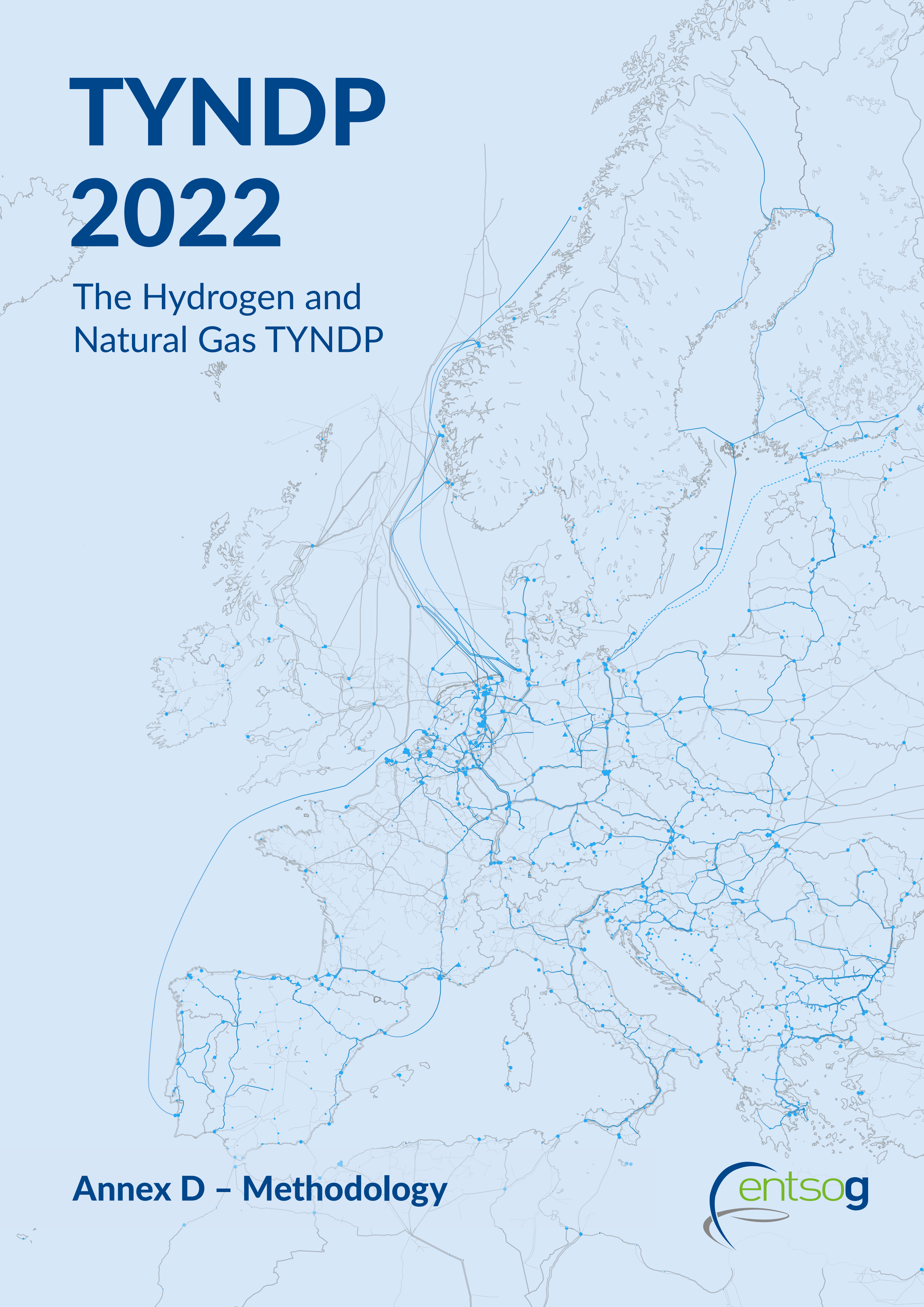

TYNDP 2022

The Hydrogen and Natural Gas TYNDP

Annex D – Methodology

entsog

TABLE OF CONTENTS

GENERAL CONSIDERATIONS ON THE METHODOLOGY

The European gas infrastructure supports the completion of the Internal Energy Market and contributes to the achievement of the European climate and energy policies, where sustainability represents one of the major pillars together with security of supply, competition, and market integration.

The objective of the CBA methodology is to provide guidelines to be **applied for the cost-benefit analysis of projects and more generally of the overall gas infrastructure**. This methodology reflects the specific provisions from the Regulation and aims to ensure their consistent application by all parties involved.

The primary field of application of this CBA methodology is within the TYNDP process and the selection of Projects of Common Interest (PCI).

The TYNDP comprises an assessment of the gas system and gas infrastructure projects and subsequently of an assessment of the impact of gas infrastructure projects.

The ENTSOG 2nd CBA Methodology is based on a multi-criteria analysis, combining a monetised CBA with non-monetised elements to measure the level of completion of the pillars of the EU Energy Policy from an infrastructure perspective.

Picture courtesy of Plinacro

1 ASSESSMENT FRAMEWORK

1.1 SCENARIOS

The assessment framework must be in line with the provision of Annex V of the Regulation 2022/869, which requires that the CBA for projects on the Union list shall be done "in view of the Union's 2030 targets for energy and climate and its 2050 climate neutrality objective and shall comply with the following principles".

In order to evaluate projects impact against the targets set by the European policies while keeping the number of results reasonable, by default the assessment framework is defined for 2025, 2030, 2040 and 2050.

The TYNDP 2022 contains different demand scenarios, out of which the data for the following scenarios is selected as input data for the assessment:

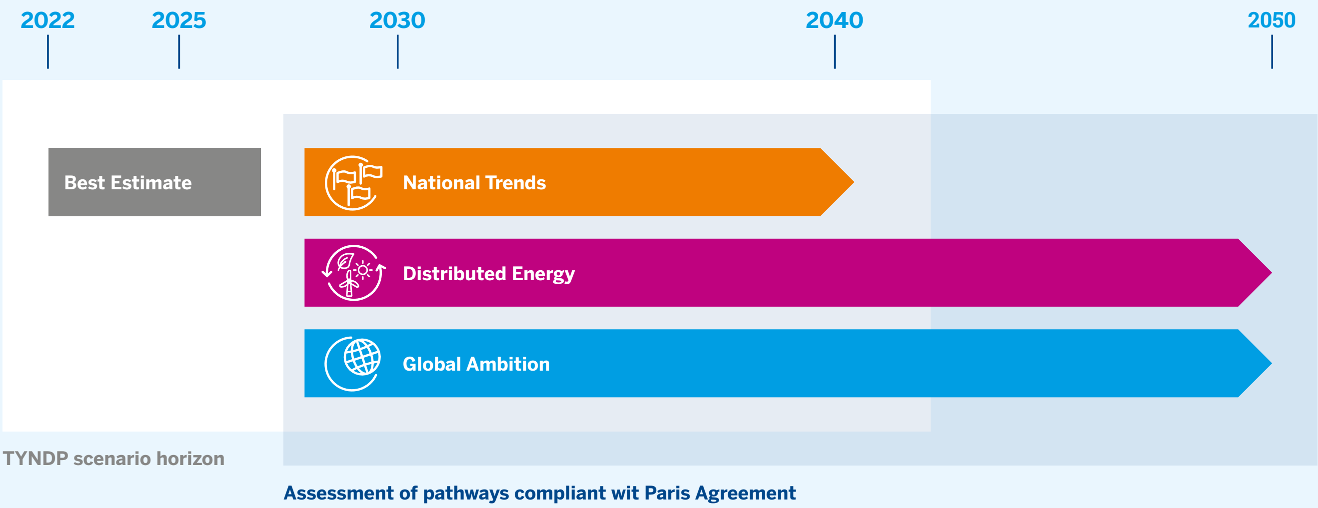

Figure 1: TYNDP 2022 Scenarios

For details see the demand chapter of the TYNDP2022 Scenario report[1].

1 TYNDP 2022 Scenario Report | Version. April 2022 (entsog.eu)

1.2 NETWORK AND MARKET MODELLING ASSUMPTIONS

1.2.1 APPROACH TO MODELLING

ENTSOG has developed a dual gas system modelling approach in the PLEXOS Energy Modelling Software considering hydrogen and methane networks simultaneously. The networks model represents the hydrogen and methane infrastructure within the geographical scope of the TYNDP.

Entry-Exit model

European Union member states and other countries in the European Economic Area are represented in the model. In the following, the term "node" will be used generally to refer to a country or a bottleneck.

The basic block of the topology is the node at which level demand and supply shall be balanced. The nodes are connected through arcs representing the sum of the capacity of all Interconnection Points between these two nodes (after application of the lesser-of-rule).

Arcs defined for the modelling, including the relevant capacities for each infrastructure level of the two networks can be found in Annex C1.

Focus on a Node

The supply and demand balance in a node depends on the flow incoming from another nodes or direct imports from a supply source. Hydrogen and methane may also come from national production, underground storage and LH_2/LNG facilities connected to the node. The sum of all these entering flows must match the demand of the node, plus the need for injection and the exit flows to adjacent nodes.

In case the balance is not possible, a disruption of demand is used as a last resort virtual supply. This approach enables an efficient analysis of the disrupted demand.

Constraints in the model

Hard constraints: constraints that the model has to respect whatever the consequences (even if it leads to the absence of solution).

Some examples of hard constraints are capacities, working gas volumes, the maximum supply potentials, etc.

Soft constraints: parameters that the model will incorporate to find the "best" solution. They are "constraints" because they put some restrictions on what can be the best solution. But they are also "soft" because the model can still use the related quantity, even if it increases the cost of the solution. These soft constraints are price/cost related.

Some examples of soft constraints are cost of curtailment, storage target penalty, CO_2 cost, supply price, infrastructure residual cost, etc.

Objective function

The primary objective of the modelling is to define a feasible flow pattern to balance supply and demand for every node, using the available system capacities defined by the arcs. This optimum differs from national optimums which are potentially not reached through the same flow pattern.

The objective function is defined, for a given simulation, as the sum of all costs in the system. Parameters which values are known before the simulation, are represented in blue. The variables, or values that will be known after the simulation, are represented in purple:

"SUM" represents the sum for all concerned objects and for all periods. Hence there is not one objective function per period, but only one objective function for the full simulation horizon.

OBJECTIVE FUNCTION = *SUM for all supplies (unitary cost of supply × related supply quantity)*

+ SUM for all arcs (unitary residual cost × related flow)

+ unitary CO_2 cost × CO_2 emissions

+ SUM for all countries (unitary curtailment cost × related curtailed quantity)

+ SUM for all storage (unitary target penalty × quantity below target)

Optimisation of the objective function

The "best" solution is found through the mathematical minimization of the objective function under constraints, which is formulated to:

Minimise (objective function) subject to (hard constraints)

There is no closed-form formula that gives the solution. It is found through an optimization program. Most of the times there is no best solution but one best solution among many.

Merit Order

The way to create a merit order is to affect different costs/prices to soft constraints, and hence to weigh differently the quantities in the objective function.

Model has the following costs categories, listed from highest to lowest:

1. **Curtailment** (as the highest cost, to avoid curtailment is prioritised)
2. **Storage target penalty** for Peak and 2 W. In yearly simulation the target is mandatory (or equivalently the target penalty has an infinite cost).
3. **Carbon price:** CO_2 emissions are third in the order. The only intention is to have curtailment cost and storage target penalty above, and residual costs (supply, infrastructure...) below.
4. **Residual incremental costs:**
   - Supply (Import and national production prices)
   - Infrastructure: incremental residual costs
   - SMR costs: residual incremental cost to induce harmonised/cooperative behaviours between SMRs (which is used in a broader sense as Hydrogen production from methane), along the different periods and with blue H_2 imports

1.2.2 NETWORK ASSUMPTIONS FOR HYDROGEN AND METHANE INFRASTRUCTURE

ENTSOG developed the topology of the hydrogen and methane infrastructure to reflect the infrastructure of the European network. The topology refers to both the existing and planned infrastructure. Capacities provided to ENTSOG by network operators and project promoters are requested to be calculated based on hydraulic modelling, taking into consideration repurposing of CH_4 capacities to H_2 using a general estimated coefficient, when not provided by TSOs. All the corresponding capacities are publicly available in Annex C1.

The topology reflects at least the following European infrastructure:

- H_2 Transmission Infrastructure
- LH_2 terminals infrastructure
- H_2 underground storage infrastructure
- SMR representing hydrogen production from methane – not defining that it will be done only by Steam Methane Reforming
- CH_4 Transmission Infrastructure
- LNG terminals infrastructure
- CH_4 underground storage infrastructure
- Connection to production infrastructures
- The hydrogen and methane infrastructure in adjacent countries to the EU when their infrastructures contribute to imports to or exports from Europe.

In the TYNDP 2022 there is one dual gas topology used for the assessment of both hydrogen and methane and the modelled grids (CH_4 and H_2) are connected through SMR (hydrogen production from methane).

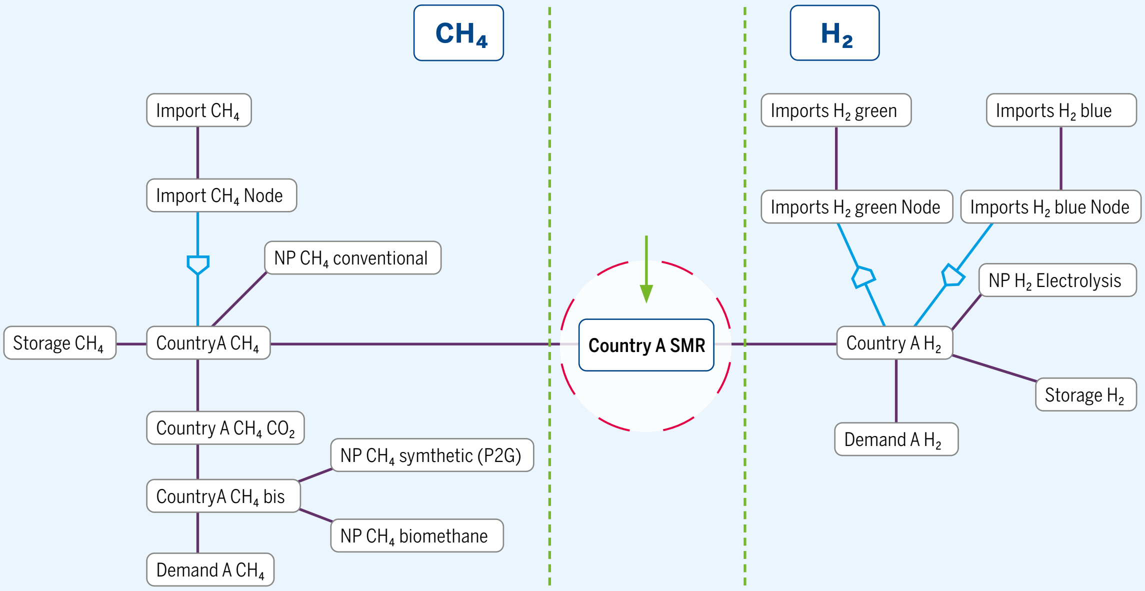

Figure 2: Topologies and SMR

SMR and SMR-gap

The SMR (hydrogen production from methane) capacities are inputs from scenarios included for Global Ambition and Distributed Energy. They are equally used in Hydrogen infrastructure storylines Level 1 and Level 2.

For Hydrogen Level 2 the model also integrates a second layer of SMR called SMR-gap. This layer introduces a new cost, just below the curtailment cost, so it is used as a last resort.

SMR-gap will indicate if additional SMR capacity is needed to satisfy the demand. If the results show that this additional capacity is not used along the yearly simulations, it will not be available for high demand cases (2-week, DF and peak). If the yearly results show that this capacity is needed, the resulting amount will be used as an additional capacity for high demand cases (2-week, DF and peak).

The second layer of the hydrogen production from methane (SMR-gap) is not integrated in the Hydrogen infrastructure storyline Level 1. This means that instead of producing more hydrogen from methane than foreseen in the scenarios, in Hydrogen infrastructure storyline Level 1 a curtailment of hydrogen demand would be displayed.

Infrastructure levels

Proper selection of infrastructure development level is key for the identification of infrastructure gaps and a reliable system and project assessment. In line with CBA Methodology provisions, the following infrastructure levels are considered.

H_2 Level 1

The hydrogen infrastructure level 1 is a project-based infrastructure level composed by all projects submitted to the TYNDP 2022 project collection process and to the first PCI selection process under the revised TEN-E Regulation.

H_2 Level 2

The hydrogen infrastructure Level 2 is a policy based infrastructure level composed by all projects submitted to the TYNDP 2022 project collection process and to the first PCI selection process under the revised TEN-E Regulation with additional infrastructure assumptions defined to meet policy targets. It therefore contains the project-based hydrogen infrastructure level 1 as well as additional infrastructure.

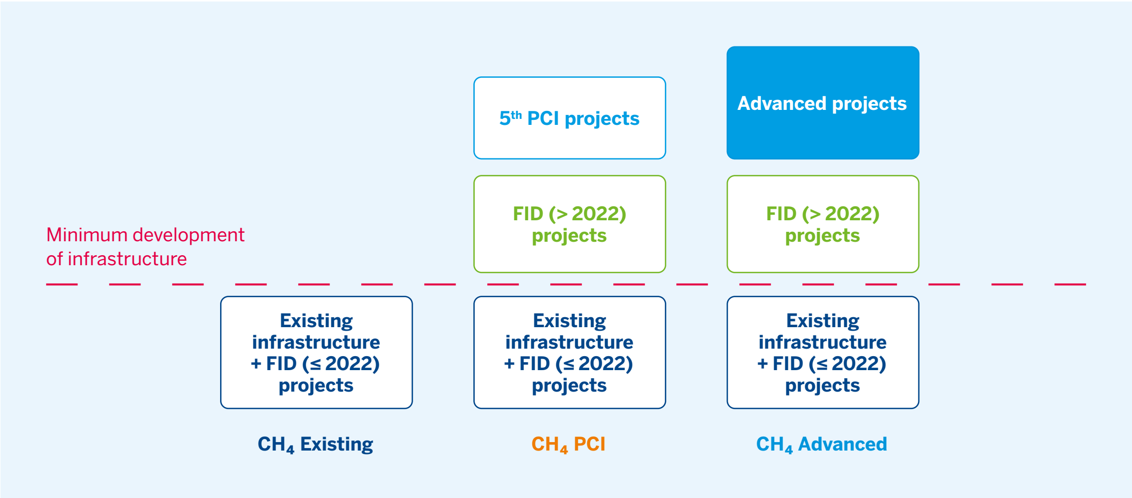

Figure 3: CH_4 Existing infrastructure level, the reference grid

CH_4 Existing infrastructure level, the reference grid

The Existing infrastructure level is formed only of existing infrastructure already in operation on the 1st of January 2023. It allows to assess existing infrastructure in confrontation with different scenarios' assumptions. It allows to build a basis for further investigations of other infrastructure levels exposing infrastructure gaps.

The assessment of the European gas system is complemented by assessing the overall impact of additional infrastructure levels:

PCI

The PCI infrastructure level gathers all the projects from the 5th PCI list, although these projects are of varying maturity. This infrastructure level also includes the existing infrastructure, and all the FID projects, whether PCI or not.

Advanced

The Advanced infrastructure level includes existing infrastructure, all FID projects, and all the projects with an Advanced status[2].

All hydrogen infrastructure levels are crossed with all CH_4 infrastructure levels, as detailed in Figure 4 below.

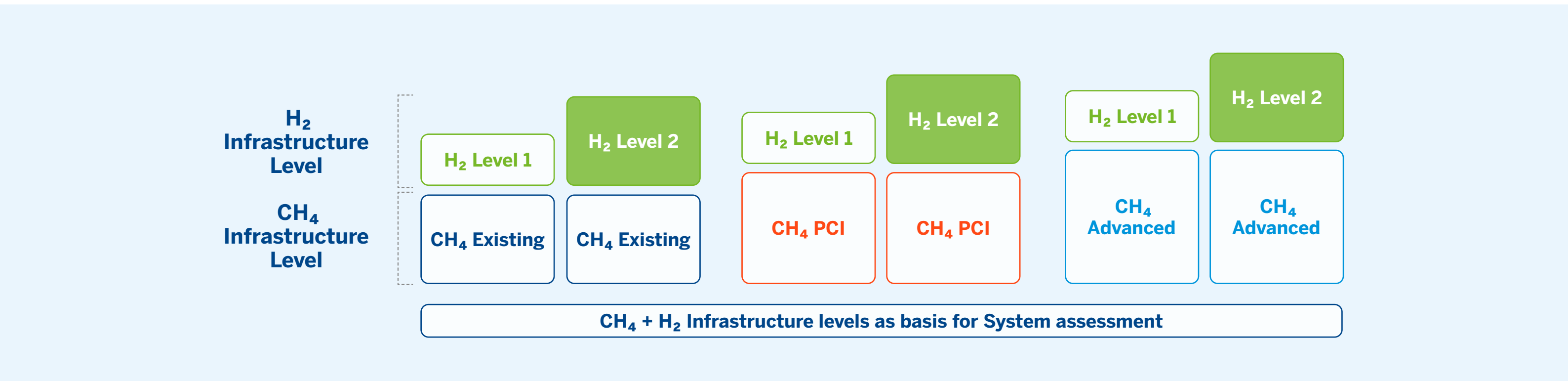

Figure 4: Infrastructure levels

For more details, please refer to the TYNDP 2022 Infrastructure Report.

2 Definition of Advanced maturity status according to TYNDP2022 PID:
– Project commissioning year expected at the latest by 31 December of the year of the TYNDP project data collection + 6 (e. g. 2028 in case of TYNDP 2022, for which projects were collected in 2022) o and
– or whose permitting phase has started ahead of the TYNDP project data collection OR
– FEED has started (or the project has been selected for receiving CEF grants for FEED ahead of the TYNDP project data collection).

1.2.3 SUPPLY DISRUPTIONS (S – 1)

Most of the gas consumed in Europe is imported through pipelines and LNG cargos and it is expected to stay like this in the future for both hydrogen and methane. The disruption of any of the supply sources can have a significant impact on the infrastructure capabilities to satisfy demand.

The assessment focuses on the disruption cases which are expected to show a risk of demand curtailment in the Union-wide simulation:

1. **Russia Methane Supply Disruption**
2. **North Africa Hydrogen Supply Disruption**
3. **Norway Hydrogen Supply Disruption**
4. **Ukraine Hydrogen Supply Disruption**
5. **Liquified Hydrogen Supply Disruption**

For disruption simulations, demand curtailment follows the logic of unified allocation. In **unified allocation**, all member States cooperate by avoiding a demand curtailment to the extent possible by transporting other supply and furthermore by sharing the curtailment equally in such a way that they try to reach the same curtailment rate.

Picture courtesy of Teréga

2 INPUT DATA ITEMS

ENTSOG focuses the simulations on network-related demand and supply depending on the data availability.

2.1 HYDROGEN AND METHANE DEMAND

The total hydrogen and methane demand is comprised of the corresponding final demand (Industrial, Residential & Commercial and Transport) and the respective demand for power generation. The evolution of the total demand and production depends on the scenarios storylines taking into account monthly profiles.

In addition to the demand within the geographical scope of the TYNDP, gas exports to EU neighboring countries are also considered.

For new consumption areas, the demand is not dependent of infrastructure connecting this area to supply.

Details on the hydrogen and methane demand can be found in the TYNDP 2022 Scenario Report and in the System Assessment report.

Monthly profiles

Gas demand in Europe follows a strong seasonal pattern, with higher demand in winter months than in summer months. These variations are largely driven by temperature-related heat demand and, in the future, electrification of the heating sector could add seasonality to the gas demand for power generation. High variations could also be expected in monthly profiles for hydrogen and methane demand for power generation due to greater capacities of solar and onshore and offshore wind production that might not be fully mitigated by hydrogen and methane storage and batteries. For this reason, monthly profiles are applied to final and power demand of both hydrogen and methane.

High case demand situations

2-Week demand is a maximum aggregation of demand reached over 14 consecutive days once every 20 years in each country to capture the influence of a cold spell on supply and especially on storage.

2-week DF demand captures the role of gas-fired power plants being the back-up for variable renewables in a "kalte Dunkelflaute" (German for "cold dark doldrums" describing a 2-week cold spell with very low variable renewable electricity generation).

The **Design Case (DC)** is the maximum level of demand used for the design of the network to capture the maximum transported energy and ensure consistency with national regulatory frameworks. The day of highest consumption in the year (also referred to as peak demand) is a key input that represents one of the most stressful situations to be covered by the infrastructure (transmission, distribution and storage).

As a result of these situations, seasonal variation and high demand cases data is contemplated. In the following table the different cases are represented:

Average Yearly Demand (AY)	AY Final Demand × Monthly profile
	AY Power Demand × Monthly profile
2 Week Cold Spell (2W)	Final 2W Demand
	Power 2W Demand
Dunkelflaute (DF)	Final 2W Demand
	Power Demand Dunkelflaute
Design Case (DC)	Final Peak Demand
	Power Peak Demand

Table 1: Seasonal and high demand case variations

2.2 HYDROGEN AND METHANE PRODUCTION

National production is the supply with the lowest cost, this means it is always the first source used to satisfy demand and, in case of surplus, conventional methane production and hydrogen (from electrolysers and SMR) can be transported to other countries. Biomethane production and synthetic methane production can only be consumed locally.

2.3 SUPPLY

2.3.1 HYDROGEN AND METHANE SUPPLY POTENTIAL

The actual use of supply is a result of the model taking into account the minimum and maximum constraints. For each climatic case and each import supply sources, a range is defined as:

- **Minimum:** The Minimum Supply Potential as defined for TYNDP 2022
- **Maximum:** The Maximum Supply Potential as defined for TYNDP 2022

Pipeline supplies are all treated the same way with residual incremental costs to induce an average use of equivalent routes.

- Maximum for LNG in Peak and 2-week cases:
  - Flexibility from the LNG tanks is used as additional supply for Peak day and 2-week cold spell in both weeks.
  - In the first week, the global LNG flows are limited to the level observed in February from the previous modelling of the whole year.
  - In the second week, additional cargos can arrive allowing supply to reach the daily maximum supply potential of 2-week.
- **No LH_2 tanks** have been considered for additional hydrogen supply.

Supply Price Methodology

Within the modelling tool the supply mix has no impact on the indicators, each supply source has the same residual price curve. On top of that:

LNG has an additional spread (still residual compared to CO_2 price) so that LNG is used after pipelines.

Russia also has an additional spread (still residual compared to CO_2 price). This spread is higher than for LNG so that Russian gas is minimised in all configurations.

The goal is to have Russian gas "minimised" in all circumstances. This will provide the information regarding the minimum amount or Russian gas needed to avoid curtailment and meet storage targets.

Hydrogen supply methodology follows the same logic, with an additional spread for LH_2.

This supply price methodology influences the supply mix but never the indicators related to curtailment or CO_2 emissions. Supply price methodology and carbon price are not related.

2.3.2 HYDROGEN AND METHANE STORAGES

The working gas volume of the storages starts and ends with the same level (30 %) for the whole year (with country-specific exceptions if this level is different). The modelled storage fill rate at the beginning of winter is determined by the whole year simulation.

The working gas level, the withdrawal capacities and the withdrawal curves define the constraints for the storage use during high demand situations. The actual use of storages is a result of the model taking into account these constraints.

2.4 INFRASTRUCTURE

2.4.1 EXISTING INFRASTRUCTURE (CAPACITY, STORAGE VOLUMES)

The existing transmission infrastructure is defined as the firm capacities available on a yearly basis as of 1st January 2023. In addition to the existing transmission infrastructure, the existing LNG and storage infrastructure is considered.

The transmission infrastructure is defined by the technical capacities between countries. For this, the technical capacities at interconnection points between these countries are aggregated after the application of the lesser-of-rule[3].

Two types of capacity were provided by some TSOs for the simulations, firm capacity and enhanced capacity. The enhanced capacity is only applied in the case of S-1 no Russia.

LNG infrastructure is defined by the regasification capacity along the average year and during high demand situations. The LNG tank volumes have operational characteristics specific for each terminal; a flexibility factor defines the share of the tank volume that can be expected to be available during high demand situations. This flexibility has been provided by GIE.

In addition to the working gas volumes and the withdrawal and injection capacities, withdrawal and injection curves for storages are taken into account. These curves define the abilities of storages to withdraw or inject gas depending on the fill level. The curves for the TYNDP 2022 have been provided by GIE.

2.4.2 PROJECT DATA

Project data has been collected directly from promoters in two dedicated project collection phases for TYNDP 2022. For Hydrogen Infrastructure projects Promoters had the chance to update their Data or submit new projects during the 1st PCI Call under the revised TEN-E between October and December 2022.

More information regarding the Project Collection process and periods can be found directly in the TYNDP2022 Infrastructure Report and related list of projects[4].

The following project information are collected from promoters and used in ENTSOG's TYNDP 2022 assessment:

- Transmission capacity increment, as the value of the capacity (in GWh/d) added by the project realisation,
- decrease of capacity submitted as decommissioning project or capacity modification as the value of the capacity (in GWh/d) caused by the project realisation,
- LNG yearly volume, as the expected increment in the maximum yearly volume of a terminal regasification (in bcm/y),
- underground storage working gas volume (in GWh), injection and withdrawal (in GWh/d), as respectively, the capacity increment stemming from project realisation (in GWh/d),

The final capacity value used in the modelling are the results from the application of the "lesser-of-rule".

2.4.3 DATA COLLECTION

Latest TYNDP2022 Project data has been collected from promoters between May 2022 and June 2022.

In addition, for PCI projects, project data has been collected from promoters between October 2022 and December 2022.

3 The lesser-of-rule applied by ENTSOG aggregates available capacities on the two sides of a point to generate consistent capacity for modelling purposes. In case operator A submits an exit capacity with the value of 100 and operator B submits at the same point but in entry a capacity with a value of 50, the lower value of 50 will be considered as final value.

4 Link to Annex A

2.4.4 GENERAL AND TECHNICAL INFORMATION

The general and technical information covers project-specific data like the capacity increment, the expected commissioning date, the FID status, the advanced status and the PCI status according the 5th PCI List[5]. This information was submitted by the project promoters during the project data collection and is used to aggregate the different infrastructure levels based on the individual projects.

Picture courtesy of Moldovatransgaz

5 PCI status is based on the lastest available approved 5th PCI list published in November 2021.
All projects can be found here: Fifth list of energy Projects of Common Interest (PCIs) (europa.eu)

3 INDICATORS

The TEN-E Regulation identifies four main criteria: market integration, security of supply, competition, and sustainability[6]. The European system and projects are assessed to meet these criteria.

Indicators are refined over time as part of the successive TYNDP processes. This represents an opportunity to regularly improve projects' CBA assessments in a timely and efficient manner. Some indicators are used only for the project-specific cost-benefit analysis (PS-CBA) or the system assessment while others are used for both cases.

3.1 INDICATORS USED IN TYNDP FOR SYSTEM ASSESSMENT

In the definition of the indicators, the term capacity corresponds to the technical firm capacity. Curtailment and any results derived from it will be the result of imbalances between supply and demand due to hard constraints like capacities.

The following results are not dependent on any price: Curtailment Rate, S-1, SLID, SLDC.

Once curtailment is reduced to the minimum, and storage targets are met, to choose between several possible flow patterns, the solver will minimise the carbon emissions (quantity).

3.1.1 DEMAND CURTAILMENT AND CURTAILMENT RATE (CR)

To achieve the energy pillar of Security of Supply it is important to identify whether there are countries in Europe that risk to face any demand curtailment (i.e. to be not fully supplied). The analysis should allow to identify where projects provide benefits coming from mitigating possible demand curtailment.

Identification of demand curtailment risk should be performed individually for:

- Normal (climatic) conditions
- Climatic stress conditions (2W, 2W-DF and Peak)
- Supply stress conditions (S-1)
- Infrastructure stress conditions (SLID and SLDC)

Curtailment Rate (CR) is the ratio of demand curtailment by the demand. This indicator is calculated considering full cooperation among all countries.

$$Curtailment\ rate = \frac{Curtailed\ demand}{Demand}$$

Monetisation as Cost of Disruption of Gas (CoDG) to quantify the monetary impact of any avoided demand curtailment could be done in the PS-CBA stage.

6 Art. 4 of Regulation (EU) 347/2013: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0347&from=en

3.1.2 S-1 FOR CH_4 AND H_2

The S-1 indicator aims at identifying dependence to a specific supply source and allows to identify cases where this dependence is related to an infrastructure bottleneck (physical dependence).

The lower the value of S-1, the lower the dependence.

As for the curtailed demand and rate, this indicator has been calculated considering a full cooperative approach, this means all countries fully cooperate with the rest of Europe even when exposed to demand curtailment, and will share the same level of dependence unless an infrastructure-related limitation prevents them to align their dependence.

The supply dependence to source S is calculated as follows (the steps are repeated for each source):

1. **The availability of source S is set down to zero**
2. **The availability of the other sources remains in line with the defined supply assumptions**

The supply source dependence of the country Z to the source S is defined as:

$$S - 1_{Z,S} = \frac{CD_{Z,S}}{Demand_Z}$$

Where:

$CD_{Z,S}$ is the curtailed demand (in GWh) in Z when S is not available

$Demand_Z$ is the demand of Z (in GWh)

3.1.3 SINGLE LARGEST INFRASTRUCTURE DISRUPTION (SLID) FOR CH_4

This indicator intends to investigate the impact of the disruption of the methane **single largest infrastructure of a country** during a Peak day.

The SLID computation can be presented as an indicator or a disruption configuration. Either way, the result is the disrupted quantity (demand curtailment) measured following the disruption of the single largest infrastructure entering a given country (excluding storage and national production).

The SLID is computed in a peak day situation, with the associated supply and national production in this configuration.

This computation allows to identify potential bottlenecks for the considered country and the other European countries.

The simulation of the single largest infrastructure of the different countries looks at the impact of such disruptions at a European level.

The list of CH_4 SLID capacities is published by ENTSOG as Annex D – SLID Values.

3.1.4 SINGLE LARGEST CAPACITY DISRUPTION (SLDC) FOR H_2

This indicator intends to investigate the impact of the disruption of the hydrogen single largest capacity during a Peak day.

The SLCD computation can be presented as an indicator, or a disruption configuration. Either way, the SLCD simulation output is the curtailment rate in the context of the disruption of the SLC of a given country, with the associated cooperative behaviour, all countries fully cooperate with the rest of Europe.

The SLCD is computed on a peak day situation, with the associated supply and national production in this configuration.

The list of H_2 SLDC capacities in published by ENTSOG as Annex D – SLCD Values.

3.1.5 SUSTAINABILITY

New gas projects can contribute to sustainability by enabling the replacement of more pollutant fuels (primarily oil and coal) with gaseous fuels.

Emission savings computation

In the TYNDP 2022, benefits from fuel switching have been measured in terms of:

1. **CO_2 emission in tons,** as an output of the simulations.

An ex-post treatment will be applied to derive the CO_2 cost, based on a CO_2 price.

2. **Other externalities** (i.e. NO_X, SO_2 ...)

Other externalities will be computed ex-post based on CO_2 emissions and/or other inputs/outputs of the model.

Picture courtesy of TAP

LIST OF **FIGURES**

LIST OF **TABLES**

LIST OF **ABBREVIATIONS**

ACER	Agency for the Cooperation of Energy Regulators
BIO	Biomethane Development Projects
CAPEX	Capital expenditure
CBA	Cost-Benefit Analysis
CoDG	Cost of Disruption of Gas
CR	Curtailment Rate
DC	Design Case
DF	Kalte Dunkelflaute (German for "cold dark doldrums")
EC	European Commission
ENTSO-E	European Network of Transmission System Operators for Electricity
ENTSOG	European Network of Transmission System Operators for Gas
EU	European Union
FEED	Front End Engineering Design
FID	Final Investment Decision
GWh	Gigawatt hour
HYD	Hydrogen
IP	Interconnection Point
LNG	Liquefied Natural Gas
mcm	Million cubic meters
MS	Member State
MWh	Megawatt hour
NG	Natural Gas
OTH	Other Infrastructure-Related Projects
P2G	Power-to-Gas
PCI	Project of Common Interest
PID	Practical Implementation Document
PLEXOS	Energy Analytics and Decision Platform
PS-CBA	Project-Specific Cost-Benefit Analysis
RES	Renewable Energy Sources
RET	Projects for Retrofitting Infrastructure to further integrate Hydrogen
SLDC	Single Largest Capacity Disruption
SLID	Single Largest Infrastructure Disruption
SMR	Steam Methane Reforming
SoS	Security of Supply
TEN-E	Trans-European Networks for Energy
TSO	Transmission System Operator
TYNDP	Ten-Year Network Development Plan
UGS	Underground Gas Storage (facility)

COUNTRY CODES (ISO)

AL	Albania
AT	Austria
AZ	Azerbaijan
BA	Bosnia and Herzegovina
BE	Belgium
BG	Bulgaria
BY	Belarus
CH	Switzerland
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
DZ	Algeria
EE	Estonia
ES	Spain
FI	Finland
FR	France
GR	Greece
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
LY	Libya
MA	Morocco
ME	Montenegro
MK	North Macedonia
MT	Malta
NL	Netherlands, the
NO	Norway
PL	Poland
PT	Portugal
RO	Romania
RS	Serbia
RU	Russia
SE	Sweden
SI	Slovenia
SK	Slovakia
TM	Turkmenistan
TN	Tunisia
TR	Turkey
UA	Ukraine
UK	United Kingdom

LEGAL **DISCLAIMER**

The TYNDP was prepared by ENTSOG on the basis of information collected and compiled by ENTSOG from its members and from stakeholders, and on the basis of the methodology developed with the support of the stakeholders via public consultation. The TYNDP contains ENTSOG own assumptions and analysis based upon this information.

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The reader in its capacity as professional individual or entity shall be responsible for seeking to verify the accurate and relevant information needed for its own assessment and decision and shall be responsible for use of the document or any part of it for any purpose other than that for which it is intended.

In particular, the information hereby provided with specific reference to the Projects of Common Interest ("PCIs") is not intended to evaluate individual impact of the PCIs and PCI candidate. For the relevant assessments in terms of value of each PCI the readers should refer to the information channels or qualified sources provided by law.

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