Getting to Net Zero: Part 1 The technical pathway

Stuart Bird 1 July 2021

Since the UK parliament declared a climate emergency in May 2020 there have been a number of significant actions from government:

In April 2021 the government enshrined CO_2 reduction targets in law; namely to achieve net zero carbon emissions by 2050 and achieve a cut in emissions of 78% by 2035 (compared to 1990 levels).

To achieve these targets the government has already announced the ending of sales of new cars with petrol or diesel engines from 2030 (although sales of some hybrid engine variants will be permitted until 2035).

In addition a new building standard called the Future Homes standard will be introduced by 2025 and will ensure that new homes are zero carbon, effectively prohibiting the use of fossil fuel heating (gas and oil).

The government has also published details of plans for the decarbonisation of industry in line with the overall carbon reductions to 2050. Importantly these plan includes provision to ensure that electricity prices remain competitive to ensure Carbon emission are not simply off-shored.

As far back as 2008 the Climate Change Act had established The Climate Change Committee (CCC) as an independent, statutory body *to advise the UK and devolved governments on emissions targets and to report to Parliament on progress made in reducing greenhouse gas emissions and preparing for and adapting to the impacts of climate change*.

How feasible is it to get to Carbon neutral?

These plans will require significant change across our entire economy and will necessitate on-going investment by homeowners, business and government, however the required investment is over a long period of time and will to a large extent follow the normal replacement cycles of key infrastructure, thereby off-setting much of the costs. The CCC has recently stated that the overall cost will be well below the original 2% of GDP per annum estimate it made in 2008 as the cost of renewable energy and enabling technologies such as electric cars is coming down faster than expected. For example the lifetime ownership costs of Electric Vehicles (EVs) are already considered to be lower than conventional cars.

However almost all the decarbonisation plans are predicated on the use of zero carbon electricity meaning a continued expansion of the renewable generation sector.

Not only does the generation of electricity need to be zero carbon but the amount of electricity required will increase as we move away from fossil fuel burning in space heating, industry and transport. A full electrification of these areas will increase UK wide demand for electricity from the current level of 300 Terra-Watt-hours per annum (TWh) to over 500TWh/an.

There are already many technologies for generating zero carbon electricity including wind (on and off shore), Solar Photo Voltaic (PV), Nuclear (Fission), Hydro-electric and Bio energy (wood burning in conventional power stations using mostly imported wood from Canada). Other technologies that have never quite made the mainstream may also be deployed to reach the zero carbon targets such tidal barrages, wave power and Nuclear Fusion.

The costs for Solar Photovoltaic have fallen by 82% since 2010 and wind energy by over 30% and in terms of cost per unit of electricity generated are now by far the cheapest sources. At under 4p per kWh they are less than half the cost of coal. Economies of scale from mass production and incremental improvements in performance have created a virtuous circle of cost reductions.

What about renewables in winter?

Solar and wind power are by definition variable. In particular a weather pattern known in Germany as a 'Dunkelflaute' or Dark Doldrum (or lull) is an occasional phenomenon of mid-winter, when there is little sun and no wind, resulting in reduced output from solar and wind.

To deal with low periods of renewables and for the other carbon emission challenges such as aviation, cement and new steel production (whose production processes produce CO2) further technologies may be required such as Carbon sequestration and Green hydrogen (Hydrogen produced by Electrolysis from renewables and stored for later use when renewables are scares).

Although conversion efficiency is still quite low (34% end to end efficiency) Green Hydrogen is gaining a lot of investment and can also be added to natural gas up to a concentration of 20% allowing an offset to be made as natural gas is decommissioned.

Storage of electricity using batteries will be an important (at least for day to night storage) and these are reducing in cost (driven by EVs). According to Bloomberg NEF Lithium-ion battery pack prices, which were above $1,100 (£800) per kWh in 2010, have fallen 89% in real terms to $137 (£100)/kWh in 2020. Alternative battery technologies are also an important area of technical development.

Expanded Grid

Over a large geographical area such as Europe the sun is likely to be shining or the wind blowing somewhere hence the increased transmission of electricity across larger distances will have an important role to play. Interconnections between regions using High Voltage Direct Current (HVDC – which have higher efficiency over longer distances than traditional Alternating Current grids) will enable an efficient market to exist across a wider geographical region reducing the impact of low renewables in a particular area; as electricity can be imported from another region.

The UK and Norway have recently completed a new interconnect across the North Sea. This will allow the UK to access cheap hydro power from Norway and Norway to consume excess renewables from the UK. Further collaborations are being planned. The HVDC technology opens up the possibility of energy flowing from the solar rich south of Europe or north Africa to northern Europe or in the other direction when the wind is blowing in the north.

Whilst the building of improved regional interconnects will help with acute generation short-falls the key to minimising investment in infrastructure is to locate as much of the generation capacity close to consumers as possible. This localisation of energy production is being actively encouraged by government as a key enabler for achieving net zero. A bill to enable the local production and sale of electricity was submitted to parliament in June 2021.

The important role of solar

In the UK Solar and Wind are complimentary and both will be needed in large measure. The government is being urged by the CCC to target at least 40GW of solar capacity by 2030. This is compared with the current installed capacity of 14GW.

The UK is particularly wind rich but even so to derive all our power from wind would require a large part of the country to be covered in wind turbines. Solar panels are particularly good at capturing the suns energy and are now achieving a phenomenal 25% efficiency (converting 25% of the solar radiation into high grade energy i.e. electricity). In comparison the ability of plants or trees to convert radiation into energy through photosynthesis is only 2% (ref: There is no Planet B, Mike Bernes-Lee P101).

Solar therefore offers a major opportunity for local energy production as solar panels can be fitted in many location from building roofs to solar farms.

Coupled with Community ownership solar power offers a great potential for local energy production, and combined with some wind and battery storage (with maybe some hydro-electric if available) can offer the real potential to achieve local energy resilience.

Sustainable Danbury is working toward the formation of a Community Benefit Society to invest in local energy production with profits going back into the local community.

