IEAGHG Information Paper 2018-IP26; Fully Decarbonising Europe's Energy System by 2050

Pöyry, an international consulting and engineering company[1] have published an analysis of how Europe's energy system can be decarbonised in line with the Paris Agreement of limiting global temperature rise to 1.5^0C. A summary of the study can be found at:
http://www.poyry.com/news/articles/fully-decarbonising-europes-energy-system-2050

This study investigates the key question: "How can a fully decarbonised energy sector be achieved and what are the risks of reducing options in favour of certain technologies?"

The challenge as stated in the report, is that to achieve the Paris Agreement temperature target, which means that Europe must go beyond its previously agreed 80% economy-wide greenhouse gas reduction target by 2050[2] and achieve a 95% reduction relative to 1990. This equates to a reduction in greenhouse gas emissions of 3,771Mt CO_2e by 2050.

As the basis of the study, Pöyry has looked at options for decarbonisation of the power, heat and transport systems in Europe. They have two pathways, accepting that multiple pathways exist, but feel that by comparing the outcomes of the two pathways chosen has provided information that allows an assessment of the risks and challenges to be made.

The first pathway is ***The 'Zero Carbon Gas' Pathway.*** In the study, the term 'zero carbon gas' refers to all gaseous fuels that can have a zero carbon footprint across their production chain. This includes:

- Biogas/Biomethane: Carbon emissions resulting from burning the gas are offset because of the sustainable source of the gas.
- Hydrogen from methane reforming: Carbon content has been removed from methane and then captured and stored.
- Hydrogen from electrolysis: No carbon emissions arise in the process.
- Carbon capture and storage (CCS): Although it does not fully remove CO_2 from the process, 'negative emissions' can be created if sustainable bioenergy carriers are used in CCS. These 'negative emissions' arise since carbon has already been captured in growing the precursor for the bioenergy carrier.

The Zero Carbon Gas Pathway represents a future scenario where economics determine which technologies are employed to fully decarbonise the energy sector.

In the Zero Carbon Gas Pathway, decarbonisation is achieved by the following technology mixes in each sector.

Transport	The use of hydrogen[3] vehicles in the freight sector and electric vehicles in the passenger sector is proposed.
Heating	For non-process heating a mixture of NG district heating (with CCS), hybrid heat pumps and standalone hydrogen[3] boilers are suggested
Power	Renewables (solar and on shore wind) form the bulk of the capacity balanced by gas fired and hydrogen CCS plants, with some nuclear capacity

[1] http://www.poyry.com/about-poyry
[2] https://ec.europa.eu/clima/policies/strategies/2050_en
[3] The hydrogen supplied is produced from steam methane reforming of natural gas with CCS. Electrolysis is considered to be too costly in most situations but does featire in countries with very high renewable penetration.

Grids	NG distribution largely converts to hydrogen; a CO_2 storage network is developed and electrify grids reinforced.

The second pathway considered is the '**All Electric Pathway',** which assumes that only electrification can achieve deep decarbonisation and that polices are put in place to prevent the deployment of 'Zero Carbon Gas' alternatives.

In the All Electric Pathway, the following technology mixes in each sector achieve decarbonisation:

Transport	Electricity is used for both passenger and freight haulage.
Heating	For non-process heat – heat pumps are used (air sourced in urban environments and ground source in rural areas For process heat current fossil based production switches to biomass, as does CHP.
Power	Increased demand for electrify is met by renewables with significant amounts of nuclear electrify also required to balance intermittency
Grids	Gas networks are decommissioned, Europe wide electrify interconnection doubles to more than 300Gw to enable sharing of all generation sources.

As the study indicates, the good news is that there are options to achieve the decarbonisation targets required under the Paris Agreement.

However, achieving this level of decarbonisation will require transformation of the energy sector whichever pathway you choose. Decarbonising will require significant investment estimated at around €1trillion for the energy sector alone.

Overall, the study suggests that allowing competition between all energy solutions leads to a more integrated and lower cost solution. The restricted All Electric pathway prohibits competition and leads to an overall higher cost world.

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