Consultation response to the technology assumptions regarding energy for the upcoming EU Reference scenario

From the Danish Council on Climate Change

The EU Commission has proposed for the EU to undertake the massive and necessary task of decarbonizing the entire European economy by 2050. Accurate and transparent analyses are pivotal in achieving that goal in a cost effective way. The importance of the modelling efforts carried out by the EU Commission to provide a solid basis for policy making can therefore not be underestimated.

In this regard, basing analyses on well-researched and transparent data is crucial. We see great potential to improve the current assumptions and encourage the EU Commission to rethink how assumptions for analyses are derived, documented, and not least made available to the public.

Energy systems become increasingly interlinked and numerous technological solutions are offering prospects of delivering greenhouse gas emission reductions. In particular electrification based on wind and solar power is set to play a key role in decarbonizing the energy system towards 2050 as pointed out by the Commission's Long Term Strategy published last year. Proper analyses of these technologies set new requirements for the modelling framework, which needs to be adapted to remain fit for purpose.

It is crucial for the model results, that the assumptions on capacity and prices of technologies reflect the best guess on how these evolve in the future. In the areas of e.g. renewables and batteries, development is happening very fast and there is therefore a stronger need for up-to-date data on cost and performance. If studies that are just a few years old are used to derive costs, one may well end up with too high cost estimates. Literature studies should therefore be undertaken with care and up-to-date analyses on cost and performance of technologies be given more weight.

Going through the assumptions in consultation we have found a number of values that deviates substantially from the numbers in the Danish Energy Agency's well-documented Technology Data Catalogue (DATC).[1] The consultation document does not contain references to data sources and hence we have not been able to check their

[1] https://ens.dk/en/our-services/projections-and-models/technology-data

validity, but several values, which have a strong impact on modelling results, could benefit from being brought up to date.

Our main concerns regarding the technological assumptions are:

1) **Domestic**: Current assumptions severely penalizes district heating as well as heat pumps. We encourage the Commission to adjust these figures, potentially using the numbers from DATC.
2) **Power & Heat**: With limited transparency regarding the potentials and capacity factors for wind power in different countries, it is difficult to assess whether assumptions are reasonable or not. We therefore encourage the EU Commission to disclose what data is used.
   We also find that assumptions for electricity to district heating technologies are very unfavorable compared to the values in DATC.
3) **New Fuels**: Assumptions for battery storage seem to put this technology at a disadvantage. However, the level of detail provided in the consultation documents make it difficult to assess whether the assumptions for storage are reasonable.
   There seems to be a need for re-evaluation for cost figures for storage technologies in general.

Furthermore, we have found a number of minor errors in the way data is presented, which cause confusion as to how data should be interpreted. In order to ensure quality feedback, the consultation documents should be very clear on the units of values presented.

Modelling the entire European energy system in detail is a massive task. On top of this, the relatively small group of consultants need to derive assumptions and process the vast amount of inputs from stakeholders. We encourage the EU Commission to consider spending more resources and potentially insourcing the task of providing well-documented, transparent technology assumptions. Such data can form the basis of all models used by the EU Commission eliminating discrepancies between different models.

Inspiration can be found in the DATC, which is published by the Danish Energy Agency and contains frequently updated well-documented cost and performance data for a wide range of technologies. The technology data is used in all major energy systems studies in Denmark and provide a common ground for discussion.

The chapters below elaborate our main concerns; give further comments on, and questions to the work carried out by the EU Commission. Following the initial general comments to the assumptions and consultation process, the below chapters are structured according to the sheets in the consultation document provided (Domestic, Power & Heat and New Fuels).

General comments

The consultation does not show all technologies, which complicates the process of reviewing the assumptions. In this regard we encourage providing the full list of technologies to stakeholders. Ideally, this should also include the assumptions for existing plants (lifetime extension costs and fixed O&M that define the economics of plants leaving the market).

We suggest checking which technologies are being used by the model. This has at least two purposes. First, this could provide valuable input to how the list of technologies put in consultation can be structured to put the most relevant first. Second, it could form the basis of a valuable discussion on why some technologies are not chosen by the model. If the technologies are currently being deployed in the market, but this is not reflected in the model, there is reason to revisit assumptions.

Consider also doing sensitivity analysis on technology costs. This is different from the previous approach, where sensitivity analyses have been carried out on policy rather than technology (according to the EU Commission at the workshop). However, history shows that costs of e.g. wind and solar power have developed very differently from what was expected. With the emergence of market driven renewables, rather small changes in cost assumptions can cause major differences in the extent to which renewables are deployed.

Where relevant, the consultation should include data and description of methodology used for parameters that affect the modelling outcome. This is particularly relevant for the renewables potentials, but also the non-linear cost additions for increased electricity demand and expansion of renewables that simulates increased public opposition.

Domestic

We are concerned that the assumptions on efficiency on domestic heating units are too low in general, and much too low for some specific technologies. We generally find much higher efficiency values in the DATC.

District heating units have an efficiency close to 100 % in the real world (it is just a simple heat exchanger). Using a value of 74 % puts district heating at a major disadvantage as cost of all district heating increases by 35 % in the model. E3M consultants said at the workshop that the efficiency only covers the unit itself and that network losses are added on top of this.

- ➔ The efficiency of district heating units should be corrected to 98-100 % as stated in the DATC.[2]

At the workshop, it was stated that efficiencies of heat pumps are low due to the need for inefficient back-up heating (e.g. an electric boiler) as a heat pump cannot cover the entire heat demand of a household. This does, however, not justify such low efficiencies.

- ➔ We propose to adjust efficiencies bringing them in line with data from the DATC. In particular, for the heat pump air COP. It is currently too low (both current = 1.98 and 2030 = 2.13-2.65). The DATC suggests 3.55 for air/water heat pumps connected to radiators in 2030 in Denmark.[3]

Furthermore, we suggest the following minor corrections to the provided consultation data:

- ➔ Please clarify what "current" refers to in the consultation document. Current fleet average or new installations today?
- ➔ Please elaborate in the document how the "From … to" costs and efficiencies should be interpreted. If the model can choose between the categories won't it always pick the best option?
- ➔ Please clarify in the document if "heat pump air" refers to air/air heat pumps or air/water heat pumps.

[2] See page 47 here: https://ens.dk/sites/ens.dk/files/Analyser/technology_data_catalogue_for_individual_heating_installations.pdf

[3] See page 89 here: https://ens.dk/sites/ens.dk/files/Analyser/technology_data_catalogue_for_individual_heating_installations.pdf

Power & heat

Our main concerns and recommendations to this part of the assumptions relate to wind and solar power and electricity to district heating.

Wind and solar

We would like to highlight again the need for transparency regarding the potentials and capacity factors for wind and solar power in different countries. This information is pivotal in the modelling and the aggregate numbers provided unfortunately do not provide confidence that in particular offshore wind is modeled correctly.

- ➔ We therefore encourage the Commission and E3M to disclose numbers on how much wind and solar capacity can be built in each category per country. Potentials should be based on non-proprietary sources. Iain Staffell, Imperial College London (who did the study for the IEA offshore wind potentials) and/or the JRC[4] could be relevant sources.
- ➔ Along with the above, information on what wind turbine design is assumed should be disclosed, i.e. specific power of turbines. Also, turbine choice should be optimized to different wind speed categories (both onshore and offshore) reflecting that turbines with larger rotors relative to generator capacity are deployed in low wind speed sites. These turbines have higher CAPEX, but also higher capacity factors.
- ➔ Please state what DC/AC factor is assumed for solar PV. Do different assumptions here explain the large difference in capacity factors for utility scale and residential solar?[5]
- ➔ Consider including solar PV with tracking in the modelling. These should have a higher CAPEX, but also higher capacity factor than regular fixed tilt solar PV. The Danish Energy Agency have just published their updated technology data on solar PV (including tracking). We encourage the EU Commission to use the numbers found there[6].

Determining the validity of assumptions for wind and solar should be done using the most recent tenders as cost declines seen over past years have been dramatic. Using historical costs should therefore be done with care. For offshore wind in particular data should be analysed based on auctioning rather than commissioning years of projects in order to reveal the clear trend[7].

A litmus test for whether the modelling is adequate is whether it is able to reproduce the coming boom in market driven renewables in Europe. A single Danish company expects to put up 7 GW solar PV in Denmark, 10 GW in Sweden and 20 GW in Poland in the coming years. While this may not all materialize it is a strong indication that we are at the brink of a new era[8].

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[4] https://publications.jrc.ec.europa.eu/repository/handle/JRC116900
[5] It was said in the workshop that solar PV data is given on an AC basis.
[6] See chapter 22 here:
https://ens.dk/sites/ens.dk/files/Analyser/technology_data_catalogue_for_el_and_dh.pdf
[7] https://www.spglobal.com/marketintelligence/en/news-insights/trending/vbj3VXq0qnVpfm8DeTlabg2
[8] https://energywatch.eu/EnergyNews/Renewables/article11748178.ece

Electricity to district heating

The assumptions for electricity to district heating technologies currently make it unattractive to invest in these technologies, which is contrary to what we are seeing in Denmark.

- ➔ We propose adjusting the COP upwards for DH Heat pumps. In the consultation spreadsheet the COP is 2.5 by 2020. The DATC (sheet 40) suggests 3.6 rising to 3.8 by 2030 using ambient heat sources in Denmark.[9]
- ➔ We propose adjusting the cost for DH heat pumps and electric boilers down. They are currently a factor of 4.5 and 12 more expensive than the DATC.[10]

New Fuels

Assumptions for batteries should reflect the type of batteries that the model actually uses. If the model e.g. uses batteries for diurnal storage purpose, costs for batteries with several hours of storage should be used. Answers at the workshop implied that large batteries are assumed to be more expensive than small because the literature shows that. But large batteries have historically been deployed for frequency regulation and hence have high power/energy ratings (and high per energy costs). If frequency regulation is not modeled, (which we assume it is not, given that it was also said that PRIMES have about 200 time steps per year) then the batteries do not see revenues from offering this service and hence will appear too expensive to be deployed.

- ➔ Please adjust battery costs to reflect the type of battery (energy/power ratio) simulated in the model
- ➔ Consider expanding the data for consultation with information on how many hours of storage are assumed. This will allow for a better assessment of whether assumptions are reasonable. Furthermore, it allows for understanding the fixed O&M costs which are given per kW as opposed to the investment cost, which is given per MWh.

It should also be considered that the economics of using storage technologies in the model are strongly affected by temporal granularity of the model and depending on whether time steps are chronological or not. If the time steps are larger than the duration of a full charge or discharge of the storage, then the capacity value seen by the model will be less than what is seen in the real world. Batteries could have a significant role to play as peakers in the energy system if capacity costs decline below the cost of gas and diesel peakers. The modelling should reflect this.

Regarding other storage technologies, we believe that the technology costs need to be revised:

- ➔ The numbers in consultation for thermal storage technology states 100,000 €/MWh and an 80 % efficiency. We propose using data from DATC on large

[9] See page 246 in https://ens.dk/sites/ens.dk/files/Analyser/technology_data_catalogue_for_el_and_dh.pdf
[10] See page 257 in https://ens.dk/sites/ens.dk/files/Analyser/technology_data_catalogue_for_el_and_dh.pdf

hot water tanks for district heating, having a loss of 0.2 % per day and a CAPEX of 3000 €/MWh.[11]

- ➔ H_2 underground storage is currently 160 times more expensive than underground CH_4 storage. This seems to call for a revision.
- ➔ We would like to see a footnote on how efficiencies for CH_4 and H_2 storage should be interpreted. Do losses relate to lost fuel or energy used for compressors?

There are a number of misleading headlines, units and definition in the tables provided in the New Fuels section. These cause confusion and make it difficult to provide quality feedback to the assumptions:

- ➔ It does not make sense that PtL numbers are given per 1 MWh CH_4 HHV as CH_4 is not the output.
- ➔ Consider splitting the CO_2 part from the rest of the table. It needs to have special units.
- ➔ The unit for variable costs of CO_2 transmission networks is wrong (EUR/kWh).
- ➔ "Investment cost per unit of energy stored per year (EUR/MWh)" should be relabeled to "Investment cost per unit of energy storage (EUR/MWh)". Consider adding in a footnote that the values are given per unit of storage discharge capacity – if that is the case.
- ➔ Similarly "Investment cost per ton CO_2 stored per year (EUR/tCO_2)" should be relabeled to "Investment cost per ton of CO_2 storage capacity (EUR/tCO_2))"
- ➔ If pumping is given in another unit, it would be preferable to split it from the table. However, if the cost of pumping mainly relates to establishing the reservoir, the cost should be given per unit of energy rather than capacity.

We propose to not show units in the descriptions (column A) and split tables such that units in headlines always match the values below.

We would also prefer if data in the New Fuels sheet were given for the same years as in Power & Heat (i.e. 2020, 2030, 2040, 2050). As a minimum, we would like to see a formula that shows how costs for 2020 and 2025 are derived based on 2015 and 2030 values.

We are looking forward to your response and will be happy to clarify any of the above.

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[11] See page 59 in
https://ens.dk/sites/ens.dk/files/Analyser/technology_data_catalogue_for_energy_storage.pdf