Comments on the IEA World Energy Outlook 2021

The WEO 2021 report is a very comprehensive and well prepared overview of the current status and three possible scenarios for the future up to 2050 and beyond. The comments below are meant to supplement the report with a few ideas, that could be incorporated and influence the scope of subsequent WEO's.

Hydrogen is referred 410 times in the report, and it seems to be a lot, but it doesn't come clearly through, that we are moving towards a hydrogen society. Hydrogen is seen as one of the sources for low-emission liquified fuels like methanol and ammonia. However hydrogen is applicable directly in the transportation, industry and energy sectors. Hydrogen cars are not mentioned in the report, that has an overwhelming focus on electric vehicles. However, in cities it is impossible to provide enough roadside charging facilities, so electric vehicles cannot be dominant in the cities until an EV can be charged in less than 5 minutes on a filling station. This is future. Hydrogen cars however can refill at a filling station with hydrogen filling facilities in less than 5 minutes today. In South Corea Hyundai leads a roll-out of hydrogen infrastructure to the whole country, covering the full supply chain, from production via distribution to sale at filling stations. Hydrogen cars are not a technology of the 2030'es and beyond but has the potential to be scaled up today. Hydrogen is applicable today for cars, trucks, railways, intercontinental ships and soon also aircrafts. Hydrogen is supposed to be cheaper than methanol and ammonia, as it is a raw material for the latter.

Electric grid flexibility supported by energy storage is mentioned, but with a focus on battery storage. Hydrogen storage is an alternative, that should be considered, not after 2030 but in the 2020's. The cycle of hydrogen production, storing, and utilization for electricity production leads to a considerable energy loss, but if this loss is utilized in for example a district heating system, it is not a loss anymore but just another source of energy supply for the district heating plant. This is not applicable everywhere, but a big proportion of the people on this planet has a demand for space heating and could benefit from district heating. District heating is mentioned only once in the report. In a country like Denmark, where more than 50% of the population are already served by district heating, this is an option, that must not be missed, but district heating would be beneficial in a lot of cities worldwide even if it is not there yet.

There is a focus on the electric grid, but the costs for developing the electric grids to the capacity and flexibility needed in the future has not been assessed. This may be one of the most expensive elements of the transition to the non-fossile society. Besides the direct cost of grid expansion there are the derived costs of traffic congestion in the construction phase. In Denmark almost all electric infrastructure is under ground (not prone to tornadoes!) which means that grid expansion must be done by digging most of the roads, but even if the extra capacity is provided as overhead electricity like in the USA the traffic will be severely disturbed during construction. The congestion costs should be considered as well. Minimizing the demand for grid expansion may very well be a succes criteria for the green transition.

The energy consumption in the agriculture is covered in the report but the CO2- and methane emissions of the livestock is not considered. Thus the temperature rises computed cover only energy, and the complete temperature rises will be higher. We should reduce our livestock dramatically but governments dislikes this, as there is a big and growing demand for meat and dairy products globally. However, it is not fair, that the richer half of the Earth's population can sustain a food production, that emits enormous amounts

of CO2 and methane, when the yield from vegetarian agriculture is 10 times higher and with a negligible emission of CO2, at least when organic farmimg is applied.

If the livestock is reduced this way globally, there will be no raw materials for biogas production. I don't see a future, where the gas grids of today transport biogas, not even if enriched with 20-30% hydrogen. The gas grids may in the future be used to transport CO2 from CCS-installations distributed across the countries like district heating plants are in Denmark today, back into the underground via retired oil- and gas production platforms, reversing the flow direction in the gas grids.

The EU considers integration across sectors (EU-term ”sector coupling”) a key to optimization of the green transition. The above example of hydrogen storage coupled with district heating is an example of sector coupling. The idea is that a lot of value can be released, as waste in one sector may be value in another. Sector coupling is not mentioned in the WEO 2021 report but may nevertheless be a key concept in the green transition to come.

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