# Annex 3 – Methodology & Modelling

***Question 1: Does modeling of sector coupling identify the potential benefits and challenges of sector coupling?***

**Feedback (Germanwatch):**

*The sector coupling methodology has been much improved from our point of view. As the developments are very dynamic we expect this improvement to continue in the future.*

**Response:**

We welcome your acknowledgment of sector coupling enhancement and are committed to work on further improvements in the future editions. Any insight in that matter is welcomed.

**Feedback (Wind Europe):**

*The ENTSOs energy model favours gas at the expense of reduced electrification in the approach followed for sector coupling. The share of electricity in final demand is way lower than in the European Commission scenarios. According to our calculations and data published in the 2030 Climate Target Plan assessment by the European Commission, policy scenarios in support of Increased Climate Ambition foresee a direct electrification share of the final demand ranging 46-50% by 2050. Other modelling optimization exercises such as Eurelectric's Decarbonisation Pathways and Compass Lexecon-Enerdata-Enel Foundation "Sustainable paths for EU increased climate and energy ambition" point at 60% of direct electrification. However, the Global Ambition scenario falls too low in terms of electrification, with a very questionable 36% by 2050.*
*In addition to this, to continue using gas in any form and from any source perpetuates the possibility to continue having significant methane leakages along the value chain, thus heavily increasing GHG emissions.*

**Response:**

The figure 3 of the Draft scenario report includes non-energy use. As such it is a misleading basis for the calculation of the direct electrification rate. As stated in the chapter 6.2, the draft COP21 scenarios had an electrification rate between 40% and 45% (40%-42% range for EC Scenarios) when taking into account ambient heat in the overall energy demand.

The update of the COP21 scenarios based on stakeholder feedback results into a higher direct electrification. Using a more usual metric excluding ambient heat in order to improve comparability with other scenarios, direct electrification reaches now 52% in Distributed Energy 2050.

Methane leakage are taken into account within the quantification of GHG emission based on EC Impact Assessment. The development of electrolysis-based hydrogen also provides a gaseous energy carrier without any methane leakage risk.

**Feedback (Enel SpA):**

*The ENTSOs energy model favours gas at the expense of reduced electrification in the approach followed for sector coupling. The share of electricity in final demand is way lower than in the European Commission scenarios. According to our calculations and data published in the 2030 Climate Target Plan assessment by the European Commission, policy scenarios in support of Increased Climate Ambition foresee a direct electrification share of the final demand ranging 46-50% by 2050. Other modelling optimization exercises such as Eurelectric's Decarbonisation Pathways and Compass Lexecon-Enerdata-Enel Foundation "Sustainable paths for EU increased climate and energy ambition" point at 60% of direct electrification. However, Global Ambition scenario falls too low in terms of electrification, with a very questionable 36% by 2050. In addition to this, to continue using gas in any form and from any source perpetuates the possibility to continue having significant methane leakages along all the value chain. As stated by the IEA in their Zero Emission by 2050 report and scenario, cutting methane leakages is essential to reach the 1.5ºC goal, and the scenarios proposed are moving in the opposite direction.*

**Response:**

The figure 3 of the Draft scenario report includes non-energy use. As such it is a misleading basis for the calculation of the direct electrification rate. As stated in the chapter 6.2, the draft COP21 scenarios had an electrification rate between 40% and 45% (40%-42% range for EC Scenarios) when taking into account ambient heat in the overall energy demand.

The update of the COP21 scenarios based on stakeholder feedback results into a higher direct electrification. Using a more usual metric excluding ambient heat in order to improve comparability with other scenarios, direct electrification reaches now 52% in Distributed Energy 2050.

Methane leakage are taken into account within the quantification of GHG emission based on EC Impact Assessment. The development of electrolysis-based hydrogen also provides a gaseous energy carrier without any methane leakage risk.

**Feedback (CAN Europe):**

*CAN Europe repeatedly asked for TYNDP scenarios to run a cross-sectoral optimisation of infrastructure needs by comparing costs and availability of all flexibility options, be it on the generation side, on the demand side or be it related to infrastructure solutions. We welcome the far-reaching improvements for integrating district heating supply, the flexibility provided by prosumers and electric vehicles as well as the new, much more realistic methodology for power-to-gas modelling. These improvements appear to fine-tune mainly the electricity demand and supply sides to reflect the increasing degree of interaction. It is not yet fully clear to what extent the integration of these flexibility solutions in the electricity sector interacts with demand and supply of methane and hydrogen. We would welcome a more in-depth presentation of the demand response potential across sectors and why it is considered to remain at a relatively low level.*

*Regarding the district heat supply, the potential expansion of district heat networks as well as the integration of different variable and dispatchable renewable heat technologies (solar thermal heat, geothermal heat, sustainably sourced biomass) should be assessed to better understand under which conditions fossil gas (and hydrogen) demand would further decrease. The role of thermal storage technologies in view of increased flexibility of district heat networks might deserve more attention.*

*Regarding the prosumer and electric vehicles modelling, we see that the methodology assesses the flexibility potential adequately. But given that market conditions and legal frameworks for prosumer and EV markets differ strongly between European countries, it might be worth considering a more granular approach than assuming unified energy delivery costs.*

*Regarding the power-to-gas modelling, we ask to assess the additional infrastructure costs linked to the roll-out of hydrogen for low temperature heat in buildings. Besides the costs of hydrogen supply from different sources and the costs of repurposing existing gas transmission infrastructure and building new hydrogen transmission infrastructure, the costs of the 'last mile' of hydrogen distribution into end consumers' buildings should be analysed, along with the additional costs for installing fuel cells and/or hydrogen-ready boilers. The expected utilisation rates of gas distribution networks and transmission networks should be made transparent in this context. We also miss an assessment of the potential blending of hydrogen into existing fossil gas infrastructure.*
*See also our comments on the ENTSOs' interlinked model, August 2020:*
(https://caneurope.org/content/uploads/2020/08/CAN_Europe_Feedback_interlinked_model_ENTSOs_aug20.pdf).

**Response:**

We welcome your acknowledgement of methodology improvement related to flexibility and power-to-gas. The energy demand component of TYNDP scenarios is not cost optimized. The holistic optimisation of the energy mix (demand, supply and midstream) taking into account energy, flexibility and cost exceeds the mandate of the TYNDP scenario building process and could not take place in the 2-year process as defined by the TEN-E regulation. The scenario building process fits the purpose of infrastructure assessment as set by the TEN-E regulation while ensuring broad consistency with EC Impact Assessment scenarios.

Based on stakeholder feedback, the updated version of the COP21 scenarios bring more clarity on demand side management by distinguishing demand shedding from batteries, V2G and other flexibility sources. Beyond enhanced transparency, scenarios also show a higher role of demand shedding and batteries.

The methodology put in place for the first time to capture district heating does take into account some thermal storage as stated in the Scenario Building guidelines (Appendix 1). Further work with district heating partners will offer the opportunity to improve our modelling approach in future editions. The closer cooperation with DSO operators may provide the opportunity to better capture country specifics related to EV and prosumers and to better tackle the challenge of hydrogen roll-out at distribution level in next editions.

**Feedback (Oeko-Institut):**

*The improvements of the implementation of flexibility options like demand side responds and the way how power-to-gas modelling is implemented are a very good step towards a sector coupling model. But this flexibility is mainly used to match predefined amount of electricity demand and supply. A total energy model should show more results on the question which energy carrier is used for which application. As mentioned in the answer for question 8, gas and electricity demand are predefined in the ambition tool and not resulting from a cost-optimal investment decision. Especially the question* *how and where hydrogen is distributed to end consumers and which costs are resulting from this seem to be worth a deeper analysis. In Germany we are discussing decommissioning and demolition of existing methane distribution grids as gas demand must go down and costs to run parts of gas infrastructure will increase significantly. This topic should no longer be ignored by TYNDP analysis.*

**Response:**

We welcome your acknowledgement of methodology improvement related to flexibility and power-to-gas. The energy demand component of TYNDP scenarios is not cost optimized. The holistic optimisation of the energy mix (demand, supply and midstream) taking into account energy, flexibility and cost exceeds the mandate of the TYNDP scenario building process and could not take place in the 2-year process as defined by the TEN-E regulation. The scenario building process fits the purpose of infrastructure assessment as set by the TEN-E regulation while ensuring broad consistency with EC Impact Assessment.

The closer cooperation with DSO operators may provide the opportunity to better tackle the challenge of hydrogen roll-out at distribution level in next editions.

**Feedback (Eurelectric):**

*Using a total energy model to capture the impacts of sector coupling between energy carriers is a good approach as such. However, the development of energy scenarios and their quantification should be more integrated:*

- *Today, even if the TYNDP scenarios are common to ENTSO-E and ENTSO-G, part of the quantifications and modelisation computing seem to be still performed separately by ENTSO-E and ENTSO-G, with limited interactions and, at the end, favouring certain energy carriers over the other at the expense of reduced direct electrification in the approach followed for sector coupling. The 2030 Climate Target Plan impact assessment by the European Commission, policy scenarios in support of Increased Climate Ambition foresee a direct electrification share of the final demand ranging 46-50% by 2050. Even if the DE scenario is reaching the low ranges of the EC's scenarios with 47% direct electricity demand share, GA scenario falls too low with only 36% by 2050. The Modelling approach of sector coupling consider expansion model for both electricity and hydrogen systems. However, the future development of the methane system is not included. The residual demand for methane (shifting progressively from natural gas to biomethane and synthetic methane) should be taken into account in the modelling exercise and become the result of the interaction of market and technology, in opposition of a narrative driven outcome. For instance, Eurelectric estimates that methane gas will still represent 15% of total installed capacities and 5 % of yearly electricity volumes by 2050, to ensure system stability in regions with a limited access to RES, nuclear or hydro.*
- *The current approach (which is still limited in terms of interactions between energy carriers – electricity, gases, heat…) is likely to undervalue the benefits of system integration that could be achieved with a more integrated and comprehensive view on the energy systems, esp. for achieving the decarbonization targets in cost-efficient way for the consumers (residentials and industrials). For instance, power-to-gas and gas-to-power flows should be better described and highlighted, notably when it comes for 2-week cold snaps, extreme daily peaks and "kalte Dünkelflaute" scenarios modelling. Such scenarios are instrumental not only to assess the supply/demand balance of each system but also for identification of both adequacy issues or*

*network congestion constraints (for which infrastructure investments needs may be identified).*

**Response:**

We welcome the acknowledgment of added-value of using a total energy model. Even if not cost-optimised, the definition of the demand scenarios has been jointly carried out by ENTSO-E and ENTSOG with the Ambition Tool.

Regarding electrification rate, the figure 3 of the Draft scenario report includes non-energy use and provides as such a misleading basis for its calculation. As stated in the chapter 6.2, the draft COP21 scenarios had an electrification rate between 40% and 45% (40%-42% range for EC Scenarios) when taking into account ambient heat in the overall energy demand.

The update of the COP21 scenarios based on stakeholder feedback results into a higher direct electrification. Using a more usual metric excluding ambient heat in order to improve comparability with other scenarios, direct electrification reaches now 52% in Distributed Energy 2050.

The expansion loop is used for the design and location of electricity and hydrogen production, storage and conversion capacity. The associated cross-border transmission capacity is only a by-product and does not precast the design of infrastructure projects at TYNDP level. It was deemed not a priority to apply the same approach to methane at scenario level as the use of transmission infrastructures decreases under the combine effect of a lower demand and the switch from natural gas imports to European biomethane, reducing the transportation distances.

Being for electricity, methane and hydrogen, the actual infrastructure analysis will occur at TYNDP stage.

The updated scenario report provides additional information on the benefit of sector coupling, especially gas-to-power and power-to-gas, during stressed period as a "kalte Dünkelflaute". In addition, it has to be noticed that the core of adequacy and network congestion assessment will occur in the upcoming stage rather than within the scenario building process.

**Feedback (EDF):**

*Using a total energy model to capture the impacts of sector coupling between energy carriers is a good approach as such. However, the interactions between energy carries is not straightforward. A deep dive into data is necessary. The development of energy scenarios and their quantification should be more integrated:*

- *Today, even if the TYNDP scenarios are common to ENTSO-E and ENTSO-G, part of the quantifications and modelisation computing seem to be still performed separately by ENTSO-E and ENTSO-G, with limited interactions and, at the end, favoring certain energy carriers over the other at the expense of reduced direct electrification in the approach followed for sector coupling. The 2030 Climate Target Plan impact assessment by the European Commission, policy scenarios in support of Increased Climate Ambition foresee a direct electrification share of the final demand ranging 46-50% by 2050. Even if the DE scenario is reaching the low ranges of the EC's scenarios with 47% direct electricity demand share, GA scenario falls too low with only 36% by 2050.The Modeling approach of sector coupling consider expansion model for both electricity and hydrogen systems. However, the future development of the methane system is not included. The residual demand for methane (shifting progressively from natural* *gas to biomethane and synthetic methane) should be taken into account in the modeling exercise and become the result of the interaction of market and technology, in opposition of a narrative driven outcome.*

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Being for electricity, methane and hydrogen, the actual infrastructure analysis will occur at TYNDP stage.

The updated scenario report provides additional information on the benefit of sector coupling, especially gas-to-power and power-to-gas, during stressed period as a “kalte Dünkelflaute”. In addition, it has to be noticed that the core of adequacy and network congestion assessment will occur in the upcoming stage rather than within the scenario building process.

**Feedback (Environmental Action Germany):**

*Climate Action Network (CAN) asked for TYNDP scenarios to run a cross-sectoral optimisation of infrastructure needs by comparing costs and availability of all flexibility options, be it on the generation side, on the demand side or be it related to infrastructure solutions. DUH welcomes the far-reaching improvements for integrating district heating supply, the flexibility provided by prosumers and electric vehicles as well as the new, much more realistic methodology for power-to-gas modelling. These*

*improvements appear to fine-tune mainly the electricity demand and supply sides to reflect the increasing degree of interaction. It is not yet fully clear to what extent the integration of these flexibility solutions in the electricity sector interacts with demand and supply of methane and hydrogen. We would welcome a more in-depth presentation of the demand response potential across sectors and why it is considered to remain at a relatively low level.*
*Regarding the district heat supply, the potential expansion of district heat networks as well as the integration of different variable and dispatchable renewable heat technologies (solar thermal heat, geothermal heat, sustainably sourced biomass) should be assessed to better understand under which conditions fossil gas (and hydrogen) demand would further decrease. The role of thermal storage technologies in view of increased flexibility of district heat networks might deserve more attention.*
*Regarding the prosumer and electric vehicles modelling, we see that the methodology assesses the flexibility potential adequately. But given that market conditions and legal frameworks for prosumer and EV markets differ strongly between European countries, it might be worth considering a more granular approach than assuming unified energy delivery costs.*
*Regarding the power-to-gas modelling, we ask to assess the additional infrastructure costs linked to the roll-out of hydrogen for low temperature heat in buildings. Besides the costs of hydrogen supply from different sources and the costs of repurposing existing gas transmission infrastructure and building new hydrogen transmission infrastructure, the costs of the 'last mile' of hydrogen distribution into end consumers' buildings should be analysed (Author's note: Hydrogen does not belong in the building sector!), along with the additional costs for installing fuel cells and/or hydrogen-ready boilers. The expected utilisation rates of gas distribution networks and transmission networks should be made transparent in this context. We also miss an assessment of the potential blending of hydrogen into existing fossil gas infrastructure.*

**Response:**

We welcome your acknowledgement of methodology improvement related to flexibility and power-to-gas. The energy demand component of TYNDP scenarios is not cost optimized. The holistic optimisation of the energy mix (demand, supply and midstream) taking into account energy, flexibility and cost exceeds the mandate of the TYNDP scenario building process and could not take place in the 2-year process as defined by the TEN-E regulation. The scenario building process fits the purpose of infrastructure assessment as set by the TEN-E regulation while ensuring broad consistency with EC Impact Assessment scenarios.

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**Feedback (Gas Distributors for Sustainability):**

*Basically, the assumptions present sector coupling as the full electrification of end-use and the way to complete the picture with hydrogen.*
*As shown by the lack of contrast in the assumptions and the lack of integration of infrastructure (at the distribution level), the sector coupling is only partially implemented in the approach.*
*We can define sector coupling at upstream level with hydrogen and syngas to allow the maximisation of renewable energy production and availability and at downstream level with hybrid systems at end-users, micro-generation, etc. A major aspect and merit of sector coupling is the link between upstream and downstream: the infrastructure optimisation part, which is not developed today by the ENTSOs and could only be done with a strong involvement of EU DSO entities for electricity and gas.*

**Response:**

Due to wind and solar potential and the efficiency of some electricity end-use appliances, direct electrification is a key component of the energy transition. Nevertheless, direct electrification of the COP21 scenarios is in 40-50% range far from the full electrification of end-use.

Using bidding zone as the basic building block, the scenarios assume a perfect integration of transmission and distribution level. RES connection and sector coupling can occur both at transmission and distribution level. In addition a wide range of technologies are specifically connected to distribution level: prosumers, hybrid heat pumps, district heating, V2G… These technologies are all present in each scenario but in a different extent.

Dedicated modelling methodologies have been developed for each technology (see Scenario Building Guidelines) in order to capture their impact on the overall energy system. Such methodologies should be further improved in the future especially through enhanced cooperation with DSO associations.

Scenarios do not intend to assess the TSO/TSO and TSO/DSO interfaces, they provide a consistent basis for such analyses.

**Feedback (Eurogas):**

*The development of energy scenarios and their quantification should be more integrated. It seems as if the TYNDP scenarios are common to ENTSO-E and ENTSO-G, but that at least part of the quantifications seems to be still performed separately by ENTSO-E and ENTSO-G, with limited interactions. Emphasis has been made on the modelling of electricity system, the integration of H2 and district heating. But the modelling of gas was absent. More explanations are needed to understand the integration of the different energy carriers and the infrastructures.*
*The market coupling at DSO level and consumer's level could be further investigated.*

**Response:**

ENTSO-E and ENTSOG have jointly defined energy demand (per country, sector and carrier) of COP21 scenarios based on shared view of their members on national specifics. Supply where then jointly quantified at European level with the support of expansion modelling for electricity and hydrogen along a jointly defined methodology (see Scenario Building guidelines).

Regarding methane modelling, it was deemed not a priority to apply the same approach to methane at scenario level. Such choice is based on the decreasing use of transmission infrastructures under the combined effect of a lower demand and the switch from natural gas imports to European biomethane, reducing the transportation distances.

Being for electricity, methane and hydrogen, the actual infrastructure analysis will occur at TYNDP stage.

Taking into account the bidding zone granularity of electricity modelling, coupling and RES generation can occur both at transmission and distribution level. The location of the infrastructure has a limited influence on the assessment of infrastructure at European level in TYNDPs and CBA stages. The investigation of the TSO/DSO interface goes beyond the scenario building process but scenarios can provide a robust basis for such assessment.

**Feedback (ENGIE):**

*The development of energy scenarios and their quantification should be more integrated. Today, even if the TYNDP scenarios are common to ENTSO-E and ENTSO-G, part of the quantifications seem to be still performed separately by ENTSO-E and ENTSO-G, with limited interactions.*
*During the presentation by ENTSOs on 20/10/2021, emphasis was set on the modelling of electricity system and the integration of hydrogen and district heating. But the modelling of the gas system was absent. More explanations are needed to understand the integration of the different energy carriers and their infrastructures.*
*The current approach tends to undervalue the benefits of system integration that could be achieved with a more integrated and comprehensive view on the energy systems, especially for achieving the decarbonization targets in cost-efficient way for the consumers (residential and industrial).*

**Response:**

ENTSO-E and ENTSOG have jointly defined energy demand (per country, sector and carrier) of COP21 scenarios based on shared view of their members on national specifics. Supply where then jointly quantified at European level with the support of expansion modelling for electricity and hydrogen along a jointly defined methodology (see Scenario Building guidelines).

Regarding methane modelling, it was deemed not a priority to apply the same approach to methane at scenario level. Such choice is based on the decreasing use of transmission infrastructures under the combined effect of a lower demand and the switch from natural gas imports to European biomethane, reducing the transportation distances.

Being for electricity, methane and hydrogen, the actual infrastructure analysis will occur at TYNDP stage.

While demand derives from consulted storyline rather than an overall cost estimation, a wide range of coupling technologies are taken into account at consumer level (e.g. hybrid HP, V2G, prosumer batteries, district heating). The flexibility benefits from all these downstream technologies are factored in the modelling of the electricity and hydrogen modelling. They help to minimise the infrastructure needs to be investigated at TYNDP stage.

**Feedback (Edison SpA):**

*Using a total energy model to capture the impact of sector coupling between energy carriers is a good approach as such. Still the model is very complex and interaction between energy carriers is not very easy to comment on. Deeper explanations regarding the model would be welcome.*

**Response:**

We welcome your acknowledgment of sector coupling enhancement and all-energy approach. The downside of such developments is the increasing complexity of the scenario building process. The Scenario Building guidelines published together with the scenario report provide a very detailed overview of the interaction between carriers. Would you feel the need of further explanation, we invite you to contact us to arrange a bilateral meeting.

**Feedback (BDEW):**

*BDEW welcomes the dedicated measures to capture the impact of sector coupling. This constitutes a considerable improvement compared to the previous scenario report.*

**Response:**

We welcome your acknowledgment of sector coupling enhancement and all-energy approach.

***Question 2: Do you agree that including external LULUCF and net-negative emission technologies within the scenario is appropriate?***

**Feedback (Germanwatch):**

*However, using external data on LULUCF, BECCS and CCS instead having it endogenous to the scenario modelling seems odd. Through this practice these decarbonization options are not put in competition with other decarbonization options and conflicts e.g. between increasing biomass/-gas needs projected by the scenario and referenced LULUCF needs cannot be assessed properly. Here, we see a special need to adjust and improve the scenario building process.*

**Response:**

TYNDP Scenario building process aims at providing input data to a meaningful infrastructure assessment (e.g. TYNDP, PCI selection). As a result the optimisation focuses on the energy system. Expanding the optimisation to the energy demand (by carrier and sector) and emission reduction/abatement measures is more related to the definition of energy policy and would require more time than the current 2-year process.
In order to ensure that COP21 scenarios do not overestimate the use of biomass for negative e mission and energy use, LULUCF are taken from EC Impact Assessment and bioenergy are maintained below European Commission scenarios.

**Feedback (CAN Europe):**

*It is appropriate to integrate the net carbon sink from LULUCF into the scenarios. We however are not sure to what extent the important LULUCF potential and the strong use of bioenergy are consistent. If external data on LULUCF, BECCS and CCS are integrated instead of having them endogenous to the scenario modelling, these options might not be put in proper competition with other decarbonisation options. The net carbon sink potential from LULUCF should not be linked to the proper energy modelling*

*if this allows for an increased use of fossil fuels on the other side. We see a need to adjust and improve the scenario building and modelling in this area.*
*Following CAN Europe's criticism on the relatively high contribution of potentially unsustainable biomass, the TYNDP 2020 Distributed Energy scenario saw an update with slightly lower amounts of bioenergy in view of the 2040 horizon. We are surprised to see that the total amount of bioenergy supply in the TYNDP 2022 Distributed Energy scenario apparently is significantly higher than in the previous TYNDP 2020 Distributed Energy scenario.*

**Response:**

TYNDP Scenario building process aims at providing input data to a meaningful infrastructure assessment (e.g. TYNDP, PCI selection). As a result the optimisation focuses on the energy system. Expanding the optimisation to the energy demand (by carrier and sector) and emission reduction/abatement measures is more related to the definition of energy policy and would require more time than the current 2-year process.
In order to ensure that COP21 scenarios do not overestimate the use of biomass for negative e mission and energy use, LULUCF are taken from EC Impact Assessment and bioenergy are maintained below European Commission scenarios.
The Distributed Energy scenario puts a strong emphasis on the reduction of energy imports thanks to the maximisation of the European renewable energy potential according its storyline. Based on stakeholder feedback the level of bioenergy has been decreased in Distributed Energy.

**Feedback (Oeko-Institut):**

*The Scenario LULUCF+ used for 2030 is a scenario with very high LULUCF usage. As there is a direct dependency between LULUCF-usage and biomass-potential both assumptions should be taken from the same source/scenario. For the LULUCF+ scenario no biomass potential was estimated by the EC so that this scenario does not seem to be an appropriate basis for the TYNDP work. At 425 mt the value for 2050 is even higher than the one from TYNDP 2020 (390 mt). We already criticised that the TYNDP 2020 value was too high, esp. in combination with the high biomass usage. See question 19*

**Response:**

We thank you for the identification of the inconsistency between LULUCF and bioenergy on the 2030 time horizon. The updated COP21 scenarios now use a lower LULUCF scenario for 2030 in order to ensure consistency with bioenergy at that horizon.

The Distributed Energy scenario puts a strong emphasis on the reduction of energy imports thanks to the maximisation of the European renewable energy potential according its storyline. Based on stakeholder feedback the level of bioenergy has been decreased in Distributed Energy.

**Feedback (Agora Energiewende):**

*Negative emission technologies are important and will play a role in achieving carbon neutrality but should be limited as their application will be more expensive than alternative technologies and can't avoid all related emissions. Agora Energiewende finds that CO2 can be extracted from the atmosphere through green polymers, bioenergy with CCS and Direct Air with CCS, see climate neural Germany 2045 study:*
*https://static.agora-energiewende.de/fileadmin/Projekte/2021/2021_04_KNDE45/A-EW_213_KNDE2045_Summary_EN_WEB.pdf (p. 19/20).*

**Response:**

COP21 scenarios use CCS in the industry sector and for blue hydrogen production at a contrasted level according to the respective storyline in order to reflect a wide range of external references.
Direct Air Capture is not taken into account in this scenario building process but future editions may provide the opportunity to enlarge the scope of technologies based on stakeholder feedback.

**Feedback (Eurelectric):**

*We do not oppose their inclusion because, in principle, LULUCF and net negative emissions are also drivers of the effort to reach climate neutrality and can reduce the need for other decarbonization technologies. However, there should be an expectation of economic viability if they are indeed considered. Further details on forecasts and cost references are needed.*
*Their best estimate should be adequately taken into account, and this could well be from external sources, provided that data reflects the most accurate and up-to-date view. In this case data seem however not to be the most up to date (Long-Term Strategy of the European Commission 2018).*

**Response:**

COP21 scenarios use CCS in the industry sector and for blue hydrogen production to ensure high utilisation rate. Their levels reflect the respective storyline in order to reflect a wide range of external references. The cost of CCS is factored in blue hydrogen assumptions as stated in the Scenario Building Guidelines.

The EC Impact Assessment still refers to Long Term Strategy scenarios for LULUCF and CCS use. As such 1.5 Tech and 1.5 Life scenarios are considered as fitting the purpose of benchmark for negative emissions. For the next edition, we welcome any more recent source from the European Commission.

**Feedback (EDF):**

*The external data could be inconsistent with the assumptions of each scenario. For example, biomethane production impacts the LULUCF.*

**Response:**

In order to ensure that COP21 scenarios do not overestimate the use of biomass for negative emission and energy use, LULUCF are taken from EC Impact Assessment and bioenergy are maintained below European Commission scenarios.

**Feedback (Ember):**

*Given that net-negative emission technologies are at very early stages of development and are untested, a heavy reliance on these technologies for remaining within the carbon budget by 2100 is not appropriate. This is compounded by the fact that the report makes reference to them coming online some time after 2050; there is no foresight on the scale of the carbon budget overshoot by the time such technologies are at commercial stage and therefore the costs involve to install the potentially massive capacities required.*

**Response:**

Technologies linked to the CO2 chain (capture, transport and sequestration) are all at commercial stage as being used for decades in the USA for Enhanced Oil Recovery. The main obstacles for their deployment are a reliable carbon price and public acceptance, both are challenges faced by many other technologies.
The Carbon budget assessment chapter identifies both the deployment and extent of negative emission technologies. Distributed Energy and Global Ambition picture a wide and well-established range of CCS level (EC and IEA).

**Feedback (ENGIE):**

*In principle yes, as LULUCF and net negative emissions are also drivers of the effort to reach climate neutrality, and can reduce the need for other decarbonization technologies. Their best estimate should be adequately taken into account and this could well be from external sources, provided that data reflect the most accurate and up-to-date view. In this case data seem however not to be the most up to date (Long-Term Strategy of the European Commission 2018).*

**Response:**

LULUCF assumptions derives from the EC Impact Assessment still referring to Long Term Strategy scenarios for LULUCF and CCS use. As a result 1.5 Tech and 1.5 Life scenarios are considered as fitting the purpose of benchmark for negative emissions. For the next edition, we welcome any more recent source from the European Commission.

**Feedback (Edison SpA):**

*Edison agrees on the importance of integrating data on LULUCF as it is assessed as necessary to reach the carbon neutrality with negative carbon emission at an affordable cost. Still the effective decarbonization should be adequately evaluated taking into account that in some countries the reforestation is already close to its maximum.*
*(cf document published in sept 30th 2021 "Strategia Italiana di Lungo Termine sulla riduzione delle emissioni dei gas a effetto serra" paragraph 3.5). That's why it would be useful to consider the associated country breakdown.*

**Response:**

The LULUCF quantification is based on EC Impact Assessment scenario which is provided at EU27 aggregated level only. A more detailed view could be considered for next edition if data are available.

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***Question 3: Do you agree that the CCS assumptions in the different scenarios sufficiently capture the storylines?***

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**Feedback (Germanwatch):**

*The very strong role of post-combustion CCS in the Global Ambition scenario is to our understanding not necessarily backed by the TYNDP 2022 Storyline Report*

**Response:**

Global Ambition storyline is close to AIE scenarios leaving room for all technologies and global market. As a result the CCS level of the IEA Net Zero 2050 scenario has been used.

**Feedback (Wind Europe):**

*The CCS figures in the GA scenario assume a high efficiency (95% for low-carbon hydrogen). These figures are apparently not achievable today. You should provide insights into how these rates are expected to increase.*
*CCS should be limited to use with biomass and hard to abate sectors (e.g. cement industry) and its share is acceptable in the DE scenario.*
*CCS in combination with SMR should also include upstream process emissions such as CH4 leaks.*
*The Global Ambition scenario considers way too much CCS (716 MtCO2 removals), far beyond any other relevant scenario from the Commission or from relevant studies, to offset the remaining residual emissions in that scenario, which are also surprisingly high. In our view, the ENTSOs scenarios could be overestimating the actual potential of CCS and net-negative technologies. CCS and net-negative emission technologies should be treated with caution when incorporated into long-term decarbonization scenarios exercises, as they have been under discussion for years with no material results. CCS may have a role in the heavy industry to pursue net-zero emission by 2050. For the power sector, the societal, safety and cost challenges that CCS faces make it inconvenient to implement, given that other less risky and more cost-effective solutions are already available.*

**Response:**

The draft report erroneously mentioned steam methane reforming as the only technology to convert methane in hydrogen which indeed limits the CO2 capture rate. In the final COP21 scenarios, SMR capacity is progressively replaced by Auto Reforming Technology in order to enable higher capture rate.
CCS is only used in industrial process and with steam methane reforming for blue hydrogen production. As the industrial sector uses biomass and biomethane, part of the CCS will actually result into BECCS. There is no CCS applied to the power sectors as thermal plant load factor is expected to be too low to justify the investment.
The non-CO2 emissions are taken from the EC Impact Assessment scenarios which have a higher use of methane compared to COP21 scenarios. As a result associate CH4 leaks are taken into account.

The amount of CO2 removal in Global Ambition reached 662 Mt/yr in 2050 (Table 2 §6.7), the 716 Mt mentioned in the text is a mistake. The level derives from the IEA Net Zero scenario activating a wide range of technologies (RES, nuclear, CCS…) to maximize the chance to reach carbon neutrality. It helps to ensure a high contrast with Distributed Energy which CCS level is lower to all EC carbon neutral scenarios.

**Feedback (Enel SpA):**

*The Global Ambition scenario considers way too much CCS (716 MtCO2 removals), far beyond any other relevant scenario from the Commission or from relevant studies, to offset the remaining residual emissions in that scenario, which are also surprisingly high. In our view, the ENTSOs scenarios could be* *overestimating the actual potential of CCS and net-negative technologies. CCS and net-negative emission technologies should be treated with caution when incorporated to long-term decarbonization scenarios exercises. Such strong assumption, and in both scenarios, can lead to underestimate the deployment of other technologies that could be required to reach the carbon neutrality at 2050 in absence of such intensive use of CCS. CCS technologies have been under discussion for years with no material results. CCS may have a role in the heavy industry to pursue net-zero emission by 2050. For the power sector, the societal, safety and cost challenges that CCS faces make it inconvenient to implement, given that other less risky and more cost-effective solutions are already available.*

**Response:**

The amount of CO2 removal in Global Ambition reached 662 Mt/yr in 2050 (Table 2 §6.7), the 716 Mt mentioned in the text is a mistake. The level derives from the IEA Net Zero scenario activating a wide range of technologies (RES, nuclear, CCS…) to maximize the chance to reach carbon neutrality.
Distributed Energy relies on a much lower level of CCS which is actually lower than any EC carbon neutral scenario as indicated in aforementioned table. As a result, the COP21 scenarios cover a wide range of possible evolution of such technologies.

CCS is only used in industrial process and with steam methane reforming for blue hydrogen production. As the industrial sector uses biomass and biomethane, part of the CCS will actually result into BECCS. There is no CCS applied to the power sectors as thermal plant load factor is expected to be too low to justify the investment.

**Feedback (CAN Europe):**

*Following the storyline matrix, the two scenarios correctly show the foreseen lower and higher importance of CCS technologies for the Distributed Energy scenario and for the Global Ambition scenario. In our understanding, the very strong role of post-combustion CCS in the Global Ambition scenario however is not necessarily backed by the TYNDP 2022 Storyline Report. The total CCS potential for the EU seems to be derived in a rather simplified way from the IEA Net Zero 2050 report. The importance of CCS for reaching net zero emissions and the 1.5°C objective beyond 2050 merits a more in-depth assessment of the economic viability of post-combustion and pre-combustion CCS in different sectors, together with the associated infrastructure costs for transporting carbon to potential storage sites. On top of that, the assumed capture rate of 90% (Scenario Building Guidelines, p. 10) appears to be very optimistic for a technology that is not yet introduced at large scale on European markets.*

**Response:**

The Global Ambition storyline does ensure a higher penetration of low carbon solutions, being nuclear power generation, imports or CCS. There is indeed a lack of reference for regional share of CCS across the world.

The scenario building approach does not compare the cost of technologies beyond the economic expansion of the electricity system. Nevertheless, the chapter 4.3 of the Scenario building guidelines provide the cost of the different fuel including blue hydrogen deriving from methane reforming combined with CCS. It is within the range of other molecule supply.

The draft report erroneously mentioned steam methane reforming as the only technology to convert methane in hydrogen which indeed limits the CO2 capture rate. In the final COP21 scenarios, SMR capacity is progressively replaced by Auto Reforming Technology in order to enable higher capture rate.

**Feedback (Oeko-Institut):**

*The strong application of post-combustion CCS in Global Ambition scenario is not clearly resulting from the storyline. As already mentioned in previous commentaries, relying on a strong role of CCS is a path to climate neutrality with a high uncertainty, esp. compared to a stronger expansion of electricity generation from wind and PV (see relevant questions on this topic).*

**Response:**

Global Ambition pictures a path activating a wide range of technologies to maximize the chance to reach carbon neutrality by 2050. It is consistent with the IEA Net Zero scenario which is used as reference for Global Ambition.

CCS is a mature technology as shown by its use for decades in the USA for Enhanced Oil Recovery. The uncertainty within Europe is mostly related to public acceptance which is a common challenge to many technologies.

**Feedback (Agora Energiewende):**

*Agora Energiewende finds the volume of methane in both scenarios too high to meet the climate targets and not cost efficient. Agora Energiewende suggests that methane demand in the industry and buildings sector is very low in 2040, reaching zero in 2050, with respective consequences for CCS (p. 19). See also https://static.agora-energiewende.de/fileadmin/Projekte/2021/2021_07_EU_GEXIT/AgoraEW_Phasing_out_fossil_gas_in_the_EU_Interim_Results_20211028.pdf.*

**Response:**

In 2050, methane demand (including non-energy use and power generation) is reduced by 57% in Distributed Energy and Global Ambition. The decrease is even stronger in the residential and tertiary sectors. For the industrial sector most of the methane demand aims at non-energy use.

In 2050 for Distributed Energy, methane is only composed of biomethane and synthetic methane. As a result it does not trigger the use CCS unless aiming some BECCS.

**Feedback (Eurelectric):**

*We take note that DE scenario considers a minimum CCS assumption, while the GA scenario envisages a significant role for CCS (761 MtCO2 removals), way beyond any other relevant scenario from the Commission scenarios, to offset the remaining residual emissions. In our view, GA scenario could overestimate the actual potential of CCS and net-negative technologies which feasibility at commercial size remains to be tuned and proven. CCS and net-negative emission technologies should be treated with caution when incorporated into long-term decarbonization scenarios exercises. Such*

*assumptions, and in both scenarios, can have significant impact on the global results and on the contribution of other technologies that could be required to reach carbon neutrality in 2050 in absence of such intensive use of CCS.*
*In the finalisation of the assumptions regarding CCS, we encourage the ENTSOs to consider the following elements:*

- *The EC's 2030 Climate Target Plan impact assessment does not see significant deployment by 2030 of CCS for power generation in any of the scenarios considered during this time period. By 2030, the European Commission would rather see the necessity to look at all innovative low-carbon and carbon neutral technologies to turn industry carbon neutral, such as CCS or hydrogen-based steel*
- *For Eurelectric, the total CO2 abated through CCS should represent less than 200 Mt by 2050, which is in line with the EC's scenarios. Indeed, 4 - 6% of electricity will be supplied by emitting sources by 2045. Therefore, emissions will need to be offset by CCS/CCU or other CO2 offset technologies in order to reach 100% decarbonisation. CCS can be a solution to abate emissions from centralized fossil generation that is operating at sufficient utilization to justify the high upfront costs required for these installations. Moreover, we see additional use of CCS for industrial processes. While CCS is still an expensive technology, there are potential synergies in technology development and scale advantages as it is also likely to be needed for other sectors where no other solution is feasible (e.g. abating process emissions in cement production).*

**Response:**

The amount of CO2 removal in Global Ambition reached 662 Mt/yr in 2050 (Table 2 §6.7), the 716 Mt mentioned in the text is a mistake. The level derives from the IEA Net Zero scenario activating a wide range of technologies (RES, nuclear, CCS…) to maximize the chance to reach carbon neutrality.
Distributed Energy relies on a much lower level of CCS which is actually lower than any EC carbon neutral scenario as indicated in aforementioned table. As a result, the COP21 scenarios cover a wide range of possible evolution of such technologies.

COP21 scenarios do not use CCS in power generation apart for the share of blue hydrogen used in thermal plants. In such a case CCS is used at methane reforming level, ensuring a high load factor supporting the economics of capture.

**Feedback (EDF):**

*CCS is a disruptive technology and still appears as a very uncertain breakthrough which would require to cope with both cost and technical challenges. Decarbonisation cannot be strongly based on CCS in all scenarios and EDF agrees with the strong reduction of CCS penetration in DE compared to TYNDP 2020.*
*However, in GA, the CCS assumption is based on the highest scenario of benchmark (studies from Hydrogen for EU excluded) and is much higher than the most ambitious scenario of LTS. GA scenario could overestimate the actual potential of CCS and net-negative technologies which feasibility at commercial size remains to be tuned and proven. CCS and net-negative emission technologies should be treated with caution when incorporated into long-term decarbonization scenarios exercises. Such assumptions, and in both scenarios, can have significant impact on the global results and on the contribution of other technologies that could be required to reach carbon neutrality in 2050 in absence of such intensive use of CCS. Therefore, a more conservative assumption should be envisaged.*
In the finalisation of the assumptions regarding CCS, EDF encourage the ENTSOs to consider the following elements:

- The EC's 2030 Climate Target Plan impact assessment does not see significant deployment by 2030 of CCS for power generation in any of the scenarios considered during this time period. By 2030, the European Commission would rather see the necessity to look at all innovative low-carbon and carbon neutral technologies to turn industry carbon neutral, such as CCS or hydrogen-based steel.
- The total CO2 abated through CCS should represent less than 200 Mt by 2050, which is in line with the EC's scenarios. Indeed, 4 - 6% of electricity will be supplied by emitting sources by 2045. Therefore, emissions will need to be offset by CCS/CCU or other CO2 offset technologies in order to reach 100% decarbonisation. CCS can be a solution to abate emissions from centralized fossil generation that is operating at sufficient utilization to justify the high upfront costs required for these installations. Moreover, we see additional use of CCS for industrial processes. While CCS is still an expensive technology, there are potential synergies in technology development and scale advantages as it is also likely to be needed for other sectors where no other solution is feasible (e.g. abating process emissions in cement production).

**Response:**

The amount of CO2 removal in Global Ambition reached 662 Mt/yr in 2050 (Table 2 §6.7), the 716 Mt mentioned in the text is a mistake. The level derives from the IEA Net Zero scenario activating a wide range of technologies (RES, nuclear, CCS…) to maximize the chance to reach carbon neutrality. Distributed Energy relies on a much lower level of CCS which is actually lower than any EC carbon neutral scenario as indicated in aforementioned table. As a result, the COP21 scenarios cover a wide range of possible evolution of such technologies.

COP21 scenarios do not use CCS in power generation apart for the share of blue hydrogen used in thermal plants. In such a case CCS is used at methane reforming level, ensuring a high load factor supporting the economics of capture.

**Feedback (Environmental Action Germany):**

*Following the storyline matrix, the two scenarios correctly show the foreseen lower and higher importance of CCS technologies for the Distributed Energy scenario and for the Global Ambition scenario. In our understanding, the very strong role of post-combustion CCS in the Global Ambition scenario however is not necessarily backed by the TYNDP 2022 Storyline Report. The total CCS potential for the EU seems to be derived in a rather simplified way from the IEA Net Zero 2050 report. The importance of CCS for reaching net zero emissions and the 1.5°C objective beyond 2050 merits a more in-depth assessment of the economic viability of post-combustion and pre-combustion CCS in different sectors, together with the associated infrastructure costs for transporting carbon to potential storage sites.*

**Response:**

The aim of COP21 scenarios is to cover a wide range of possible futures especially for technologies associated with political uncertainties such as CCS. As a result Distributed Energy and Global Ambition deviate much lower and higher than EC Impact Assessment scenarios. The high level of Global Ambition derives from the IEA Net Zero and we acknowledge the lack of reference for the European share of the global CCS figure. We hope that next edition will provide the opportunity to improve our assumptions.

**Feedback (Gas Distributors for Sustainability):**

*A CO2 economy will be developed as the climate change could impose rapid and concrete actions. Carbon capture and sequestration technologies and practices would be fostered with great opportunity for renewable gases. For instance, methanation appears as a great synergy with biomethane production and grid injection and such potential and promising activity is for instance not considered by the ENTSOs.*
*The energy transition will rely, in part, on new business models of production and consumption that are not easy to assess as of today. Therefore, it is necessary to assess value creation at the wide level of the energy system to allow innovative solutions and effective sector coupling to materialise.*

**Response:**

In COP21 scenarios, biogenic carbon sources are first used to produce synthetic liquids for heavy mobility and especially aviation. For gas, scenarios favour European hydrogen over methanation as it avoids additional conversion losses when hydrogen could be directly used. The scenario update has provided the opportunity to add synthetic methane production based on dedicated RES and off-grid electrolyser, possibly combined with biomethane production in order to use the same injection point in the methane network.

**Feedback (Ørsted):**

*The storyline and scenarios could be more elaborate on the utilization of CO2 for e-fuels, providing more details on what is the demand for, and what could be the sources of CO2 (BECCS and DACS for instance) that are available at adequate quantities for the e-fuels market to ramp up and to decarbonize hard to abate sectors (e.g. olefin industry, aviation). There is significant political focus on CCU in Denmark and other parts of Europe as a way to generate net-zero emission products from biogenic CO2 sources and lower emission products from unabatable CO2 sources (e.g., cement plants). We do not see this clearly reflected in the scenarios.*

*The report indicates that CCUS from biomethane/synthetic methane-fired thermal power plants is economically more feasible than from biomass-fired plants. Our internal analysis shows that CCUS on bio-converted CHPs can be an economical option and will be cost-competitive with bio-/syn-methane fired thermal power plants. CCUS on bio-converted CHPs can be an economical option and will be cost-competitive with bio-/syn-methane fired thermal power plants.*

*There is an assumption that SMR equipped with CCS has a 95% efficiency. If CCS is retrofitted on SMRs the capture rates are significantly lower and whether this can be achieved on new builds is still largely unproven. It is also important to consider the potential methane leakages when estimating the full-cycle emissions.*

**Response:**

COP21 scenarios do not apply CCUS to power generation being on biomethane or synthetic methane as it is assumed that running hours will be lower than industrial processes. As a result CCUS is only applied to industrial processes and methane reforming for hydrogen production. Depending on stakeholders' insights, BECCS could be considered in next edition for specific plants (e.g. CHP) with higher running hours.

Capture rate of steam methane reformer are indeed lower than 95%. Scenarios have been adapted accordingly with the identification of the need to move to autothermal reforming to achieve higher capture rate.

**Feedback (Eurogas):**

*The role of CCS in the two COP21 compliant scenarios is very different by construction (from almost nothing in 2030 in DE to 700 Mt CCS in 2050 in GA). The real potential for CCS would be very likely between these two extremes. The split in the use of CCS in power generation and other sectors is unclear from the Report, thus it is difficult to give a more in-depth comment while it is mentioned that "technologies to achieve negative emissions (CCS) are essential to meet the COP 21 objectives".*
*Carbon capture and sequestration technologies and practices would be fostered with great opportunity for renewable gases. For instance, methanation appears as a great synergy with biomethane production and grid injection… such potential and promising activity is for instance not considered by the ENTSOs.*

**Response:**

CCS is only used in industrial sector and blue hydrogen production. There is no direct use in power generation but some indirect as part of hydrogen-fired power generation will derive from natural gas reforming combined with CCS. Such approach is justified by the low number of running hours of thermal units.

Carbon captured from biogenic sources was already used in COP21 scenarios for e-liquid production in order to support the decarbonation of heavy mobility and aviation in particular. The scenario update has provided the opportunity to add synthetic methane production based on dedicated RES and off-grid electrolyser, possibly combined with biomethane production in order to use the same injection point in the methane network.

**Feedback (current Europe):**

*The CCS figures in the GA scenario assume a high efficiency (90% for low-carbon hydrogen). These figures are not achievable today. You should provide insights on how these rates are expected to increase.*
*CCS should be limited to use with biomass and hard to abate sectors (e.g. cement industry) and its share is acceptable in the DE scenario.*
*CCS in combination with SMR should also include upstream process emissions such as CH4 leaks.*

**Response:**

Indeed a 90% capture rate cannot be achieved with Steam methane reformer. The udpated reports will signal the need to develop autothermal reforming in order to enable higher capture rate.
In COP21 scenarios, CCS is limited to the industrial sector and hydrogen production from natural gas reforming.
For non-CO2 emissions, the value has been taken from the EC Impact Assessment which uses more methane than COP21 scenarios (including methane reforming).

**Feedback (ENGIE):**

*The role of CCS in the two COP21 compliant scenario is very different (from almost nothing in 2030 in DE to 700 Mt CCS in 2050 in GA), while it is mentioned that "technologies to achieve negative emissions (CCS) are essential to meet the COP 21 objectives". The real potential for CCS would be very likely between the two extremes. The split in the use of CCS in power generation and other sectors is unclear from the Report, thus it is difficult to give a more in-depth comment.*

**Response:**

CCS is only used in industrial sector and blue hydrogen production. There is no direct use in power generation but some indirect as part of hydrogen-fired power generation will derive from natural gas reforming combined with CCS. Such approach is justified by the low number of running hours of thermal units.

**Feedback (Edison SpA):**

*The importance of CCS/U is key to reach the decarbonization objective, that's why the conditions for using this technology should be better detailed. For example, some general principles could be more clarified:*

- *will the CCS/U be implemented close to the consumption point or at the border?*
- *How will the cost be allocated?*

*We also notice that looking at the Benchmarking in p.58 of the TYNDP 2022 draft scenario report, the assumption of 662 Mt of CCS per year in the GA scenario seems more ambitious compared to the EC Long term strategy, and very much higher compared to DE scenario (64 Mt/year). One could expect more explanation justifying these discrepancies, in particular in the case of GA scenario where CCS becomes key to achieve the COP21 objectives. For example, the conditions (cost, feasibility,…) to reach such level of CCS should be clarified.*

**Response:**

CCUS is applied to industrial sector and hydrogen production. Capture will therefore occur close to the industrial facility in the first case and at the natural gas import points in the second case.
In case of hydrogen production, the cost of CCS is factored in the cost of "Decarbonized H2 imports" as reflected in the Scenario Building Guidelines (see chapter "Overview of modelling parameters of TYNDP scenarios").
The aim of COP21 scenarios is to cover a wide range of possible futures especially for technologies associated with political uncertainties such as CCS. As a result Distributed Energy and Global Ambition deviate much lower and higher than EC Impact Assessment scenarios. The high level of Global Ambition derives from the IEA Net Zero and we acknowledge the lack of reference for the European share of the global CCS figure.

***Question 4: Do Prosumer and vehicle-to-grid modeling improvements meet your expectations?***

**Feedback (EU DSO Entity):**

*These improvements shall be elaborated in cooperation with DSO experts. Prosumers (active consumers) and vehicle-to-grid modelling are both in a DSO area of activity.*

**Response:**

Some DSO experts have taken part to the scenario building process and ENTSO-E and ENTSOG intend to deepen their collaboration with distributors for the 2024 edition. Any contribution from a modelling methodology perspective or dataset fitting the European and transparency standards of the scenario building process is very much appreciated.

**Feedback (Eurelectric):**

*While we notice and welcome several improvements to the methodologies in relation to prosumer and vehicle-to-grid, we would like to mention the two following elements:*

- *Prosumers and vehicle-to-grid modeling are both in a DSO area of activity. Therefore, we would welcome an even closer cooperation with DSO experts on this matter particularly.*
- *The modelling approach with separate EV and Prosumer nodes makes a lot of sense. They are a key driver of self-consumption for residential customers and very different across countries. Differentiating the delivery cost per country would also be an appropriate refinement.*

**Response:**

ENTSO-E and ENTSOG welcome the acknowledgment of the enhanced methodology regarding technologies at distribution scale. We clearly perceive further cooperation with DSO experts as the most efficient way to improve scenarios in this regard and better take into account country specifics.

**Feedback** (Ørsted):

*The potential for demand side response should be higher. In the scenarios DSR is estimated at around 5 TWh in 2050 or just over 0.1% of final electricity demand. However, numerous different sources for flexible/responsive demand are likely to exist, for example EV charging (V2G), heating, various residential uses and from industry. A more flexible demand side will support building out the large, required amounts of variable renewable power and be a very important balancing tool in addition to flexible power generation, batteries and grid/interconnection expansions.*

**Response:**

As part of the Draft Scenario report, Demand-Side Management only covers demand shedding. The updated report clarifies its scope and the overall demand-side management (demand shedding, prosumer batteries and V2G) amounts for 5 and 10 % of the final electricity demand in Global Ambition and Distributed Energy in 2050.

**Feedback (ENGIE):**

*The modelling approach with separate EV and Prosumer nodes makes a lot of sense. However, to get more meaningful results, the delivery costs to the Prosumer node should include taxes and levies, which are very different in the different countries. They are a key driver of self-consumption for residential customers. Differentiating the delivery cost per country would also be an appropriate refinement.*

**Response:**

COP21 scenarios contemplate a system view up to 2050, as a result market and fiscal design are not considered. We expect that the deeper involvement of DSO experts will help to better capture country specifics even if one could expect that the differences will reduce on the long term.

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***Question 5: Do power-to-gas configurations reflect your expectations about the future operation of these units?***

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**Feedback (Wind Europe):**

*There has been a lack of dedicated offshore and onshore wind capacities for hydrogen production. Germany, for example, plans to tender its first offshore wind zones without planned electricity grid links in 2022 to help ramp up the production of offshore renewable hydrogen.*

**Response:**

Following stakeholders' feedback on Draft scenarios, additional dedicated RES have been implemented in the updated scenarios. In 2050, dedicated onshore and offshore wind will amount for 12% of the electrolyser supply of Distributed Energy.

**Feedback (CAN Europe):**

*See also our answer to question 15. Given that it is very likely that European hydrogen demand besides in transport will mainly occur in the steel and chemical industry that are geographically concentrated in a few regional clusters, the geographical location of the electrolyser matters a lot in view of their operation mode. Accordingly, it influences the optimisation of the infrastructure connection (electricity transmission to industries' on-site electrolysers versus hydrogen from dedicated renewable capacities (DRES) being transported to industries). TYNDP modelling should better illustrate the potential advantages from linking geographically close clusters of hydrogen demand and potential hydrogen supply in contrast with hydrogen imports and related transport costs (shipping, repurposed or newly built pipelines).*
*Furthermore, we would like to question the integration of its principles and key assumptions of the European Hydrogen Backbone study into the TYNDP modelling. The European Hydrogen Backbone study was commissioned by gas industry stakeholders to analyse the benefits of a further use of fossil gas infrastructure. As a consequence, despite being a comprehensive analysis, it does not necessarily pursue the optimisation of the EU's entire energy system (demand, supply, infrastructure and flexibility options) in view of the Paris Agreement. We would have seen this exercise as an opportunity to run a peer-reviewed process with independent researchers. Recent studies show that large parts of the existing fossil gas infrastructure might be superfluous if the EU energy infrastructure planning is optimised consistently towards the 1.5°C objective*

*(see Artelys: What energy infrastructure to support 1.5°C scenarios?, November 2020, https://www.artelys.com/wp-content/uploads/2020/11/Artelys-2050EnergyInfrastructureNeeds.pdf).*

**Response:**

The definition of the location of electrolyser is defined with a country granularity. Nevertheless the scenarios do not take the European Hydrogen Backbone as an input. For the purpose of transporting energy between power generation and hydrogen consumption locations, the model does apply a cost optimisation in order to decide an expansion of the electricity interconnection or the creation of an hydrogen one being trough the retrofitting of existing methane pipelines or through new ones. The actual analysis of transmission infrastructures (electricity, methane and hydrogen) is done at TYNDP level using the capacity and location of demand, generation, storage and conversion as resulting from scenarios.

**Feedback (Oeko-Institut):**

*Most recent studies conclude that hydrogen should be mostly directed into processes that do not have other decarbonisation options. This implies that hydrogen demand will be very focussed in several European regions with high shares of chemical and steel industry. To cover this demand there are several options: onsite electrolysers with high needs for electricity grid deployment vs. electrolysers close to areas with high RES-E generation and transport via hydrogen grids vs. imports of hydrogen that implies very different structures of hydrogen transport. Those options should be reflected within the configurations of PTX.*
*It is not sufficient to built European infrastructure on a single study such as the European Hydrogen Backbone. The range of options should be considered in the scenarios and own modelling on possible infrastructure should be carried out and influence of the different options of configurations analysed.*

**Response:**

The split of hydrogen demand in different electrolyser configuration is defined as an assumption (see Scenario Building Guidelines Appendix III on P2G modelling). Configurations 2 and 3 are purely onsite electrolysis (at industrial facility or platform level).
Regarding Configurations 4, there is no ex-ante decision to go through a hydrogen or electricity grid expansion. The choice is an output of the expansion model between the energy source (e.g. wind or solar) and the hydrogen consumption.

**Feedback (Environmental Action Germany):**

*See also our answer to question 15.*

*Given that it is very likely that European hydrogen demand besides in transport will mainly occur in the steel and chemical industry that are geographically concentrated in a few regional clusters, the geographical location of the electrolyser matters a lot in view of their operation mode. Accordingly, it influences the optimisation of the infrastructure connection (electricity transmission to industries' on-site electrolysers versus hydrogen from dedicated renewable capacities (DRES) being transported to industries).*

*TYNDP modelling should better illustrate the potential advantages from linking geographically close clusters of hydrogen demand and potential hydrogen supply in contrast with hydrogen imports and related transport costs (shipping, repurposed or newly built pipelines).*

*Although DUH has no doubts about the accuracy of the European Hydrogen Backbone study, we would like to question the integration of its principles and key assumptions into the TYNDP modelling. The European Hydrogen Backbone study was commissioned by gas industry stakeholders to analyse the benefits of a further use of fossil gas infrastructure. As a consequence, despite its high scientific quality, it does not necessarily pursue the optimisation of the EU's entire energy system (demand, supply, infrastructure and flexibility options) in view of the Paris Agreement.*

*We would have seen this exercise as an opportunity to run a peer-reviewed process with independent researchers. Recent studies show that large parts of the existing fossil gas infrastructure might be superfluous if the EU energy infrastructure planning is optimised consistently towards the 1.5°C objective (see Artelys: What energy infrastructure to support 1.5°C scenarios?, November 2020, https://www.artelys.com/wp-content/uploads/2020/11/Artelys-2050EnergyInfrastructureNeeds.pdf).*

**Response:**

The definition of the location of electrolyser is defined with a country granularity. Nevertheless the scenarios do not take the European Hydrogen Backbone as an input. For the purpose of transporting energy between power generation and hydrogen consumption locations, the model does apply a cost optimisation in order to decide an expansion of the electricity interconnection or the creation of an hydrogen one being trough the retrofitting of existing methane pipelines or through new ones. The actual analysis of transmission infrastructures (electricity, methane and hydrogen) is done at TYNDP level using the capacity and location of demand, generation, storage and conversion as resulting from scenarios.

**Feedback (Gas Distributors for Sustainability):**

*We regret that power-to-methane has not been clearly assessed as a contributor to sector coupling. In synergy with biomethane production, power-to-methane's potential is significant and offers an efficient way to valorise hydrogen while using the existing gas infrastructure (storage) and appliances.*

**Response:**

Due to biogenic carbon has been use in priority for synthetic liquids to answer the need of heavy mobility and aviation in particular. Following stakeholders' feedback on the Draft Scenario report some European production of synthetic methane has been added based on dedicated RES. It amounts for 2 to 3% of the methane supply in 2050 in addition to synthetic methane imports.

**Feedback (currENT Europe):**

*There has been a lack of dedicated offshore wind capacities for hydrogen production. Germany plans to tender its first offshore wind zones without planned electricity grid links in 2022 to help ramp up production of offshore renewable hydrogen.*

**Response:**

Following stakeholders' feedback on Draft scenarios, additional dedicated RES have been implemented in the updated scenarios. In 2050, dedicated onshore and offshore wind will amount for 12% of the electrolyser supply of Distributed Energy.