entsog

european network of transmission system operators for gas

TEN-YEAR NETWORK DEVELOPMENT PLAN 2017

TYNDP 2017

ANNEX C

DEMAND AND SUPPLY

C4: DEMAND METHODOLOGY

ENTSOG – A FAIR PARTNER TO ALL!

1 Demand Scenarios Development Process

1.1 BACKGROUND

From January to March 2016, ENTSOG organised five full-day Stakeholder Joint Working Sessions (SJWS) to inform and get feedback from stakeholders on all building blocks of the TYNDP. This included the demand scenario storylines and parameters.

Three demand scenarios (Slow Progression, Blue Transition and Green Revolution) had been specified in order to provide a credible range of future demand, based on reasonable parameters defining the evolution of the gas and energy sectors, as well as general considerations such as macro-economic influences and EU climate targets.

The storylines and parameters developed for the scenarios are provided by ENTSOG to the TSOs together with data questionnaires. Based on their national expertise, TSOs complete the questionnaires that populate the database maintained by ENTSOG. This input data forms a key element of the TYNDP process.

As part of the scenario development process, it appeared a valuable addition to refine the Green Revolution storyline into two variations, taking either a national or European perspective to achieving EU climate targets. At this point, these variations were renamed to Green Evolution and EU Green Revolution.

1.2 SLOW PROGRESSION, BLUE TRANSITION, GREEN EVOLUTION, EU GREEN REVOLUTION

Overall EU demand was expected to range from an increasing to a decreasing trend. Slow Progression was envisaged as having a relatively stable gas demand. This would provide ENTSOG a range of demand levels with which to assess the gas infrastructure and projects.

Upon collection and subsequent validation of the data, the Green Evolution was achieving the EU climate targets and saw a reduction in Final demand. The increase of gas for power generation in this scenario displacing coal-fired generation and supporting RES, plus the effects of strong economic growth across all sectors, lead to a relatively stable Total demand at EU level.

Blue Transition and Green Evolution meet the EU climate targets through increasing and stable gas demand respectively. ENTSOG created a fourth demand scenario called **EU Green Revolution** that featured a decreasing total gas demand level. This ensures an assessment of gas infrastructure against a reasonably wide range of gas demand futures that are compliant with EU targets.

This scenario was defined by many of the same parameters as Green Evolution, but whereas that scenario was a combination of national approaches, EU Green Revolution would take an accelerated European or even global perspective on the energy transition, in light of recent developments such as the Paris Agreement and the latest EU Climate Package.

1.2.1 Slow Progression, Blue Transition, Green Evolution Process

Data collected for the Slow Progression, Blue Transition and Green Evolution followed the standard bottom-up process, with TSOs providing information based on national expertise. TSOs complete the questionnaires that populate the database maintained by ENTSOG. The storylines and parameters developed for the scenarios are provided by ENTSOG to the TSOs, together with data questionnaires and any further supporting information.

Country level assumptions on the demand scenarios are also collected from TSO and provided as part of Annex C1: Country Specifics.

1.2.2 EU Green Revolution Process

Data collected from the TSOs for the Green Evolution scenario was used to derive the EU Green Revolution, by applying consistent elaborations to the collected data. This was a collaborative approach between both ENTSOG and TSOs.

Depending on the country, the impact of the shift in green ambitions could be expected to affect the various demand sectors differently. Depending on national specificities, TSOs could either specify a reduction applied to final demand (comprising of residential & commercial, industrial and transport sectors) or gas demand for power generation, or a combination of both, within a defined range calculated by ENTSOG. Alternatively, TSOs could choose to submit new scenario data or to accelerate the Green Evolution demand progression.

Through this process, the EU Green Revolution was created, achieving both the goal of having a decreasing gas demand scenario within the TYNDP 2017, but also maintaining country level demand specificities. The table below shows which method of demand reduction was applied on a country level basis. The corresponding demand values for this scenario can be found in Annex C2 and C3.

COUNTRY LEVEL DEMAND REDUCTION PROCESS, EU GREEN REVOLUTION

Country	EU Green Revolution Demand reductions observed	Country	EU Green Revolution Demand reductions observed
AT	Final, Power	HU	Final, Power
BA	Final	IE	Final, Power
BE	Final	IT	Final, Power
BG	Final, Power	LT	Final, Power
CH	Final	LU	Final
CY	N/A	LV	Final, Power
CZ	Power	MK	Final, Power
DE	Power	MT	N/A
DK	Final, Power	NL	Final
EE	FInal	PL	Final
ES	Final	PT	Final
FI	Final, Power	RO	Final
FRn	New TSO data submitted	RS	Final
FRs	New TSO data submitted	SE	Final, Power
FRt	Final	SI	Power
GR	Final, Power	SK	Final
HR	Final, Power	UK	Accelerated Green Evolution

Table 1.1: Country level demand reduction process, EU Green Revolution

2 Power Generation Methodology

Gas demand for power generation is an integral part of the TYNDP and the demand scenarios. Due to the growing interdependency of gas and electricity in the increasingly integrated energy system, along with the requirement for ENTSOG and ENTSO-E to develop a consistent and interlinked approach between the scenarios in their respective TYNDPs, the gas demand scenarios require full consideration of developments in the electricity system.

As a result, ENTSOG produced this Power Generation Methodology based on the installed capacities, generation and electricity consumption visions as considered and published by ENTSO-E in the electricity TYNDP 2016.

This methodology was developed by linking scenarios with the ENTSO-E visions that best aligned based on storylines and parameters. It then allows the flexibility to determine gas demand for power generation within the 'Thermal Gap' of coal and gas generation in order to account for specificities within countries or accurately reflect the merit order of the scenarios, which may not have been reflected in the visions.

TSOs were given the option to use the Thermal Gap approach, raw ENTSO-E data or for TSOs to submit their own data, to reflect the fact that ENTSOG was not involved with the development of the scenarios for the electricity TYNDP 2016. Where possible, Gas TSO were encouraged to submit their own data for Peak Day (1-Day Design Case) and 2 Week (14-Day Uniform Risk), as the electricity generation models were simulated using specific climatic years, which may not correspond to the national requirements of the gas network.

Country level assumptions relating to gas for power generation can be found in Annex C1: Country Specifics. Data corresponding to gas for power generation can be found both in Annex C2: Demand and Annex C3: Power Generation Assumptions. More detail can be found about the ENTSO-E TYNDP 2016 Visions in the ENTSO-E Scenario Development Report[1)].

1) https://www.entsoe.eu/Documents/TYNDP%20documents/TYNDP%202016/150521_TYNDP2016_Scenario_Development_Report_for_consultationv2.pdf

2.1 THERMAL GAP

Determining how much gas may be consumed to produce electricity, is the same as asking how much electricity is to be produced from gas and applying an efficiency factor.

How much electricity will be produced from gas will depend on how much electricity will be consumed, and secondly on how this electricity will be produced as result of the functioning of the electricity market.

The production from some electricity sources shows little sensitivity to market conditions. That may be the case for nuclear production coming usually base load, or RES like wind, hydro or solar where the production, having zero to low marginal costs, will only depend on the availability of the driving source.

Other sources, on the contrary, will be present in the generation mix depending on the market conditions. That is the clear case for coal[1)] and gas. Here the balance between emissions price, coal price and gas price will favour the predominance of one source against the other whenever both sources are available. There is a direct market competition between coal-fired and gas-fired power generation.

In order to take that into account, this methodology has been defined in two steps:

- **Definition of the thermal gap:** how much electricity will be required from coal and gas production, once all other sources are removed from the total

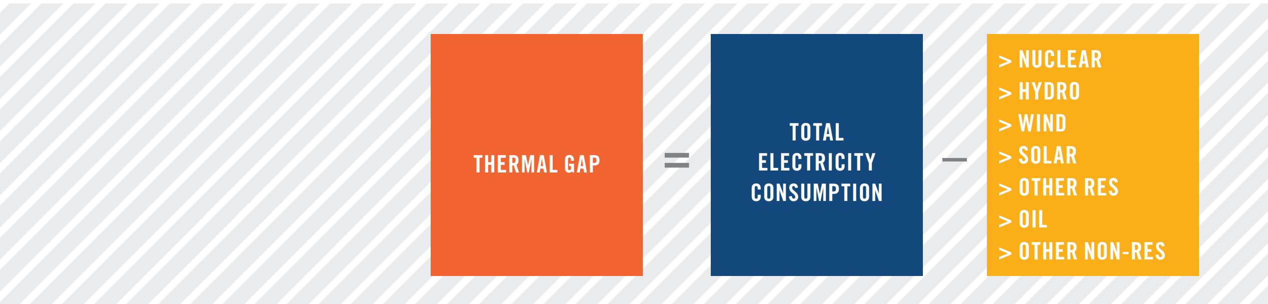

Figure 2.1: Definition of the thermal gap

- **Split of the thermal gap:** between gas and coal under opposite market conditions:

This split will produce two opposed scenarios setting the maximum and minimum of the range: an upper scenario, where gas is favoured against coal and a lower scenario when coal is favoured against gas.

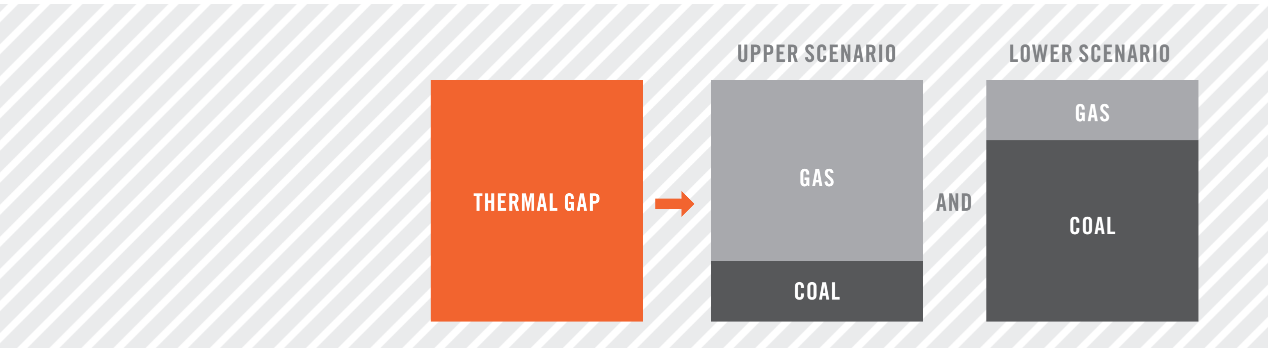

Figure 2.2: Thermal gap approach

1) Coal can be lignite or hard coal.

2.2 DATA AND ASSESSMENT PERIODS

The following section refers to information that can be viewed on a country level basis in Annex C3: Power Generation Assumptions.

Demand Evolution

For the continuity of the assessment which for the ENTSOG scenarios requires data outside of the 2030 scope of the data from the visions, the historic data from the TSOs or ENTSO-E will be connected to the data derived by this methodology.

Interpolation and extrapolation define the values for steps in 2017, 2020, 2025, 2030 and 2035, if TSOs did not provide this progression as part of the data collection.

Assessment Periods

The rationales to model the electricity mix on high demand situations and a yearly basis are essentially the same, but there is a significant difference between the expected figures.

For example, the yearly assessment can be based on average productions from intermittent sources, as in relative terms the variation in the production from these sources comes mostly from the increase of installed capacity while their yearly individual load factors remain stable.

A completely different behaviour is observed in the high demand situation analysis, where sudden changes in the availability of sources such as wind imply very significant changes in the daily load factors.

As a result ENTSOG uses data covering the following periods:

- **Average day:** Yearly average gas demand for power generation, as a daily value.
- **2-week high demand case (2W, 14 day uniform risk):** Gas demand from power generation during a 14 consecutive days once every twenty years in each country to capture the influence of a long cold spell.
- **1-day Design Case (DC, Peak):** Gas demand for power generation during the peak day used for the design of the network in each country to ensure consistency with national regulatory frameworks.

Although data for these high demand situations was generated from the detailed modelling results provided to ENTSOG from ENTSO-E, TSOs were asked to provide data based on their own assumptions where possible. This is due to the fact that the electricity generation models were simulated using specific climatic years, which may not correspond to the national high demand case requirements for the assessment of the gas transmission network.

2.3 DEFINITION OF THE SCENARIOS

Derived from ENTSO-E TYNDP 2016 vision assumptions for yearly future capacities and yearly electricity demand per country.

CAPACITY, GENERATION AND DEMAND COUNTRY LEVEL EXAMPLE

e-MW – NET GENERATION CAPACITY	ENTSO-E HISTORIC 2015	2030 V1	2030 V3	2030 V4
NUCLEAR	9,779	4,552	9,022	9,022
HYDRO	1,086	400	1,116	1,116
HYDRO – PUMP	2,897	4,354	6,616	4,354
OTHERS – RES	60	5,560	8,740	8,740
OTHERS – NON RES	0	4,070	4,290	4,290
GAS	30,752	45,017	38,206	38,206
COAL	23,265	2,897	0	0
OIL	2,123	309	225	225
WIND	9,225	23,320	52,820	59,491
SOLAR	0	8,470	15,860	12,165
BIOFUEL	1,180	0	0	0
IMPORT	0	12,800	12,800	12,800
EXPORT	0	12,800	12,800	12,800

e-GWh – GENERATION	ENTSO-E HISTORIC 2015	2030 V1	2030 V3	2030 V4
NUCLEAR	59,549	31,696	61,539	57,099
HYDRO	3,452	2,504	6,987	6,987
HYDRO – PUMP	2,547	10,938	15,935	14,192
OTHERS – RES	75	27,588	40,428	40,428
OTHERS – NON RES	1,934	10,349	10,915	10,915
GAS	81,695	94,502	73,757	89,642
COAL	80,726	19,366	0	0
OIL	21	0	0	0
WIND	22,520	69,034	164,576	173,263
SOLAR	0	8,329	15,599	11,964
BIOFUEL	103	0	0	0
ANNUAL DEMAND (e-GWh/Y)	311.285	340.297	371.772	383.475
NET IMPORTS (e-GWh/Y)	58.663	65.993	-17.964	-21.015
NET DEMAND (e-GWh/Y)	252.622	274.304	389.736	404.491

Figure 2.3: Capacity, generation and demand country level example (Source: ENTSO-E scenario report data)

2.4 INPUT ASSUMPTIONS

The following assumptions were defined as part of the Power Generation Methodology; they differ depending on which method the TSO followed to produce the data for each scenario.

2.4.1 ENTSO-E Default assumptions

The ENTSO-E Default option represents the information driven directly from the ENTSO-E supplied data (installed capacity, generation and demand).

Gas power plant efficiency is derived using a weighted average approach of the technologies specified in the ENTSO-E data. An efficiency of 50 % was used for the historic data to give context to the Vision data.

2.4.2 Thermal Gap assumptions

The Thermal Gap option represents the information derived from ENTSO-E supplied data (installed capacity, generation and demand), using the thermal gap approach incorporating TSO inputs.

Gas consumption: Conversion form electricity generation from gas

The electricity production from gas is transformed into gas consumption through the application of the average efficiency of the gas-fired power plants.

- Average weighted efficiency from ENTSO-E data could be referenced from the ENTSO-E default data for yearly efficiency.
- Default value is 50%

Share of Gas in 'Others – Non RES'

Within the data received from ENTSO-E, there is a generation source called 'Others – Non RES'. A breakdown by fuel of what constitutes this category is not available; as a result there is an option to move capacity and generation from 'Others – Non RES' to Gas where it is considered applicable by the gas TSO

- Upon entering figures corresponding to the different ENTSO-E scenarios and visions, the corresponding percentage of the values for capacity and generation will be transferred into the gas category and subsequently considered as part of the thermal gap.
- Default value is 0 %

Load Factors – Minimum and Maximum Limits

In order to generate the Upper and Lower (Gas v. Coal) scenarios used by the Thermal Gap approach, minimum and maximum load factors are required for both gas and coal.

As described earlier in the chapter, ENTSO-E data is based on a specific climatic year and therefore the high demand results might not be appropriate. TSOs were encouraged to provide own data for high demand gas for power generation, but thermal gap or ENTSO-E data could be used if required.

- Load factors are used to split the split the thermal gap in the Upper and Lower scenarios across all visions.
- Yearly average default values are 10 % and 75 % for both fuels.
- 2 Week default values are 10 % and 85 % for both fuels.
- Peak day default values are 10 % and 95 % for both fuels.

2.4.3 Own Data assumptions

Application of the Thermal Gap approach was the default selection of the Power Generation Methodology, in order to both achieve consistency with the ENTSO-E TYNDP 2016 Vision data whilst still reflecting the assumptions of the ENTSOG scenarios.

However, TSOs could submit their own data, to reflect the fact that ENTSOG was not involved with the development of the scenarios for the electricity TYNDP 2016. Assumptions were provided by gas TSO and used as an early basis for feedback to ENTSO-E for future collaboration.

As discussed earlier in this methodology, TSOs were encouraged to provide own data for high demand cases, but thermal gap or ENTSO-E data could be used if TSOs couldn't provide their own data.

Data provided by TSO was subject to validation against potential generation from ENTSO-E capacities and the thermal gap approach to ensure consistency in the alignment of the scenarios and visions.

Image courtesy of Elering

3 Seasonal Injection Factor

In order to capture the seasonality of the gas market in the over-the-whole-year simulation, different levels of gas demand are considered as follows:

- **Average Summer day:** Summer is defined in TYNDP 2017 as the 7 month storage injection period (April to October, 214 days). Average summer demand is calculated using a factor per country applied to the yearly average demand.
- **Average Winter day:** Winter is defined in TYNDP 2017 as the 5 month storage withdrawal period (November to March, 151 days). Average winter demand is calculated using a factor per country applied to the yearly average demand.

This replaces average summer conditions and average winter conditions from TYNDP 2015 to represent a higher alignment with the reality observed, where October is typically still a month for storage injection. Data has been collected to calculate the demand within these two periods from the yearly average.

Yearly demand

=

365 × Yearly average demand

=

214 × Storage injection period average demand +
151 × Storage withdrawal period average demand

Figure 3.1: SIF/SWF Calculation

TSO experts were asked to provide these values as part of the data collection. The figures used in TYNDP 2017 can be found in Annex C2: Demand.

List of Annexes

All Annexes are available as PDF or Excel-file on
www.entsog.eu/publications/tyndp

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