TYNDP // 2024

July 2023

Scenarios Storyline Report

CONTENTS //

1 INTRODUCTION TO TYNDP 2024 SCENARIOS //

What is this report about?

Regulation (EU) 2022/869 ('Regulation')[1] requires that the European Network of Transmission System Operators for Electricity ('ENTSO-E') and the European Network of Transmission System Operators for Gas ('ENTSOG') jointly develop scenarios for the future European energy system in the context of their respective Ten-Year Network Development Plans ('TYNDPs').

The development of the scenarios marks the first step in the TYNDP 2024 process. Defining the scenarios, however, requires the development of the (qualitative) storylines to be explored. The TYNDP 2024 scenarios are based on the TYNDP 2022 scenario storylines and thus requires revisiting of these storylines. The TYNDP 2024 scenario building process launched together with a storyline review workshop organised on the 20th of July 2022 where ENTSOG and ENTSO-E presented their proposal for the updates for the TYNDP 2024 storylines to collect stakeholder feedback. This storyline report presents the scenario framework for TYNDP 2024, consisting of one national policy scenario and two deviation scenarios, and explains the storyline development of these deviation scenarios.

The storylines captured in this report are the foundation of the scenario building quantification phase for the deviation scenarios which starts by gathering the input parameters and developing methodologies. These input parameters and methodologies which are part of the public consultation launched between 4th of July 2023 and 8th of August 2023, and should be analysed together with their respective scenarios. After collecting stakeholder feedback, ENTSO-E and ENTSOG will finalise the input parameters and methodologies which will feed into the modelling. This modelling will result in full energy scenarios, including accompanying datasets which will be consulted later in 2023.

1 Regulation (EU) 2022/869

Why do ENTSOG and ENTSO-E build scenarios together?

Joint scenarios are a key step towards an interlinked approach to energy system analysis. Joint scenarios allow ENTSO-E and ENTSOG to undertake infrastructure analysis from a common and consistent set of assumptions and data. The TYNDP 2018 was the first time ENTSOG and ENTSO-E cooperated on scenario development. For the TYNDP 2020 and 2022 cycles, the scenario building process was further expanded and improved. Since there are strong synergies and co-dependencies between gas and electricity infrastructures, it is increasingly important to understand the impact of European policies that aim to achieve a carbon-neutral European energy system by 2050.

Joint scenarios allow ENTSOG and ENTSO-E to assess future infrastructure needs and projects against the same future outlooks. The TYNDP 2024 scenarios go beyond the EU-27 to the ENTSO-E & ENTSOG perimeters, which includes members, observers and associated partners. Gas and electricity Transmission System Operators ('TSOs') incorporate the technical knowledge and experience to provide European-focused scenarios that demonstrate how the energy transition could impact the European electricity and gas systems; along with an assessment of the challenges for the long-term horizon.

The outcome of the joint scenario development process provides decision makers with important information, as they seek to make informed choices that will benefit all European consumers. Combining the efforts from gas and electricity TSOs offers ENTSOG and ENTSO-E an opportunity to leverage cross-sectorial and country specific knowledge and expertise that would otherwise be missing. Joint working provides access to a broader range of stakeholders who are actively participating in the energy sector. The scenario building process for TYNDP 2024 builds on the work from previous editions and aims to continually improve the overall quality, level of detail and transparency. The purpose is to grant stakeholders access and enable the use of scenario data to understand what is required to deliver a cleaner and better energy system for everyone of Europe.

What is the goal of the TYNDP scenarios and their storylines?

As outlined in the Regulation, ENTSOG and ENTSO-E are required to use scenarios as the basis for the official TYNDP (created every two years by ENTSO-E and ENTSOG) and also for the calculation of the Cost-Benefit Analysis (CBA) used as an input to assess EU electricity and gas infrastructure Projects of Common Interest (PCI). ENTSOG and ENTSO-E design their scenarios specifically for this purpose. The scenarios are intended to project the long-term energy supply and demand considering the ongoing energy transition. Furthermore, the scenarios draw extensively on the current political and economic consensus and attempt to follow a logical trajectory to achieve future energy and climate targets.

The scenarios and their storylines are designed to reflect the EU and national policy goals and strategies, including the Energy Efficiency First principle, such that they specifically explore the uncertainties that are relevant to the development of gas and electricity infrastructure. As such, they primarily focus on aspects which determine infrastructure utilisation. The differences between the scenario storylines are therefore predominantly related to possible variations in demand and supply patterns. To this end, all the scenarios developed within the TYNDP 2024 framework remain technology, source and energy-carrier neutral.

What is new in the TYNDP 2024 storyline report?

The TYNDP 2024 scenario storylines rely extensively on the storyline framework developed during the TYNDP 2022 scenario cycle. On the one hand, this approach was followed since the proposed deviations from the national policy scenarios remain largely unchanged. In this context, the extensive feedback received on the 2022 draft storyline report provided a solid basis for our current scenarios. On the other hand, the decision to update the previous cycle storylines rather than to develop completely different ones was also supported by Framework Guidelines for the joint TYNDP scenarios to be developed by ENTSO for Electricity and ENTSO for Gas ('TYNDP Scenarios Guideline').[2]

2 TYNDP Scenarios Guideline

2 SCENARIO FRAMEWORK //

Scenarios will cover different time horizons

The scenario building process for the TYNDP 2024 builds on the work of previous editions. The TYNDP process has shown that scenarios have to combine different expectations along their time horizon: supporting infrastructure project assessment, analyzing investment needs or illustrating the shape of prospective energy systems. Figure 1 illustrates how ENTSO-E and ENTSOG plan to cover the different time horizons in their scenarios for TYNDP 2024.

TYNDP 2024 SCENARIOS STRATEGY

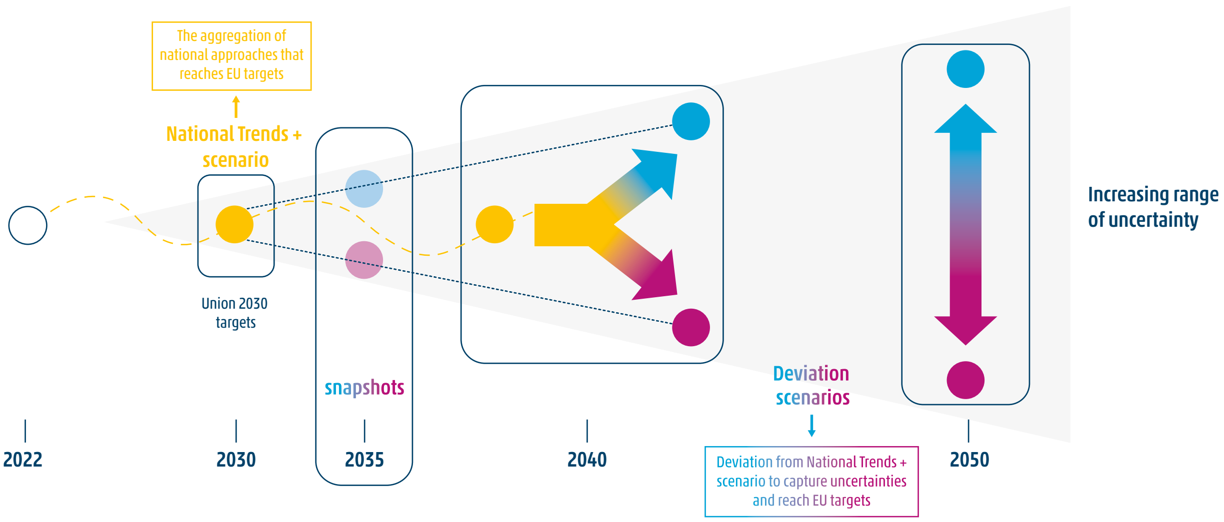

Figure 1: TYNDP Scenario horizon and framework

TYNDP 2024 scenario cycle will include six scenarios and depending on how there are developed, these scenarios are labelled either **National Trends+** ('NT+') scenarios or **Deviation Scenarios** (Distributed Energy 'DE' and Global Ambition 'GA').

- **National Trends** will be the scenario in line with national energy and climate policies (NECPs[3], national long-term strategies[4], hydrogen strategies…) derived from the European targets. 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. These scenarios will be created for the 2030 and 2040 time-horizons, because datasets for the 2050 time-horizons are not available in all Member States (MS). For this cycle, the collected datasets represent TSOs best estimate as they are in accordance with the anticipated NECPs whose draft versions are to be published in summer 2023. Additionally, for the first time in this edition, the National Trends scenario will be quantified for all energy carriers (as opposed to just electricity and gas in the previous installments). This will enable an assessment of the European Union's 2030 targets for energy and climate as required by the Regulation. If there is a gap between the EU targets and this scenario, this gap will be transparently presented and closed according to the 'NT+ Energy mix gap filling methodology' (Annex-2). Consequently, this scenario is now called National Trends+ (NT+). As this scenario is based on MS's NECPs, they will not be part of public consultation. However, the Annex-2 'NT+ Energy mix gap closing methodology' is published as part of public consultation in July 2023.
- In addition to the NT+ scenario, which is aligned with national policies, ENTSOG and ENTSO-E will develop **two deviation scenarios** (DE and GA). These scenarios are deviations from the NT+ 2030 scenario according to their respective storylines. Therefore, they require a Storyline Update Process. These scenarios will be created for the 2040 and 2050 time horizons (2030 NT+ is the starting point). In addition, the 2035-time horizon will be reported as a snapshot. These will also be built as full energy scenarios (all sectors, all energy carriers) in order to quantify compliance with EU targets. For 2035 and 2040, a meaningful transition from 2030 EU targets is sought, while for 2050 reaching carbon neutrality is mandatory.

Scope of this storyline report

NT+ scenarios have a strong country-specific narrative that provides insight into the evolving policies and market developments for each area. This is also in line with the legal requirements that the dataset shall reflect European Union and Member State national law in force at the date of analysis (Regulation (EU) 347/2013, Annex V, point 2) and furthermore, conforms with provisions stated in (EC) No 714/2009 and (EC) NO 715/2009, Article 8 point 10. The assumptions used in the NT+ scenario are already being discussed on a national level. That is why ENTSOG and ENTSO-E will not publish NT+ for public consultation, rather for information.

The two deviation scenarios on the other hand, require specific storylines defined on a European level. The next chapters lay out the deviation storylines ENTSOG and ENTSO-E will use in further scenario development for TYNDP 2024 captured in this report.

3 National Energy and Climate Plans

4 National long-term strategies

3 SCENARIO STORYLINES FOR TYNDP 2024 //

The definition of each scenario should enable the gas and electricity infrastructure assessment as part of TYNDP and TEN-E processes. In parallel, Member States define NECPs and national long-term strategies within the Paris Agreement Framework on a regular basis, while the European Commission proposes European focused strategies. The scenario building process is designed to be incremental and iterative and encourages multilateral engagement resulting in several benefits.

The full TYNDP process is achieved in the following ways:

- By providing insights to Member States and decision-makers about the interactions between national strategies;
- By ensuring both alignment of national and European strategies while taking into account country specifics;
- By creating a platform ensuring the consideration of all options with a technology neutral approach.

Following the regulatory obligation, ENTSO-E and ENTSOG have launched the scenario building process for the TYNDP 2024 by regularly engaging with the stakeholders. The scenarios intend to incorporate the aforementioned process outcomes based on the experience of previous editions and stakeholder feedback. The storylines used for the TYNDP 2024 scenarios are an evolution from the ones used for the previous TYNDP 2022 which is finalised after an extensive stakeholder public consultation & workshop. These updates were introduced in specific areas to reflect the latest developments and new insights. Furthermore, the scenario storylines are designed as deviations from the National Trends+ scenario.

The key elements defining the scenario selection strategy are:

- To reflect the latest development in national energy and climate policies that are in line with European greenhouse gas reduction ambitions;
- To acknowledge the need for high ambition in terms of European energy efficiency and renewable energy deployment;
- To acknowledge the uncertainties associated with maximising the renewable development and energy efficiency, or relying on low-carbon technologies and energy imports;
- To explore different levels of independence for the European Union, both in terms energy supply, as well as for industrial activity, agricultural yield, and consumer goods.

As these elements impact the European energy infrastructure to different degrees, it is necessary to develop two scenarios to provide an appropriate basis for infrastructure assessment. In addition, many intermediate pathways could materialise based on different combinations of drivers. Nevertheless, it is expected that the two deviation scenarios cover a wide range of possible future evolutions of energy infrastructure.

It is beyond the remit of ENTSO-E and ENTSOG's to favour one storyline against the other. However, highlighting similarities and differences in the storylines is a way to manage the uncertainty of future energy system evolution. Differentiating scenarios supports a robustness in CBA calculations and PCI assessments.

The following table provides an overview of storyline differentiation based on the high-level drivers.

	DISTRIBUTED ENERGY HIGHER EUROPEAN AUTONOMY WITH RENEWABLE AND DECENTRALISED FOCUS	**GLOBAL AMBITION** GLOBAL ECONOMY WITH CENTRALISED LOW CARBON AND RES OPTIONS
GREEN TRANSITION	Fully in line with the energy efficiency first principle and with the Union's 2030 targets for energy and climate and its 2050 climate neutrality objective	
DRIVING FORCE OF THE ENERGY TRANSITION	Transition initiated on local/national level (prosumers)	Transition initiated on a European/international level
	Aims for EU energy-independence and strategic independence through maximisation of RES and smart sector integration (P2G/P2L/P2M)	High EU RES development supplemented with low carbon energy and diversified imports
ENERGY INTENSITY	Reduced energy demand through circularity and better energy consumption behaviour	Reduced energy demand with priority is given to decarbonisation and diversification of energy supply.
	Digitalisation driven by prosumer and variable RES management	Digitalisation and automation reinforce competitiveness of EU business.
TECHNOLOGIES	Focus of decentralised technologies (PV, batteries, etc) and smart charging	Focus on large scale technologies (offshore wind, large storage)
	Focus on electric heat pumps and district heating	Focus on a wide range of heating technologies, e.g., hybrid heating technology
	Higher share of EV, with e-liquids and biofuels supplementing for heavy transport	Wide range of technologies and energy carriers across mobility sectors (electricity, hydrogen, e-liquids and biofuels)
	Minimal CCS and nuclear	Integration of nuclear and CCS

Table 1: Storylines differentiation based on high-level drivers

3.1 DISTRIBUTED ENERGY (DE)

This scenario pictures a pathway achieving EU-27 carbon neutrality target by 2050 with higher European Economy. The scenario is driven by a willingness of the society to achieve high levels of independence in terms of energy supply and goods of strategic importance (e.g., industrial and agricultural produce). It translates into both a behavioural shift and strong decentralised drive towards decarbonisation through local initiatives by citizens, communities and businesses, supported by authorities.

On the demand side this means a high focus on electrification and a strong commitment to reduce energy consumption. Residential and tertiary sectors achieve this through a transition towards renewable heat provided by all-electric heat pumps, district heating and energy efficiency renovations. The transport sector also aims for high electrification rates and a decrease in individual mobility. The industrial sector invests in energy efficiency and circularity to reduce energy demand, while maintaining or insourcing strategic industries. Technologies such as heat pumps and EVs ensure the high efficiency gains necessary to limit demand, so it is balanced by potential energy production at local, national and European levels.

On the supply side, public acceptance for a very ambitious RES development rate is achieved. The development of prosumer behaviours become common place as citizens gain a better understanding of the energy system and its impact on climate. Further to this, higher involvement of citizens in local RES projects (e.g., via rooftop PV, district heating/cooling, geothermal and biomass) is crucial to meet this challenge.

Specific European legislation sets the decarbonisation framework of activities managed at European scale such as aviation, shipping and some industrial sectors. In tandem, hard-to-decarbonise sectors that currently rely on fossil fuel imports switch to bio- and synthetic fuels (derived from electrolysis of renewable electricity) produced in Europe, further reducing import dependence.

From an electricity system perspective, strong increase of heat pumps and EVs results in a deep electrification of final energy demand. This demand is met by maximising the use of wind and solar resources, which results in a power system with little dispatchable thermal generation remaining. The dispatchable capacities that are available are based on solid biomass and power plants fuelled by renewable gas. Demand-side flexibility solutions are required, so that the electricity system remains balanced on an hourly basis. In residential and tertiary sectors, the use of home batteries and the smart charging of EVs can support short term balancing of the electricity grids.

Large consumers in agriculture, industry and district heating can provide flexibility through demand side response (DSR) (moving tasks to an earlier or later time period). Sector integration through the production of storable energy in the form of gas and liquids by electrolysis provides seasonal flexibility to the electricity system.

The factors influencing the design of the European energy system are the development of local optimization (circularity, prosumers), the need to connect huge amounts of RES energy and flexibility management from a geographical and temporal perspective. The available European primary energy sources require the coupling between energy carriers and infrastructures to cover the energy demand throughout all sectors.

The achievement of European energy autonomy based on renewable energy relies on a range of prerequisites such as:

- The public acceptance of energy infrastructures and hosting of generation technologies associated with the maximisation of RES development across the whole Europe;
- The understanding and willingness of European citizens to adapt their behaviour to minimise energy demand and fully participate to the system adequacy;
- The maturity of technologies (hydrogen fuel cell, batteries, DSR, etc.) ensuring:
  - the security of the electricity system with limited dispatchable generation
  - the production of synthetic fuels for hard-to-electrify processes in absence of energy imports

This scenario targets European energy autonomy and therefore, sourcing low carbon energy imports from global markets is not prioritised. This focus discards possible (economic and competitiveness) opportunities in favour of a geopolitical priority to be more self-sufficient.

3.2 GLOBAL AMBITION (GA)

This scenario pictures a pathway to achieving carbon neutrality by 2050, driven by a fast and global move towards the Paris Agreement targets. It translates into development of a very wide range of technologies (many being centralised) and the use of global energy trade as a tool to accelerate decarbonisation.

This scenario takes a global CO_2 avoided cost approach to define the evolution of the energy system. It considers the full scope of available technologies and energy sources to reduce CO_2 emissions at the lowest possible cost. It requires a holistic approach of the energy mix where demand and supply are considered together when defining the most efficient actions.

On the demand side, decarbonisation is achieved through a wide variety of technologies. Modern well insulated buildings are heated with all-electric heat. In cold areas with existing widespread gas distribution infrastructure, hybrid heat pumps offer optimization potential for lowering the need of deep renovation and providing flexibility to the electricity system. Passenger transport is increasingly electrified. In other transport modes, electricity technologies complemented with a wide range of solutions like bio LNG, biomethane and fuel cell electric vehicles (FCEV) form the makeup. Europe benefits from biomass conversion into liquid and gas as well as low carbon energy imports. Industrial sectors strengthen their competitive position through automation and digital production. Substitution of natural gas by hydrogen and biomethane reduces adaptation cost. Activities participating to global trade (aviation, shipping and a wide range of industrial sectors) align on global decarbonisation solutions in order to avoid any loss of competitiveness.

European decarbonisation effort is driven strongly by a high European RES development, complemented by energy imports and low-carbon solutions. This leads to a great variety of energy carriers used like electricity, hydrogen, biomethane and synthetic biofuels. CCS is an option to support decarbonisation of some industrial processes; and to achieve negative emissions where bio/synthetic fuels are used within the next ten years, an international market for hydrogen and biofuels is established, which rapidly expands after 2030. This offers Europe the opportunity to import competitive green hydrogen and derived fuels. This provides gaseous and liquid fuels for hard-to-decarbonise sectors while avoiding the conversion loss of European energy production. The EU aims to secure a diversified portfolio of energy suppliers for methane, hydrogen and liquid fuels, to avoid dependence on a single import source.

From an electricity system perspective, renewable deployment is optimised at European level in order to seek both cost efficiency and build public acceptance. Global efforts see offshore wind as major technology in northern Europe with the formation of North Sea Energy Hubs while centralised solar is leading in the south of Europe. Nuclear power complements the energy mix to a limited extent, largely led by national energy policies. Moreover, the power sector will also benefit from the development of biomethane and hydrogen in the gas mix. Despite the existence of dispatchable generation there is still some need for additional flexibility, to be provided by utility-scale batteries, demand-side management (including hybrid heat pumps) and smart charging of EVs.

There is a progressive evolution of the transition towards a net-zero European energy system. This energy system is characterised by a balanced energy mix of electricity, gas and biofuels sourced by renewable development and diversified imports. Carbon capture and storage provides abatement and negative emissions. A balanced share of energy carriers and split of end user technologies means that the need for conversion of electricity to gas and liquid is limited.

The materialisation of a scenario based on European renewable, that are complemented by low carbon technology use and energy imports, relies on the following key prerequisites:

- The public acceptance and economic competitiveness of nuclear and CCS technologies within Europe;
- The availability of competitive and diversified low carbon energy for European imports by 2050.
- The maturity of technologies (hydrogen fuel cell, batteries, DSR, etc.)

4 STORYLINE DEVELOPMENT METHODOLOGY AND SCENARIO DRIVERS //

This section gives stakeholders more information on the methodologies and guiding factors that shape the deviation scenario storylines. The storylines are a key step to ensure differentiated and consistent scenarios. They aim at contrasted views on future energy demand and supply patterns, to test infrastructure needs within the TYNDP process. ENTSOG and ENTSO-E use a top-down methodology to identify and define contrasting political, societal and technology underlying choices – so called "high-level drivers".

To explain the concept some examples are useful:

1. Electrification is mentioned from time to time as a driver or target per se; however, it often results from higher level choices, led by the adoption of electricity-using technologies (e.g. efficiency of heat pumps). Moreover, the penetration of electric appliances differs within sectors.
2. In transport the use of energy carriers will depend on technology choices that are likely to differ between transport modes (road, rail, aviation and navigation). All in all, technologies and their future market shares are identified as one specific high-level driver as part of the storylines.

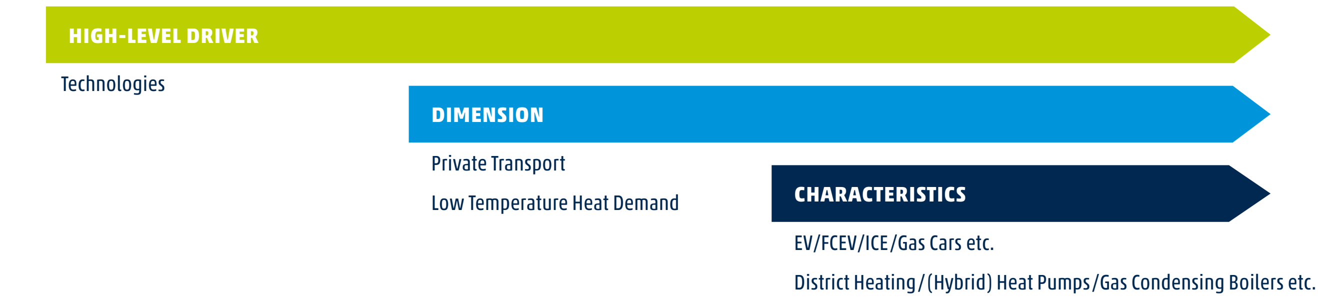

Figure 2: How to specify storyline characteristics (example)

Storylines aim to ensure sufficient differences are made between the scenarios by correctly identifying high-level drivers and quantifying the outcomes. The storylines for the TYNDP 2024 scenarios continuing to use the same high-level drivers of TYNDP 2022 storylines; as illustrated in Figure 3.

Figure 3: High-Level Drivers of top-down scenarios

Green Transition

Green Transition reflects the level of GHG reduction targets and is one of the most important political drivers of energy scenarios. The European Union has ratified the Paris Agreement. This implies a commitment to the long-term goal of keeping the increase in global average temperature to well below 2 °C compared to pre-industrial levels and to pursue efforts to limit the increase to 1.5 °C. Since there are different emission mitigation pathways[5] as described by the Intergovernmental Panel on Climate Change (IPCC), intermediate targets for 2030 and 2050 and a carbon budget up to 2100 have to be defined.

The European climate law, since July 2021, writes into law the objective outlined in the European Green Deal, establishing a legally binding commitment for Europe's economy and society to achieve climate neutrality by 2050. Additionally, the law establishes a milestone target of reducing net greenhouse gas emissions by a minimum of 55% by 2030, relative to the levels recorded in 1990.[6] These overall EU targets should be accompanied by draft NECPs, which each Member State had to submit to the European Commission by 30th of June 2023[7].

The scenarios will consider a carbon budget including emissions and removals from agriculture and from Land Use, Land Use Change and Forestry (LULUCF) to make sure the increase will be limited with 1.5 °C. The scenario building exercise will result in a decarbonisation pathway till 2050 and the ENTSOs will transparently present the cumulative emissions of their scenarios in comparison with the carbon budget assumed for the EU27.

5 IPCC Report, 2019

6 European Climate Law

7 National Energy and Climate Plans

Driving force of the Energy Transition

GREEN TRANSITION	**DRIVING FORCE OF ENERGY TRANSITION**
ENERGY EFFICIENCY	TECHNOLOGIES

Beyond climate targets, the European energy system will be increasingly shaped by societal decisions and initiatives acting as a driving force of the energy transition. Today, the EU imports account for almost 60 % of its primary energy demand, but the import needs differ highly from fuel to fuel and country to country. These large imports entering Europe through a limited number of points together with large scale thermal power generation units have shaped a rather centralised European energy system.

There is rapid decline of the indigenous natural gas production within the EU, amongst others noteworthy factors are the future shut down of the Groningen field and the exit of the United Kingdom from the EU-28. At least in the short to medium term, the EU-27 will need to maintain its current share of import of gas demand. It is worth stating that the uptake of renewables[8] has not led to lower import shares over the past 20 years[9]. At the same time, continued dependence on energy imports is perceived as a risk by some stakeholders due to uncertainties in the geopolitical context. In addition, the need to switch to low carbon or renewable imports triggers the question of their long-term availability. Such availability can be negatively impacted by a slow energy transition of producing countries or a situation of high global demand where Europe would be a price-taker. These stakeholders favour the maximisation of the EU RES potential facilitated by local initiatives and a greater participation of prosumers in the operation of the energy system as described in the Clean Energy Package. Following that path would move the structure of the energy system away from its current centralised structure.

Regarding hydrogen, the ESI and EU Hydrogen Strategy illustrate the duality of the driving forces. The ESI emphasises the benefits of "linking up the different energy carriers and through localised production, self-production and smart use of distributed energy supply. System integration can also contribute to greater consumer empowerment, improved resilience and security of supply". The EU Hydrogen Strategy also foresees "cooperation opportunities with neighbouring countries and regions of the EU" and the establishment of a "global hydrogen market". The strategies of EU Member States present a wide range of perspectives, with some NECPs and National long-term strategies aiming at a strong reduction of energy imports while some hydrogen strategies emphasise the need for global cooperation for a future hydrogen economy. On a global scale, similar trends can be seen in Japan and Korea as importing countries and Morocco, Australia or Norway as possible hydrogen exporting countries.[10]

The level of decentralisation and autonomy can strongly impact the structure of the European energy system and therefore the need of infrastructure. At present there are a range of possible futures reflecting the uncertainties around societal aspiration, global evolution and technological requirement. The purpose of different scenario storylines is to understand the impact from traveling differing paths that lead to a common net-zero future.

8 Share of renewables in gross inland consumption, EC

9 EU Imports and exports in 2020, EC

10 INTERNATIONAL HYDROGEN STRATEGIES, Ludwig Bölkow Systemtechnik and World Energy Council, 2020

Energy Efficiency

GREEN TRANSITION	DRIVING FORCE OF ENERGY TRANSITION
ENERGY EFFICIENCY	TECHNOLOGIES

Energy Efficiency is a result of innovation and consumer behaviour and can be a major factor in the transition of the energy system. New appliances and technological innovations reduce specific energy demand (e.g. heat pumps) or facilitate the participation of consumer in the energy system (e.g. digitalisation and smart metering). On the other, new technologies can lead to additional energy demand (e.g. e-scooters replacing walk or public transport).

Moreover, increasing energy efficiency can also lead to an increased rate of consumption (Jevons Paradox). Heat pumps for example provide reduced energy demand through more efficient heating.

But at the same this technology also provides the option for cooling, increasing energy demand in summer. Finally, consumers can reduce their consumption by modal shifts, for example using the bike instead of the car for shorter distances or by more shared economy through public transport and vehicle sharing. This also applies to agriculture and industrial sectors, where a drive towards circularity could lower energy demand, but an increase economic activity could at least in part offset the efficiency gains. Assumptions need to be made for each sector and energy application.

The following table describes two examples:

SECTOR	RESIDENTIAL	TRANSPORT
SUB-SECTOR	Heating	Passenger Travelling
ISSUE	Heat pumps in new houses	Increasing share of home-office
ISSUE DESCRIPTION	Heat pumps have a higher efficiency, also called coefficient of performance. Moreover, in new houses with a necessary ventilation system, heat pumps can be used for cooling using a reversing valve.	Recent trends show a higher share of home-office (after the Corona pandemic).
QUESTION	Although heat pumps will reduce the annual heat demand in buildings, will they create new electricity demand for cooling (e.g. in northern-European countries)? How will this impact the energy system?	- How will home-office influence commuting and transport demand? - Will this reduce the number of individual cars? - Will ownership still be the main trend, or will car sharing take over? - How will this influence the flexibility by vehicle2grid for the electricity system?

Table 2: Storylines differentiation based on high-level drivers

Technologies

GREEN TRANSITION	DRIVING FORCE OF ENERGY TRANSITION
ENERGY EFFICIENCY	**TECHNOLOGIES**

Technological progress is a driver for the energy system evolution. It can act both as an enabler of other drivers (e.g. more powerful wind turbine helping to further harvest EU RES potential) and as a trigger (e.g. electrolysis paving the way to a low carbon hydrogen economy). Further assumptions are needed to define the market shares for different technologies/appliances. Assumed market shares should reflect maturity and replacement rate of the relevant technologies.

Assumptions need to reflect national policies/strategies and future consumer trends. Moreover, in certain cases it is necessary to make the assumptions that are specific to certain countries, sub-sectors or even individual processes.

Storyline Matrix

ENTSOG and ENTSO-E apply the aforementioned methodology to create a storyline matrix. The storyline matrix provides an overview of each parameter taken into account and reflects the technological or societal behaviour drivers being considered. It illustrates from a qualitative perspective how they differ from one storyline to the next (and not compared to present situation). This storyline matrix is published as Annex-1.

All the parameter choices in the storyline matrix translated into a detailed quantification in the next stage of the scenario building process. This quantification also accounts for European and national policies as well as other studies. The scenario input datasets as a result of this quantification is provided as part of the public consultation published in July 2023.

5 INPUT PARAMETERS //

ENTSO-E and ENTSOG published following input parameters for the public consultation to receive stakeholder feedbacks before finalising them. As explained before, only the datasets for deviation scenarios are part of public consultation and these datasets should be analysed together with their respective storylines. The NT+ datasets are provided for the information where the energy mix gap closing methodology (as an Annex to this Storyline Report) is provided for the public consultation.

- **Draft supply inputs for TYNDP 2024 Deviation Scenarios**
  - Trajectories for Solar, Wind, Nuclear and Battery Capacities
  - Technology Costs
  - Commodity and CO_2 prices
  - Extra EU Import Potentials for Methane
  - Extra EU Import Potentials and Prices for Hydrogen
  - Supply Tool
- **Draft demand inputs for TYNDP 2024 Deviation Scenarios**
  - Full demand scenarios (input and outputs) will be available with the open-source tool for full transparency.
- **Draft Methodology Assumptions**
  - Including the tool chain, modelling principles and five main innovations
- **Draft Carbon Budget Methodology**[11]
- **Electricity and Hydrogen Reference Grid, electricity and hydrogen project candidates for investment with their draft cost assumption**
  - These datasets are provided only for information (except for the methodology for the costs) as the collected datasets are for the next steps of TYNDP for the Identification of System Needs and CBA process. For the scenario purposes the expansion methodology considers the listed candidates by assuming linear relaxation.
- **NT+ demand and supply inputs**
  - Solar, Wind, Nuclear and Battery Capacities (indicated as Best Estimates) and NT+ energy demand mix[11] as collected by the TSOs and provided for information, not part of consultation.
  - Annex-2 'NT+ energy mix Gap closing methodology' for consultation

11 NT+ energy demand mix is aimed to be published a week after the publication of the input parameters (e.g. 11th of July 2023)

6 STAKEHOLDER ENGAGEMENT FOR THE TYNDP 2024 SCENARIOS //

In the development of the TYNDP 2024, the Scenario Building Team set four principle goals for the stakeholder engagement process:

- Stakeholder engagement from Day One
- Input on key parameters
- Consultation on hard data – not just concepts
- Transparent documentation of feedback and interactions

Building on the goals the Scenario Building Team set itself for the 2022 process, the 2024 cycle aims to achieve deeper and more inclusive stakeholder engagement than ever before.

The 2024 cycle began with a kick-off meeting outlining goals and innovations for the TYNDP 2024 Scenarios. The intention of the meeting was to offer stakeholders input and structure from the outset. It also allowed stakeholders their first opportunity to answer questions and provide comment on the proposals of the Scenario Building Team. As the release of the updated TYNDP Storyline Report was moved to July 2023, an additional Process Update Webinar was held in February 2023 in order to provide stakeholders with updates on the scenario development process and outline upcoming milestones. In particular, this event dealt with two major additions to the stakeholder engagement process: The Scenarios External Technical Advisory Group and Stakeholder Roundtables.

The Scenarios External Technical Advisory Group (Scenarios ETAG)

Article 12(3) of Regulation 2022/869 (TEN-E Regulation) of 30 May 2022 specifies that ENTSO-E and ENTSOG 'shall invite the organisations representing all relevant stakeholders [...] to participate in the scenarios development process, in particular on key elements such as assumptions and how they are reflected in the scenarios data. ACER's Framework Guidelines on the joint TYNDP scenarios states that ENTSO-E and ENTSOG should create a stakeholder reference group. It adds that a call for interest should target stakeholders listed in Article 12(3) of the TEN-E Regulation and other relevant organisations and independent experts. The Scenarios ETAG aims at providing timely, expert input to the development of scenarios by ENTSO-E and ENTSOG in accordance with the scenario development timeline. It is not meant to replace other stakeholder engagement methods (including public consultations, stakeholder events and bilateral discussions) but to complement them.

A call for interested candidates was launched on 5 May 2023 with the deadline of 5 June 2023. Stakeholders from the following categories (determined by the ACER's Scenario Framework Guidelines) were invited to apply.

- Associations involved in the electricity market
- Associations involved in the gas (methane and hydrogen) market
- Heating and cooling stakeholders
- Carbon capture and storage and carbon capture and utilisation stakeholders
- Independent aggregators
- Demand-side operators
- Supply-side operators
- Organisations involved in energy efficiency solutions
- Energy consumer associations
- Civil society representatives
- Other organisations
- Independent experts

At the deadline for applications, some categories remained un(der)represented in the Scenarios ETAG and the call was extended for one week to encourage additional applicants. Once established, the Scenarios ETAG will operate separately from the Scenario Building Team, organising its own activities and input to the scenario development process based on the timeline and tasks agreed with the Scenario Building Team and ACER.

Stakeholder Roundtables

The Stakeholder Roundtables concept has been introduced to supplement the written feedback received during the public consultation and the questions and comments received during the Consultation Workshop. It also aims to expand our commitment to both the second and third stakeholder engagement goals: Input on key parameters and consultation on hard data – not just concepts. The intention of the Roundtables is to dive deeper into key assumptions for the development of the Global Ambition and Distributed Energy scenarios. Stakeholders are invited to register for the Roundtables (occurring after the Scenarios Stakeholder Consultation Workshop) where a small selection of topics will be discussed in greater detail. These discussions will then be documented, and a summary will be uploaded to the scenarios' website to ensure full transparency.

The topics for four Roundtables are:

- **Demand -** Country-level final energy demand per sector and per carrier.
- **Methodology -** Modelling innovations on power-to-H2, electric vehicles, heat pumps and offshore together with related assumptions.
- **Supply -** Trajectories of renewable technology capacities, nuclear technology capacities, costs, prices, import potentials, conversion factors and other supply assumptions.
- **Carbon budget**

Transparency

As one of the goals set in 2022, the Scenario Building Team remains dedicated to transparent document of feedback and interactions. To this end, a new TYNDP Scenarios website has been created for the publication of all materials and data related to the TYNDP 2024 Scenario Report. As in previous cycles, interactions with external stakeholders, such as responses to the Stakeholder Consultation and feedback received via the Stakeholder Roundtables, will be clearly documented and published via the website.

7 NEXT STEPS //

In this report ENTSOG and ENTSO-E propose the scenario storylines for TYNDP 2024. This publication is an important foundation for further scenario building and quantification, which spans until the end of this year.

Next steps in the scenario building process are the following:

- ENTSOG and ENTSO-E will finalise the input parameters based on the public consultation and stakeholder round-tables and perform the quantification and modelling needed to build the TYNDP 2024 scenarios. With this modelling the (qualitative) storylines will be translated into fully quantified scenarios. A draft scenario report is expected to be published by the end of 2023 for the public consultation.
- ENTSOG and ENTSO-E will use all consultation feedback to refine and establish the final quantified scenarios to be used in TYNDP 2024. The draft scenario report after public consultation is expected to be published in early 2024 and submitted to the ACER, MS and EC. Within three months of this submission, the ACER will provide its opinion on compliance of the scenarios with the Scenarios Framework Guideline and the EC will approve the scenarios report (or request to amend it) within three months after receiving the ACER opinion. The final scenarios feed into the TYNDP 2024 development process. The scenario datasets are used within the system needs assessment process and the cost-benefit analysis (CBA) for the PCI selection.

	2022			2023				2024			
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
PUBLISHING 2022 SCENARIOS REPORT	■										
2024 KICK-OFF AND STORYLINE REVIEW WORKSHOP		■									
STAKEHOLDER UPDATE WEBINAR				■							
CALL FOR INTEREST FOR SCENARIOS ETAG (Scenarios Reference Group)					■						
RELEASE OF INPUT PARAMETERS; BEGINNING OF FIVE-WEEK CONSULTATION PERIOD						■					
CONSULTATION WORKSHOP & STAKEHOLDER ROUNDTABLES						■					
CREATION OF SCENARIOS ETAG (SCENARIOS REFERENCE GROUP)						■					
RELEASE OF DRAFT SCENARIOS; BEGINNING OF SIX-WEEK CONSULTATION PERIOD							■	■			
CONSULTATION WORKSHOP (two weeks after the consultation start date)							■				
RELEASE OF DRAFT SCENARIOS POST-CONSULTATION								■			
ACER & MS & EC OPINION FOR THE DRAFT SCENARIOS POST-CONSULTATION									■		
EUROPEAN COMMISSION APPROVAL PROCESS										■	
RELEASE OF FINAL SCENARIOS											■

ANNEX 1

Storyline Matrix

	DISTRIBUTED ENERGY Higher European autonomy with renewable and decentralised focus	**NATIONAL TRENDS +** The aggregation of national pathways to reach EU targets	**GLOBAL AMBITION** Global economy with centralised low carbon and RES options
GREEN TRANSITION	Fully in line with the energy efficiency first principle and with the Union's 2030 targets for energy and climate and its 2050 climate neutrality objective		
DRIVING FORCE OF THE ENERGY TRANSITION	Transition initiated at a local/national level (prosumers)	Deviation extent will depend on "National Trends +" setting resulting from national perspectives	Transition initiated at a European/ international level
	Aims for EU energy independence and strategic independence through maximisation of RES and smart sector integration (P2G/P2L/P2M)		High EU RES development supplemented with low carbon energy and diversified Imports
ENERGY EFFICIENCY	Reduced energy demand through circularity and better energy consumption behaviour		Reduced energy demand with priority is given to decarbonisation and diversification of energy supply.
	Digitalisation driven by prosumer and variable RES management		Digitalisation and automation reinforce competitiveness of EU business.
TECHNOLOGIES	Focus of decentralised technologies (PV, batteries, etc.) and smart charging		Focus on large scale technologies (offshore wind, large storage)
	Focus on electric heat pumps and district heating		Focus on a wide range of heating technologies e.g. hybrid heating technology
	Higher share of EV, with e-liquids and biofuels supplementing for heavy transport		Wide range of technologies and energy carriers across mobility sectors (electricity, hydrogen, e-liquids and biofuels)
	Minimal CCS and nuclear		Integration of nuclear and CCS

Green transition

HIGH LEVEL DRIVER	DIMENSION	CHARACTERISTIC	STORYLINE 1 (DE)	STORYLINE 2 (GA)
GREEN TRANSITION	**by 2030**	Fully in line with the energy efficiency first principle and with the Union's 2030 targets	Yes	Yes
	by 2050	Reach carbon neutrality	Yes	Yes
	EU Carbon Budget	Compliant with EU strategies (LTS)	Yes	Yes
	Energy Efficiency	Fully in line with the energy efficiency first principle and with the Union's energy and climate targets	Yes	Yes

Driving Force of the Transition

HIGH LEVEL DRIVER	DIMENSION	CHARACTERISTIC	STORYLINE 1 (DE)	STORYLINE 2 (GA)
DRIVING FORCE OF THE TRANSITION	Initiative	Level of Decentralisation (Prosumer vs. Global)	Higher	Lower
	Global Trade	Benefits from global synergies (efficiencies)	Lower	Higher
	Energy Autonomy	Share of energy autarky	Higher	Lower

Energy efficiency

HIGH LEVEL DRIVER	DIMENSION	CHARACTERISTIC	STORYLINE 1 (DE)	STORYLINE 2 (GA)
ENERGY EFFICIENCY	Residential and Tertiary	Behaviour: surface per person	Lower	Higher
		Behaviour: share of home office	Higher	Lower
		Level of energy efficient consumer behaviour (lower room temperature)	Higher	Lower
		Level of energy efficient consumer behaviour (technology choice)	Higher	Lower
		Level of renovation rate	Higher	Lower
	Transport	Level of public/shared transport (occupation per car)	Higher	Lower
		Number of travelled km per person (including vacation, trade and work)	Lower	Higher
		Share of autonomous vehicles	Similar	Similar
		Share of non-motorised transport	Higher	Lower
	Industry	Growth of industry (on shoring, export)	Lower	Higher
		Raw materials and feedstock (focus on non-energy fuels)	Lower	Higher
		Data centres	Similar	Similar
		Circularity in production (more recycling)	Higher	Lower

Technologies

HIGH LEVEL DRIVER	DIMENSION	CHARACTERISTIC	STORYLINE 1 (DE)	STORYLINE 2 (GA)
TECHNOLOGIES	Low Temperature Heat Demand	District heating (circularity)	Higher	Lower
		Small scale gas boilers (households)	Lower	Higher
		Small scale hybrid heat pumps (households)	Lower	Higher
		Small scale all-electric heat pumps (households)	Higher	Lower
		Small scale CHP incl. fuel cells (households)	Higher	Lower
	Private transport	EV	Higher	Lower
		FCEV	Lower	Higher

HIGH LEVEL DRIVER	DIMENSION	CHARACTERISTIC	STORYLINE 1 (DE)	STORYLINE 2 (GA)
TECHNOLOGIES	**Heavy goods transport**	EV	Higher	Lower
		FCEV	Lower	Higher
		Compressed Methane Cars	Lower	Higher
	Aviation and shipping	Liquids (methane, hydrogen, bio or synthetic fuels)	Lower	Higher
		Electricity	Higher	Lower
	Industry: high temperature heat	Methane	Lower	Higher
		Hydrogen	Lower	Higher
		Electricity	Higher	Lower
	Carbon economy	CCS (all sources)	Lower	Higher
		DAC	Lower	Higher
	Sector coupling	Share of P2X	Higher	Lower
	Electricity supply for direct electricity demand	Solar-PV	Higher	Lower
		Onshore wind	Higher	Lower
		Offshore wind	Lower	Higher
		(New) nuclear	Lower	Higher
		CHP (including fuel cells)	Higher	Lower
		Concentrated Solar Power	Lower	Higher
	Adequacy or Flexibility technologies	Peakers	Similar	Similar
		DSR based on Smart Metering	Higher	Lower
		Flexible power to heat	Higher	Lower
		Batteries (behind the meter)	Higher	Lower
		Large scale electrity storage	Lower	Higher
		Smart charging	Higher	Lower
		P2x	Higher	Lower

ANNEX 2

NT+ Energy Mix Gap Filling Methodology

This document provides a brief description of the proposed methodology to align the energy mix data collected from member TSOs with the European Commission final energy demand reduction targets for 2030/2040, as approved in April 2023.

Important: The following numbers are dummy variables to illustrate the adjustment process. They will be replaced by the final NT+ figures once they are ready.

Let's assume the TSOs have submitted the energy mix data (from hereafter, the NT Energy Mix) covering a pre-defined set of economic sectors and energy carriers, respectively.

Upon analysing the data, Working Group Scenario Building (WGSB) realises that the total final energy demand is, e.g., 1,000 TWh above the energy demand target for a given target year. In consequence, the following methodology will be applied so that the final energy demand surplus is removed from the energy mix and therefore the EU27-wide numbers comply with the European targets.

The proposed methodology develops in four steps:

1. WGSB establishes a ranking of the economic sectors and energy carriers based on their greenhouse gas emission potential and their decarbonisation potential.

Once this ranking is determined, a subset of the sectors/carriers are selected and, among those, the surplus final energy demand would be subtracted. For instance, an example subset of such carriers is depicted below.

ECONOMIC SECTOR	ENERGY CARRIER
DISTRICT HEATING	Solid fossil
INDUSTRY	Solid fossil
RESIDENTIAL + TERTIARY	Solid fossil
AGRICULTURE	Solid fossil
DISTRICT HEATING	Crude oil and products
INDUSTRY	Crude oil and products
RESIDENTIAL + TERTIARY	Crude oil and products
AGRICULTURE	Crude oil and products
TRANSPORT (EXCL. INTERNATIONAL AVIATION AND SHIPPING)	Crude oil and products
INTERNATIONAL AVIATION	Crude oil and products

2. Then, for the subset of sectors/carriers selected for demand reduction, the associated final energy demand (GWh) is computed. Furthermore, the relative shares (%) of these items are also determined.

ECNOMIC SECTOR	ENERGY CARRIER	DEMAND (GWH)	SHARE (%)
DISTRICT HEATING	Solid fossil	27,967	0.9 %
INDUSTRY	Solid fossil	137,153	4.6 %
RESIDENTIAL + TERTIARY	Solid fossil	42,092	1.4 %
AGRICULTURE	Solid fossil	3,391	0.1 %
DISTRICT HEATING	Crude oil and products	435	0.0 %
INDUSTRY	Crude oil and products	186,625	6.3 %
RESIDENTIAL + TERTIARY	Crude oil and products	160,333	5.4 %
AGRICULTURE	Crude oil and products	121,540	4.1 %
TRANSPORT (EXCL. AVIATION AND SHIPPING)	Crude oil and products	1,855,072	62.1 %
INTERNATIONAL AVIATION	Crude oil and products	451,170	15.1 %

3. Once the relative shares of each of these sectors/carrier pairs are determined, the energy demand surplus will be reduced pro-rata, as in the example below.

SECTOR	FUEL	SPLIT (%)	REDUCTION (TWH)
DISTRICT HEATING	Solid fossil	0.9 %	9.8
INDUSTRY	Solid fossil	4.6 %	47.9
RESIDENTIAL + TERTIARY	Solid fossil	1.4 %	14.7
AGRICULTURE	Solid fossil	0.1 %	1.2
DISTRICT HEATING	Crude oil and products	0.0 %	0.2
INDUSTRY	Crude oil and products	6.3 %	65.2
RESIDENTIAL + TERTIARY	Crude oil and products	5.4 %	56.0
AGRICULTURE	Crude oil and products	4.1 %	42.5
TRANSPORT (EXCL. AVIATION AND SHIP)	Crude oil and products	62.1 %	648.0
INTERNATIONAL AVIATION	Crude oil and products	15.1 %	157.6

4. At this stage, one knows, among the sector/carrier pairs considered, the EU27-wide reduction level required, yet not the country-specific one. Therefore, in order to reduce each category from the associated EU27-wide demand, country keys have to be determined. To this end, for each sector/carrier pair, the country distribution is obtained (see table below for the first item in the table above – District Heating/Solid fossil), the country keys are computed as relative shares and the reduction is applied pro-rata. The same approach is then repeated for all other sector/carrier pairs. It should be noted that the methodology does not allow for a complete reduction (to 0 GWh) of a certain sector/carrier pair.

COUNTRY	DISTRICT HEATING/SOLID FOSSIL (GWH)	SPLIT (%)	REDUCTION (GWH)
AUSTRIA	100.00	0.36 %	35.0
BELGIUM	0.00	0.00 %	0.0
BULGARIA	29.08	0.10 %	10.2
CROATIA	0.00	0.00 %	0.0
CYPRUS	0.00	0.00 %	0.0
CZECH REPUBLIC	7,161.19	25.61 %	2,509.4
DENMARK	0.00	0.00 %	0.0
ESTONIA	34.89	0.12 %	12.2
FINLAND	0.00	0.00 %	0.0
FRANCE	0.00	0.00 %	0.0
GERMANY	3,520.00	12.59 %	1,233.5
GREECE	0.00	0.00 %	0.0
HUNGARY	29.08	0.10 %	10.2
IRELAND	0.00	0.00 %	0.0
ITALY	0.00	0.00 %	0.0
LATVIA	0.00	0.00 %	0.0
LITHUANIA	0.00	0.00 %	0.0
LUXEMBOURG	0.00	0.00 %	0.0
MALTA	0.00	0.00 %	0.0
NETHERLANDS	0.00	0.00 %	0.0
POLAND	17,037.95	60.92 %	5,970.4
PORTUGAL	0.00	0.00 %	0.0
ROMANIA	17.45	0.06 %	6.1
SLOVAKIA	11.63	0.04 %	4.1
SLOVENIA	2.00	0.01 %	0.7
SPAIN	0.00	0.00 %	0.0
SWEDEN	23.26	0.08 %	8.2
TOTAL	**27,966.52**	**100.00 %**	**9,800.00**

GLOSSARY

Biomethane: Gaseous renewable energy source derived from agricultural biomass (dedicated crops, by-products and agricultural waste and animal waste), agro-industrial (waste from the food processing chain) and the Organic Fraction Municipal Solid Waste (OFMSW).

Bottom-Up: This approach of the scenario building process collects supply and demand data from Gas and Electricity TSOs.

Carbon budget: This is the amount of carbon dioxide the world can emit while still having a likely chance of limiting average global temperature rise to 1.5°C above pre-industrial levels, an internationally agreed-upon target.

CBA: Cost Benefit Analysis carried out to define to what extent a project is worthwhile from a social perspective.

CCS: Carbon Capture and Storage. Process of sequestrating CO_2 and storing it in such a way that it won't enter the atmosphere.

CHP: Combined heat and power

DE: Distributed Energy

DSR: Demand Side Response. Consumers have an active role in the balancing of energy supply and demand by changing their energy consumption according to the energy price and availability. For example by softening demand peaks in case of congestions, or by increasing energy use during surplus supply.

EC: European Commission.

ECI: Energy System Integration Strategy from the European Commission

EVs: Electric vehicles

ENTSOE: European Network of Transmission Operators for Electricity

ENTSOG: European Network of Transmission Operators for Gas

EU27: 27 members of the European Union

ESI: Energy System Integration

ETAG: External Technical Advisory Group

FCEV: Fuel cell electric vehicle

GA: Global Ambition

GHG: Greenhouse gas.

Hybrid Heat Pump: heating system that combines an electric heat pump with a gas condensing boiler to optimize energy efficiency.

ICE: Internal combustion engine

IEA: World Energy Outlook.

Indirect electricity demand: Indirect electrification means electricity demand for production of other energy carriers like hydrogen or synthetic liquids for replacing the use of fossil fuels. Besides industrial processes and hydrogen electrolysis, this could be e.g. heat pumps and electric boilers for district heat production.

LNG: Liquefied natural gas.

IPCC: Intergovernmental Panel on Climate Change

LTS: Long Term Strategy

LULUCF: Land Use, Land Use Change and Forestry. Sink of CO_2 made possible by the fact that atmospheric CO_2 can accumulate as carbon in vegetation and soils in terrestrial ecosystems.

NECPs: National Energy and Climate Plans are the new framework within which EU Member States have to plan, in an integrated manner, their climate and energy objectives, targets, policies and measures to the European Commission. Countries will have to develop NECPs on a ten-year rolling basis, with an update halfway through the implementation period. The NECPs covering the first period from 2021 to 2030 will have to ensure that the Union's 2030 targets for greenhouse gas emission reductions, renewable energy, energy efficiency and electricity interconnection are met.

NGO: Non-governmental Organization.

NT: National Trends

NT+: A version of the National Trends scenario which has been adapted to meet the latest EU targets

P2G: Power to gas. Technology that uses electricity to produce hydrogen (Power to Hydrogen – P2H2) by splitting water into oxygen and hydrogen (electrolysis). The hydrogen produced can then be combined with CO_2 to obtain synthetic methane (Power to Methane – P2CH4) or can be converted to other energy carriers like for example synthetic ammonia (P2NH3)

P2L: Power to liquids. Combination of hydrogen from electrolysis and Fischer-Tropsch process to obtain synthetic liquid fuels.

P2M: Power to Methane. Creation of methane through the methanation process, where CO_2 is combined with H_2.

P2X: Aggregation of power to gas and power to liquids.

PCI: Project of Common Interest.

Power-to-Hydrogen/P2Hydrogen: Hydrogen obtained from P2H2.

Power-to-Methane/P2Methane: Renewable methane, could be biomethane or synthetic methane produced by renewable energy sources only.

RES: Renewable energy source.

Synthetic fuel: fuel (gas or liquid) that is produces from renewable or low carbon electrical energy.

TEN-E: Trans-European Networks for Energy, EU policy focused on linking the energy infrastructure of EU countries.

Top-Down: The "Top-Down Carbon Budget" scenario building process is an approach that uses the "bottom-up" model information gathered from the Gas and Electricity TSOs. The methodologies are developed in line with the Carbon Budget approach.

TSO: Transmission System Operator.

TYNDP: Ten Year Network Development Plan.

LIST OF FIGURES & TABLES

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ENTSOG
European Network of
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for Gas
Avenue de Cortenbergh 100
1000 Brussels, Belgium
www.entsog.eu

ENTSO-E
European Network of
Transmission System Operators
for Electricity
Rue de Spa, 8
1000 Brussels, Belgium
www.entsoe.eu

Co-authors

Alexander Kättlitz
David Radu
Joan Frezouls
Laura Lopez
Mads Boesen
Nalan Buyuk

Sub-Team leads of the Joint WG Scenario Building
Joint WG Scenario Building
ENTSOG WG Scenarios
ENTSO-E Regional Groups

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