Annex 2 – Scenarios & Storylines

Question 1: Do you agree that the ENTSO-E and ENTSOG's joint scenarios should be built to be compliant with EU-27 2030 and 2050 targets as a minimum standard?

Feedback (WindEurope):

Yes, if we don't plan the system to support achieving the energy and climate goals, then we will not meet the goals. Using a more conservative scenario is in itself a distraction and a barrier to tackle climate change and the transformation of the energy system. However, clear support to work on scenarios compliant with 2030 targets and 2050 climate neutrality does not mean sharing the views of the ENTSOs' current joint scenarios.

Response:

TYNDP Scenarios are developed under the framework of the TEN-E regulation. As a result, they should both capture the national perspectives and ensure consistency with the European strategy. The first requirement is met through the National Trends scenarios while the second translate into Distributed Energy and Global Ambition.

Feedback (EU DSO Entity):

Neutral, scenarios should maximally be realistic and relate to general circumstances. It means that scenarios should show risks and suggest that some goals may be modified time to time.

Response:

Carbon neutral scenarios are by definition very ambitious. The two paths illustrated by Distributed Energy and Global Ambition do not intend to be the most realistic ones but rather jointly provide a basis for a robust infrastructure assessment. We do support the need to take into account that objectives may change over the time. The regular update of the scenarios serves this purpose.

Feedback (EDF):

No, EDF strongly supports the targets set by European Commission. However, the global set of scenarios should be credible and contrasted enough to assess long-term uncertainties in TYNDP analyses. As ENTSO-E mentions in question 12, "scenario diversity is essential when it comes to the assessment of future infrastructure needs". Therefore, the scenario of a delayed transition, although not desirable, is still a credible option that could lead to possible stranded costs and put at risk highly capitalistic infrastructures investments. Such a scenario is not explored, and it should be in order to best determine the "no regret option".
If the objective is to build scenarios compliant with the EU targets, why not use the LTES scenarios?

Response:

Distributed Energy and Global Ambition are contrasted pathways to carbon neutrality in 2050. The climatic ambition of the National Trends scenario is quite diverse across Europe and difficult to

quantify as capturing only electricity and gas. Nevertheless, from an electricity perspective, it shows a slower evolution of final electricity demand and RES generation capacity than the COP21 scenario.

The direct use of LTES scenarios would not provide enough contrast on key parameters resulting from stakeholder engagement (e.g. direct electrification, nuclear capacity…).

Feedback (currENT Europe):

Yes, if we do not plan the system to support achieving the energy and climate goals, then we will not meet the goals. Using a more conservative scenario is in itself a distraction and a barrier to tackle climate change and the transformation of the energy system.

Response:

TYNDP Scenarios are developed under the framework of the TEN-E regulation. As a result they should both capture the national perspectives and ensure consistency with the European strategy. The first requirement is met through the National Trends scenarios while the second translate into Distributed Energy and Global Ambition.

Feedback (Edison S.p.A.):

EDISON supports the reference to the targets set by the European Commission regarding as the final objectives to be reached. However, the different scenarios proposed have to be credible, contrasted and realistic, otherwise there is a risk to have to deal with an effective path not included in the range suggested by the scenarios. That would make the TYNDP less significant in the assessment of the infrastructure needs.
Therefore, the scenario of a delayed transition, although not desirable, is still a credible option that could lead to possible stranded costs and put at risk highly capitalistic infrastructures investments; such a scenario is not explored.

Response:

Distributed Energy and Global Ambition are contrasted pathways to carbon neutrality in 2050. The climatic ambition of the National Trends scenario is quite diverse across Europe and difficult to quantify as capturing only electricity and gaz. Nevertheless, from an electricity perspective, it shows a slower evolution of final electricity demand and RES generation capacity than the COP21 scenario.

Feedback (Anonymous):

Neutral, adequacy of the power system should also be considered

Response:

The updated scenarios include an adequacy step ensuring that every country has a number of hours of unserved electricity below 3 hours, which triggers additional thermal plants.

Question 2: ENTSO-E and ENTSOG introduced National Trends as the central policy scenario. National Trends is aligned with national energy and climate policies and strategies as stated at the

end of 2020. Do you agree that member state energy and climate policies should be used to develop National Trends?

Feedback (Fortum Power and Heat Oy):

Neutral, the current National Energy and Climate Plans (NECPs) are mostly based on earlier national targets, and not on the Paris and EU's Fit-for-55 climate targets. Thus, National Trends should not be considered as the central TYNDP 2022 scenario, but only as a lower ambition scenario. The system needs in TYNDP 2022 should be based on the scenarios compatible with the EU 2030 and 2050 climate targets.

Response:

For the TYNDP 2022 Scenario report, National Trends has been built based TSO data capturing the national policies and strategies as stated end of 2020. As a result, it goes beyond the sole NECPs.

The use of the scenarios within TYNDP 2022 goes beyond the scenario building stage.

Feedback (Brintbranchen / Hydrogen Denmark):

No, we agree that national strategies and policies should be the basis of National Trends. But there is a certain disconnect between overall EU targets and national strategies, and in those cases, it would make sense to take into account additional capacity from established EU targets as well. Specifically, we note that expected electrolyser capacity for 2030 in figure 29 for National Trends does not match the EU's Hydrogen Strategy target of 40 GW. Some EU Member States (e.g. Denmark) are still working on their national PtX Strategies, but it is almost unthinkable that the EU target of 40 GW would not be met. And so it would be preferrable for the TYNDP 2022 to already include the 40 GW capacity and corresponding TWh electricity demand. In this regard we also note that figure 19 for National Trends shows no electricity demand from electrolysers in 2030, even though there is expected electrolyser capacity in this scenario in 2030 (e.g. figure 29). We assume this is a result of national strategies and policies not having taken sufficient account of the impact of their own electrolyser goals on the electricity system, and this should be corrected for.

Response:

According to the TEN-E regulation, scenarios should cover both national strategies and European climatic ambition. The first requirement translates into the National Trends scenario which capture national policies and strategies as stated end of 2020. In this regards electrolyser capacity is indeed a good example between national strategies and European strategies. It is not up to ENTSOG or ENTSO-E to modify the content of national data, the approach is to complement them with other scenarios. For example, 2030 electrolysis capacity reaches 32 GW in National Trends and around 60 GW in Distributed Energy and Global Ambition.

Feedback (WindEurope):

No, the most available EU targets should be reflected in the NT scenario. Currently the NT scenario doesn't even reach the 55% GHG reduction target, which was officially agreed on in April 2021.

Therefore, the NT scenario should not be used for planning but clearly stated that it would be used only as a baseline scenario and built with absolute transparency.

Response:

With National Trends, Distributed Energy and Global Ambition, the TYNDP 2022 Scenario report provides a contrasted basis for infrastructure assessment. The choice of scenarios for infrastructure assessment is beyond the scope of the scenario building process.

Feedback (Enel SpA):

No, national long-term strategies submitted to date give the necessary inputs to perform a full-fledged current policies model to 2050, if complemented with sensitivities for the MSs still to submit their Strategy. By the way, National Trends should not be considered as the central policy scenario to guide other scenarios, as it misses the 2030 decarbonization target agreed in the EU Climate Law.

Response:

National long-term strategies are in many cases not quantified enough to be used as the basis for scenario development. This is one of the reasons why National Trends is limited to the 2040 time horizon using national strategies and policies as stated end of 2020. As part of the TYNDP Scenario report, National Trends is not considered as central but as the aggregation of national perspectives compared to more European focus scenarios (Distributed Energy and Global Ambition).

Feedback (Eurelectric):

Yes, over the last years, Eurelectric has been advocating for ambitious and coherent NECPs to ensure that EU reaches its 2030 targets. This will provide more certainty to investors across sectors and ensure consistent reporting under the United Nations Framework Convention on Climate Change. The NECPs can be a strong basis for ENTSOs scenarios but only if the key elements are adequately defined and reflected in the final plans. However, the current versions of NECPs are not complete nor sufficiently robust. Indeed, the forecasts lack sufficient level of information regarding cost analysis, policies needed to ensure their implementation and hurdles to be cleared. Indeed, the downside of using the NECPs is that when focusing too much on "declared political ambitions", one could lose sight of reality (ambitions are important, actions and policies even more, without the latter, the ambitions will not materialize (fully) and the scenarios could become disconnected from reality). In addition, successful "breakthrough" innovations can drive investments in certain technologies, such events are hard to predict and can also increase the disconnection between ambitions and realisation. All the above means that building such scenario with minimum quality and transparency standards is very challenging.

To be effective, the NECPs should come with credible and effective policies, this will provide confidence to investors that the regulatory framework is fit for purpose and to deliver the needed investments, and flexible capacity in particular. Overall, we welcome that the Global Ambition and the Distributed Energy scenarios are built in line with the Paris Agreement, also here, sufficiently ambitious actions and policies will be required to be in line with such scenarios.

If not, then unfortunately the NECPs do not meet this ambition, any NT scenario based on them would then devolve to 'Business as usual' alternative Scenario. In that case, National Trends should not be

considered as the central policy scenario to guide other scenarios, as it misses the 2030 decarbonization target agreed in the EU Climate Law.

Response:

We share your view that current NECP cannot be the sole basis of scenario development as they do not ensure that 2050 European climatic ambition is met. For the 2022 edition, the National Trends scenario covers a wider scope than NECP as it intends to take into account all national policies and strategies as stated end of 2020. The respective role of National Trends, Distributed Energy and Global Ambition scenarios in infrastructure assessment exceeds the scope of the scenario building process.

Feedback (Gas Distributors for Sustainability (GD4S)):

Indeed, the NECPs are the basic information to be used but they should be put into the perspectives of the very challenging energy transition we will be facing. Uncertainty level is significant, and it is difficult to see if the sum of the national plans would be the optimal EU framework as regards the implementation of solidarity in case of crisis. For instance, if some countries are under performing their NECPs, the impacts could be reflected on neighbouring countries… Therefore, we recommend having an approach with sensitivity analysis to assess the margins of manoeuvre and the interactions.

Response:

We share your views on the possible suboptimal outcome of just aggregating current NECPs. We expect that on the long run, NECP and European scenarios will converge, and consistency will increase.

For this reason, the COP21 scenarios, Distributed Energy and Global Ambition, provide alternative path of greater consistency between countries around 2 storylines. Such an approach has been favored to a central scenario with sensitivity analyses as each of them would require running a specific expansion model which is too time/resource consuming taking into account the present TEN-E timeframe. A two-scenario approach helps to better capture future uncertainties than a central scenario.

Feedback (Ørsted):

No, the European Climate Law "writes into law the goal set out in the European Green Deal for Europe's economy and society to become climate-neutral by 2050][and to reduce] net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels." (European Commission 2021) However, NT is not compliant with this law as the emissions trajectory exceeds any pathway for carbon neutrality by mid-century. Since NT is used for planning, it could become a self-fulfilling prophecy in which planning and funding would go towards a non-compliant scenario, which would in turn make it even more difficult to reach that target. Therefore, it is of utmost importance that NT is only used as a baseline scenario, and not for planning. For planning use, a scenario compliant with the European Climate Law and the Paris Agreement must be developed.

Response:

The National Trends scenario aims at ensuring compliancy with the TEN-E regulation stating that scenarios should be consistent with national policies. For the 2022 edition, the scope of this scenario is more ambitious than the NECPs as it also takes into account national policies and strategies as stated en of 2020.

In order to complement this national perspective, Distributed Energy and Global Ambition scenarios have defined in compliancy with Paris Agreement. As a result the TYNDP 2022 Scenario report provides a robust basis for infrastructure assessment.

Feedback (Eurogas):

Neutral, the NECP are policy driven. The national trend are grid and technology driven. The overall long term targets given by the NECP are of course important for the national trends. Still, the trends have to be technically feasible. If e.g. a political target foresees 100 % electric heating in southern Germany but the grid transporting the electricity is not ready in the short term future then this target is just not realistic and should not be put into the scenario. The association building the national trends are much closed to the market and technical developments and faster than the political process which takes quite some time and is not always very update with these developments.

Response:

We share your views on the possible suboptimal outcome of just aggregating current NECPs and the fact that market view may evolve faster than policies.

For this reason the COP21 scenarios, Distributed Energy and Global Ambition, provide alternative path of greater consistency between countries around 2 storylines. These scenarios are certainly also more ambitious at EU level.

Feedback (currENT Europe):

Neutral, the most recently available EU targets should be reflected in the NT scenario. Currently, the NT scenario doesn't even reach the 55% GHG reduction target, which was officially agreed on in April 2021. Therefore, the NT scenario should not be used for planning but clearly stated that it would be used only as a baseline scenario.
We need a top-down approach that clearly delivers the 55% per cent emission reduction target as per EU legislation. The NECPs are not yet updated and therefore using the NT is not delivering the EU ambition.

Response

With National Trends, Distributed Energy and Global Ambition, the TYNDP 2022 Scenario report provides a contrasted basis for infrastructure assessment. The choice of scenarios for infrastructure assessment is beyond the scope of the scenario building process.

The full consideration of the Fit-for-55 package will likely be a central element of the 2024 scenario building process.

Feedback (ENGIE):

Yes, the downside of using the NECPs is that when focusing too much on "declared political ambitions" one could lose sight of reality (ambitions are important, actions and policies even more, without the latter, the ambitions will not materialize (fully) and the scenarios could become disconnected from reality). In addition, successful "breakthrough" innovations can drive investments in certain

technologies, such events are hard to predict and can also increase the disconnection between ambitions and realization.
To be effective, the NECPs should come with credible and effective policies, this will provide confidence to investors that the regulatory framework is fit for purpose and to deliver the needed investments, and flexible capacity in particular. Overall, we welcome that the Global Ambition and the Distributed Energy scenarios are built in line with the Paris Agreement, also here, sufficiently ambitious actions and policies will be required to be in line with such scenarios.
There should therefore be some interest for adding a sensitivity based on Scenario National Trends, but which enforces somehow compliance with the European policy targets.

Response

The TEN-E regulation defines the obligation to build scenarios consistent with Member States policies, this the driver of the National Trends scenario. In the 2022 edition, this scenario is not limited to NECP but covers national policies and strategies as stated end of 2020. It is not up to the TYNDP Scenario Building process to discuss the national approaches.

We welcome your acknowledgment of the addition of COP21 scenarios to complement the National Trends view in terms of European ambition and consistency around predefined storylines. Such approach has been preferred to a sensitivity analysis to increase National Trends scenario ambition due to resource limitation and the need to have all-energy scenarios.

Feedback (SolarPower Europe):

No, National energy and climate policies in several member states are not necessarily aligned with EU ambition and at times do not correctly represent renewable technology current state of play. This is well reflected in unambitious solar PV targets from NECPs that are significantly below our current market trends based forecast for 2030.

Response

The National Trends scenario aims at meeting the TEN-E requirement of translating national policies and it is not up to ENTSOE and ENTSOG to review upward those national ambition. The development of the Distributed Energy and Global Ambition helps to provide a complementary view with a solar capacity respectively 67% and 24% higher in 2030 than National Trends.

Feedback (Edison S.p.A.):

Yes, we appreciated the introduction of a National Trends Scenario, but we would retain the opportunity to maintain a Business As Usual scenario that should be considered as a back-up scenario (comparable to the Italian "Business as usual" one, or the "current trend" scenario which ENTSO-e refers to in its TYNDP 2020 document) to assess to discrepancy between the "desirable scenarios" and a delayed transition situation.

Response

We welcome your feedback on the need of contrasted scenarios. The National Trends scenario stands as an intermediate one between a Business as Usual and Distributed Energy/Global Ambition. We would be interested to know if you consider that there is a need of additional scenario of lower ambition than National Trends.

Feedback (BDEW Association of German Energy and Water Industries):

Yes, The National Trends scenario is an important tool to check whether the „sum" of the national energy and climate policies (NECPs) is sufficient to reach the EU's 2030 climate targets. If this is not the case the National Trends Scenario can, in the best case, be a starting point for EU Members to commonly check in which regions and which sectors more efforts are feasible. The grid expansion measures which are needed to achieve the NECPs constitute a robust, no-regret development of the TYNDPs which is to be implemented at any case.

Response

We thank you for your feedback on the value of contrasted scenarios and the added-value of comparing them to identify the no-regret options.

Question 3: Scenario diversity is essential when it comes to the assessment of future gas and electricity infrastructure needs. In your opinion, do the 3 scenarios cover a broad enough range of plausible pathways aiming to achieve 2050 EU-27 targets?

Feedback (Fortum Power and Heat Oy):

The range of pathways is mostly broad enough, but some additional diversity could be included in solar generation development where the solar capacity difference between DE and GA is quite small. More diversity would as well be needed in the domestic (EU) production of synthetic methane instead of imports, as onshore wind resources especially in the Nordic countries could be used for profitable production of synthetic fuels. There could also be more demand response (both downward and upward) in Distributed Energy.

Response

Based on stakeholders' feedback updated TYNDP 2022 scenarios Provide a more contrasted view on solar (Distributed Energy capacity is 56% above Global Ambition in 2050). Some European synthetic methane production has also been added based on dedicated RES.

The updated scenarios also bring more transparency on demand side response when the DSR category only covered demand shedding the draft scenario. The wide demand side response amounts for 5% and 10% for the final electricity demand for Global Ambition and Distributed Energy in 2050.

Feedback (Germanwatch):

We would like to see a 100% Renewables Scenario included in the TYNDP to grasp the magnitude of the challenge. Also, the 1.5° scenario includes budget overshoots - it would be great to have a scenario without overshoots to also grasp the magnitude of this challenge. Both could be included as variants in the TYNDP.

Response

According to the TEN-E regulation, scenarios should reflect national and European ambition. For this reason the EC Impact Assessment scenarios are used as a benchmark, and it is to be noted that Distributed Energy sees a much higher RES development than any EC scenario. With nuclear amounting for 2% of the generated power in 2050, this scenario can be considered as on the pathway to a 100% Renewable scenario.

The next edition will provide the opportunity to better integrate the Fit-for-55 package with an expected decrease of the carbon budget consumption.

Feedback (Brintbranchen / Hydrogen Denmark):

Although the 3 scenarios are essential and very well designed, we believe there should be a full scenario also for what now is just a "carbon budget assessment". If this section was unfolded into a full scenario, it would provide greater clarity of what it would require of the energy system to meet the 1.5 degrees target from COP21, rather than just assuming that a significant amount of CCS will be necessary for the 3 current scenarios to live up to the Paris Agreement. Specifically, we think there should be a scenario showing what the electricity and gas systems would have to achieve to meet the 1.5 target should CCS have a smaller/more realistic role.

Response

The TYNDP scenarios main purpose is to be used as a basis for infrastructure assessment under the TEN-E regulation. They do not aim at defining what should be the energy mix. While the Global Ambition does rely on a significant amount of CCS, deriving from the IEA Net Zero scenario, the Distributed Energy has a very minor use of this technologies much below any EC carbon neutral scenario.

Feedback (WindEurope):

While we do understand the methodology for building scenarios and acknowledge that the method has its advantages, it might be more useful to build scenarios that give a wider range of the needed infrastructure build-out, including non-grid alternatives. The current scenarios are built on narratives, which are not necessarily consistent with specific projections on technology costs/commodity prices and convey very different implications on the infrastructures to operate/deploy. The effects on the needed infrastructure build-out themselves often cancel each other out e.g. that in the GA scenario there is an emphasis on centralised offshore wind build-out, but limited hydrogen/e-fuel build-out inside Europe. This will condition the range of the needed infrastructure build-out.
In light of the recent increase in energy prices across Europe as well as the concerns on energy security and the volatility on energy burden due to the reliance on gas imports, the European Union should focus even more on linking and expanded renewable generation with producing hydrogen domestically, from dedicated offshore wind farms and other renewable facilities (not necessarily in combination with the public grid). This should not be opposed to an open contribution of energy imports driven by market conditions (not only "pure narrative"), at least in one of the scenarios. The GA scenario is foreseeing too large of an import and demand of P2X-related products, limiting the necessary infrastructure build-out needed in the case of a large uptake of both onshore and offshore wind, partially driven by a strong domestic renewable hydrogen demand, imposing the reuse of current gas infrastructure and limiting the timing of potential repurpose.
Electrification rates should be more ambitious. The methane demand (0.5-1 PWh in 2050) is estimated to be overoptimistically (apparently delinked to cost/prices consensus projections on bio or synthetic methane) high due to use in residential and industry – where already today the potential for direct

electrification is enormous and fully consistent with an efficient path for decarbonisation. A solution could be having one of the scenarios focused on electrification as the main measure for efficiently decarbonising (and to truly decarbonise) in order to show that direct electrification will be more energy efficient than indirect electrification through other means.

Response

The COP21 scenarios are built based on data and trajectories that are differentiated based on their respective storylines. This projections on technology costs are derived from reliable sources and the differentiation has been made within the price range stated on these sources considering the scenarios narrative. For instance, regarding RES costs; Global Ambition considers the lower bound of costs for offshore wind in coherence with the focus on large generation units. Distributed Energy considers the lower bound for onshore wind and solar PV in coherence with decentralised technologies.

COP21 scenario storylines explicitly explore different pathways regarding energy autonomy. These storylines were publicly consulted in 2020. Distributed Energy focusses more on energy production in Europe. This is also reflected in the overall level of renewables and electrolyser capacity. Global Ambition on the other hand shows a more balanced energy supply mix with also somewhat higher imports. As a results, the role of electrolysis is a bit lower in this scenario compared to Distributed Energy. By using both scenarios for the infrastructure assessment, we aim to factor in the relevant uncertainties.

We also like to point out that the role of electrolysis has been increased in both scenarios based on stakeholder feedback. In particular the offgrid electrolysers with dedicated renewables have been expanded in the updated scenarios.

Regarding direct electrification the COP21 scenarios are consistent with European Commission assumptions. Following stakeholder feedback on further electrification especially for the heavy truck segment, direct electrification in the updated Distributed Energy scenario is 52% which is above REG scenario and draft report level. Regarding methane the COP21 scenarios for TYNDP 2022 are below the level observed in the Impact Assessment, in particular for natural gas imports and synthetic methane.

Feedback (Enel SpA):

Leaving aside the National Trends scenario, which is not in line with the current targets agreed at EU level, the other 2 scenarios are polarized in excess and subsequently do not necessarily reflect a sufficiently coherent and comprehensive range of pathways towards 2030 and 2050 targets.

Response

All together the two COP21 scenarios aim to create contrasted scenarios with differentiated narratives and assumptions that project long term demand and supply, explore uncertainties, provides insight on challenges that energy infrastructure facing during the energy transition. Due to this contrast enabling a robust infrastructure assessment, the scenarios do not intend to depict the most likely path towards carbon neutrality. The number of scenarios is dependent from the resources and timeline available for the process.

Feedback (Climate Action Network (CAN) Europe):

Compared to the TYNDP 2020, scenarios are slightly more contrasted on the supply side. The variation of technologies and energy carriers now shows better that a broad range of solutions is already available to achieve the EU's climate and energy targets. CAN Europe would have welcomed the integration of a new TYNDP scenario that describes a fully renewable energy system, compatible with the Paris Agreement's 1.5°C objective.
By way of example, the European Resource Adequacy Assessment (ERAA) that ENTSO-E is currently preparing will consider five different scenarios (https://www.youtube.com/watch?v=o-2y43bjddA). While it is true that the TYNDP and the ERAA serve different purposes, both comprise a modelling of European energy systems over the long term.
The scenarios are not very contrasted on the demand side. Energy demand in all scenarios is on a relatively high level. The mobilisation of energy savings potentials and energy efficiency gains in view of achieving the EU's climate and energy targets could have been presented in a more prominent and nuanced manner.
Recent research confirms the urgency of very swift emission reductions to keep the 1.5°C objective in reach, see Climate Analytics' 1.5°C pathways for the EU and its Member States, building on CAN Europe's Paris Agreement Compatible (PAC) scenario, October 2021, https://climateanalytics.org/publications/2021/15c-pathways-for-europe-achieving-the-highest-plausible-climate-ambition. Against this backdrop, a variation in time would have increased the pertinence of the TYNDP scenarios. One scenario should have assessed the conditions for the EU reaching net zero emissions before 2050. This forerunner role of the EU also would have underlined the equity principle in the carbon budget approach. Given that both 'COP21 compatible' scenarios in the TYNDP 2022 Draft Scenario Report exhaust the carbon budget before 2050, we regret that no alternative pathway is suggested to speed up emission reductions earlier as a reaction to the expected overshooting.

Response

The scope scenarios of 2022 cycle are result of the stakeholder consultation. Next cycle (TYNDP 2024 edition) will re-visit the storylines with the contribution of stakeholders to redefine the scope of the scenarios. Developing additional scenarios would certainly exceed the 2-year timeframe set by TYNDP process. The decision should come as a balance between modelling improvements (e.g. sector coupling, adequacy…) -*that are acknowledged by stakeholders*- and building & consulting an additional scenario. Next cycle, the aim is to re-evaluate the stakeholder comments and revisit this balance.

On the demand side, the differentiation of COP21 scenarios has been further increased:

- Final electricity demand in 2050 is 12% higher in Distributed Energy than in Global Ambition (16% higher when taking also into account electrolysis) and direct electrification reaches 52%, above EC scenario level
- Final methane and hydrogen demand in 2050 is 30% higher in Global Ambition than in Distributed Energy

The Fit-for-55 package and its enhanced energy efficiency targets will certainly be a predominant part of the discussion with stakeholders for the 2024 edition storylines and scenarios. It may provide the opportunity to reduce carbon emission on the path to 2050 and reduce the carbon budget overshoot.

Feedback (Oeko-Institut):

We welcome the slightly broader range of solutions on the supply side. But still see a high relevance for a 100% RES scenario to consider all relevant futures of the energy system. On the demand side energy efficiency is still not considered strong enough. In combination of these two elements a scenario reaching net zero before 2050 would be appropriate.

Response

The scope scenarios of 2022 cycle are result of the stakeholder consultation. Next cycle (TYNDP 2024 edition) will re-visit the storylines with the contribution of stakeholders to redefine the scope of the scenarios. In any case, the number of scenarios will continue to be set by the available resources (of ENTSO-E, ENTSOG and other partners) and timeline set by the TEN-E regulation.

The scenarios do not aim at bringing a political message but support infrastructure assessment. Under a power generation mix perspective, the Distributed Energy scenario already represents a path very much close from a 100% renewable scenario. RES amount for 89% of power generation in 2040 and 97% in 2050 compared to 84% in EC Impact Assessment scenarios.

The updated scenarios have provided the opportunity to slightly increase direct electrification and thus energy efficiency especially in heavy road transport. The level of energy efficiency and associated benefits and challenges will certainly be further discussed within the framework of the 2024 scenario building process.

Feedback (Eurelectric):

Eurelectric agrees with the necessity to develop diverse scenarios for the development of the TYNDP. Looking at the TYNDP 2022 draft scenario Report – apart from the National Trends scenarios – there are only two scenarios available over the long-term (2030/2040/2050), not three.

These two scenarios are rather extreme/opposite ones (polarized), either decentralized or centralized development of the energy system, covering a wide range of possible pathways for the decarbonisation process. Therefore, it is not easy to predict whether which one might materialise in Europe and may subsequently lack coherence and comprehensive range of pathways towards 2030 and 2050 targets.

Thus, it could be interesting to:
- quantify a more balanced scenario ("a mix" of the extreme ones) to get a more probable picture of the future.
- Adequately insert DSOs in the methodology while their role is not adequately re-transcripted (based on the evolution of the market and the decentralization of the energy sources).
- Provide a two-ways sensitivity analysis (more pessimistic / more optimistic). The variations of electrification and demand should, theoretically, affect the primary energy supply scenarios, and maybe some variations on the technologies providing the energy needed (4.2.1 of the report).
- Include some additional diversity in solar generation development where the solar capacity difference between DE and GA is quite small.
- More diversity would as well be needed in the domestic (EU) production of synthetic methane instead of imports, as onshore wind resources especially in the Nordic countries could be used for profitable production of synthetic fuels.
- More demand response (both downward and upward) in Distributed Energy.

Response

Indeed the National Trends scenario does not reach the 2050 time horizon. Such situation results from the lack of quantified information to accurately translate national strategies and policies up to 2050 in every Member States. We can expect that situation will improve in the future.

We acknowledge that an intermediate scenario may materialize in between Global Ambition and Distributed Energy. At the same time, both scenarios show many common evolutions on the medium term compared to the present situation.

We agree that additional scenarios will bring more information but given the available resources (not only from ENTSOG and ENTSOE but also from stakeholders contributing to the process) and timeline, it is beyond our reach to produce more scenarios and we need at least two contrasted ones.

Some DSO experts have started to engage as part of the 2022 scenario building process and we expect further engagement in the 2024 edition. It should help to better capture the dynamics occurring at distribution scale.

Sensitivity analysis may provide additional insight but it would require multiple runs of a large part of the modelling process (e.g. the expansion loop). The choice between a multi-scenario approach or a central one with few sensitivity analysis may be discussed as part of the next edition.

The scenario update has provided to implement stakeholder feedback on the three items you have identified: contrast in solar capacity, synthetic methane production based on European RES and additional demand response.

Feedback (EDF):

The TYNDP has to capture a large scope of robust, sustainable and consistent possible futures to highlight the risk to invest in infrastructures and explore different pathways of decarbonisation.
Different scenarios should be envisaged in order to cover the uncertainties:
- Electrification is recognized as the most cost-effective and energy efficient way to decarbonize final energy demand. A scenario with a higher electrification rate for final demand should be considered. The market share of EV for passenger cars or for heavy trucks in DE could be higher than envisaged. For example, for France, in the RTE's recently published reference scenario, EV accounts for 94% of the fleet in 2050 whereas the highest level in TYNDP is only 82% (in DE). Moreover, the penetration of electric heating (heat pumps…) is lower than 50% in DE and GA in 2050 whereas the RTE's reference scenario makes the assumption of 70% of electric heating in 2050.
- GA and DE bet on a strong development of decarbonized gas, in particular hydrogen (the two scenarios bet on a 13%/y growth of hydrogen between 2022 and 2040). Hydrogen is a key decarbonisation vector but, due to the large uncertainties, it is essential to be careful about its development. Therefore, at European level, a scenario with lower growth rate of hydrogen consumption should be envisaged.
- Nuclear is a no-intermittent free carbon technology. GIEC and EIA consider that nuclear is essential technology to reach the neutrality carbon. Moreover, ten European countries called to include nuclear in the taxonomy. Therefore, if the scenarios have to capture a large scope of possible future, in the context to power demand growth, the construction of a few new nuclear capacities should be envisaged too in DE.

Response

Regarding direct electrification and the level of hydrogen (being for final demand, power generation and upgrade to synthetic fuels), the COP21 scenarios are consistent with European Commission assumptions. Following stakeholder feedback on further electrification especially for the heavy truck segment, direct electrification in the updated Distributed Energy scenario now reaches 52% which is above REG scenario and draft report level.

The aim of COP21 scenarios is to cover a wide range of possible futures especially for technologies associated with political uncertainties such as nuclear. As a result Distributed Energy and Global Ambition illustrate a wider range than EC Impact Assessment scenarios. The absence of new nuclear units in Distributed Energy is an intermediate path between the construction of new ones and the push of some stakeholders to phase-out completely this technology before 2050.

Feedback (Environmental Action Germany (Deutsche Umwelthilfe e.V., DUH)):

Compared to the TYNDP 2020, scenarios are slightly more contrasted on the supply side. The variation of technologies and energy carriers now shows better that a broad range of solutions is already available to achieve the EU's climate and energy targets. DUH would have welcomed the integration of a new TYNDP scenario that describes a fully renewable energy system, compatible with the Paris Agreement's 1.5°C objective.

The scenarios are not very contrasted on the demand side. Energy demand in all scenarios is on a relatively high level. The mobilisation of energy savings potentials and energy efficiency gains in view of achieving the EU's climate and energy targets could have been presented in a more prominent and nuanced manner.

Recent research confirms the urgency of very swift emission reductions to keep the 1.5°C objective in reach, see Climate Analytics' 1.5°C pathways for the EU and its Member States, building on CAN Europe's Paris Agreement Compatible (PAC) scenario, October 2021, https://climateanalytics.org/publications/2021/15c-pathways-for-europe-achieving-the-highest-plausible-climate-ambition.

Against this backdrop, a variation in time would have increased the pertinence of the TYNDP scenarios. One scenario should have assessed the conditions for the EU reaching net zero emissions before 2050. This forerunner role of the EU also would have underlined the equity principle in the carbon budget approach. Given that both 'COP21 compatible' scenarios in the TYNDP 2022 Draft Scenario Report exhaust the carbon budget before 2050, we regret that no alternative pathway is suggested to speed up emission reductions earlier as a reaction to the expected overshooting.

Response

The scope scenarios of 2022 cycle are result of the stakeholder consultation. Next cycle (TYNDP 2024 edition) will re-visit the storylines with the contribution of stakeholders to redefine the scope of the scenarios. Developing additional scenarios would certainly exceed the 2-year timeframe set by TYNDP process. The decision should come as a balance between modelling improvements (e.g. sector coupling, adequacy…) -*that are acknowledged by stakeholders*- and building & consulting an additional scenario. Next cycle, the aim is to re-evaluate the stakeholder comments and revisit this balance.

On the demand side, the differentiation of COP21 scenarios has been further increased:

- Final electricity demand in 2050 is 12% higher in Distributed Energy than in Global Ambition (16% higher when taking also into account electrolysis) and direct electrification reaches 52%, above EC scenario level
- Final methane and hydrogen demand in 2050 is 30% higher in Global Ambition than in Distributed Energy

The Fit-for-55 package and its enhanced energy efficiency targets will certainly be a predominant part of the discussion with stakeholders for the 2024 edition storylines and scenarios. It may provide the opportunity to reduce carbon emission on the path to 2050 and reduce the carbon budget overshoot.

Feedback (Ember):

Ember notes that the two top-down scenarios are not well contrasted between themselves, nor with the National Trends scenario (until 2030), both on the supply and demand side. It is disappointing that the exploration of the uncertainties around the energy transition, the specific purpose of the two COP21 scenarios, is limited to a narrow range. Some examples are included below to highlight the narrow range of pathways explored for key elements of the energy transition:

• Supply: The power generation mix is similar across the scenarios, and both COP21 scenario feature a slow decline in fossil fuel generation. Indeed, natural gas capacity and methane consumption for power generation follows almost identical paths. As a result, carbon intensity of electricity generation decreases at an almost identical rate.

• Demand: The rate of electrification is moderate and similar across the scenarios: 25-27% in 2030 and 38-44% in 2050. This high degree of similarity is also present in all end-use sectors. The potential impact of higher levels of electrification on the power system (including the impact on peaks) is not explored.

• Demand: Both scenarios prioritise indigenous hydrogen production, with no exploration of the impacts of a scenario with a more equal distribution between import and domestic production for hydrogen.

• Demand: As a result of the two above points, growth in electricity demand in the two scenarios follows similar trajectories.

Furthermore, it is disappointing to see that neither COP21 scenarios explore the impact of early action and the potential pathways to decarbonise the power sector by 2035. This was identified in the IEA's Net-Zero Report as a key milestone to reach net-zero by 2050, a commitment legally enshrined in the EU's climate commitments.

Finally, it is concerning to see that both scenarios considered to be aligned with the Paris Agreement massively overshoot the EU's carbon budget by 2050. Remediating this by placing the onus on untested carbon negative technologies after the time horizon covered by the TYNDP scenarios only serves to delay action and should not be considered compatible with the EU's energy and climate goals.

Response

The COP21 scenarios aim at a meaningful differentiation based on their respective storyline. As a result, some storyline drivers may counteract each other (e.g. higher hydrogen demand in Global

Ambition resulting from a wider range of technologies does not result in higher electrolysis capacity as it is compensated by higher hydrogen imports).

As a difference from other publications, COP21 scenarios do not intend to promote a specific technology. Nevertheless, it achieves a significant contrast on some key parameters:

- Final electricity demand in 2050 is 12% higher in Distributed Energy than in Global Ambition (16% higher when taking also into account electrolysis)
- Final methane and hydrogen demand in 2050 is 30% higher in Global Ambition than in Distributed Energy
- Wind and solar (resp. battery) capacity in 2050 is 40% (resp. 70%) higher in Distributed Energy than in Global Ambition

Feedback (Gas Distributors for Sustainability (GD4S)):

Due to the fact that the scenarios are intended to feed the assessment of international flows and the needs for additional major infrastructure (PCI), we understand they could not be as contrasted as a fully integrated energy system approach.
For instance, the local dimension of the energy transition is not perfectly represented even in the DE. We cannot see real diversity in the two long term scenarios as regards mobility and heating for instance. Both are assuming deep electrification assumptions without exploring the related assumption on renovation, availability and affordability. Such approach does not appear to us the most pragmatic and secured one.
Additional feedback will be provided in the coming weeks.

Response

The basic granularity of the scenarios is the country level as a result they do not preclude on the location of many technologies being at distribution or transmission scales.
The level of direct electrification is rather contrasted as it evolves from the present 23% to 43% in Global Ambition and 52% in Distributed Energy.

Feedback (Ørsted):

Electrification rates should be more in line with the trajectories identified by the European Commission. To begin with, methane demand (0.5-1 PWh in 2050) is estimated to be overoptimistically high due to use in residential and industry - where already today the potential for direct electrification is enormous. Furthermore, ~50% of heavy trucks in 2050 are still internal combustion engine, while there is slow uptake of BEVs in the passenger cars in the 2020s and 2030s. This both stands in contrast to carbon-neutrality and fails to reflect rapid developments in vehicle electrification (direct and in-direct).

A solution could be having one of the scenarios focused on electrification as the main measure for decarbonizing in order to show that direct electrification will be more energy efficient than indirect electrification through other means.

Response

On the demand side, following to the stakeholder comments on further electrification especially for the heavy truck segment, direct electrification in the updated Distributed Energy scenario is 52% which is above REG scenario and draft report level.

Feedback (Eurogas):

In the context of infrastructure, the role of gas DSOs should be enhanced as much as the electricity DSOs. Many of the technical developments needed to ensure the energy transition are based on the DSO/local level ((such as production of biomethane, renewable electricity, hydrogen, heating-mobility). The gas DSOs need to be structurally involved in the TYNDP process, they need to be more involved not only as "regular" stakeholders, especially in designing the grids conversion process and planning. We also think that the gas DSO should be involved in the national trend projects. In detail, some sensitivities analysis may strengthen the results and illustrate the impact of some of the key inputs. In particular the assumption linked to the energy efficiency which is "key to achieve the EU long-term climate and energy objectives" according to the report

Response

We agree on the point that DSOs should be more involved in the Scenario Building process and we aim to increase their involvement for the next cycle.

Feedback (currENT Europe):

While we understand the methodology for building scenarios and acknowledge that the method includes some improvements over previous versions, it would be more useful to build scenarios that give a wider range of the needed infrastructure build-out, including non-grid alternatives. In the current scenarios, the effects on the needed infrastructure build-out often cancel each other out, e.g. in the GA scenario there is an emphasis on centralized offshore wind build-out, but limited hydrogen/e-fuel build-out inside Europe. This will unrealistically limit the scale of the needed infrastructure build-out.

In light of the recent increase in energy prices across Europe as well as energy security concerns based on relying on gas imports, the European Union should focus even more on producing hydrogen domestically, from dedicated offshore wind farms (not in combination with the grid), at least in one of the scenarios.

The GA scenario is estimating too large of an import of P2X-related products, limiting the necessary infrastructure build-out needed in the case of a large uptake of both onshore and offshore wind, partially driven by a strong domestic renewable hydrogen demand.

Electrification rates should be more ambitious. The methane demand (0.5-1 PWh in 2050) is estimated to be overoptimistically high due to use in residential and industry - where already today the potential for direct electrification is enormous.

A solution could be having one of the scenarios focused on electrification as the main measure for decarbonising in order to show that direct electrification will be more energy-efficient than indirect electrification through other means.

We also note that innovative grid technologies could be incorporated into the scenarios. By optimizing grid operations, they can play useful roles in mitigating the variability of renewables and accelerating their integration, while at the same time reducing the overall cost of the transition. See, e.g.,

WindEurope, Making the most of Europe's grids – Grid optimisation technologies to build a greener Europe, September 2020 (https://windeurope.org/wp-content/uploads/files/policy/position-papers/20200922-WindEurope-Grid-optimisation-technologies-to-build-a-greener-Europe.pdf).

Response

The COP21 scenarios are built based on data and trajectories that are differentiated based on their respective storylines. This projections on technology costs are derived from reliable sources and the differentiation has been made within the price range stated on these sources considering the scenarios narrative. For instance, regarding RES costs; Global Ambition considers the lower bound of costs for offshore wind in coherence with the focus on large generation units. Distributed Energy considers the lower bound for onshore wind and solar PV in coherence with decentralised technologies.

COP21 scenario storylines explicitly explore different pathways regarding energy autonomy. These storylines were publicly consulted in 2020. Distributed Energy focusses more on energy production in Europe. This is also reflected in the overall level of renewables and electrolyser capacity. Global Ambition on the other hand shows a more balanced energy supply mix with also somewhat higher imports. As a results, the role of electrolysis is a bit lower in this scenario compared to Distributed Energy. By using both scenarios for the infrastructure assessment, we aim to factor in the relevant uncertainties.

We also like to point out that the role of electrolysis has been increased in both scenarios based on stakeholder feedback. In particular the offgrid electrolysers with dedicated renewables have been expanded in the updated scenarios.

Regarding direct electrification the COP21 scenarios are consistent with European Commission assumptions. Following stakeholder feedback on further electrification especially for the heavy truck segment, direct electrification in the updated Distributed Energy scenario is 52% which is above REG scenario and draft report level. Regarding methane the COP21 scenarios for TYNDP 2022 are below the level observed in the Impact Assessment, in particular for natural gas imports and synthetic methane.

Feedback (ENGIE):

As argued in more detail in other questions, we believe that the two long-term scenarios compliant with the new EU decarbonization goals (DE/GA) are very often not diverse enough to cope with technological uncertainty. For instance, DE and GA scenarios represent by definition two extreme and very unrealistic scenarios as they are built on extreme assumptions. In particular the Distributed Energy scenario, which builds upon very decentralized production and consumption patterns, requires the realization of millions of investment/consumption choices at decentralized level and its realization is therefore very difficult to be achieved/controlled in practice.

Thus, the uncertainty about the maturity of investment options creates uncertainty which should be reflected in some variants of the two scenarios. For instance there could be a third central scenario (like the MIX from the EU Commission Impact Assessment), in order to capture the fact that the energy transition will most probably feature a balanced mix of decentralized and centralized technologies.

Alternatively, the two long-term scenarios should strive to be diverse enough to include different pathways to achieve decarbonization. In this sense, we regret that in many instances the role of gases

in the transition (e.g. power generation, e-methane, hybrid heat pumps) is not adequately reflected neither in DE nor in GA.

Some sensitivities analysis may strengthen the results and illustrate the impact of some of the key inputs. In particular the assumptions linked to the energy efficiency, which is "key to achieve the EU long-term climate and energy objectives" according to the report, should be made more transparent and elaborated upon.

Response

The COP21 scenarios aim at a meaningful differentiation based on their respective storyline. As a result, some storyline drivers may counteract each other (e.g. higher hydrogen demand in Global Ambition resulting from a wider range of technologies does not result in higher electrolysis capacity as it is compensated by higher hydrogen imports).

As a difference from other publications, COP21 scenarios do not intend to promote a specific technology. Nevertheless, it achieves a significant contrast on some key parameters:

- Final electricity demand in 2050 is 12% higher in Distributed Energy than in Global Ambition (16% higher when taking also into account electrolysis)
- Final methane and hydrogen demand in 2050 is 30% higher in Global Ambition than in Distributed Energy
- Wind and solar (resp. battery) capacity in 2050 is 40% (resp. 70%) higher in Distributed Energy than in Global Ambition

The scope scenarios of 2022 cycle are result of the stakeholder consultation. Next cycle (TYNDP 2024 edition) will re-visit the storylines with the contribution of stakeholders to redefine the scope of the scenarios. Our stakeholder must know that an additional scenario will require additional time and resources. Due to the 2-year timeframe set by TYNDP process, the decision should come as a balance between advancing the modelling scope -*that are acknowledged by stakeholders*- and building & consulting an additional scenario. Next cycle, the aim is to re-evaluate the stakeholder comments and revisit this balance.

Sensitivity analysis may improve scenario robustness, but they would require a longer timeframe than the 2 years defined by regulation. Next edition would provide the opportunity to stakeholders to express the preference between a single scenario approach with sensitivity analysis or a multi scenario approach.

Feedback (SolarPower Europe):

We remain very critical of this approach of not having one central 2050 scenario indicating the most likely development of the energy sector, including sensitivities on the parameters that are used to build the two 2050 scenarios. The current approach does not indicate a clear direction for steering investment projects. It is questionable why certain parameters (e.g. extent of circularity improvements; large-scale vs distributed RES deployment) have been attributed to a larger extent to one scenario rather than another.

Response

The scope scenarios of 2022 cycle are result of the stakeholder consultation. Next cycle (TYNDP 2024 edition) will re-visit the storylines with the contribution of stakeholders to redefine the scope of the scenarios. Our stakeholder must know that an additional scenario will require additional time and resources. Due to the 2-year timeframe set by TYNDP process, the decision should come as a balance between advancing the modelling scope -*that are acknowledged by stakeholders*- and building & consulting an additional scenario. Next cycle, the aim is to re-evaluate the stakeholder comments and revisit this balance.

Sensitivity analysis may improve scenario robustness, but they would require a longer timeframe than the 2 years defined by regulation. Next edition would provide the opportunity to stakeholders to express the preference between a single scenario approach with sensitivity analysis or a multi scenario approach.

Feedback (Edison S.p.A.):

The DE and GA scenarios are well contrasted and cover a large range of possibilities generally in coherence with EC scenarios with two different approaches to reach the net zero emissions in 2050. The effective pathway to decarbonization will probably be a combination of the approaches depending on technology maturity, initial energy mix, and national situations. Still as mentioned in the answer to question 11, it would still be appreciated to maintain a Business As Usual scenario, considered as a back-up scenario (in case of delayed transition situation).

We note in both scenarios that the importance of H2 has increased with respect to the previous TYNDP: GA and DE rely on a strong development of decarbonized gas, in particular hydrogen (the two scenarios rely on a 13%/y growth of hydrogen between 2022 and 2040). If we agree on the fact that hydrogen is a key decarbonisation vector, it requires a huge diffusion of RES that in some cases could seem to exceed the potential expected. Therefore, at European level, a scenario with lower growth rate of hydrogen consumption should also be considered.

Moreover, Edison notes relevant discrepancies with EC scenarios benchmark, at Paragraph 6.4.1, with regards to methane supply. It might be useful in such cases to provide additional information to adequately explain the non-alignments with the benchmark scenarios.

Response

We thank you for your feedback.

Regarding methane supply both COP21 scenarios for TYNDP 2022 are below the level observed in the Impact Assessment, as illustrated in chapter 6.4.1. This is in particular due to lower natural gas imports and lower production of synthetic methane. Instead, the TYNDP 2022 scenarios assume higher hydrogen demand from electrolysis, which is more efficient as it avoids the additional conversion step to synthetic methane. This is also illustrated in chapter 6.4.2.

Feedback (BDEW Association of German Energy and Water Industries):

We should be open for additional scenarios, if necessary, but at the moment these three scenarios provide a broad enough range.

Response

The scope scenarios of 2022 cycle are result of the stakeholder consultation. Next cycle (TYNDP 2024 edition) will re-visit the storylines with the contribution of stakeholders to redefine the scope of the scenarios. Our stakeholder must know that an additional scenario will require additional time and resources. Due to the 2-year timeframe set by TYNDP process, the decision should come as a balance between advancing the modelling scope -*that are acknowledged by stakeholders*- and building & consulting an additional scenario. Next cycle, the aim is to re-evaluate the stakeholder comments and revisit this balance.

Question 4: The Distributed Energy and Global Ambition scenarios aim at achieving a carbon-neutral EU-27 economy by 2050. Do you think the scenarios are helpful in identifying / assessing those challenges?

Feedback (Germanwatch): Neutral

The scenarios are a very good start. However, as indicated above, in order to assess the respective challenges, a 100% renewables scenario and a no-overshoot 1.5° scenario would be very helpful.

Response

The scope scenarios of 2022 cycle are result of the stakeholder consultation. Next cycle (TYNDP 2024 edition) will re-visit the storylines with the contribution of stakeholders to redefine the scope of the scenarios. Our stakeholder must know that an additional scenario will require additional time and resources. Due to the 2-year timeframe set by TYNDP process, the decision should come as a balance between advancing the modelling scope -*that are acknowledged by stakeholders*- and building & consulting an additional scenario. Next cycle, the aim is to re-evaluate the stakeholder comments and revisit this balance.

Feedback (WindEurope):

In addition to answers to question 12, the scenarios aren't mentioning ***offshore hybrids.*** *Offshore hybrids configurations (wind farms connected to interconnectors or grid hubs) and energy islands are a crucial part of the future infrastructure and should therefore already be mentioned in the TYNDP scenarios in order to get stakeholder feedback on the uptake of offshore hybrids and energy islands across Europe. Scenarios do not address sufficiently (in a transparent and explicit way) either, the contribution of storage associated with the renewable facilities or high scale storage (hydro pumping, large batteries, CAES, eventually hydrogen, etc.) to facilitate the integration of renewable energy. The DA and GA scenarios miss some targets needed to achieve the Fit for 55 ambitions, for example, the level of energy efficiency is significantly low if compared to PRIMES policy scenarios linked to the 2030 target plan and the Fit for 55.*
Moreover, there is a certain risk that more costly solutions are cannibalizing cost-effective solutions already available in the scenarios designed in the TYNDP 2022 scenario report, with a subsequent impact on the design of the future EU electricity and gas networks. This could be the case for electrification technologies, which are already recognized as a "no regret option" by the European Commission in the long-term decarbonisation scenarios and have increasingly decreased their cost in

the recent years at higher rates than expected before but are considered at lower penetration rates in the ENTSOs scenarios than if compared into the Commission PRIMES scenarios in support of 55% and 2050 net-zero ambition.

Response

The basic granularity of the scenario building process is the country scale, as a result it does not preclude on the approach to connect offshore wind farms. The future ENTSO-E TYNDP will provide further insights on the topic. The updated report has provided the opportunity to provide more transparency on flexibility options covering demand shedding, V2G, batteries (utility-scale and prosumer), thermal storage on district heating, hydro pump storage and electrolyser with back-up. Scenarios do not cover CAES and the future edition may provide the opportunity to include a wider range of energy storage based on future TSO feedback and data.

While Distributed Energy and Global Ambition do not reach the Fit for 55 efficiency target, the direct electrification rate of Distributed Energy reaches 52% in 2050 beyond EC scenario level.

Feedback (Enel SpA): NO
The DA and GA scenarios miss some targets needed to achieve the Fit for 55 ambitions, for example the level of energy efficiency is significantly low if compared to PRIMES policy scenarios linked to the 2030 target plan and the Fit for 55.

Moreover, there is a certain risk that more costly solutions are cannibalizing cost-effective solutions already available in the scenarios designed in the TYNDP 2022 scenario report, with a subsequent impact on the design of the future EU electricity and gas networks. This could be the case for electrification technologies, which are already recognized as a "no regret option" by the Commission in the long-term vision scenarios and have increasingly decreased their cost in the recent years at higher rates than expected before but are considered at lower penetration rates in the ENTSOs scenarios if compared to the Commission PRIMES scenarios in support of 55% and 2050 net-zero ambition.

Response

The updated scenarios based on stakeholder feedback have offered the opportunity to further improve energy efficiency in particular for Distributed Energy scenario.

The scope scenarios of 2022 cycle are result of the stakeholder consultation. Next cycle (TYNDP 2024 edition) will re-visit the storylines with the contribution of stakeholders to redefine the scope of the scenarios. Our stakeholder must know that an additional scenario will require additional time and resources. Due to the 2-year timeframe set by TYNDP process, the decision should come as a balance between advancing the modelling scope -*that are acknowledged by stakeholders*- and building & consulting an additional scenario. Next cycle, the aim is to re-evaluate the stakeholder comments and revisit this balance.

Feedback (Eurelectric): YES

The DA and GA scenarios miss some targets needed to achieve the Fit for 55 ambitions, for example the level of energy efficiency is significantly low if compared to PRIMES policy scenarios linked to the 2030 target plan and the Fit for 55.

The DE and GA scenarios are indeed elaborated in line with the ambition enshrined in the Paris Agreement and in the EU Green Deal and Climate Law. The finalisation of the Fit-for-55 & the Gas decarbonisation Packages, and their transposition in national Law shall define the specific tools and policies to make the EU ambition a reality. Until then, we can argue that the DE and GA scenarios represent, by definition, two extreme and not very realistic scenarios, because built on extreme assumptions. In particular, DE scenario, which builds upon a very decentralised production and consumption patterns, requires the realization of millions of investment/consumption choices at decentralised level and might therefore be very difficult to achieved in practice.

More generally, the uncertainty about the maturity of investment options in any of the two scenarios creates uncertainty which has to be reflected in some variants to both scenarios. For instance, there could be a third central scenario (like the MIX from the EU Commission Impact Assessment), in order to capture the fact that most probably the energy transition will feature a balanced mix of decentralised and centralised technologies with for example, a narrative more biased to electrification solutions but still open to market signals and energy imports; if compatible with cost/prices outlook may provide a workable base for future infrastructure analysis. Furthermore, even though the genuine purpose of TYNDP scenarios is not to deal with adequacy and cost for consumers, we observe that those two dimensions are key in influencing the realisation of the scenarios.

Response

The updated scenarios based on stakeholder feedback have offered the opportunity to further improve energy efficiency in particular for Distributed Energy scenario.

The scope scenarios of 2022 cycle are result of the stakeholder consultation. Next cycle (TYNDP 2024 edition) will re-visit the storylines with the contribution of stakeholders to redefine the scope of the scenarios. Our stakeholder must know that an additional scenario will require additional time and resources. Due to the 2-year timeframe set by TYNDP process, the decision should come as a balance between advancing the modelling scope -*that are acknowledged by stakeholders*- and building & consulting an additional scenario. Next cycle, the aim is to re-evaluate the stakeholder comments and revisit this balance.

Feedback (EDF): NO

The main objective of the TYNDP is to capture a large scope of robust, sustainable and consistent possible futures to highlight the risk to invest in infrastructures and not to identify the challenges of the energy transition. For example, one of the main challenges of the energy transition will be the cost of its implementation depending on the choices made and the cost of each scenario. EDF notes improvements compared to the previous financial year which highlight certain challenges of the energy transition. During the previous TYNDP, EDF regretted that the two scenarios were partly based on disruptive technologies (CCS) and on massive imports of carbon-free energies (hydrogen or methane) leading to transfer a large part of the decarbonisation to countries outside of Europe. EDF notes that for TYNDP 2022, the scenarios are more contrasted for CCS and imports which highlights that GA, which assumes less direct electrification and gives more place for gas (methane and hydrogen)

requires a massive import of carbon-free energy and strong development of CCS to achieve carbon neutrality. Therefore, the achievement of carbon neutrality seems much more risky in such a scenario.

However, and despite these improvements, EDF notes that the two scenarios are based on a strong development of the decarbonized hydrogen. There are many uncertainties concerning the development of hydrogen (storage capacities, renewable capacities for electrolysers…). In case of less ambitious development of hydrogen, the TYNDP does not seem to identify alternatives and network requirements.

Response

The scenarios intend to show contrasted pathways to provide a robust basis for infrastructure assessment. In fact, they both include the same and wide range of technologies but at different levels.

Regarding the development of hydrogen, the scenarios are different in terms of hydrogen demand and supply (either domestically produced or imported) to address the uncertainty of future development of hydrogen.

Feedback (Gas Distributors for Sustainability (GD4S)): Neutral

The TYNDP exercise is interesting but it should continue to improve in relation to the evolution of the TEN-E regulation and the finalisation of the Fit for 55.
For instance, it could be interesting to see two additional scenarios build on sensitivity on key assumptions such as: building renovation rate, development rate of new power generation, development of renewable gases (assumptions on biomethane and synthetic biomethane appear very cautious, especially in comparison to the power generation ones)… These scenarios could be possible trajectories according to some risk analysis on the key assumptions and also integrating some society changes (evolution to a more circular economy and sobriety, to more local production and consumption…).
Last but not least, better integrating the infrastructure dimension, especially at distribution level, in the construction of the scenarios supposes to develop in detail the analysis on peak demand evolution and how the system covers it in a reliable and cost-efficient way.

Response

We support the vision of a scenario building process being in constant evolution to better translate an evolving European regulation.

The 2022 edition is based on a multi-scenario approach rather than a sensitivity analysis one. The latter may help to picture the specific impact of some assumptions, but it would require a range of analysis too big to fit the existing timeline and resources. For example changing the renovation rate upward or downward would require to rerun a large part of the scenario building process and especially the time-consuming expansion loop building the electricity and hydrogen system. The 2024 edition will provide to discuss the merits of each approach. In any case the report highlights identify a wide range of requirements (e.g. evolution of the political, financial and societal frameworks) for scenario to materialize.

Regarding the distribution scale, the scenarios does not define at which geographical scale the renewable energy production would occur.

The updated scenarios now include a specific security of supply script for the power system and the illustration of hourly adequacy under stressed situations such as a "Kalte Dunkelflaute".

Feedback (Ørsted):

The two scenarios show to very different solutions, while in reality it may be necessary to use a combination of solutions (pointed out in question to 12.).

The scenarios are descriptive and provide a good picture of what needs to happen with energy demand and the energy mix in order to achieve net-zero. It does however not describe in any detail what are the main challenges and obstacles to achieve this or describe the impact this will have on energy end-users. An important part of this is related to what kind of investments are required and what will be the impact on end-user prices and costs of energy.

The scenarios aren't mentioning offshore hybrids. Offshore hybrids configurations (wind farms connected to interconnectors or grid hubs) and energy islands are a crucial part of the future infrastructure and should therefore already be mentioned in the TYNDP scenarios in order to get a stakeholder feedback on the uptake of offshore hybrids and energy islands across Europe.

Response

The two scenarios intend to strike the right balance between contrasted pathways to provide a robust basis for infrastructure assessment, and "realism". In fact, they both include the same and wide range of technologies but at different levels.

The Executive summary identifies six highlights, the first being the need to review the political, financial and societal frameworks to ensure that scenarios can materialize. It is an acknowledgment of the many challenges to be met to achieve carbon neutrality. The identification of each obstacle and the full monetisation of the scenarios go beyond the definition of contrasted scenario for infrastructure assessment purpose.

Regarding offshore hybrid, the basic granularity of the scenario building process is the country scale, which does not preclude on the approach to connect offshore wind farms. The future ENTSO-E TYNDP will provide further insights on the topic. The updated report has provided the opportunity to provide more transparency on flexibility options covering demand shedding, V2G, batteries (utility-scale and prosumer), thermal storage on district heating, hydro pump storage and electrolyser with back-up. Scenarios do not cover CAES and the future edition may provide the opportunity to include a wider range of energy storage based on future TSO feedback and data.

Feedback (Eurogas):

Even though the purpose of TYNDP scenarios is not to deal with adequacy and cost for consumers, we observe that those two dimensions are key in influencing the realization of the scenarios. For instance, as far as adequacy in the power system is concerned, we note that in both COP21 compliant scenarios the high penetration of RES-E (64%-67%) seems challenging for the adequacy of the electricity system, considering the low levels of baseload and dispatchable generation (e.g. nuclear around 10% of generation in 2030 and between 1% and 5% generation in 2050, while gas represents 15% in 2030 and 5% in 2050). The management of peak electricity demand through the various DSM

systems and batteries on the one hand and the back-up provided by flexible electricity generation should be further clarified. Last but not least, without integrating the infrastructure dimension, especially at distribution level, in the construction of the scenarios. This supposes to develop in detail the analysis on peak demand evolution and how the system cover it in a reliable and cost-efficient way

Response

While the scenarios do not provide a total cost of energy, the updated report provides more details on adequacy management and demand side flexibility. Moreover, a script has been added to the methodology to ensure a high level of security of supply. The report now illustrates the hourly balance of the power system under stressed events such as Kalte Dunkelflaute. It confirms that Europe can combine carbon neutrality with security of supply under a very high level of RES penetration.

Feedback (currENT Europe): No

In addition to answers on question 12, the scenarios do not mention offshore hybrids. Offshore hybrid configurations (wind farms connected to interconnectors or grid hubs) and energy islands are a crucial part of the future infrastructure and should therefore already be mentioned in the TYNDP scenarios in order to get a stakeholder feedback on the uptake of offshore hybrids and energy islands across Europe.

Response

The basic granularity of the scenario building process is the country scale, as a result it does not preclude on the approach to connect offshore wind farms. The future ENTSO-E TYNDP will provide further insights on the topic.

Feedback (ENGIE): Neutral

The DE and GA scenarios are indeed built in line with the ambition enshrined in the Paris Agreement and in the EU Green Deal and Climate Law. However, pending the finalization of the Fit-for-55 and Gas Packages and their transposition in national laws, which shall define the specific tools and policies to make the EU ambition a reality, we can argue that the DE and GA scenarios represent by definition two extreme and very unrealistic scenarios, because they are built on extreme assumptions. In particular the Distributed Energy scenario, which builds upon very decentralized production and consumption patterns, requires the realization of millions of investment/consumption choices at decentralized level and its realization is therefore very difficult to be achieved/controlled in practice. More in general, the uncertainty about the maturity of investment options creates uncertainty which should be reflected in some variants to the two scenarios.
For instance there could be a third central scenario (like the MIX from the EU Commission Impact Assessment), in order to capture the fact that most probably the energy transition will feature a balanced mix of decentralized and centralized technologies.
Furthermore, even though the purpose of TYNDP scenarios is not to deal directly with adequacy issues and costs for consumers, both dimensions are key in influencing the realization of the scenarios, but the report is missing relevant information on these two aspects.
For instance, as far as adequacy in the power system is concerned, we note that in both COP21 compliant scenarios the high penetration of RES-E (64%-67%) seems challenging for the adequacy of the electricity system, considering the low levels of baseload and dispatchable generation (e.g. nuclear

around 10% of generation in 2030 and between 1% and 5% generation in 2050, while gas represents 15% in 2030 and 5% in 2050). In particular we believe that gas is key to manage the transition towards full decarbonization, therefore we would expect a higher role of gas in 2030 in both scenarios. Please refer to our answer to Q.32 for more considerations about the role of gases. Finally, the management of peak electricity demand through the various demand-side management systems and batteries on the one hand and the back-up provided by flexible gas-fired electricity generation (which will have to use more and more renewable and low-carbon gases in the future) should also be further clarified.

Response

Distributed Energy and Global Ambition do not pretend to illustrate the most realistic pathways to carbon neutrality which could be indeed an intermediate path. The aim of theses contrasted view is to ensure the robustness of infrastructure assessment at TYNDP level. A single medium scenario would not enable the same robustness as not capturing enough uncertainty and the addition of such a scenario to the three existing ones exceeds the available resources and 2-year timeline.

While the scenarios do not provide a total cost of energy, the updated report provides more details on adequacy management and demand side flexibility. Moreover, a script has been added to the methodology to ensure a high level of security of supply. The report now illustrates the hourly balance of the power system under stressed events such as Kalte Dunkelflaute where gas has a key role in the scenarios. It confirms that Europe can combine carbon neutrality with security of supply under a very high level of RES penetration.

Feedback (Edision S.p.A.): Yes

The scenarios are definitely helpful in identifying the challenges of the zero-emission objective for 2050, in particular with a focus of necessary energy efficiency and negative CO2 emission.

Response

We thank you for your feedback.

Question 5: The Distributed Energy and Global Ambition scenarios consider different technology pathways to decarbonisation. The Distributed Energy is a scenario focusing on higher RES development and aiming at EU energy autonomy. The Global Ambition scenario focuses on the development of a global clean energy economy with low-carbon technologies and large-scale RES development. Do you agree that these scenarios are consistent with the assumptions made in the Storyline Report?

Feedback (Germanwatch): Yes

We do remain critical of the Global Ambition scenario as a storyline, though.

Response

The merit of the multi-scenario approach is to ensure a wider consensus on the set of scenarios if not on each scenario. This would be more challenging with a central scenario combined with a sensitivity-analysis.

Feedback (Agora Energiewende): No

Regarding the global ambition scenario, it is important to show that the imported hydrogen can be provisioned sustainably, including taking into account methane leakage issues, not endangering the energy transition in the exporting countries and having realistic assumption on cost developments. Hydrogen imports, e.g., will likely remain limited due to high transport costs. See also Agora Energiewende's H2 insights, p.33/34: https://static.agora-energiewende.de/fileadmin/Projekte/2021/2021_11_H2_Insights/A-EW_245_H2_Insights_WEB_V2.pdf

Response

The potential H2 supply sources used in the TYNDP draft scenario report are Norway, Russia, North Africa, and the Turkish Hub. This choice was based on several factors, namely the potential for RES, existing access to the trans-European gas infrastructure, methane production, and being able to store CO2.

These H2 supply sources have been revised to include Ukraine in the updated scenario report. The country was added as a potential H2 supply source based on the good climatic and geographic conditions for H2 production and the existing connection to the trans-European gas infrastructure

Feedback (Eurelectric): Yes

As already stated, both scenarios GA and DE appear polarised and uncertain to materialise (especially DE, which requires coordination and realisation of millions of investment/consumption choices). In some cases, the results of two scenarios are very similar and shouldn't be expected to capture the risk of divergent outcomes. In practice, this might give a wrong impression about the decarbonisation pathways to users of the scenarios, possibly leading to some form of technologic lock-in or neglecting the impact of alternative solutions. Therefore, there is the need for one or more additional scenarios, more balanced, to capture uncertainty and risk.

Response

The scope scenarios of 2022 cycle are result of the stakeholder consultation. Next cycle (TYNDP 2024 edition) will re-visit the storylines with the contribution of stakeholders to redefine the scope of the scenarios. Our stakeholder must know that an additional scenario will require additional time and resources. Due to the 2-year timeframe set by TYNDP process, the decision should come as a balance between advancing the modelling scope -*that are acknowledged by stakeholders*- and building & consulting an additional scenario. Next cycle, the aim is to re-evaluate the stakeholder comments and revisit this balance.

Feedback (Gas Distributors for Sustainability (GD4S)): Neutral

On certain aspects, the 2 scenarios are not very contrasted. On the contrary, the vision seems rather monolithic as regards the options of end-users.
The difference is in fact just about production patterns with two extremes that cannot be taken as the most probable ones. Even when the level of uncertainty is very high about trajectories relying on millions of individual investment decisions, the EU energy system will be a mix of centralized and decentralized and even if it could support some design thinking, such scenarios cannot be taken as realistic.

Response

The COP21 scenarios aim at a meaningful differentiation based on their respective storyline. As a result, some storyline drivers may counteract each other (e.g. higher hydrogen demand in Global Ambition resulting from a wider range of technologies does not result in higher electrolysis capacity as it is compensated by higher hydrogen imports).

As a difference from other publications, COP21 scenarios do not intend to promote a specific technology. Nevertheless, it achieves a significant contrast on some key parameters:

- Final electricity demand in 2050 is 12% higher in Distributed Energy than in Global Ambition (16% higher when taking also into account electrolysis)
- Final methane and hydrogen demand in 2050 is 30% higher in Global Ambition than in Distributed Energy
- Wind and solar (resp. battery) capacity in 2050 is 40% (resp. 70%) higher in Distributed Energy than in Global Ambition

Feedback (Eurogas): No

In some cases the results of two scenarios are very similar, this might give a wrong impression about decarbonization pathways to users of the scenarios, possibly leading to some form of technologic lock-in (in particular in full electric heat pumps or FCEV, etc.), or neglecting the impact of alternative solutions (e.g. hybrid heat pumps,gas/ H2 heat pumps/Fuel cells, e-methane, etc.) especially in the heating sector. More explanations and justifications are therefore required. Unfortunately already in the set up of the assumptions and the storylines the preselection of few technologies was done.. The impact of switching heat loads to electricity is enormous and under consideration of the seasonality and the fluctuating of renewable resource unproven that it is feasible or cost efficient (sie Frontier study).
Sensitivities analyses may help to identify the key parameters influencing the success or the challenges of achieving the targets.
The Energy efficiency first and the need to develop demand flexibility could be further detailed. The energy system should be assessed as a whole: generation, demand and infrastructure design on peak demand and security of supply. Ideally the scenarios should integrate sensitivities on key parameters of these components to provide insights and visibility on the decarbonisation pathway.

Response

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Sensitivity analysis may improve scenario robustness, but they would require a longer timeframe than the 2 years defined by regulation. Next edition would provide the opportunity to stakeholders to express the preference between a single scenario approach with sensitivity analysis or a multi scenario approach.

The updated scenarios based on stakeholder feedback have offered the opportunity to further improve energy efficiency in particular for Distributed Energy scenario.

Feedback (ENGIE): Neutral

As already stated above (Q.14) both scenarios GA and DE appear extreme and unrealistic per se (especially Distributed Energy, which requires coordination and realization of millions of investment/consumption choices).
In some cases the results of both scenarios are very similar, thus they do not capture the risk of divergent outcomes; this might give a wrong impression about decarbonization pathways to users of the scenarios, possibly leading to some form of technologic lock-in (in particular in full electric heat pumps or FCEV, etc.), or neglecting the impact of alternative solutions (e.g. hybrid heat pumps, e-methane, etc.). More comments about those technologies are outlined in our answers below. Therefore we believe that there is the need for one or more additional scenarios, more balanced, to capture uncertainties and risks.

Response

The COP21 scenarios aim at a meaningful differentiation based on their respective storyline. As a result, some storyline drivers may counteract each other (e.g. higher hydrogen demand in Global Ambition resulting from a wider range of technologies does not result in higher electrolysis capacity as it is compensated by higher hydrogen imports).

As a difference from other publications, COP21 scenarios do not intend to promote a specific technology. Nevertheless, it achieves a significant contrast on some key parameters:

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- Wind and solar (resp. battery) capacity in 2050 is 40% (resp. 70%) higher in Distributed Energy than in Global Ambition

The scope scenarios of 2022 cycle are result of the stakeholder consultation. Next cycle (TYNDP 2024 edition) will re-visit the storylines with the contribution of stakeholders to redefine the scope of the scenarios. Our stakeholder must know that an additional scenario will require additional time and resources. Due to the 2-year timeframe set by TYNDP process, the decision should come as a balance between advancing the modelling scope -*that are acknowledged by stakeholders*- and building & consulting an additional scenario. Next cycle, the aim is to re-evaluate the stakeholder comments and revisit this balance.

Feedback (Bosch Thermotechnik): No

Regarding the residential and tertiary consumption of energy for space heating, we believe some clarifications would be welcome on the technology and fuel aspect. Indeed, many companies are working on hydrogen boilers, whether pure hydrogen boilers, or hydrogen-ready boilers that can be easily retrofitted to 100% hydrogen when volumes become available across Europe or in certain regions. In Bosch Thermotechnology, we foresee between 300-500k H2-ready boilers to be sold in 2030 only in Germany, the Netherlands and the UK. Extrapolation across Europe and taking into account other companies would of course increase the number considerably.
These boilers could of course be used by themselves or in hybrid setups with heat pumps depending on building type, capacity requirement and local preconditions.
We would therefore highly recommend a clarification in the report and the visualisation platform that H2 in residential and tertiary may be consumed through

1. *individual "gas" boilers that may be H2 ready or already H2 compatible without need for retrofits - rather than having a methane only category*
2. *fuel cells producing power as well as possibly heat (included already)*
3. *hybrid setups of a heat pump and a H2-ready boiler (unclear whether included within gas hybrid)*

Response

Market shares for different heating technologies are available per country on the visualization platform. The gas-based technologies like boilers and hybrid heat pumps cover both methane and hydrogen. The split between both gases is shown in the final demand section of the visualization platform. Domestic heating with hydrogen has the highest market share in Global Ambition, whereas Distributed Energy foresees more methane.

Feedback (Edison S.p.A.): Yes
The two different scenarios proposed by the ENTSOs, Global Ambition and Distributed Energy identify two pathways allowing to reach the objectives of zero net carbon emission by 2050 both based on the large deployment of new technologies.

For this reason, it would be useful to assess the consequences of a situation in which development of such technologies on a large scale does not occur as forecasted. In this case, not desirable, it should be considered the potentiality of a shift in the energy transition that could be illustrated by the introduction of a back-up scenario (comparable to the "Business as usual" scenario developed by the Italian TSOs, or the "current trend" scenario the ENTSO-e refers to in its TYNDP 2020 document).

Response

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Feedback (BDEW Association of German Energy and Water Industries): Yes
The two top-down scenarios are consistent with the respective assumptions made in the Storyline Report. The scenarios can be considered as two extremes, both of which are un-likely to be realised in all details. Comparing the two scenarios BDEW expects the „Global Ambition" scenario as more realistic.

Response

All together the two COP21 scenarios aim to create contrasted scenarios with differentiated narratives and assumptions that project long term demand and supply, explore uncertainties, provides insight on challenges that energy infrastructure facing during energy transition. Therefore, different assumptions on the storylines had been performed in the first year of scenario development and they are resulted in April 2021 as a result of public consultation and our scenarios are in line with these ranges defined with these storylines.