Call for evidence, launched by BEIS on 10 November 2016

In its opening paragraphs, the invitation notes that:

“Barriers to smart energy such a storage and DSR will need to be addressed through regulation, National Grid, and by networks themselves“.

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I am a retired research scientist, having spent the last 35 years of my professional career at the Atomic Energy Research Establishment at Harwell in Oxfordshire. Since retirement I have continued to take a keen interest in all energy matters, and have a wide circle of very experienced contacts in all aspects of the industry. I have thus acquired a wide knowledge of the spectrum of energy matters from nuclear generation to renewables. I became, by examination, an Associate of the Royal Institute of Chemistry in 1954, and was elected a Fellow in 1971.

Introduction

Electricity is a unique entity. It is only generated at the instant of its use. Any generator which is not being called upon to provide power, is only providing the *availability* of power; awaiting Mrs Jones to switch on her kettle. Only when Mrs J does so, does the generator supply electricity, and in the exact amount needed. No demand; no supply, just availability. But the latter is *utterly essential* to our existence.

“A key focus of the consultation is on removing barriers to electricity storage and demand-side response (DSR).”-----*invitation opening note.*

It goes on to say that

“Regulatory clarity for storage is vital because it forms the basis for industry codes for network charging, connections, Ofgem guidance and levies related to climate change and renewable”.

It has long been axiomatic in the field of technology, that the foundation science of any proposed scheme of work has to be demonstrably true, and that the ensuing engineering has to produce an economically viable process.

But in its opening remarks, above, HMG, via the agency of BEIS states that

“Barriers to smart energy such a storage and DSR will need to be addressed through regulation, National Grid, and by networks themselves“.

Governmental thinking is immediately directed towards an administrative solution to a technical problem; an intellectual oxymoron. Nature, in the form of principles to which no exception has been exposed, cannot be controverted by Governmental edict. Ever.

But why should such considerations be germane to the subject of energy storage?

Energy storage.

In physics, energy may be identified in a variety of forms. For the present purposes, electrical energy is the form under consideration.

The direct storage of electricity, at the present time, has no practical application; nor is there any prospect of such a system being developed. Storage in a system of electrical capacitors (condensers) is incapable, using known materials, of storing more than a minute quantity of electricity, insufficient for even household purposes. A cryogenic storage facility was examined, in principle, several decades ago, and could have stored large amounts of electricity in super conductors at very low temperatures. In case, however, of loss of coolant, sufficient for the superconductors to resume their normal resistance, the consequent energy release would have been totally catastrophic. The system was abandoned on these safety grounds.

Indirect storage, in which the electricity is converted into another, storable, form of energy, is therefore the only option.

Three areas are possible, mechanical, chemical, and thermal.

Mechanical storage.

1. Electricity may be used to power motors which pump water to an elevated position where it is stored, awaiting its release through turbines which regenerate electricity. The system is simple in principle, but requires the highest engineering standards in the manufacture of motors, pumps and turbines. Even then, fundamentally insuperable losses occur such as friction and hydraulic turbulence. Some 80% recovery of power is claimed for modern systems. A second requirement is the geography suitable for these large schemes, and the UK has little such land now available.

2. Purely mechanical energy storage may take the form of kinetic or potential energy. Kinetic devices have been built in which a large cylindrical mass mounted on a central axis is rotated by an electric motor, up to a high speed, preferably in a vacuum to reduce air friction, and the rotational kinetic energy thus stored is extracted by external connection to a generator. The size of the installation is limited by purely practical considerations, but cannot be considered as a power source on a truly industrial scale. Other devices involving raising large masses to an elevated position and allowing their fall to drive a generator.

Chemical storage.

1. The fundamental process involved in this form of storage, is to drive a reversible chemical reaction in one direction, and to recover the energy used in this process by allowing the reverse reaction to take place. This is the basis of the familiar rechargeable battery. The lead/acid battery used in the conventional car is a familiar example.. The advent of the lithium-ion battery has broadened the use in electronic items from mobile phones to laptop computers, and other household objects.

On an industrial scale a number of installations using thousands of large lithium-ion units have been built for use in conjunction with the National Grid. The fundamental problem lies in the “power density” of these units. Although they have undergone much improvement in this area, it is a fundamental fact that they are limited, absolutely, by the natural densities of the lithium material which is the active material of construction. No amount of “development” can improve upon this fundamental limit. The size of unit needed for grid scale operation is extremely large, buildings much larger than the central warehouses operated by supermarkets.

The size of large battery complexes is usually quoted in mega-watts, MW[#]. The length of time, however, for which that rate of output can be maintained is only known when the MW.hour capacity is also quoted. This time is obtained by dividing the MW.hour figure by the MW value.

An eco publication, edienews, recently named the top ten battery storage units in the world. They totalled 152MW with a capacity of 542MW.hours. This would supply 150 MW for some four hours. Six such installations could replace a standard power station (1 GW) for just four hours.

A second system, the Flo-battery, has a lower power density, but is less complicated to manufacture.

I would not expect battery systems to be able to operate as anything but stop-gap power providers, and even that would be at a very high cost, even if battery prices dropped to 50% of present levels.

2. Electrolysis of water to produce hydrogen and oxygen has been developed to the stage of stand-alone units to supply fuel cells in motorised transport. The electrolysis is carried out at high pressure, thus producing both hydrogen and

oxygen to be stored and fed directly into the electric vehicle. The electrolysis has an efficiency of some 80%. The fuel cell efficiency has also to be taken into consideration when assessing the overall efficiency. Taken as a whole, the process replaces the battery in an electric vehicle.

Thermal storage

The concept in such units is to use molten salts as a high temperature heat store for later use in combination with a steam generator and turbine. The concept has been incorporated in an array of mirrors directing sunlight onto a furnace containing a salt filled heat exchanger. The molten salt is retained in an insulated container. An advantage over photovoltaic generation is the avoidance of the complex manufacture of the voltaic cells, and ancillary equipment to convert the current to comply with grid standards.

Demand side response

Two separate sides must be addressed in this matter, the domestic market and the industrial side.

The domestic market is inexorably tied in with the universal installation of “smart meters”. At the moment these instruments are not adapted to the instant imposition of a variable tariff, but when this is imposed, the individual households will be obliged to shift their pattern of consumption, or pay peak rates for the privilege of a convenient lifestyle. It would certainly be a disruption of the family timetable to rearrange cooking and thus dining schedules to fit off-peak usage. This is a form of rationing by means to pay, whereas in the previous era of rationing, it was achieved by individual allocation. This matter is closely associated with the “smart meter” roll out, to which HMG has allocated £10.8 billion; an astronomic sum, £10,800,000,000, nearly £500 per household. The only return to the family has been estimated as about £23 per annum, by careful observation of the costs displayed by the meter. At a time of financial stringency, this imposition is abominable, far greater benefit for such sums are not difficult to find. The benefits will certainly not accrue to the family.

The picture is quite different when the industrial sector is involved. As part of a policy to flatten peak usage, industrial consumers may be offered financial benefit for reducing or ceasing consumption, on request, at specified times of day. This may suit the work pattern of some undertakings.

Some companies have a reserve generating capacity which they are prepared to use for grid generation upon demand, again a financial arrangement is made.

A further reserve is in the form of arrays of 0.5 and 1.2MW diesel generators, known as “diesel farms”, and collectively as STOR, Short Term Operating Reserve.

It has, of course, to be financially attractive to the collaborators, the price being paid, without any itemisation on their bills, by the consumer.

The different treatment of the two sectors is, I believe, little understood by a gullible public, and certainly not broadcast.

Comment

It is glaringly apparent to even a passing interest in Government Energy Policy, that the personnel at executive level, have little or no scientific knowledge in the technical aspects of electricity generation on a national scale.

There is no Member of the Cabinet with any such graduate qualification, and there are very, very few MPs so qualified.

This was graphically demonstrated when David Cameron, we can go no higher, declared on air "Why do we send electricity up and down the length of the country, with a loss of 10 percent, when it can be generated locally more efficiently. It makes no sense" The electricity is not sent in any realistic sense, it is available. The high voltage grid losses are 1.9%, low losses are exactly the point of high voltage. The much higher losses are in local networks, exactly because they are at lower voltages, the losses are about 5.6%. Large power stations are built because they have the highest thermodynamic efficiency, small units are less efficient. But David did not know and furthermore, I suspect, did not care; the public had been lectured.

The technical support advice does not appear to any better. I believe that it was Ed Davey, an economist by career, who had a Public Relations expert and Economist as his Advisors in his capacity as Sec. of State for Energy and Climate Change. It was obviously stupid of me to expect that they would fountains of knowledge on Energy and on Climate Change. When technical matters are touched upon, how does the Minister, there are six of them, obtain his advice, and more importantly, how does he make a judgement upon its veracity, being himself bereft of the knowledge??

So where does the expert advice come from? Upon submitting a specific question on wind energy to both the DECC and BWEA, now Renewables UK, I received identically worded responses! I thereafter regarded the DECC as little more than the Governmental representative of Renewables UK. I suspect that the same personnel form the core of the Energy arm of BEIS.

The Scientific Alliance wrote the attached submission to the House of Lords in response to an official request for comment. The signal point made was to the effect that until a unified electricity industry, run not by politicians who operate with Acts of Parliament and not with scientific and engineering knowledge, it will continue to be in a state of crisis. Moreover, if renewable is insisted by Government, a reliable and affordable supply of electricity will be impossible.

The BEIS Management team would be well advised to study this document in detail, it is written by the real experts with copious practical knowledge.

Conclusion

There is no way in which electrical storage systems will become available at the required cost and in the necessary capacity, to address the problems of peak demand and renewables intermittency.

The prospect of imposing Demand Side Response policies will impose hardship upon the poorest in our Nation whilst giving rewarding financial advantages to commercial institutions.

Neither is acceptable, the problems as at present experienced cannot be solved by edict, only by the skill, presently ignored, of Chartered Power Electrical Engineers, of whom I am not one.

Earmarked note

The **watt** is a measure of the *rate* of supply or consumption of energy. The *amount* of electricity involved is measured as the number of watts, multiplied by the time for which it is used. Wattage is analogous to the speed of a car, and watt.hours to the distance travelled. To refer, (as has been done by television reporters!), to a power station producing two gigawatts per year, is rather like quoting a car doing twelve thousand miles per hour per year, It is nonsense.

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