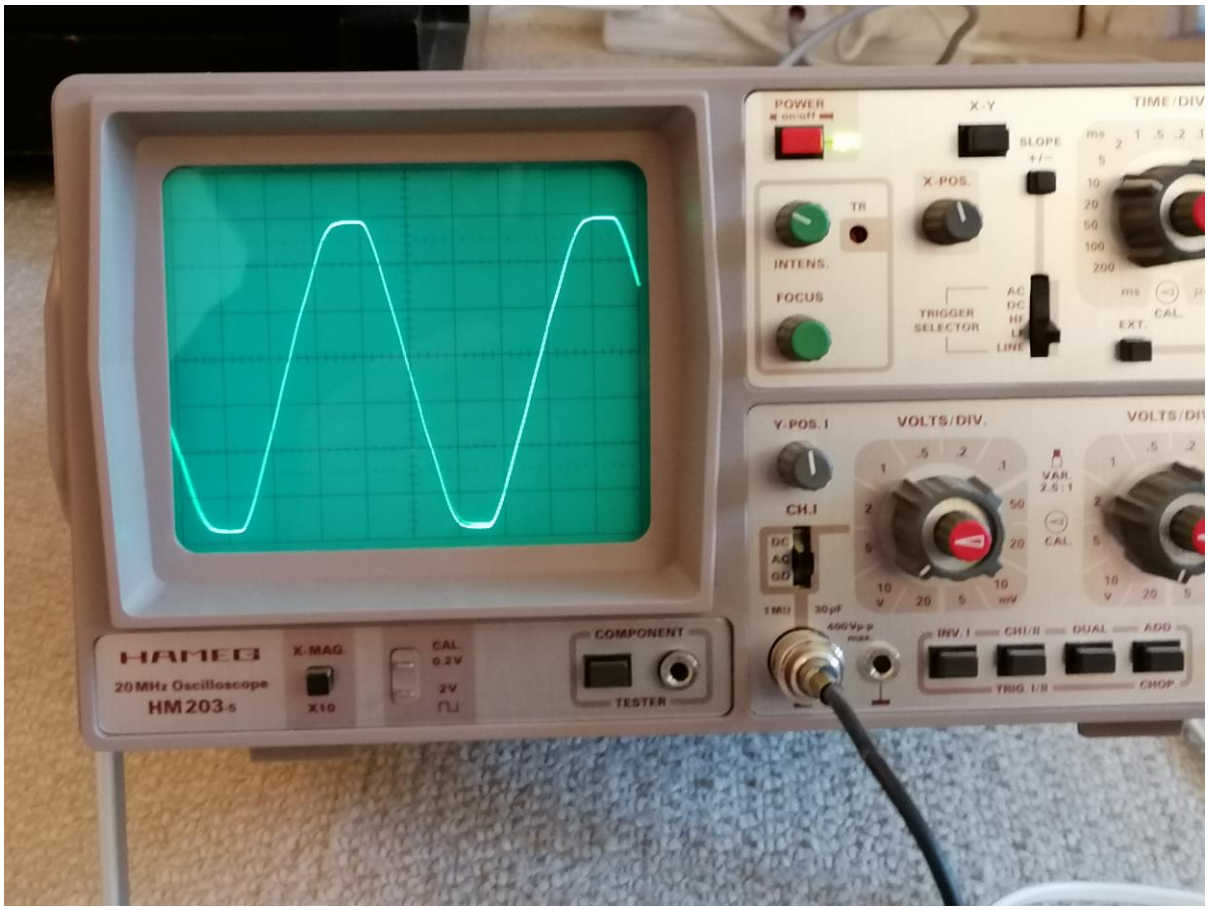

Figure 1 – Consumer Waveform

2. Local

Use of the Consumer to provide Flexibility (CER) is the first (and probably the worst) place to start. The incentives are too small, the average consumer just isn't interested, and I'd say you need at least ten million participating consumers to be effective.

Provision of Storage (e.g. Hydrogen Electrolysers) at the point of Generation (e.g. where Wind Power comes ashore), is probably the second worst location; and is only done to fit the archaic Business Model to which the Industry works.

We have said that Wind and Solar complement each other; so the best place to put storage is where they meet, that is virtually at the NBP (Notional Balancing Point) which in real terms means Coventry, Warwickshire. – But, of course, the NBP is a fictitious concept only used to satisfy economic models.

I've seen other analyses that divide Britain into about half a dozen regions, each region defined as sharing a common distribution cost. This is far more interesting, and each may be equipped with a Local Control Centre, a Local Balancing Point (LBP), and Local Flexibility or Storage. Not to say that they cannot be managed remotely (at the centre); but the finances and economic justifications should be done locally. - Not every part of the country would put the same value on Quality, Availability, Price, and hence VLL (Value of Lost Load).

Whenever Production and Consumption within a Region (however big or small) do not match; there are three possible things to do:-

I. Adapt (Flexible Production & Consumption)
II. Storage
III. Trade with neighbouring regions (or internal averaging)

These local regions can be cascaded with ever smaller granularity. Some stopping points being: 8MW (smallest Power Station Instrument Resolution); and 500kVA (recommended by IEEE 1547 for regulatory devolution), 5MW & 50kW written into the SEG Scheme. But the only place where Quality Control can truly be affected is at the Low Voltage Transformer, and this is surely the lowest granularity for providing Flexibility too. Some considerations:-

I. I do believe that the Japanese have a technology for providing Voltage Control at the Low Voltage Transformer, but I don't know what that technology is.
II. The Dutch Company, Victron, has a semiconductor marine technology called Load Support, which, I'm sure, can be scaled up for Grid use.
III. Simply using an urban Distribution Ring Main would improve averages and hence Voltage Quality and facilitate measurement without the expense of smart-meters.
IV. A classic Constant Voltage Transformer is probably a very bad idea; increasing losses and worsening THD.

Before closing this section, I acknowledge that devolving Grid Control to regions with different values placed on Availability can lead to Islanding. And it's a devil of a job to recover from Islanding. Therefore there is a growing interest in the use of a DC Super Grid, which is also far more efficient. I do believe that the technology exists for controlling multi-drop DC Grids.

3. Timing

Upstream fuels are normally purchased on year-ahead contracts (sometimes up to 20 years ahead); with seasonal demands; and maybe with the finest granularity of weekly delivery.

The Industry's practice of week-ahead and day-ahead scheduling, with hourly (or half hourly in the case of the UK), delivery was designed when most Electricity was generated by Coal, and half-hour metering was the best available at the time.

With Distributed Flexibility, the half-hour window is too wide. (A Solar Eclipse can come and be gone within half an hour.) – Also most domestic Solar Batteries (CER) are only scaled for day-ahead use otherwise they become far too expensive. – It is clear that the Current itself must most generally be used as a measure of demand; with a range of high response technologies otherwise.

4. Questions

Section 1

1. What do you think distributed flexibility could contribute to the energy system?

A lot

2. Will a focus on CER flexibility also help enable other forms of flexibility, especially distributed flexibility?

No

Section 2

3. Is there a 'case for change' and a need for a common vision for distributed flexibility?

Absolutely

4. What is your vision for how to accelerate the delivery of accessible, coordinated and trusted markets for distributed flexibility?

Distributed Flexibility is wholly the responsibility of the DSOs and RECs, there is no market. I do not believe that there is a future for CERs; though DERs may have a place; though direct ownership of the assets by DSOs/RECs would surely be more efficient. They have already merged (to an extent) and could become ESOs in their own right, with the GSO (NGC) becoming a DC Super-Grid Operator, and Generator and Reserve supplier of last resort. I estimate that Distributed Flexibility will eventually cost the economy about 1 Trillion Pounds, for which there is zero monetized return. – Therefore we have to look at other financing models such as state subsidy or nationalization. However, we can start by collecting and publishing data on Electricity Quality (and Availability) in order to name-and-shame, and grow political consensus. - How does the law handle prices in excess of VLL? The Consumer will not invest in Flexible Assets unless subjected to draconian price-rises, and/or frequent load-shedding.

5. Will certainty of an end vision help accelerate enabling work and make it cohesive?

Yes, but end visions will depend on local circumstances, so central prescription will be difficult to define.

6. *When should a common digital energy infrastructure be in place? And therefore, when should development begin?*

A common digital energy infrastructure is not relevant to Distributed Flexibility.

Section 3

7. What should a common energy digital infrastructure look like, and why? Please consider the archetypes or develop your own proposition.

An energy digital infrastructure is only necessary in the extremes of for instance DC Transmission between Off-shore Wind Farms and Pumped-Storage. (And as that is so unique, there is nothing common about it.)

8. What is your view on the desirability and feasibility of the archetypes or your own alternative proposition?

Distributed Infrastructure must be managed locally, with reference to the centre only for half-hour and daily balancing using the usual channels.

Section 4

9. Should a common digital energy infrastructure be new-build, or should it build-out from existing infrastructure?

It should be built-out

10. What are the important areas for consideration when designing institutional delivery models for a common digital energy infrastructure?

Speed

11. What are the important areas for consideration when designing financial delivery models for a common digital energy infrastructure?

Distribution means Volume, Speed, and micro-Transaction; all of which are on the cost side. There are no visible benefits; therefore you need to find them.