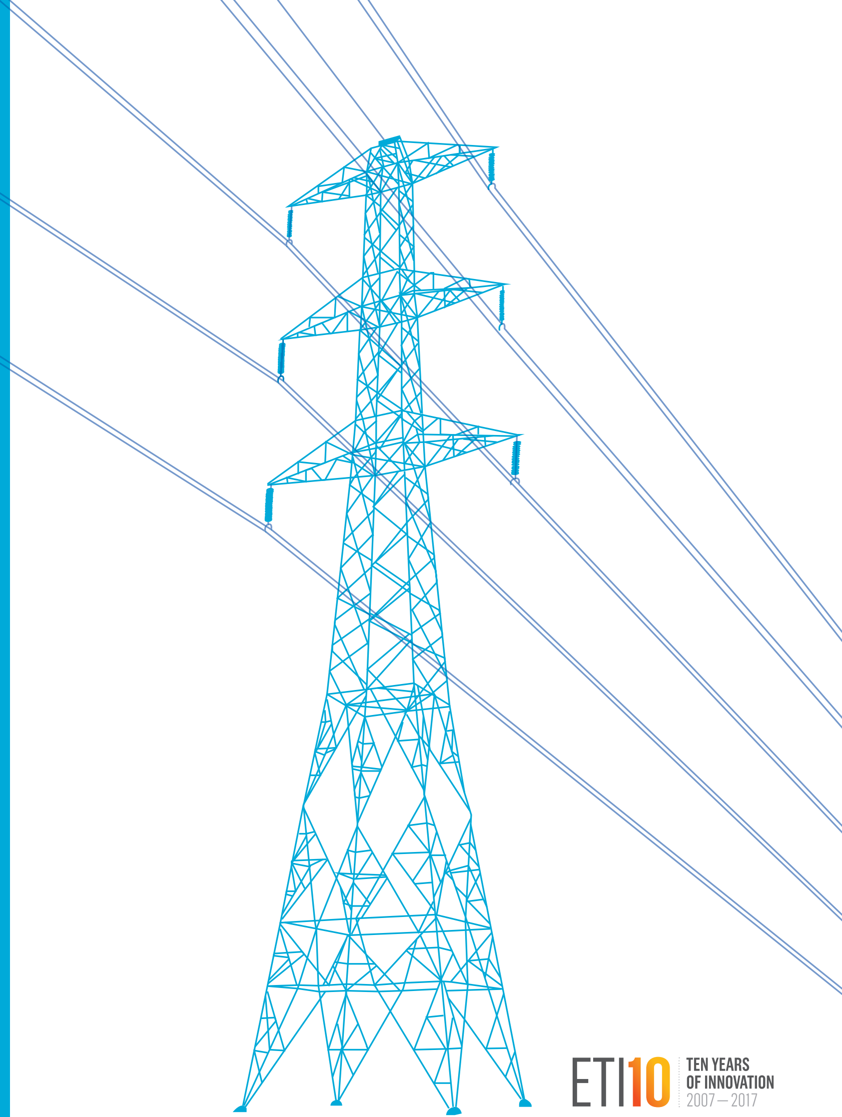
energy technologies institute

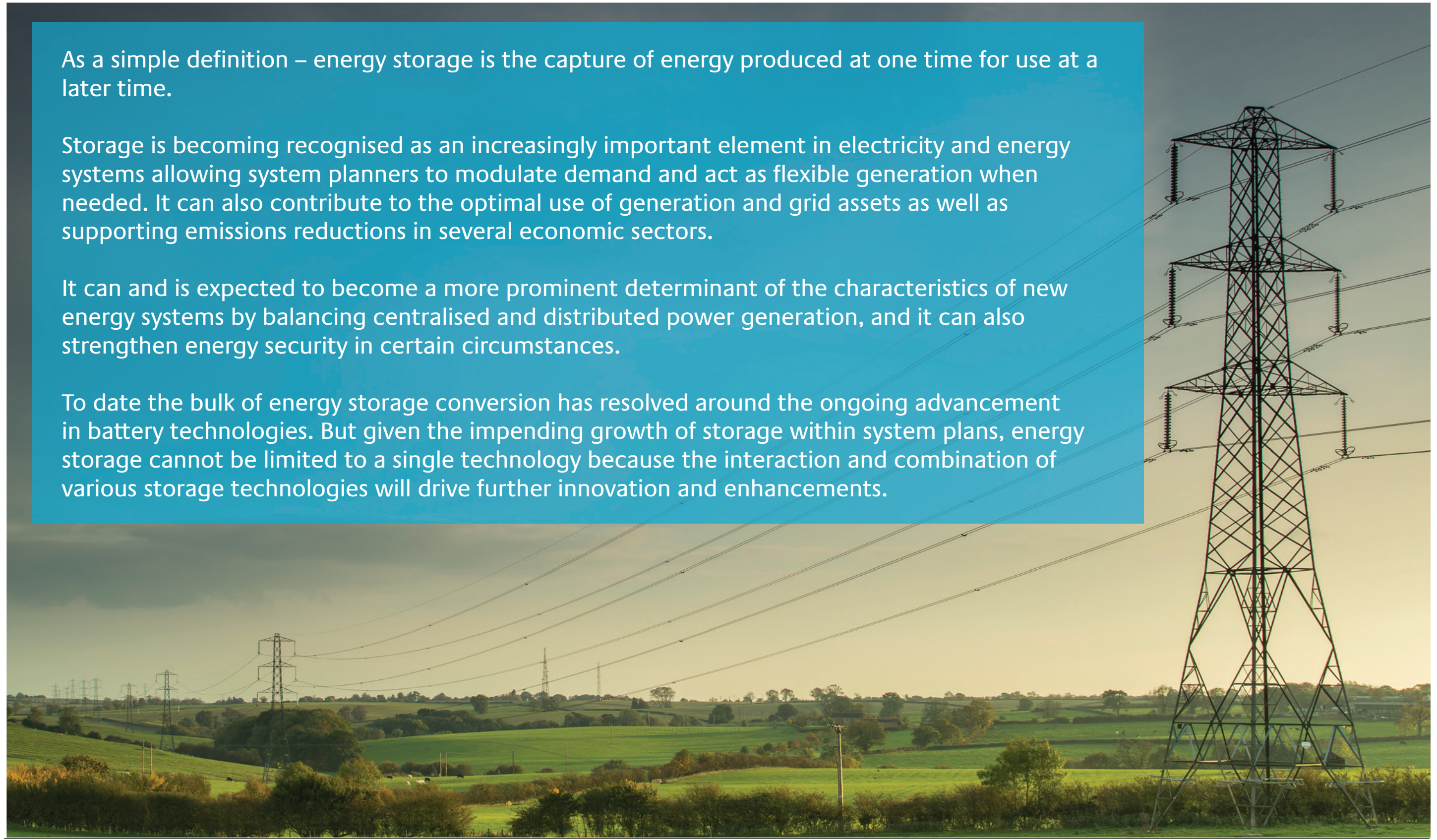
An ETI Perspective

The challenges of energy storage and its place in UK energy system planning



ETI10 TEN YEARS OF INNOVATION 2007 — 2017

WHAT IS ENERGY STORAGE?



As a simple definition – energy storage is the capture of energy produced at one time for use at a later time.

Storage is becoming recognised as an increasingly important element in electricity and energy systems allowing system planners to modulate demand and act as flexible generation when needed. It can also contribute to the optimal use of generation and grid assets as well as supporting emissions reductions in several economic sectors.

It can and is expected to become a more prominent determinant of the characteristics of new energy systems by balancing centralised and distributed power generation, and it can also strengthen energy security in certain circumstances.

To date the bulk of energy storage conversion has resolved around the ongoing advancement in battery technologies. But given the impending growth of storage within system plans, energy storage cannot be limited to a single technology because the interaction and combination of various storage technologies will drive further innovation and enhancements.

At the ETI over the last 10 years we have been involved in energy storage research and our work has covered analysis both of technologies and applications across the energy system, the modelling of energy system benefits and investment into technology development.

It has become clear to us from this work that energy storage is part of a broader issue of energy system flexibility. Being flexible with how and when we consume and produce energy means that we can be sure that the power generated and delivered to us always matches the amount that we use.

A crucial facet of a functional energy system is ensuring the right amount of energy is delivered when it is needed. This is about ensuring energy supply is in balance with energy demand. An energy system needs to have sufficient operational flexibility to allow this to happen and energy networks have an important role within this.

Much of the operational flexibility that is currently provided is done so through varying supply, i.e. increasing or decreasing the generation of energy meet changes in demand. One alternative is to shift demand to better meet available supply and some demands have the potential to be shifted in time, either partially or fully. Another alternative is for the networks to provide the flexibility through storage.

Storage is not a new part of the energy system. There are numerous ways in which fossil fuels for example, already provide storage – be that in the power sector through the storage of gas or coal before it is converted to electricity; in home heating using the capacity of the gas network; in transport it is the liquid fuels in refuelling stations and the tanks of vehicles. Other ways in which storage is already used include: storage heaters in some electrically heated homes, hot water tanks in homes and other buildings and accumulators in heat networks.

The ability to provide storage varies amongst the UK's network types. For gas and hydrogen, large-scale storage (such as in salt caverns) is very feasible. Whilst the scale of these storage options can represent a large capital cost, the cost per unit of energy is relatively low. Gaseous energy vectors also benefit from the ability of the pipeline network itself to act as storage, which is achieved by increasing the pressure in the pipeline.

Heat networks also have a level of inherent storage, with this realised by exploiting the heat capacity of the water in the pipework, and to some extent the pipework itself and surrounding ground in which it is buried. Dedicated storage can be provided through large water tanks, which can be heated up and cooled as required. Again these have a relatively low cost per unit of energy stored.

Electricity supply needs to be in real-time balance and whilst there are a wide variety of technologies able to provide storage for electricity networks, most currently available options are either expensive (e.g. batteries) when compared to other means of providing system flexibility or constrained in terms of where they can be deployed (e.g. pumped hydro).

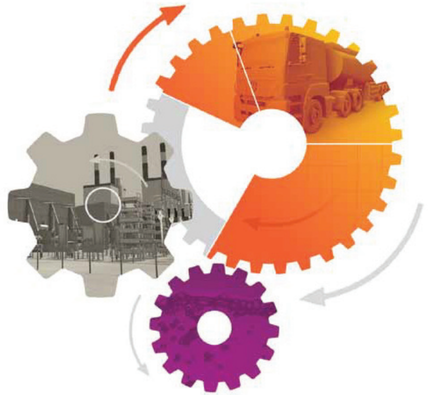
Our view is that today, no single storage technology stands out as being able to meet all of the performance requirements it needs to display, whilst also having the ability to demonstrate a clear route to being cost competitive with other means of providing system flexibility.

As with most things low carbon, because of the change involved there needs to be a suitable long term policy environment in place to support the roll-out of storage to an appropriate level. At the moment, current governance and regulatory frameworks around the management of UK energy networks are simply not designed to enable and incentivise radical transformation.

SCENARIO PLANNING

ETI has undertaken scenario planning and published two representative pathways to a future low carbon energy system out to 2050 – Clockwork based on a central well-coordinated approach and Patchwork, a collection of distinct energy strategies developed at a regional level.

Both scenarios include high levels of energy storage, with heat storage dominating in both. It is our expectation that natural gas storage will continue to hold value and that hydrogen storage will also be important out to 2050, alongside a much greater role for electricity storage systems, including batteries.



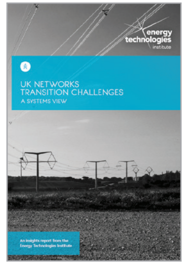
In general, we see a general shift in the provision of storage from being deployed close to supply to being closer to demand. Similarly, from being deployed in fossil fuel based mediums to a much greater reliance on other storage mediums. At the same time the drivers for storage requirements are evolving from being solely about meeting variations in demands to also having to account for greater uncertainties in the variations in supply. This places a much greater onus on understanding the utilisation of the storage systems that are used. In turn, placing more emphasis on operational strategies, business models and market mechanisms that will be needed to make them affordable.
We believe that effective choices of storage technologies – especially heat, hydrogen and natural gas can accommodate high levels of renewables cost-effectively and also mitigate large swings in demand for electricity. But this will require careful design of the supply mix and capacity markets.

SUMMARY

Analysis work undertaken by the ETI has identified a number of means of providing operational flexibility, which could be critical to the future energy system. Some of those which will have specific implications for energy networks include: gas and hydrogen storage to enable peaking power plant to help balance electricity supply; heat storage in homes allowing the load on electricity networks to be reduced at peak times; gas providing peak support for heat pumps; managed charging of plug-in vehicles; heat led combined heat and power systems managing variability of electricity output over the year by serving both heat networks and heat pumps, small modular reactors operated flexibly, pre-combustion carbon capture and storage with the flexibility to produce power or hydrogen.

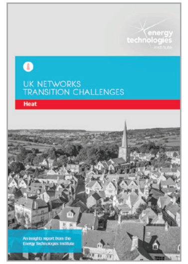
Some of these represent opportunities to manage flexibility requirements through system design, the full benefits of which would not be apparent if only considering a part of the energy system or just one of the energy networks. The current focus on electricity system flexibility, for example, is understandable but there is a danger in ignoring the flexibility opportunity from other networks. Taking a complete system perspective helps to recognise these opportunities and establish which offer the most economic solutions.

FURTHER READING



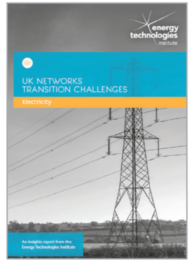
UK network transition challenges - A systems view

http://www.eti.co.uk/insights/uk-network-transition-challenges-a-system-view



UK network transition challenges - Heat

http://www.eti.co.uk/insights/network-transition-challenges-heat

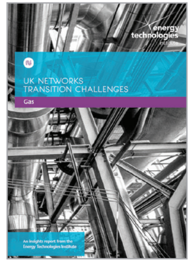


UK network transition challenges - Electricity

http://www.eti.co.uk/insights/uk-network-transition-challenges-electricity

UK network transition challenges - Hydrogen

http://www.eti.co.uk/insights/network-transition-challenges-hydrogen



UK network transition challenges - Gas

http://www.eti.co.uk/insights/uk-network-transition-challenges-gas

Options Choices Actions - UK scenarios for a low carbon energy system

http://www.eti.co.uk/insights/options-choices-actions-uk-scenarios-for-a-low-carbon-energy-system energy technologies institute

An ETI Perspective

01509 202020

www.eti.co.uk

info@eti.co.uk

@the_ETI