TECHNOLOGIES TO SUPPORT NET-ZERO CARBON

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Section 1. Introduction

The ACT Energy & Built Environment group has been looking at what technologies are likely to play an important part in getting us to near net zero Carbon by 2030 (**Net-Zero**). This date is based on the Tyndall Centre's analysis of the remaining Carbon Budget to keep us "well below 2^{o}C".

Under current UK plans and probably in the short to medium-term, much of the decarbonising of our Energy systems will be through electricity. This is because we have well established technologies to electrify much of transport and heating. This also offers an opportunity to increase Energy efficiency through electrifying some Transport and Heating.

It is envisaged that the electricity network will deliver a 2-3 fold increase in annual Energy, generated from Low-Carbon sources. To achieve Net-Zero Carbon, the Carbon intensity of the electricity grid will need to continue to reduce from the 2019 level of ~0.255kg/kWh to near net zero emissions.

Such a significant increase in the transport and distribution of Electricity and the associated changes in usage patterns, will be extremely challenging to deliver in the time available to reach Net-Zero Carbon emissions. This, however, is not the topic covered here.

It is also not our intention to cover all the different Low-Carbon energy sources nor the technologies that make Energy consumption more efficient. Instead we have focused on what we believe are the most likely technologies, in terms of efficacy and timeliness, to support the wide range of Renewable Energy generation technologies. Other significant technologies may emerge in the future. For more information and references please refer to the following sections.

For a comprehensive view on how Renewables could deliver a Net-Zero Carbon Energy system, we recommend the CAT Zero Carbon Britain (**ZCB**) documents. The CAT ZCB diagram in appendix A, provides an overview of current and future energy generation/consumption for the different sectors.

The group's focus is very much around supporting Teignbridge organisations, businesses and individuals to help them with their Carbon Reduction plans. We do this by providing the evidence and process to help them make more informed decisions on how to reach their Energy/Carbon Targets.

Like CAT, we believe that a 50-60% reduction in Energy consumption will be needed to support both Low-Carbon Energy generation and Energy efficiency technologies. Apart from the various Low-Carbon Energy generation technologies (e.g. wind, hydro, etc.), the following technologies are often quoted and promoted as supporting the move to Net-Zero Carbon:

- Hydrogen
- Storage
- Nuclear
- Carbon Capture

These are not to be confused with technologies that improve the efficiency of how we consume Energy (e.g. Electric Vehicles, Heat Pumps, etc.).

In 2018, some 80% of the UK's Energy use was provided primarily by burning fossil fuels for

- Building, electrical appliances and heating
- Transport in all sectors and all modes
- Industrial processes and manufacturing

Section 2. Storage

Storage is probably the most important technology to support fluctuations in electrical Energy generated from Low-Carbon sources such as wind and solar. There are two distinctive areas of use for storage:

- Behind the meter in residential, commercial and public sector buildings.
- In front of the meter at electricity network nodes and as part of stand-alone Renewable installations.

The TECs paper on "Future of Electricity Storage" addresses several of the options and challenges associated with in front of the meter storage using different technologies. Aspects of storage behind the meter are covered in TECs' paper on "Residential Battery Systems".

We see both types of storage as essential in supporting Renewables by:

- Smoothing out short term peaks/troughs in generation and consumption
- Longer term (including seasonal) storage to store excess electricity generated for later large-scale consumption.

Large-scale and long-term grid-level storage will be essential. Equally important will be to maximise on-site electricity consumption from our own Renewable generation and to use 'smart' technologies to smooth out the Energy flows across the meter.

Section 3. Hydrogen

Although used widely in industrial process, the majority of the hydrogen is currently 'extracted' from fossil fuels (e.g. natural gas). When this process includes the capture of ~80% of the Carbon emitted, the Hydrogen is referred to as 'blue' Hydrogen. This is not yet widely available as it requires Carbon Capture technology, please refer to a later section on this. We therefore do not consider Blue Hydrogen as a Low-Carbon Energy Source.

The other method of extracting Hydrogen is from electrolysis of water. This is an Energy intensive and therefore costly process, but could be a practical way of converting excess Low-Carbon Energy into Hydrogen.

Hydrogen itself is volatile (self-combusting when exposed to air) and requires careful storage/handling. Low-Carbon Hydrogen has several potential uses to support Renewables or replace/supplement natural gas and other combustion fuels used in Transport and Industry:

- Used direct in vehicles with fuel-cell technology and industrial processes
- Mixed with natural gas to reduce the Carbon intensity of current heating gas boilers
- Converted to more stable hydrocarbon fuel for use as a Low-Carbon fuel and in industrial processes
- Stored (medium and long-term) either in its raw form or as hydrocarbons for later use to generate Low-Carbon Electricity.

For more information on Hydrogen and its potential/challenges, please refer to ACT's paper "Hydrogen, Storage and Renewable Energy"

Section 4. Nuclear

Nuclear fission is a well-established technology which is considered to be a Low-Carbon Energy source. It of course has several 'safety' concerns associated with its use. It has traditionally been generated in a small number of large nuclear reactor sites delivering a base-load electricity supply to the grid.

More recently, smaller nuclear reactor designs have been coming on stream. These also promise to provide a faster turn-down/up response-time to the Energy output, but not with the real-time flexibility required to support Renewables.

Because of the substantial risks, both in terms of accidents/attacks and the long-term safe disposal of nuclear waste material, we do not see Nuclear as a technology to be supported. Nevertheless, it is likely to be part of the medium-term technologies used to achieve Net-Zero Carbon.

While it is the case that a 60% reduction in Energy consumption with the remainder provided entirely through Renewable is feasible, it does require a major political and social shift in the will to doing it. The CAT ZCB report outlines how this can be achieved without the use of nuclear power.

The ACT paper "Nuclear Power and Carbon Neutrality" provide further detail on this technology.

Section 5. Carbon Capture, Utilisation and Storage (CCUS)

This refers to the technology which captures CO2 for further industrial processing or safe storage. It can be used to:

- Capture CO2 from the process of using (mostly burning) fossil fuels, thereby preventing its release into the atmosphere.
- Remove CO2 already released into the atmosphere, thereby removing historical emissions.

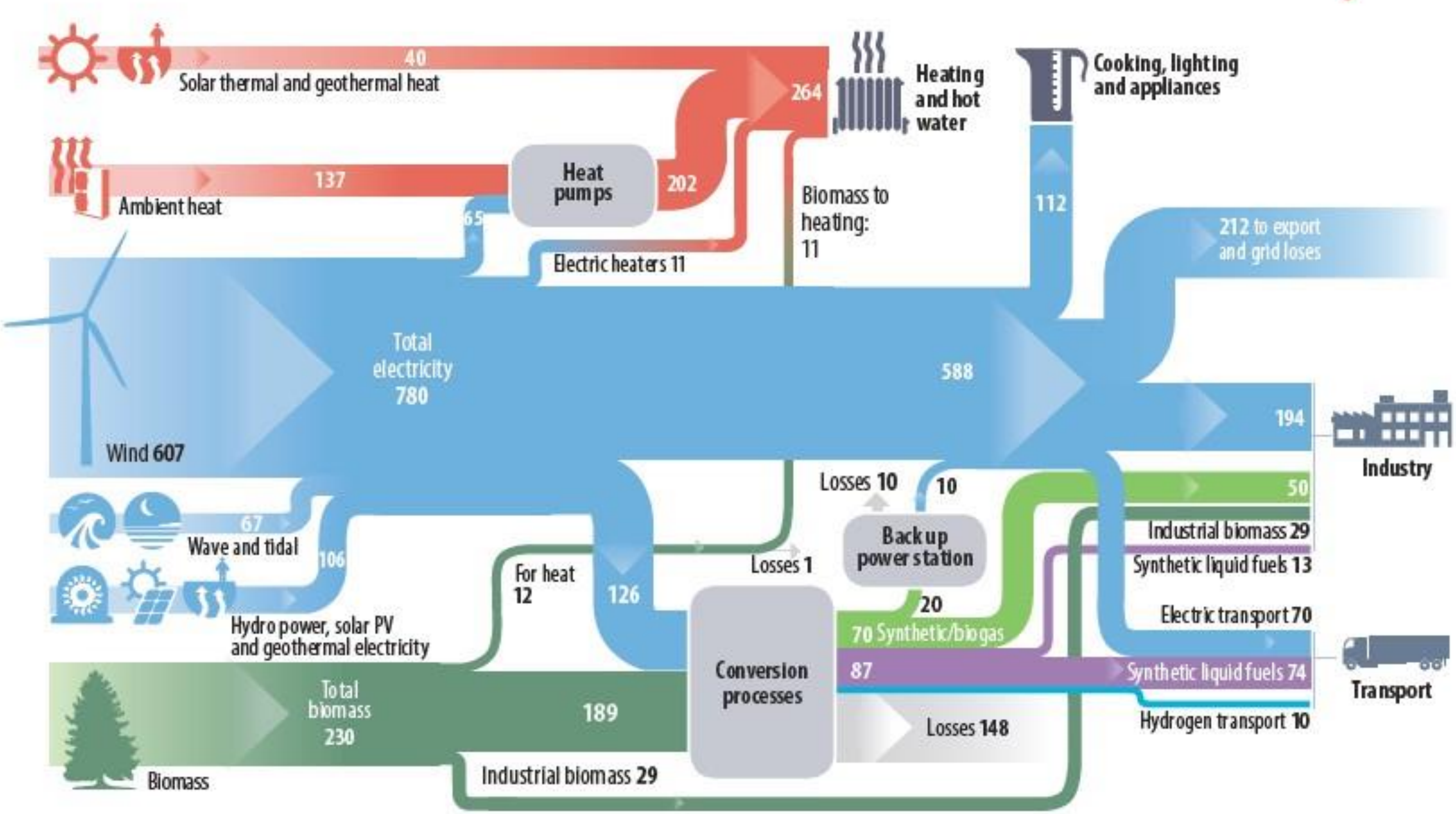
Note that we are not including natural mechanisms which also sequester CO2 from the atmosphere, e.g. photosynthesis on land and at sea.

On the face of it the technology appears a perfect solution to not only allowing us to continue to burn fossil fuels, but also rolling back the effects of Climate Change. The UK government and the Committee on Climate Change (**CCC**) see this technology as an essential pillar to achieving Net-Zero by 2050. This is because the current CCC Carbon Budgets are insufficient to meeting the "well below 2°C" by 2050.

At this stage CCUS is an emerging technology which is yet to demonstrate cost and Carbon effectiveness over its whole lifecycle. Although potentially very useful in sequestering historic Carbon emissions, there is a danger that it is relied upon to allow continued use of fossil fuels.

We therefore do not see CCUS as an effective solution in supporting Renewables, at least not in the medium term. Please refer to IEA report on CCUS for further information on this technology.

Section 6. Appendix A – CAT ZCB Energy Flows



Energy flows in our scenario – from supply to demand (figures are in TWh/yr)