

Compliance with Paris Agreement

1. **Question:** How is the compliance with the Paris Agreement defined in practice? What are the underlying assumptions / indicators & targets you consider?

Answer: We will apply a EU-wide carbon budget to reach the 1.5°C target with 67% probability. The carbon budget will be based on the IPCC special report (2018). Moreover, we assume that the scenarios need to be compliant with the EC's proposal for the Green Deal (at least -55% CO₂ by 2030, carbon-neutrality by 2050).

2. **Question:** How likely is it, that your storylines reaching the 1.5° target? 50% 65%?

Answer: We will apply a EU-wide carbon budget to reach the 1.5°C target with 67% probability. The carbon budget will be based on the IPCC special report (2018).

Technology parameters

3. **Question:** Why is the electric vehicles range for 2030 lower than in the 2020 scenarios (see figure 7)?

Answer: TYNDP 2020 the EV fleet trajectory was derived using a linear progression resulting in too high a market share in 2030 when considering supply chain effects and replacement rates. For TYNDP 2022 we propose an upper limit for EVs based on the most optimistic sales figures up to 2030 (Eurelectric 95% Scenario). This results in a slightly lower range for 2030.

4. **Question:** In your simulations/forecasts at what level of electric vehicle market share integration do you experience adequacy problems?

Answer: This needs to be modelled first. We will publish the outcome of our modelling exercise in the Draft Scenario Report later this year.

5. **Question:** Are the proposed ranges primarily based on the EC PRIMES scenarios? If yes, these should be revised in light of newer EC ambition by 2030/2050 and the NECP contributions. It would be important to consider other studies in the definition of the ranges.

Answer: We consider a range of studies, all mentioned in the Storyline Report - "External References".

6. **Question:** The fuel import graph seems to be based on 2020 scenarios, will be get an update of these for 2022? (Eu 28 and Eu 27 import of oil, gas, and bio fuels in 2050)

Answer: We will calculate the import demand and share for each fuel in the TYNDP 2022 scenarios for both Distributed Energy and Global Ambition. We will publish the outcome of our modelling exercise in the Draft Scenario Report later this year.

7. **Question:** Many technologies are in development at the moment. Which level of `readiness` do they have to show to be used in the distributed scenario? e.g. the new home electrolyzers, or the hydrogen—ready fuelcells?

Answer: Fuel Cells are included in the scenarios starting in the mid- to long-term.

Electrolysers will be occur already in 2025 at larger scale.

8. **Question:** Are the Nuclear generation projections simply the Fission technologies currently deployed? Or is Fusion modelled for later years, as this might change public opinion?

Answer: On the 2050-time horizon, only fission technology is considered for commercial deployment.

9. **Question:** "What kind of hybrid heat pumps are given?"

Answer: The hybrid heat pump consists of an electric Heat Pumps (air-to-air) combined with a gas boiler. The electric heat pump provides space heating for most the year. The gas boiler is typically used for peak situations and for hot water production.

10. **Question:** How do you loop the technologies selection with economic and financing issues?

Answer: We do run an investment model for Distributed Energy and Global Ambition based on the cost assumptions by EC PRIMES or other recently published and acknowledged institutions. Our technology and cost assumption will be published in a transparent way.

11. **Question:** Decarbonised gas includes also H₂ from Pyrolysis. Maybe I missed it, but will this also be considered? In this technology CCS is not needed.

Answer: Yes, it will be considered as part of the hydrogen production technologies from natural gas (decarbonisation technologies).

Price parameters and methodologies

12. **Question:** Hello, one question about fuel prices and CO₂ prices. At which stage of the process to you expect to set those parameters? What is the methodology for setting those parameters?

Answer: Fuel and carbon will be determined before we can start the modelling process. The assumptions we take are usually referenced to recognized studies and/or market forecasts.

13. **Question:** I am missing gas heat pumps in the chapter on heat pumps? They are highly efficient and can be used with the existing radiators in the homes which leads to lower investments on the customer side which might speed up the energy efficiency process.

Answer: We consider gas heat pumps as an end-user technology. The share of gas heat pumps will depend on the scenario but will not be the main driving force of our scenarios. Therefore, we haven't asked for feedback concerning its technology share.

14. **Question:** From a first reading of the draft scenarios, costs (both system wide and individual) seem to be addressed in a lot more detail and more consistently in the GA scenario. Is that correct, and if yes, will that make it more complicated to compare the scenarios?

Answer: Costs, wherever possible, will be applied in both scenarios following the same methodology. Technology costs will depend on investments and technology specific build-out rates at a global scale. Global Ambition assumes that not only technology costs for renewable energies but also for decarbonisation of fossil fuels will decrease at a global scale and that Europe will benefit from it. This can be by a higher share of imports compared to

Distributed Energy or by limited investments into decarbonisation technologies in the EU.

15. Question: Is it efficient to maintain a very expensive low pressure gas infrastructure to run gas boilers for a few days a year ? wouldn't it be more economical to use heat storage and insulation?

Answer: This very much depends on the yearly gas demand in all sectors (including transport and industry) and also its demand structure (seasonality). Heat demand will always be seasonal and will also depend on infrastructure which can cope with its variability, no matter if gas, electricity or hot water. Flexibility and Security of Supply will play major roles for each of the networks in the future and Energy System Integration will play a major role to overall decrease the costs. The TYNDP Scenarios will provide different pathways to this question. The network assessment will show how the infrastructure will cope with new demand and supply patterns. We strongly suggest to wait for the full analysis to see the impact on each of the infrastructures.

Process

16. Question: How are you intending to use the three scenarios in the final TYNDPs and in order to define the network planning?

Answer: For ENTSOG: all scenarios for all years will be used in ENTSOG's System Needs Assessment and for the project-specific cost and benefit analysis (PS-CBA).

For ENTSO-E: For the Identification of System Needs ENTSO-E foresees to study both the 2030 and 2040 horizon. All the three scenarios are intended to be studied although the exact scope of the study for each scenario cannot yet be specified.

17. Question: As a follow-up to the previous question, which study years will be used for electricity and gas TYNDP 2022 benefit assessments?

Answer: For ENTSOG: all scenarios for all years (2022, 2025, 2030, 2040) will be used in ENTSOG's System Needs Assessment and for the project-specific cost and benefit analysis (PS-CBA).

For ENTSO-E: the TYNDP CBA phase foresees the use of all scenarios for the 2030 and 2040 horizon.

18. Question: Why is there need for 'gas system' planning. This should be changed to 'heat system' requirements because heat is a service provided by many sources, like electricity. Otherwise, you scenario is locked into gas provision not heat

Answer: Gas is used in all final sectors as well as in non-energy consumption and in power generation. Space heating is by far not the only purpose of its consumption. However, heat demand as such makes up almost 50% of the final energy consumption in the EU and a very large share of it is currently supplied by gas (with an increasing trend in many countries across the EU). The TYNDP, following the TEN-E regulation, assesses the needs of the gas and electricity transmission networks.

19. Question: How will the projects that will be collected by the Hydrogen Alliance for the 6 GW in 2025 feed into the process?

Answer: At this stage, we do not know whether and how projects will be collected by the Hydrogen Alliance. However, every project promoter is entitled to submit its project to the TYNDP (but this is the next step after the scenarios).

20. Question: I still struggle to understand how building scenarios with different pathways will result in investment decisions. Are projects supposed to be compatible with all scenarios? It should rather be defined a central scenario and include a strong sensitivity analysis. This dichotomy seems misleading.

Answer: The TYNDP does not propose any investment nor a decision for an investment. ENTSOG and ENTSO-E collect projects by project promoters in a fully transparent and public way. Under the provision that the conditions for projects are met, everyone can submit projects to the TYNDP and apply for PCI. The scenarios are used to assess those projects under different circumstances. This is called project-specific cost and benefit analysis. The TYNDP shows costs and benefits of each submitted project which has applied for PCI.

21. Question: Do the scenarios clearly describe the phase-out path from fossil gas?

Answer: The scenarios do not come with a general assumption on the phase-out of fossil gas. However, as shown in the TYNDP 2020 scenarios the share of natural gas will decline to reach the targets of the Green Deal. In the Draft Scenario Report, we will publish later this year, the scenarios will show the share and the source of different gases including natural gas.

22. Question: Achieve all the objectives of TYNDP needs more investment. This plan provides only scenarios or will be having provide investment in different country? Because not all countries have possibility to achieve the target and they maybe don't have economic possibility for investing in all projects.

Answer: The TYNDP does not propose any investment nor a decision for an investment. ENTSOG and ENTSO-E collect projects by project promoters in a fully transparent and public way. Under the provision that the conditions for projects are met, everyone can submit projects to the TYNDP and apply for PCI. The scenarios are used to assess those projects under different circumstances. This is called project-specific cost and benefit analysis. The TYNDP shows costs and benefits of each submitted project which has applied for PCI.

23. Question: If I recall correctly from the previous slides, the National Trends scenario spans through 2040. How do you intend to build the post-2030 scenario from the national vision, considering that the NECPs have detailed activities and targets only until 2030?

Answer: Many member states have published long-term strategies and also NECPS, which go beyond 2030. Together with our members, we will build National Trends based on all publicly available and recently stated national strategies and policies as well as their assumed evolution.

24. Question: Is the investment loop new compared to the TYNDP 2020 methodology?

Answer: The investment loop will follow the same principle as the one used for 2020 scenarios. The intention is to extend the scope of decision to part of hydrogen infrastructures (electrolysers, interconnections) and downstream items such as prosumer investment decision in batteries/rooftop solar. In order to keep computation within manageable

boundaries some simplification may occur. In any case the future Methodology Guidelines will reflect the selected approach.

25. Question: hello, how do we make sure that the DSO for gas and electricity and the operators of district heating grids in the member states are included in the national trends that will be built by the TSO?

Answer: We do have bilateral meetings with DSO organisations (also presented at the Copenhagen Infrastructure Forum) and are willing to further increase the cooperation depending on the needs to improve the scenario building cycle without endangering the timeline.

26. Question: About next steps, how/when will ACER opinion on scenarios (currently not displayed in the slide) be accounted for?

Answer: During the scenario building process we already exchange with ACER.

Scenario assumptions

27. Question: It is reasonably clear that decreasing energy intensity will almost always make the Green Transition easier. What is less clear is, whether a "Global Ambition" or "Distributed Energy" is the "best" path forward. Why not keep energy intensity the same between GA and DE? Comments, considerations?

Answer: During the storyline consultations several stakeholders suggested that the draft storylines showed too much variation in terms of energy intensity (efficiency, circularity, etc.). As a consequence, ENTSOG and ENTSO-E have adapted the storyline description accordingly. The final storylines for TNYPD 2022 show only limited difference on this scenario driver, Distributed Energy going only a little bit further than Global Ambition.

28. Question: In the box "scenario drivers" you differentiate the energy transition drivers "decentralized" vs. "centralized". In the proposed storylines it becomes clear that the operationalization is rather "electricity-centered" versus "gas-centered". Would these two terms not be more appropriate and concise?

Answer: We are surprised that this is one way to read the storyline report. As the TYNDP2020 scenarios already showed, the electricity generation in the EU will ultimately be higher than the gas demand. Therefore, a gas-centralisation or electricity-centralisation was never the intention of both scenarios. However, Global Ambition does acknowledge the difficulty of direct electrification in another way than Distributed Energy.

29. Question: Why do you think that "circularity" in energy intensity should be combined with "decentralized/electricity-centered" and "comfort" be combined with "centralized/gas-centered"? It's distorting! The circularity-related assumptions, particularly energy demand of industry, should be the same for DE&GA.

Answer: We do see different levels of the recycling-quota or re-use of compost depending on countries, sometimes even regions within a country. These are developments which depend on policies and might also occur in the future. Therefore, from our point of view, scenarios can have a different "level" of circularity. During the storyline consultations several

stakeholders suggested that the draft storylines showed too much variation in terms of energy intensity (efficiency, circularity, etc.). As a consequence, ENTSOG and ENTSO-E have adapted the storyline description accordingly. The final storylines for TNYPD 2022 show only limited difference on this scenario driver, Distributed Energy going only a little bit further than Global Ambition.

30. Question: in Table 1 locally produced biomethane and hydrogen is not mentioned in the distributed energy. Why? The many hydrogen valley projects presented last week in the hydrogen week show how much is happening locally in the hydrogen sector?

Answer: The scenarios distinguish between anaerobic digestion and thermal gasification as the two technologies for biomethane. Moreover, the scenarios distinguish between several feedstock material. Some of them occur at small amounts more locally, some others more centrally. Our assumptions for feedstock and technology are based on the Gas for Climate study, however, the scenarios will make own assumptions on the utilisation rate of given potentials.

31. Question: For imports will you also model the possibility/cost-comparison of importing renewable and low-carbon vs importing natural gas and decarbonising it within the EU?

Answer: We will make different assumptions on the import quota and the gas sources. We will also consider the possibility to decarbonise natural gas in Europe. At a first order we do not see a cost difference between import decarbonised gas or to convert methane into hydrogen in Europe.

32. Question: The DE scenario seems to overlook a lot of the local production of biomethane and the possibility for electrolysis, with both technologies given more focus in the GA scenario because of a need for dispatchable generation. Does this imply that DE will not need any dispatchable generation?

Answer: Both scenarios will show an increasing production of biomethane and P2G compared to today's levels. In fact, it is the Distributed Energy storyline that foresees higher uptake of electrolysis compared to Global Ambition, not the other way around. The level of dispatchable generation will be an outcome of our electricity model depending on the electricity demand and the share of renewables.

33. Question: Why not have high shares of green gas imports combined with a pronounced decentralized electricity system storyline in the EU. This is not conflictive at all. On the contrary, I think that this is the most probable way forward and there should be a third TYNDP scenario analyzing this.

Answer: Due to the time constraint we are limited to three scenarios in total. However, Distributed Energy and Global Ambition will show parts of your assumptions.

34. Question: How is the remaining heat demand generated?

Answer: Assuming that the question refers to the shares of heating technologies which each of the do not add up to 100%, the answer is: there additional technologies such as gas boilers, fuel cells etc. which will serve the rest. We just haven't shown them in the storyline report since (in the long term) they play a minor role compared to heat pumps or district

heating.

35. Question: How is consumer acceptance modeled, particularly when it comes to DSR assumptions? Is every citizen assumed to be willing to give up his EV for DSR in 2030 or 2050 for instance?

Answer: Joint work with DSO associations should help us to define the share of each charging strategy reflecting the balance between mobility needs and flexibility provision to the electricity system.

36. Question: Will your modelling include a concrete capacity number of available Demand Response in the scenarios?

Answer: DSR capacity used in the modelling of the scenario will be published.

37. Question: "The heating sector offers a very high flexibility potential, ranging from short-term to year-over-year flexibility. In addition, systems services for heating applications can be covered. How has this flexibility potential been taken into account?"

Answer: Flexibility of the heating sector will be covered through hybrid heat -pump, DSR capacity and possibly by better picturing the functioning of district heating depending on the on-going work with this sector.

38. Question: In which granularity is demand—response modelled e.g 15 minutes?

Answer: The electricity model is run on an hourly granularity.

39. Question: Re DSR: 1 TSOs make their projections in isolation - but x-EU needs consistent assumptions.

2 DSR isn't just EVs, but also the continuation of other providers, like large industrials. Will their continued presence (or technology changes like Steelmaking using H2 not coke) be included in this?

Answer: 1. The TYNDP scenario process is one of the most transparent studies within the EU bubble (including 4 workshops and 2 consultations). Moreover, ENTSOG and ENTSO-E have engaged with various stakeholders (industrial, non-governmental, policy) bilaterally.

2. We do consider H2 in Industry and other sectors. Moreover, we will consider a range of demand side responses including hybrid demand technologies (PHEV, Hybrid Heat Pumps etc.).

40. Question: How does the model ensure that electrolyzers only use RE electricity when they are connected to the grid? otherwise this would run against the efficiency targets, wouldn't it?

Answer: The operation of electrolyzers will depend on their configuration:

- Electrolyzers supplied by dedicated RES will do not face the risk.

- Electrolyzers at end-consumer facility with no back-up except short term hydrogen storage may have to run on fossil marginal hours. Nevertheless, it may still be the best decarbonation option on yearly basis

- Electrolyzers at the interconnection between electricity and gas network will run when electricity price are below fossil fuel based power generation (CO2 cost included). Some

must-run constraints may still apply but with a minor impact.

41. Question: What is decarbonized methane? (CH₄ minus the C?) Do you mean defossilized methane? Can you outline the probabilities that the CH₄ will be really climate neutral in the final scenarioline report please? There are many reasonable doubts voiced in the public discourse.

Answer: Decarbonisation of natural gas (biomethane or synthetic methane is already renewable) can be done post-combustive (CCS in industrial sector and power generation) and pre-combustive (hydrogen production via SMR plus CCS. Moreover, there is the option to decarbonise methane with pyrolysis to produce hydrogen without the need for CCS. However, in all cases the Scenarios do consider a CO₂ capture rate of 90%. In combination with biomethane, carbon neutrality or even negative emissions can be reached.

42. Question: In e-mix building, do you model the seasonality required and propose technologies/costs to convert the share of intermittent renewables into a reliable seasonal profile?

Answer: We do consider temperature depending hourly demand based on historic climate years.

43. Question: In case of methane import, CCS would be done at the border or nearby the point of consumption?

Answer: Imported methane can be renewable (bio- or synthetic methane) or fossil (natural gas). Imported natural gas can be decarbonised either at the import terminal or at city gate (near consumption). We do not specifically distinguish between these two CCS options.

44. Question: In national trends "The electricity and gas datasets for this scenario will be based on figures collected from the TSOs translating the latest policy- and market-driven developments as discussed at national level." Does this top-down approach exclude DSO input, or will it be computed as well?

Answer: We do cooperate with DSO organisations and are willing to further increase the cooperation. However, we strongly suggest that TSOs and DSOs should also build their cooperation on national level.