EC Consultation on technology assumptions in the context of the new EU Reference scenario

Eurelectric comments on the draft technology assumptions

November 2019

Eurelectric represents the interests of the electricity industry in Europe. Our work covers all major issues affecting our sector. Our members represent the electricity industry in over 30 European countries.

We cover the entire industry from electricity generation and markets to distribution networks and customer issues. We also have affiliates active on several other continents and business associates from a wide variety of sectors with a direct interest in the electricity industry.

We stand for

The vision of the European power sector is to enable and sustain:

- A vibrant competitive European economy, reliably powered by clean, carbon-neutral energy
- A smart, energy efficient and truly sustainable society for all citizens of Europe

We are committed to lead a cost-effective energy transition by:

investing in clean power generation and transition-enabling solutions, to reduce emissions and actively pursue efforts to become carbon-neutral well before mid-century, taking into account different starting points and commercial availability of key transition technologies;

transforming the energy system to make it more responsive, resilient and efficient. This includes increased use of renewable energy, digitalisation, demand side response and reinforcement of grids so they can function as platforms and enablers for customers, cities and communities;

accelerating the energy transition in other economic sectors by offering competitive electricity as a transformation tool for transport, heating and industry;

embedding sustainability in all parts of our value chain and take measures to support the transformation of existing assets towards a zero carbon society;

innovating to discover the cutting-edge business models and develop the breakthrough technologies that are indispensable to allow our industry to lead this transition.

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WG RES & Storage
WG Hydro
WG Thermal & Nuclear
WG Environmental Protection
WG Electrification & Energy Efficiency
WG E-mobility
WG Innovation & Digital
WG WMDIF
WG Gas to Power
WG Technology
WG Institutional Frameworks
WG BM&NC

Generation & Environment Committee
Electrification & Sustainability Committee
Markets & Investments Committee
Distribution & Market Facilitation Committee
National Associations

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KEY MESSAGES

- The power sector supports a climate neutral Europe by 2050. Going forward **electricity will be a key carbon neutral carrier which will help decarbonise other sectors**, through direct and indirect electrification.

- On the way to 2050 **electrification should be further enabled** through the relevant infrastructure in other sectors like e.g. charging infrastructure, regulatory framework e.g. PEF and a future proof investment environment for clean technologies.

- The price of the commodity is also key in order to allow electrification to happen: **freeing up the electricity bill from increasing fixed cost components** will enable digitalisation, demand response and active customers' participation in the electricity markets.

- In this context, **Eurelectric welcomes the opportunity to comment on the technology and costs assumptions as input to the new EU Reference scenario** on energy, transport and GHG emissions. Nevertheless, for this crucial exercise **we regret the short consultation period to stakeholders to consolidate their views and provide comments.**

- Costs are a key element for such a modelling exercise, nevertheless regulatory frameworks, political decisions, physical limitations and societal benefits will also play a prominent role in the development and adoption of some technologies. **It is unclear whether the assumptions will be used in a pure economic optimisation model or whether key qualitative elements will be included to achieve different scenarios.**

- Data sets show **just one value per technology and per year**, which fails to encompass the diversity of situations such as new versus existing plants, as well as a number of criteria which influence investment costs such as sites of plants, tax systems and availability of natural resources (e. g. sunshine, wind speed). They are therefore only **indicative and do not reflect the situation in some areas.**

- An **appropriate regional differentiation** for investment costs, learning rates, lifetime calculations or estimated capacity factors should be introduced.

DISCLAIMER: Quantitative elements and figures in this paper are provided by individual Eurelectric members and do not reflect the view of the association as a whole.

A. General comments on the methodology

Preparing a **New EU Reference scenario on energy, transport and GHG emissions** is an exercise of critical importance. We therefore regret the extremely **short time frame** provided for this consultation which does not allow us to fully discuss and consolidate the input received.

We also regret that no further background information is provided to stakeholders ahead of the consultation meeting. For instance, it is not specified how this data will be used in different scenarios, and what type of scenarios will be developed under which storyline.

We understand that costs are a key element for such a modelling exercise, nevertheless regulatory frameworks, political decisions and taking into account societal benefits will also play a prominent role in the development and adoption of some technologies. The assessment has to take into account sociocultural aspects (e.g. acceptance of transport and storage of high volumes of CO_2, visual or acoustic impact of generation units, benefits regarding air quality, land use) and some practical limits in potential development (e.g. wave or geothermal energy). It is therefore unclear from this consultation whether these costs will be used in a pure economic optimisation model or whether key qualitative elements will be included to achieve different scenarios. We would welcome that this issue is seriously debated at the consultation workshop.

Furthermore, the figures indicate just one value per technology and per year. As limited information is provided around the datasets, it seems that the figures chosen fail to encompass the diversity of situations. Indeed, it is difficult to understand whether this data set represents an EU average or whether some geographical variations are foreseen. We therefore call for clarification of the following items:

- Whether capacity factors apply to new technologies or fleet averages (including already installed capacity).
- A reflection of the values diversity of situations that influence investment costs (e.g. soils and sites of plants) and O&M costs, of tax systems and of natural resources (e. g. sunshine, wind speed). Alternatively, it should be specified that they are therefore only indicative and do not reflect the situation in some areas.
- Differentiation between existing and mature technologies on the one hand and completely new ones that will emerge after major breakthroughs (e.g. underground storage of hydrogen, CO_2 capture from air). The costs of these innovative technologies are highly uncertain and must be used in a cautious way.

B. Detailed comments on the data set

1. Domestic

For the building sector, a more detailed set of assumptions is needed to appropriately reflect geographical, meteorological, infrastructural and societal differences across Europe. Purchasing costs of space and water heating technologies are different for situations in which a new building is constructed, an existing building is deeply renovated or an existing technology or appliance simply replaced with a presumably more efficient device of the same or comparable technology.

In addition, the existing and future energy infrastructure as well as local technological and space limitations need to be taken into account when assuming purchasing costs and potential shifts from conventional heating systems to technologies such as district heating, heat pumps or fossilfired boilers. In addition, more information is needed on the assumptions regarding average household size, floor space of housings, applicable building standards for renovation etc.

We would also welcome further explanations on the rationale for air-to-air heat pumps' efficiency. Some Eurelectric members have indicated that an efficiency of 2.17 in 2015 for air-to-air heat pumps seems to be low at the beginning of the period, while it jumps to 4.00 in 2050.

Clarification is needed if and how network and storage losses are included. It is unclear why the energy efficiency of district heat supply is higher in the service sector than in the residential sector as the two sectors often share common district heat networks. Note that the efficiency level of district heat depends greatly on the fuels and technologies used for district heat generation and supply.

Boilers, heat pumps, district heating

- Investment costs: we would like to outline that external studies point to significantly lower investment costs in future
- Efficiency of heat pumps: efficiency is underestimated as current projects have an efficiency rate of 3 rather than 2.17 (residential) for air-air heat pumps.

Prices of electric and thermal equipment: We recommend further studying and benchmarking prices of both electric and thermal appliances (e.g. oil and gas condensing boilers, dishwashers, washing machines) as they overall seem quite high comparing to those currently observed in some countries.

2. Renovation Costs

For buildings, energy efficiency gains seem too optimistic in "Medium Renovation" and "Deep Renovation". They show -78%/-87% trajectories, while Eurostat shows a maximum potential of around -50%. This was derived from the current average isolation of European Houses (namely the UBat parameter) as described in the European Building Database https://ec.europa.eu/energy/en/eu-buildings-database. Furthermore, it is unclear if the proposed Energy Efficiency has taken into account the reduction resulting from the "rebound effect".

The proposed data seems to suggest that energy saving potentials from deep renovation is highest in the North compared to South or East. This may be counter intuitive as buildings in Northern Europe have high levels of renovation and therefore are unlikely represent the lowest hanging fruits.

From a methodological point of view, it could be useful to specify whether or not the investment costs correspond to the total investment or only to the additional investment costs for the energy part of the renovation.

Questions remain on the exchange rate assumed for the renovation costs, as not all regions include Eurozone members and it can have an impact on the costs in Euros and how regions are defined and composed.

3. Industry

No comments.

4. Power & Heat

General comments

Capacity factor (CF): an accurate definition of what a CF is would be useful to adapt the data accordingly. They also vary region by region so some sensitivity assessment is recommended. According to the note file attached to the consultation (E3M PRIMES tech assumptions ENERGY note) it seems that the values presented are averages, shown for illustration purposes and the actual values differs from MS to MS. Hence, in case different capacity factors have been assumed (wind, run of river, solar, etc), it would be good to see the specific values (for regions, MS, etc.) instead of the mere averaged ones for illustration purposes.

Electrical Efficiency: the database base reflects electricity generation in electricity only plants and district heat generation in heat only plants. It remains unclear how CHP has been taken into account. For CHP and heat only systems it would be more accurate to use thermal efficiency.

Investment costs (€/kW) are attractive for modelling purposes but do not take into account economies of scale in plant sizing and the relatively large cost, per unit output, of small plants compared to larger ones. To address this there may be some value in using "reference sizes" to provide information on the typical size of an installation.

Learning rates: leading to cost reductions, for technologies will only materialise as roll out occurs. It is appropriate to assume low learning for established techniques, whereas the large learning rate and cost will manifest depending on deployment, therefore it is appropriate to conduct some sensitivity assessment (or caveat results accordingly).

Capital costs: It is assumed that capital costs are quoted on a €/kW output basis, rather than input. However, this means that comparing the costs of heat only installations with power only installations is not possible as they are fulfilling different duties.

CO_2-emission values: they are missing in the "Power & Heat" table.

Other sources mentioned by Eurelectric members:

- Arup (2016): Review of Renewable Electricity Generation Cost and Technical Assumptions Study Report (Final), Prepared for Department of Energy and Climate Change, June 2016
- BEIS (2016): Electricity Generation Costs, November 2016
- BEIS (2018): Updated Energy and Emissions Projections 2017, January 2018
- EPRI (2015): THIRD PARTY REVIEW OF ELECTRICITY GENERATION COSTS AND HURDLE RATES LOT 3
- Grantham Institute: Peer review of: "Review of renewable electricity generation cost and technical assumptions"
- Leigh Fisher (2016): Final Report Electricity Generation Costs and Hurdle Rates, Lot 3: Non-Renewable Technologies, Prepared for Department of Energy and Climate Change, August 2016

Solar and Wind

Our members are concerned that the **assumptions for wind and solar may be based on fleet averages**, and therefore include 10 and even 20 year old turbines and panels. Fleet averages neither reflect the current nor the future state of the art of wind turbines and solar panels.

Technical lifetime: a number of our members commented that the industry standard is higher and suggested revision of the lifetime upwards to consider 30 years for wind (onshore and offshore) and solar PV.

Overall the **development of the investment costs** is quite conservative especially considering the development of PPAs. Moreover, site resource potential usually does not affect the investment cost (euro/watt) of PV plants. On the contrary, low potential wind sites usually call for higher, better performing and therefore more expensive WTGs. While for solar small scale rooftop PV (residential) assumptions seem accurate other lines are quite high. It should also be clarified if the investment costs refer to the generation units only or whether the full system cost and in particular grid connection are included.

Fixed O&M: a clarification on what is included in this item is needed, if it includes other OPEX components, those are usually very country specific so a more accurate analysis can be done. Some members pointed out that numbers are too high for large scale systems.

The **overall costs are more region dependent** and this geographical element should be taken into account. Some Eurelectric members mentioned the following reports for reference:

- IEA Energy Analysis in IEA Task 26 which models different turbine types suitable for different types of sites and with different market value of production.
- The recent Report on Cost of Renewable Power Cost in 2017 (IRENA 2018) which presents examples of renewable power projects across all technologies, types and regions. This data is from real world projects and differs substantially from the ones in consultation.

Wind

For wind, different assumptions for capex and capacity factors were made depending on resource areas, hub heights and water depths. Our members believe that this could be a good method, however, they have identified two major issues:

- The given data does not give any insight on h**ow much potential is assumed within the different categories**. It makes a big difference if 90 % of the installations are expected in a category with a capacity factor of around 30% or in a category with capacity factors of around 50%.
- For **onshore wind**, it isn't clear why the Commission assumes a **correlation between the availability of resource (resource in the area where the turbine is installed) and the CAPEX of the turbine itself.**
- For **offshore wind**, it seems that the Commission assumes perfect **correlation between water depth and wind speeds**. This is contradictory as some of the best wind conditions in the North Sea can be found around the West Coast of Denmark in relatively shallow waters. Further, also locations far from the coast (i.e. the Dogger Bank) can have low water depths. In this context, a more meaningful methodology would be to combine wind data and different types of turbine designs.

In addition, members have highlighted that the assumed **load factors for offshore wind seem to be too conservative**, and further evidence can be found in the BEIS Research Paper 2019/023[1].

[1] https://www.gov.uk/government/publications/potential-to-improve-load-factor-of-offshore-wind-farms-in-the-uk-to-2035

It is not clear whether the **offshore wind capex** includes grid connection to land or not.

Our members would like to point out that the **cost assumptions and capacity factors for wind are too high.** This is confirmed by recent tenders as well as by publicly available resources, such as the **Technology Catalogue**[2] (a joint publication of Energinet, the **Danish TSO,** and Energistyrelsen, the Danish Energy Agency).

Variable	**E3: CAPEX (incl. cable to shore) (2020/2030) (€/kW/year)**	**Literature based suggestion (€/kW/year)**	**Source/comment**
Water-depth <30 m	2234/1815	**1750/1660**	Source: *Data Sheet Off-shore* – "Technology Data. Generation of Electricity and District Heating", Energinet, 2016, page 202
Water depth 30 – 60 m	2789/2058	**2130/1930**	
Water depth > 60 m	3215/2464		Capex at water depths > 60 m would be more expensive, but key variable is the wind speed
	E3: for fixed annual OPEX (2020/2030) (€/kW/year)		
Water-depth <30 m	33/27	**36/34**	Source: *Data Sheet Off-shore* – "Technology Data. Generation of Electricity and District Heating", Energinet, 2016, page 202
Water depth 30 – 60 m	42/31	**40/36**	
Water depth > 60 m	48/37		OPEX at water depths > 60 m would be similar as the two other categories
	E3: for variable OPEX (2020/2030) (€/kW/year)		
for water-depth <30 m	0,39/0,39	**0,26/0,3**	Source: *Data Sheet near-shore* – "Technology Data. Generation of Electricity and District Heating", Energinet, 2016, page 203
Water depth 30 – 60 m	0,39/0,39	**0,3/0,2**	
Water depth > 60 m	0,39/0,39		OPEX at water depths > 60 m would be similar as the two other categories
	E3: for capacity factors		
Water-depth <30 m	0,28/0,38	**0,51/0,53**	Source: *Data Sheet near-shore* – "Technology Data. Generation of Electricity and District Heating", Energinet, 2016, page 203
Water depth 30 – 60 m	0,36/0,38	**0,51/0,53**	
Water depth > 60 m	0,47/0,47	**0,51/0,53**	

[2] https://ens.dk/sites/ens.dk/files/Analyser/technology_data_catalogue_for_el_and_dh.pdf

Thermal power plants

Members have pointed out that peaking **open-cycle gas turbines (OCGT) without heat recovery should be included** as well. One good public source of OCGT parameters is the Irish single electricity market (SEM) Cost of New Entry (CONE) document[3]. In this report, the cost estimates can be found in the tables 2, 4 , 34 and 52 - with a clear difference between OCGT and CCGT costs (in both capital costs and annual fixed O&M costs).

The **specific EPC costs for the OCGT plants are about € 500/kW and the total capital costs about € 650/kW** (30% higher than EPC costs), lower than listed in the assumptions for the overnight investment costs of € 800/kW in 2020 (gas turbine with heat recovery).

CCGT:

- Fixed O&M: we would recommend checking and benchmarking the fixed OM Vs the variable OM. For CCS technologies it is not clear what portion of the full CCS chain costs are included in the figures – for instance is CO2 compression included?
- Investment costs: Figures from RTE (France) point to current numbers around 830 euros/kW for CCGT and to higher fixed O&M cost (36 euros/kW/y).

Internal Combustion Engines, ICE: The important category of gas-fired large scale Internal Combustion Engines (ICE) operated in CHP is missing, with new units having electrical efficiencies of over 42% and up to 47% and total fuel utilisation of 80 – 95%. Large-scale ICE plants are increasingly build in countries such as Germany (e.g. Kiel, Mainz, Stuttgart) and usually comprise several units of about 10 MW that are operated in a highly flexible manner in conjunction with large scale thermal storage and power-to-heat installations.

Hydropower

When considering hydropower, a wider range of classification option is needed as the document only refers to «lakes» and «run of river». For instance, all hydropower technologies (run-of-river incl. ponding, storage, pumped storage) as well as their various sizes (small, medium and large scale) should be reflected as it is also done by the recent Report on Cost of Renewable Power Cost in 2017 (IRENA 2018) presents examples of renewable power projects across all technologies, types and regions.

A VGB report[4] provides a dataset of different categories of hydropower plants

- **Technical lifetime** : typically more than 100 years in case of regular maintenance
- **Capacity factors**: if the CF is the ratio between firm capacity and installed capacity the numbers are shown in the table. In case the CF is the ratio between full load hours and total hours the numbers are 0.2 for storage and 0.45 for run of river.
- **Investment costs**: it would be more accurate to differentiate between small, medium and large hydropower (as it is done for wind and PVs) or providing a range of costs. IRENA (2012)[5] published a cost analysis of hydropower estimating lower costs - already years ago - than those provided by the technology assumptions. Therefore, various plant sizes could be included.
- **Electrical Efficiency**: electricity conversion efficiency ranging from 85% to 95%, round-cycle efficiency of more than 80% (modern pumped storage power plants).

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[3] https://www.semcommittee.com/sites/semc/files/media-files/SEM-18-025a%20Cost%20of%20New%20Entrant%20Peaking%20Plant%20and%20Combined%20Cycle%20Plant%20in%20I-SEM_FINAL.pdf

[4] https://www.vgb.org/en/lcoe2015.html?dfid=74042

[5] https://www.irena.org/documentdownloads/publications/re_technologies_cost_analysis-hydropower.pdf

Nuclear

CAPEX for Nuclear III gen (including economies of scale) are coherent with WEO 2018 figures for 2030 but divert for 2040 and 2050. These costs should be around 4000€/kW instead of 6000 €/kW.

OPEX: the assumption takes a cost of 120 €/kW in 2020 when the French Cour des Comptes shows a cost of 80 €/kW.[6] table 10 on page 50 (where they are expressed in B€).

O&M

- O&M costs are often very much influenced by the regulators' requirements, hence dependent on which country the plant is operating in.
- A normal split of operating cost for a nuclear power plant is about 1/3 for fuel (including back-end costs) and 2/3 for O&M. Fuel costs should be added to the table.
- O&M can be divided into fixed O&M (labor, administration and preventive maintenance) and variable O&M (process water, waste treatment and unplanned maintenance).

5. New Fuels

General comments: it appears inadequate to categorise storage technologies as "new" fuels as there are also mature, efficient and cost-effective storage technologies. Hydropower storage and pumped storage (with and without natural inflow) constitute proven and reliable technologies. This has to be included within the overview of storage technologies especially because current reports (Report on Cost of Renewable Power Cost in 2017 - IRENA 2018) even expect that the significance of pumped hydropower storage or reservoir hydro will increase with the shift to a truly sustainable electricity sector as it is today the only technology offering economically viable large-scale storage.

Investment cost per unit of energy stored per year: the unit "(EUR/MWh)" is difficult to interpret as this data seems to depend on the energy management strategy of the asset. It is also unclear whether that the price is referred to the MWh installed more than to the MWh stored and what the "Total cost per unit stored" number relates to. Usually, the investment cost comes with respect to the maximum energy/power that can be retrieved from the system. There are therefore a number of questions: Does the number include assumptions on utilization rate? Is it the annualized value? Or is it just the overnight cost of storage capacity? (if yes, the latter the "stored per year" should be replaced by just "storage").

Thermal storage: it was pointed out that two options exist - both technologies should be included in order to provide the needed flexibility:

- traditional hot water storage for district heating
- high temperature storage in e.g. rocks as Siemens-Gamesa's FES.

CO_2 capture from air: it is important to assess the potential effect of the proposed assumptions when running the model. Outcomes pointing that it's easier to clean up later rather than avoid

[6] https://www.ccomptes.fr/sites/default/files/EzPublish/20140527_rapport_cout_production_electricite_nucleaire.pdf

carbon emissions now may be considered with caution as technological breakthroughs in this field are not certain.

Batteries:

- **Large scale batteries CAPEX**: several members pointed to the fact the cost does not decrease fast enough. BNEF states that 2030 CAPEX could be around 120 €/kWh rather than the 250 €/kWh mentioned by the Commission. Although Bloomberg numbers are often quoted, direct access to the figures requires an access to BNEF services. Should an easily accessible reference be needed, the American Department of Energy, shows the Bloomberg CAPEX trends in their "Cost Projections for Utility-Scale Battery Storage"[7].

- **Electric truck batteries** costs today and in 2050 are in line with external benchmarks. However, the dynamic of cost decrease is slower than in other sources and globally introduces a 10 year delay. In 2030, the figures from the commission show a battery cost of around 300 €/kWh. The International Council on Clean Transportation mentions a cost of 120 $/kWh in 2030[8].

[7] https://www.nrel.gov/docs/fy19osti/73222.pdf page 6
[8] https://theicct.org/sites/default/files/publications/Zero-emission-freight-trucks_ICCT-white-paper_26092017_vF.pdf : table 6 p17

Eurelectric pursues in all its activities the application of the following sustainable development values:

Economic Development

- Growth, added-value, efficiency

Environmental Leadership

- Commitment, innovation, pro-activeness

Social Responsibility

- Transparency, ethics, accountability

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