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Consulation Summary Report

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TYNDP 2024 Scenarios

Summary Report – Public consultation on TYNDP 2024 Scenarios Input Parameters

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Introduction

Following the release of the Storylines Report, and with the objective to improve the quantification of underlying assumptions for the Ten-Year Network Development Plan (TYNDP) 2024 scenarios, ENTSO-E and ENTSOG conducted a public consultation on TYNDP 2024 Scenarios Input Parameters from 4 July to 8 August 2023. The present report provides an overview of the feedback received and explains how ENTSO-E and ENTSOG integrated stakeholders' comments when finalising the input data and methodology.

The public consultation addresses the following key topics:

- Data consistency with respect to the storylines of the DA & GA Scenarios;
- Technology costs and energy prices;
- Modelling methodologies used;
- Technology-specific assumptions; and
- Potential improvements for future TYNDP Scenarios editions.

In total, 30 stakeholders from diverse sectors engaged in the public consultation. Almost 3 out of 4 responses came from the following categories (the categories considered are those used in the TEN-E Regulation): Associations involved in the electricity, gas and hydrogen markets (9), supply-side operators (8) and civil society representatives (5). Figure 1 shows the representativeness of each of the categories:

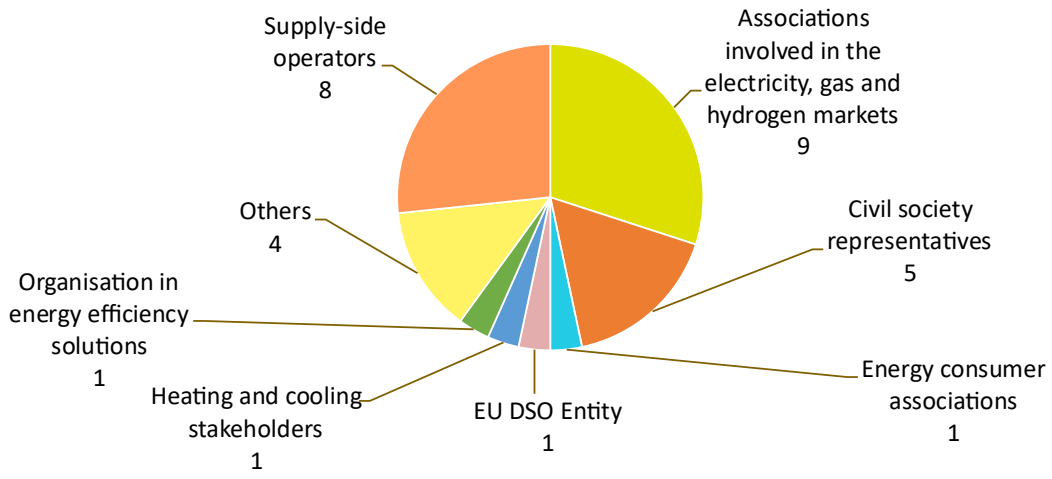

Figure 1. Responses to TYNDP 2024 Scenarios Input Parameters public consultation per TEN-E category of stakeholders.

In addition to the public consultation, ENTSO-E and ENTSOG jointly organised a hybrid workshop and stakeholder roundtables on 13 July 2023. In this event, stakeholders were prompted to share their views and discuss key topics and datasets with the Scenario Building Team. The presentation of the webinars, in addition to the summaries of the stakeholder roundtable, are available on the TYNDP 2024 Scenarios Website.[1]

[1] https://2024.entsos-tyndp-scenarios.eu/download/

Consultation outcome summary per question

1. TYNDP 2024 scenarios strategy

1.1 Comments on the TYNDP 2024 scenarios strategy

Most of the answers welcomed the opportunity to provide feedback to the TYNDP 2024 scenarios.

The most repeated topics in the answers were the publication of data and rationale of the scenarios, and the consideration of more technologies. Regarding the first, some comments refer to the clarity and validity of the assumptions and sources, and others to the explanation of the scenarios and alignment with their descriptions. There are also answers referring to flows between countries. Most of the comments asking to consider more technologies mention heat pumps and gas/ hydrogen related technologies.

Other frequent topics include the inclusion of more scenarios and sensitivities. Requested scenarios include new horizons, such as 2035 and 2045, and new hypotheses, such as 'no imports,' 'shortages' or 'more electronics'. The energy demand, generally considered slightly high, and the lack of flexibility means, was also a fairly frequent comment, such as the doubts about the achievement of the EU climate objectives or the inclusion of the updates to National Energy and Climate Plans (NECPs).It is important to note that, the scenarios report will demonstrate the alignment of scenarios with the EU energy efficiency target of 11.7% for 2030[2].

Some other repeated comments in the answers include the selection of the reference scenario, electrification, the consideration of the cost of the delay in the achievements of the climatic goals, the cost of raw materials needed for the adoption of new technologies, and the feasibility of the scenarios at distribution level.

The comments on the scenario's strategy will be reviewed during the next review period of the storylines.

1.2 Central scenario in 2030 aligned with ACER's Framework Guideline

A majority of stakeholders disagreed with having one central scenario in 2030 aligned with ACER's Framework Guidelines. Regarding the principle of having only one scenario in 2030, the stakeholders considered it essential to have sensitivities based on key input parameters, which can have a critical impact on infrastructure needs. A few stakeholders called in particular for sensitivities which show the impact of energy efficiency/demand reduction on infrastructure needs.

Several stakeholders are sceptical about a central scenario based on NECPs, because most NECPs have not been submitted/gone through public consultation. Some stakeholders called for at least two scenarios, including one close to current policies/NECPs and a more ambitious one. One asked to include a scenario with a 2030 gross emission reduction target of at least 65% below 1990 levels, aligned with what is required according to the scientific community (Climate Analytics (2022)).

Among the stakeholders who answered 'Yes', several recommended against a narrow interpretation according to ACER's Framework guidelines, which puts too much emphasis on economic growth as

[2] https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1581

the main driver. Some added that it is unclear how the NT+ scenario will be developed from 2030 to 2040.

Whether they answered Yes or No, stakeholders stressed the importance that NT be in line with the EU's latest climate target ambitions, and that a target-compliant scenario(s) be used to assess system needs and to perform the CBA of infrastructure projects.

The comments on the scenario's strategy will be reviewed in the beginning of the next cycle. The TYNDP 2024 scenarios will include only one 2030 scenario (NT+ 2030) in line with ACER framework guideline.

1.3 Updates to the 2024 Scenarios Storylines Report

Many stakeholders commented positively on the updates made to the 2024 Scenarios Storylines Report. In particular, the additional transparency and availability of data were welcomed, as were the additional stakeholder engagement measures employed by the Scenarios Building Team.

Further data transparency was requested by several stakeholders. Some stakeholders noted that the updates in the 2024 Scenarios Storyline Report were not explained sufficiently clearly when compared to the 2022 edition. Several stakeholders requested greater transparency regarding the underlying datasets used in the Energy Transition Model and the Plexos modelling. Furthermore, despite the additional tools provided, a dedicated chapter on the quantification of key parameters – as was included in the 2022 report – was still requested by some stakeholders. With regards to stakeholder engagement, an extended time period for consultations was proposed by some stakeholders, in addition to a dedicated workshop after the Storyline Consultation to review feedback.

During the publication, the related methodology of each input parameter is included in their file. In addition, a methodology slide has been created to provide further information on the underlying modelling guidelines. These were presented and explained to the stakeholder during the workshop and methodologies were further analysed during specific stakeholder roundtables, with outputs published on the website. The aim was to consult as early as possible to capture stakeholder feedback before also drafting a scenarios report to incorporate into the report. During the publication of the scenarios, a dedicated report will be drafted on the methodologies, including the quantification of key parameters.

Regarding the storylines themselves, some stakeholders found the relationship between the new NT+ storyline and the DE and GA storylines unclear, as well as the relationship of all three storylines to decarbonisation targets. Several stakeholders suggested that the storylines be more directly linked to REPowerEU targets and NECPs (although it was noted that, regarding the latter, the timelines did not fit with the scenario development process).

Finally, some stakeholders felt that the updates to the Scenarios Storylines Report did not fully consider the most recent developments in geopolitics and EU energy policy, such as the 2022 energy price crisis or the Net Zero Industry Act.

The comments on the scenario's strategy will be reviewed during the next review period of the storylines.

1.4 Other important drivers that stakeholders would like to see in the next cycle

Important drivers identified for the next cycle focused in particular on four topics: CO2 reductions, energy efficiency, geopolitical independence and social factors.

Regarding CO2 reductions, stakeholders underlined the importance of TYNDP scenarios staying within a fixed CO2 budget to achieve a suitable level of ambition. To this end, elements such as a circular economy should also be considered. One stakeholder noted that a more globalised approach to CO2 accounting is necessary to capture carbon leakage and global supply chains. Regarding energy efficiency, some stakeholders felt that the energy efficiency of primary energy demand had not been considered.

A number of stakeholders cited the recent geopolitical events in Europe as reason to place greater importance on autonomy/autarky of the EU economy and supply chains (including Extra EU Imports). In this regard, greater attention should also be paid to a reliance on critical raw materials, security of supply and stable price signals.

Social factors were also frequently cited by stakeholders as an area where greater analysis was necessary. In particular, the social acceptance – or lack thereof – of the underlying energy policies behind the scenarios should also be analysed. However, no specific proposals were given on how this could be evaluated.

2. Gap closing methodology for NT+ scenario

In general, the stakeholders expressed concerns regarding the 'need' for a gap-closing methodology and the disparity between aggregated NECPs and EU targets in 2030. While the methodology identifies the problem, stakeholders noted a lack of answers to uncertainties related to removed energy demand and its possible implications on the other targets. Emphasising the need for a meaningful transition, one stakeholder highlighted the importance of calibrating 2040 demand figures.

Considering these uncertainties, some stakeholders proposed multiple scenarios for 2030, one aggregated national data and another meeting the EU targets. However, it is essential that all scenarios adhere to the EU targets outlined in the TEN-E and ACER Framework Guideline. ENTSOs have released pre-aligned scenarios to ensure transparency regarding consolidated national datasets and the magnitude of the gap compared to EU targets.

Some stakeholders found the methodology simplistic because it proportionally reduces demand without considering sectors' decarbonisation potential and evaluating Member States' progress in reaching the targets. However, the majority of stakeholders found the methodology fair and pragmatic, providing satisfactory solutions to bridging the gap between national assessments and EU targets by remaining neutral.

It is important to clarify the sectors which are subject to the gap-closing methodology, aligning with the definition in the Proposal for a Directive of the European Parliament and Council on energy efficiency (recast)[3]. This includes international aviation but excludes the energy branch, international shipping, ambient heat and non-energy sectors.

The NT energy mix survey necessitates information on all energy carriers and their sectoral distribution. In cases where expertise is lacking, consultation with the Commission's latest scenarios (confidential) has been undertaken.

Consequently, to maintain impartial conclusions, ENTSOs have decided to retain the gap-closing methodology without modifications. To ensure a meaningful transition from 2030 to 2040, the 2040

[3] https://www.europarl.europa.eu/RegData/commissions/itre/lcag/2023/03-29/ITRE_LA(2023)002818_EN.pdf

demand will be checked and calibrated accordingly. In the interest of transparency, both pre- and post-demand reduction figures will be disclosed for each Member State, energy carrier and sector. It is important to note that this methodology will not affect the modelling results as the levels of submitted electricity and gas demand figures have remained unchanged.

3. Added value of this transition to the new tool (ETM) for the transparency of the scenarios building process – demand

For the TYNDP 2024 scenarios, ENTSOG and ENTSO-E shifted from their own Ambition Tool to the open-source Energy Transition Model (ETM) from Quintel Intelligence. With this new model, demand scenarios can be created with more detailed granularity, using more up-to-date reference data. Furthermore, transparency is also enhanced as scenario input and results can be publicly accessed through the model interface.

Nineteen stakeholders provided a response to the question 'What are your views about the added value of this transition to the new tool (ETM) for the transparency of the scenarios building process?' On a scale from 1 to 10, the average score is a 7.1. This indicates that the use of the ETM for the TYNDP 2024 scenario building has good support from stakeholders.

4. Consistency of demand figures within DE & GA scenarios with their storylines - demand

Some stakeholders argued that the energy demand is too high compared to other scenarios such as PAC 2.0 and CLEVER and recommended decreasing it. Another stakeholder felt that the decrease of the demand is too optimistic. A further stakeholder underlined that consumer behaviour could alter considerably the final energy demand.

Some stakeholders recommended a higher electrification in both scenarios. One stakeholder considered that electrification is not the only path to meet EU targets and that hydrogen, renewables and low-carbon gases should be better considered. Some stakeholders recommended the higher use of methane and hydrogen for electricity generation in the Distributed Energy scenario to cover extremely high and prolonged residual loads. Other stakeholders opined that the methane and hydrogen demand is too high compared to Agora or E3G scenarios. One stakeholder felt that all assumptions for the demand calculation taken in both scenarios lead to a strong electrification and that there will be a lack of grid electricity infrastructure. This stakeholder does not see any acknowledgement of the strong developments regarding renewable and low carbon gases.

Another stakeholder recommended avoiding the word 'blackouts' and explained its meaning. They explained that the DE and GA scenarios are not sufficiently contrasted for France; recommending higher electrification and that electricity final demand in France should be higher in 2050 compared to 2040 for at least one scenario.

Another stakeholder explained that the demand figures within the DE & GA scenarios appear to exhibit inconsistencies and discrepancies across different sectors and countries. In some cases, there are significant variations in hydrogen demand between the two scenarios for the same sector in the same country. The stakeholder advised reviewing the assumptions and methodologies used to estimate demand figures within each scenario.

A further stakeholder noted that district heating is supposed to increase in Austria according to different studies.

Another stakeholder explained that the scenarios appear less divergent than the storylines behind them, the main differences being the overall energy consumed and hydrogen. This stakeholder felt that a balanced approach between these two approaches is required.

Based upon the comments, some technologies shares were modified to better comply with the storylines if supported by publically available evidence:

- heat production in the agriculture sector in Luxembourg, Denmark and Spain;
- space heating and hot water for households and buildings such as district heating and hybrid hydrogen heat pumps;
- heat production in the chemical sector in France;
- buses in Spain;
- car technologies in France and in the Netherlands;
- trucks in Croatia; and
- vans (a subcategory of freight transport) in Sweden.

International aviation and navigation were incorrectly considered and are now correctly included.

The parameters used in the ETM are published at a country level for transparency purposes.

5. Consistency of market shares of technologies within DE & GA scenarios with their storylines - demand

One stakeholder felt that very strong electrification in DE and GA scenarios would lead to significant load increases beyond the capacity of the electricity grid for the foreseeable future in several member states. Another stakeholder explained that electrification should be increased based on some studies.

Another stakeholder advised increasing electric heat pumps and decreasing hybrid heat pumps; and to increase transport electrification particularly in cars, buses and trucks based on different studies.

Another stakeholder felt that German demand figures are too low compared to other sources.

Another stakeholder indicated that district heating should increase in Austria by 2040, leading to a parallel reduction of the market shares of other energy carriers.

Another stakeholder maintained that batteries should be considered in the GA scenario; there should be less hydrogen in the DE scenario for space heating; and flexibility for heat pumps should be considered in DE. The stakeholder mentioned that many existing buildings in EU regions are already ready to switch to a cost-efficient operation of stand-alone electric heat pumps with either no or shallow renovation, according to a study done by the same stakeholder. The stakeholder advised including non-EU imports of bioenergy carriers in the GA scenario.

Another stakeholder explained that the use of hydrogen for low-temperature heat, fuel cell electric vehicles (FCEVs), e-fuels and methane for trucks is questionable. Behaviour change is a key driver for achieving carbon neutrality: the shift from aviation to rail and the reduction of global trade of goods should be considered in at least one of the scenarios. Industry electrification should be prioritised over the use of methane and hydrogen.

Another stakeholder identified several issues with the market shares of technologies, for instance ammonia market share for international shipping

Another stakeholder contended that solar photovoltaic (PV) remains on the conservative side; the role of pure-electric heat pumps has been downplayed. This stakeholder mentioned that there is no nuclear-free scenario. They argued that DE should be a high-RES scenario and GA a nuclear based scenario.

- Several modifications have been implemented in the ETM following the public consultation: The shares of ammonia for international shipping and domestic navigation have been set to 0 in the ETM. Ammonia has been considered under the hydrogen and liquid categories in the ETM. The split of the liquid category is then done within the supply tool where the liquid category is split between subcategories (including ammonia);
- Technologies shares for space heating and hot water for households and buildings have been adjusted for Austria to increase district heating;
- The technologies shares were adjusted for Sweden for the paper industry in addition to the steel industry to better reflect the country view;
- Technologies shares for steel production in France have been adjusted to be more consistent with other countries;
- Technologies shares for steel production in Poland have been adjusted to correct inconsistencies;
- Uniform technologies shares for aviation have been implemented for all countries except Belgium, Denmark and Germany;
- For Poland, minor changes were introduced in the industrial sector resulting from the appropriate interpretation of electricity consumption in the energy sector. In addition, minor changes have been introduced to remove inconsistencies between scenarios in the Centralised ICT area;
- ETM numbers were adjusted for France; and
- Data for Germany were not stored as expected in the ETM and have been corrected.

6. Amount of biomass in the scenarios

A clear definition of the terms ‘biomass’ and ‘sustainable’ was requested, and this explained some of the reasons why stakeholders answered ‘no’ to the question. Furthermore, information on the sources was requested.

Biomass is the total amount of biomass used. This includes biomass for: biomethane production, biofuels production, electricity generation, heat generation and other processes. The biomass includes biomass from sequential agricultural cropping, forestry, harvesting residues, animal manure, food waste, wastewater and agricultural residues.

The term ‘sustainable’ is, in this context, used for a feedstock that follows the EU principles for sustainability, and the criteria listed in the RED ii directive. Among these criteria are also stated that food and feed crop-based fuels should be limited. In the final report, the definitions and sources will be made clear and mentioned explicitly.

For the specific comment regarding biomethane potential for France, this has been checked with Grtgaz, which gave ENTSOG the numbers in the first place. They have confirmed the numbers referring

the publications of 'Mix de gaz 100 % renouvelable en 2050 ?'[4] and 'La Gazéification Hydrothermale'[5]. Therefore, no change has been made regarding the biomethane potential in France.

There are several comments that state that biomethane should only be used in sectors that are hard to electrify or where a high temperature heat is needed. In the scenarios, the biomethane is used to supply a part of the methane demand, and is not directly linked to a specific type of demand. However, indirectly the biomethane will supply some of these sectors, but not explicitly. No changes have been made as it is not possible in the current set-up.

One stakeholder asked for imports of biomass as the EU today already has some imports. The imports have therefore been adjusted in GA and NT+, so there will be 43 TWh imported in 2030, 61 TWh in 2040 and 80 TWh in 2050. The numbers have been determined by assuming a linear development of the imports from 2015 to 2021, according to EU Wood Pellet Annual Report (2022)[6]. According to the storylines for DE, imports should be minimised, which is why we have not added any import of biomass in this scenario in the time of writing.

In the TYNDP scenarios, the biomethane potential was estimated by ENTSOG's biomethane tool. The numbers were reviewed by the gas TSOs, with the result that only a few TSOs asked for changes. The total potential is estimated at 379 TWh in 2030, 766.7 TWh in 2040 and 1070 TWh in 2050. This is at the lower end of the potential estimated by Guidehouse in 'Biomethane production potentials in the EU'[7] and by Engie in Geographical analysis of biomethane potential and costs in Europe in 2050[8].

JRC estimates a sustainable biomass use in EU in 2050, between 170 Mtoe and 252 Mtoe (1975 TWh – 2930 TWh)[9]. Compared to these values, the biomass used in the TYNDP scenarios is in the middle/lower end of the range (APP 2.500 TWh in DE and 2.200 TWh in GA).

7. RES trajectories (wind, solar, battery) & nuclear capacities

There is a mix of answers regarding the different generation trajectories. From a global perspective, most comments indicated that European aggregated values seem reasonable, but country values might need to be reviewed, especially in some countries that have a very small range between low and high values. While referring to the PV trajectories, several shareholders indicated that, compared with SolarPower Europe trajectories, the values are low in general and especially for southern countries. Regarding onshore wind generation, some shareholders asked to review the values of trajectories as they seem to be low, while those focusing on offshore wanted to focus more on costs. For nuclear trajectories, there were specific-country comments such as Slovakia and uneven comments regarding aggregated values. Some stakeholders found the figures too low, while others indicated they are too high. Battery trajectories are generally considered high.

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[4] https://librairie.ademe.fr/changement-climatique-et-energie/1548-mix-de-gaz-100-renouvelable-en-2050--9791029710476.html

[5] Première étude sur le potentiel de la gazéification hydrothermale en France | grtgaz.com

[6] https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=EU%20Wood%20Pellet%20Annual_The%20Hague_European%20Union_E42022-0049.pdf

[7] https://www.europeanbiogas.eu/biomethane-production-potentials-in-the-eu/

[8] https://www.engie.com/sites/default/files/assets/documents/2021-07/ENGIE_20210618_Biogas_potential_and_costs_in_2050_report_1.pdf

[9] https://www.researchgate.net/publication/331358228_Brief_on_biomass_for_energy_in_the_European_Union

Al generation trajectories were consulted with TSOs, checked and updated, if necessary.

For nuclear generation, country-specific comments were implemented. Slovakia's low values were updated and increased, and France increased the best estimate values with no change in the trajectories. Other countries such as Spain, Netherlands and Hungary also included updates. The aggregated value for DE increased by 800 MW and GA by 8 GW.

Solar PV values were consulted with TSOs and reviewed in most countries. As far as possible, High trajectories were increased to align with SolarPower Europe's Medium Trajectory figure. In addition, country-specific comments were considered to increase values, mainly in southern ones, or expand the range between the Low and High trajectory. The total values of trajectories increased by 130 GW in 2040 and decreased by 85 GW in 2050, mainly due to the correction of one value.

Onshore wind had some updates in the High values to consider NECPs' updates. Country-specific comments (France and Hungary) were also considered. Due to permitting reasons, no bigger increases are expected, so aggregated values reflect only small reductions.

Offshore values were updated and aligned with Offshore Network Development Plan (ONDP) latest data according to the non-binding Member State Agreements.

Battery trajectory values were reviewed. TSOs provided more detailed data, and the methodology also complemented that information. National data, including split among utility scale and prosumer batteries, was used as far as available to prepare the trajectories. When no split was available, aggregated European means were used with geographical differentiation. In those cases where no battery data were provided, trajectories were calculated using the mean ratio battery/PV to estimate the high values. New trajectories for batteries are approximately half the values of the public consultation.

8. Technology costs

There were some comments regarding the lack of inclusion of different types of technologies in the methodology. In the current cost methodology, only costs of technologies that will be used as an expansion candidate are considered. These are PV, onshore, offshore, batteries. On the other hand, Nuclear and Carbon Capture Storage (CCS) technology is not a candidate for expansion; therefore, it is not included in this section.

Information for sources was requested several times. All sources used are indicated in part 2 of the supply inputs. There were also several clarifying questions about source 1 (https://ens.dk/sites/ens.dk/files/Analyser/technology_data_for_el_and_dh.xlsx). This source does not take inflation into account; prices are given at the 2020 level. Accordingly, the energy crisis on raw materials also has not been considered. It is also important to mention that investment costs are unique across Europe.

Some comments noted that offshore high-voltage direct current (HVDC) stations are not included in the cost methodology. However, if we examine the offshore specification, the costs of offshore HVDC technologies are already included in radial DC wind, HVDC cables and hub-connected wind technologies. It is also important to note that offshore fixed and floating wind hubs always incorporate DC technologies and that AC radial wind technologies will always be cheaper, because they have fewer components. This is why hub technologies will be more expensive than radial AC offshore wind technologies.

The comment regarding onshore electrolysis, namely the lifetime for 2040 and the fixed O&M costs of onshore electrolysis which are indicated in kEUR instead of EUR, is indeed correct, and has been changed in the modified methodology.

Some specific comments also noted that there are cases where technology costs are higher in 2050 than in 2030 (e.g. solar PV, battery storage technologies). The issue was resolved by slightly changing the methodology for differentiating costs in top-down scenarios. We have added +/- 1% differentiation for 2030 and adjusted it to the cost reduction potential of the reference cost values.

The strongest assumption to consider only 2hr batteries was noted, because other technologies (i.e. 4hr, 8hr) might be more economically competitive. With the feedback received during the workshop & consultation, the expert team investigated possibilities of increasing the duration for utility scale batteries by 2050. However, as such an adjustment necessitates modelling adaptations and considering the investment loop starts after 2030, the expert team decided to utilise 4h batteries for both 2040 & 2050.

9. Prices

Several stakeholders found the natural gas, coal and oil prices too low, and suggested there should be an increasing price trajectory until 2050 instead of a falling trajectory as currently used. However, they have remained the same for several reasons, explained below. The only addition to the price sheet is to differentiate the blue H2 cost for DE & GA scenarios depending on their gas blend and CO2 intensity.

High priority has been given to having as few sources for commodity prices as possible. This is because the prices used will make a total price picture of all energy carriers and CO2 in the future. Because the price assumptions of the energy carriers are related, the same trends and assumptions should apply for all commodity prices. By having as few sources as possible (the preferable one) it ensures that trends, assumptions and price relations are similar for all commodity and CO2 prices, and thereby gives a reasonable overall price picture. By limiting the sources to one, the ENTSOs also avoid the chosen prices being seen as cherry picking.

The source used for the prices is the IEA World Energy Outlook (WEO), where the prices given for the Announced Pledges Scenario (APS) have been selected. Among the reasons for choosing this source is that the IEA in general is seen as a credible source, which was also mentioned by some stakeholders in this public consultation. In the WEO, the IEA gives prices for oil, electricity, coal, hydrogen, methane and CO2, and thereby supplies the scenarios with the main prices needed.

A CO2 price could not be provided by the European Commission (no CO2 price was public available) and is one of the main reasons that the prices from the Commission were not selected.

One stakeholder suggested that inflation should be applied to the prices. However, as no long term inflation is considered in the scenarios, the prices have not been corrected for inflation.

10. Extra-EU methane import potentials

Responses to the question about extra-EU methane import potentials vary. Some stakeholders supported the idea, calling for higher ambitions in renewable synthetic methane production, including biomethane and e-methane. They emphasised the potential for e-methane from hydrogen. Others expressed reservations, particularly concerning continuous gas imports from Russian via Ukraine. They suggested considering variations in Russian potential due to geopolitical and strategic concerns.

Some stakeholders outright disagreed with the extra-EU methane import potentials and advocated for reducing imports to near-zero by 2050. They promoted transitioning to RES, direct electrification and energy efficiency.

A common thread among stakeholders is the need for an ambitious phase-out of fossil gas and a strong focus on maximising EU energy independence. They refer to external reports and ACER Opinion No. 06/2023 for guidance in future planning cycles. Overall, there is a shared emphasis on decarbonisation and reducing the reliance on methane imports in the EU.

We appreciate the feedback and concerns raised by various stakeholders regarding our methane import potentials scenario. We understand the importance of aligning our goals with ambitious decarbonisation targets and increasing the imports of synthetic methane and biomethane.

In response to these inputs, the scenario will be modified to come as close to a 100% natural gas phase out as considered reasonable. This will be done by increasing other energy carriers, which also will be in line with the stakeholder comments. Although imports and EU production of synthetic methane will be increased, biomethane import will be increased, and in GA the biomethane potential will be increased from 75% of the full potential. No numbers are available yet as not all modelling has been conducted.

Regarding the natural gas import from Russia, we acknowledge that, at present, natural gas is still flowing through Ukraine from Russia, and Turk Stream continues to transport gas from Russia to Europe. Given these existing arrangements, we cannot rule out the possibility that some level of gas imports from Russia may continue in the future gas scenarios.

11. Extra-EU H2 import potentials & prices

Several stakeholders criticised the H2 import potentials, finding them too ambitious and claiming that it seems unrealistic to reach the full potential. Especially for the 2030 potentials, it seems too ambitious to establish electrolyser and RES capacity sufficiently in the exporter countries in order to reach these levels.

To respond to these comments, it is first important to note that regarding the import potential figures, it has been emphasised that the import potentials given are to be considered as the absolute maximum technically achievable level and do not necessarily reflect the actual imports from these countries.

However, to meet the stakeholders, these import potentials have been limited in the scenarios, thus only 30% of the potentials will be available in 2030. This action will also support a diversified import picture (before the cheapest route takes it all) and ensure that several RES technologies for green hydrogen production are used (wind, solar and hydro) and support SOS in the EU, by having several import routes.

This methodology has, at the time of writing, been applied to the 2030 numbers. A similar approach is expected for the import numbers for 2040 and 2050, but at the time of writing it has not been finally decided.

Some stakeholders mentioned that the huge import potentials contradict the EU ambition to focus on energy independency.

The scenarios for the 2024 cycle consist of two different storylines DE/GA. In DE, import is limited and in GA, imports are more widely used. As mentioned above, however, the huge import potentials of

hydrogen should at this stage only be seen as technical potential and does not necessary reflect the actual amount being imported.

One stakeholder suggested that the UK should be considered as exporters of hydrogen to the EU. The UK is modelled using the same approach as other EU countries within the scenario model. Due to this comment, import potential from UK has been added through the presence of pipelines. The pipeline capacity potentials have been aligned with data found in the EHB study (40 TWh in 2030, 204 TWh in 2040, 297 TWh in 2050). However, these potentials are limited to 30% of the referenced values, using a price constraint according to the methodology mentioned above, and to 0 in 2030 due to the missing pipeline connection.

One stakeholder suggested that Turkey should have an export potential to the EU. This was investigated during the screening for import potentials. In the screening, some sources indicated that Turkey would be an importer of hydrogen, e.g. the Irena report 'Global Hydrogen Trade to meet the 1.5C climate goal' [10]. Turkey has, therefore, not been seen as an exporter in the scenarios for the TYNDP 2024.

One stakeholder inquired why no more Mediterranean countries are included as exporters of hydrogen and derived liquids to the EU.

The methodology for estimating import prices for derived liquids (e.g. ammonia), was to select the six cheapest countries with no pipeline infrastructure to Europe. Countries with a pipeline infrastructure to the EU were considered to deliver pure H2 only. The countries with the lowest price were Qatar, Oman, UAE, Saudi Arabia, United States and Israel and, therefore, not Egypt, Turkey, Tunisia and Jordan, as suggested by the stakeholder. The methodology was used to estimate the prices for shipped H2 (ammonia) only. This means that the model is indifferent to where these imports are coming from, and it could therefore, in theory, also be from the Mediterranean countries, assuming they are price competitive. The tool used for the price assessment is as follows: Tool for costs of hydrogen — EWI (uni-koeln.de).

There are several concerns about ammonia being converted into hydrogen: both that it is inefficient and that it should stay as ammonia and be used as such.

First, it should be emphasised that the ammonia in the scenarios only considers ammonia for energy purposes. The ammonia market is, therefore, not affected by this import and imported ammonia for such will stay as ammonia. Second, this import shall be seen in light of the desire to diversify the imports of hydrogen and for SOS reasons. We therefore keep the methodology for ammonia conversion as it is.

One stakeholder mentioned that more synthetic methane should be available as imports from the global market. This subject is answered in the previous chapter about methane.

12. Methodology on how the demand is supplied per energy carrier and on the use of the conversion factors

Some stakeholders commented on the numbers in the supply tool, either because they disagree with the levels, or because some numbers do not fit or are inconsistent. For these comments, it should be

[10] https://2024.entsos-tyndp-scenarios.eu/download/

emphasised that the numbers in the supply tool is only preliminary. Therefore, such comments will not be answered here as the numbers and the tool will be updated in the final version.

One stakeholder asked whether non-energetic consumption is included in the supply tool.

Yes, it is covered by the final supply numbers.

Several stakeholders had questions of and suggestions to the supply for district heating.

The heat demand for district heating for DE and GA comes from the ETM as an output result. Other kinds of heat are covered by their primary energy demand (e.g. electricity demand from residential heat pumps is part of the primary electricity consumption).

The distribution of energy carriers that should cover the supply for district heating is determined in the supply tool. Data from the NT+ data collection on energy consumption in district heating (final demand of different energy carriers and their respective efficiencies) for 2030, 2040 and 2050 are used to determine the primary energy demand for each energy carrier. This methodology will be described in the scenario guidelines.

However, it shall be emphasised again that these numbers are only for district heating, and this is why the electricity share is relatively low, as a lot of electricity heating through e.g. heat pumps, comes as part of the direct electricity demand from ETM.

If the comments about 100% efficiency are understood correctly, the only place there is 100% efficiency is for solar, geothermal, excess heat P2G and excess heat industry. These sources are seen as 'free sources', meaning that they are not turned into another primary energy source. Their efficiency is therefore not used, which is why the level has never been considered and, for some reason, the value was set to 100%.

One of the stakeholders mentioned that there should be more focus on decarbonising district heating. Therefore, oil and coal is substituted with biomethane and hydrogen in 2040 and 2050 in both DE and GA.

The efficiencies and CO2 demand in the PTL processes are re assessed and used directly in the modelling instead of in the supply tool. The efficiencies shown here are, therefore, not used. In the modelling, it is mainly the efficiency for producing H2 that is used. The different synthetic fuels are then created from this H2.

In this cycle, the technology for producing H2 has been limited to electrolysis and SMR. We only consider mature technologies which, once more information and the economic viability of other supply sources are proven, can be considered in future versions of the TYNDP.

Regarding the local production of H2, Zone 1 can serve smaller productions connected directly to industries, which will not be transported through the hydrogen backbone.

13. Preliminary supply figures differentiation according to the storylines

The preliminary supply tool has been shared to collect the stakeholder feedback; currently, the supply tool is still a living document as the final version will be only available after the final modelling outputs are available. While finalising the tool, the feedback will be re-evaluated.

There is no clear consensus on the differentiation of the storyline when we examine the comments, which state 'polarisation in excess' versus 'insufficient differentiation'.

One stakeholder welcomed the stronger differentiation in scenarios, particularly in H2, while criticising the high H2 import in the DE scenario as being against its storyline to prioritise energy independence.

Some stakeholders stated that the EU production of H2 by electrolysers is very ambitious for both scenarios, and the issue is also relevant for the extra EU imports.

14. Cost methodology of H2 investment projects

One stakeholder mentioned that the shares of repurposed versus newly build pipelines should be aligned to the latest publication of the European Hydrogen Backbone, resulting in a repurposed share of 60%. Furthermore, it was mentioned that only one source was used for the cost estimation and that the methodology would benefit from incorporating more sources. Several stakeholders stated that the uptake of hydrogen is uncertain, which should be reflected in the cost methodology for H2 investment projects. More transparency about the source(s) of the underlying data was also requested.

Based on the stakeholder feedback, the repurposed share of pipelines was adjusted to 60%. Additional research showed that no source is available to provide the data in the necessary detail (e.g. ACERs unit investment cost only covers pipelines with rather large diameter). The uncertainty of the uptake of hydrogen is addressed by taking the average cost for all pipelines. To increase the transparency of the cost methodology, additional assumptions and data will be published within the framework of the scenario report.

15. Cost methodology for electricity investment candidates

The methodology for cost estimation for electricity investment candidates was well received overall. One stakeholder shared their limited concern regarding the cost methodology for electricity investment candidates for transmission. In particular, the feedback emphasised that the methodology is sufficiently aligned with the expansion methodology, yet it is unclear how grid-enhancing technologies could play a role in the scenario development. More precisely, the stakeholder suggested that the lead time required to bring such technologies in operation is rather small, an aspect that could be detrimental for their consideration in the TYNDP candidate project list and, therefore, to their potential PCI labelling. In addition, the availability of such technologies in the reference grid was also put forward.

16. Carbon budget methodology

Several stakeholders appreciated the general set-up of the carbon budget. However, they requested more clarity on details for further assessment, for example if and how the carbon budget is embedded in the storylines and its impact on the scenario-building process. Concerns were raised about the time-horizon until 2100; instead a time-horizon until 2050 was proposed by some stakeholders. Some stakeholders claimed that any overshoot of the carbon budget until 2050 should be avoided. It was mentioned that if an overshooting cannot be avoided, this and the implications on the infrastructure should be transparently explained. The alignment of the carbon budget methodology with the ESABCC is appreciated while a further alignment is requested.

17. EVs

17.1 EV innovation & its relevance to the scenario model
17.2 Assumptions on the EV methodology
17.3 Improvement of EV methodology for the next cycle

Stakeholders commented on some of the EV assumptions made in the scenarios. Comments refer to an EV efficiency of 170 Wh/km in 2030, with an increase in efficiency by 2050. The references for this are the EC's impact assessment and Bloomberg. As a result of this feedback, the efficiency was increased to 170 Wh/km.

An additional comment was made regarding home and street chargers, stating that the charge rate should be increased. As a result of this comment, the home charge rate has been increased from 5kW to 7kW; the street charge rate will remain at 16kW.

18. P2G

18.1 P2G innovation & its relevance to the scenario model?
18.2 Assumptions on the P2G methodology
18.3 Improvements of P2G methodology for the next cycle

There was no stakeholder feedback directly relating to the P2G methodology; instead, stakeholders left hydrogen-related comments. There were several comments relating to the hydrogen reference network, but the methodology for the reference network has been built into the TYNDP 2022 and cannot be further modified. A clarification question was also made regarding whether the H2 grid is new or repurposed. The grid is a blend of both.

A final comment was made regarding the demand patterns made on the industrial demand profile, which is flat. For this cycle, the demand profile will be kept flat, but the comment will be considered in the next scenario cycle.

19. Offshore

19.1 Offshore innovation & their relevance to the scenarios model
19.2 Assumptions on the offshore methodology
19.3 Improvements on the offshore methodology for the next cycle

A comment on the offshore wind trajectories questioned the 45% share of offshore wind in the total installed wind capacity. The trajectories do not describe the installed capacity, which will appear in the final scenario, but rather the maximum amount of capacity which can be built. Another comment questioned whether the 50km threshold between near and far shore zones should be 70 or 80km. In addition to the 50 km at sea, we consider an additional 30 km for landing the infrastructure, both hydrogen and electricity, to reflect the fact that the energy needs to be connected into a strongpoint in the grid so that it can be integrated into the market area. This means that we end up with 80 km in our modelling.

A further clarification on HVDC assumptions will be made in the final report, but in general HVDC assumptions are made.

20. Hybrid heat pumps

20.1 Hybrid Heat Pump innovation & its relevance to the scenario model
20.2 Assumptions on the Hybrid Heat Pump methodology
20.3 Improvements on hybrid heat pumps for the next cycle

There were also several comments on the hybrid heat pumps. The response to the question on why we model hybrid heat pumps is that there is competition between electricity, hydrogen and methane, which will be determined by the model. Other comments related to the general parameters of heating technologies or heating demand, but were either not applicable to the scope of the TYNDP scenarios or not implementable in the current cycle, e.g. 'Hot water temperatures have to be above 55 °C to avoid the creation of Legionella' – while the comment is insightful and could be useful for the modelling of water heating demand, hot water temperature is not used as an input parameter in our demand forecasting tools.

21. Assumptions on the H2 steel tanks methodology

Questions on steel tanks relate to whether 25% of industrial hydrogen consumers will require this storage, but steel tanks are only added to 25% of industrial consumers in Zone 1, which corresponds to 12.5% of the overall hydrogen consumers in 2030, 12.5% in 2030 and 3.25% by 2050.

Another stakeholder questioned whether 24-hour storage can provide sufficient resilience. We do not want to overestimate flexibility in the scenarios, and we must also consider that the tanks are very expensive.

22. Most important modelling innovations that stakeholders would like to see in the next cycle

Stakeholder feedback on important drivers to include in the next cycle focused in particular on four specific topics: CO2 reductions, energy efficiency, geopolitical independence and social factors.

Regarding CO2 reductions, stakeholders underlined the importance of TYNDP scenarios staying within a fixed CO2 budget to achieve a suitable level of ambition. To this end, elements such as circular economy should also be considered. One stakeholder noted that a more globalised approach to CO2 accounting is necessary to capture carbon leakage and global supply chains. Regarding energy efficiency, some stakeholders felt that the energy efficiency of primary energy demand had not been considered.

A number of stakeholders cited the recent geopolitical events in Europe as a reason to place greater importance on the autonomy/autarky of the EU economy and supply chains (including Extra EU Imports). In this regard, greater attention should also be paid to a reliance on critical raw materials, security of supply and stable price signals.

Social factors were also frequently cited by stakeholders as an area where greater analysis was necessary. In particular, the social acceptance – or lack thereof – of the underlying energy policies behind the scenarios should also be analysed. However, no specific proposals were given on how this could be evaluated.

Annex 1. Answers received from the public consultation.

Scenarios2024_Input_Public-consultation_All-answers-received_anonymised