Energy System Wide Cost-Benefit Analysis Methodology

Executive Summary

ENTSOG has developed the present methodology under Regulation (EC) 347/2013 (the Regulation) supporting the selection of Projects of Common Interest (PCIs) and further steps of the process. The concept of the CBA methodology developed by ENTSOG is driven by the following considerations:

- A scenario-based approach accompanied by sensitivity analysis to reflect the uncertainty on a time horizon, longer than twenty years
- A system wide assessment to capture the direct and indirect benefits of a project in a meshed network on the European social welfare
- A pragmatic approach considering the timeframe of the PCIs process and the availability of input data
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Therefore the Energy System-Wide CBA methodology is structured in two steps:

- The TYNDP-Step to be applied by ENTSOG, builds a bridge between consecutive PCI selections through the assessment of the latest PCI list. It also serves as the basic assessment supporting the PS-Step
- The PS-Step to be applied by project promoters enables the assessment of the individual impact of their project, based on the common dataset provided by the TYNDP-Step

Considering the technical complexity of the modelling approach and the short time available to promoters to run the PS-Step, ENTSOG will provide the necessary modelling results to each promoter as an interim process for the second selection of PCIs.
This methodology is composed of a set of input data covering a 21-year time horizon, to be used in a combined qualitative, quantitative and monetary analysis. It also describes the network and market modelling approach supporting the analyses.
Considering the inherent uncertainty of the gas market resulting in very different situations occurring along the lifetime of infrastructures, the methodology does not provide a direct ranking[1] of projects. The results provide decision-makers with a comparable analysis of the net benefits of each project under various assumptions, to inform the PCIs selection.

[1] According to Art.4 para 4 of the Regulation, Each Group shall determine its assessment method on the basis of the aggregated contribution to the criteria referred to in paragraph 2; this assessment shall lead to a ranking of projects for internal use of the Group. Neither the regional nor the Union list shall contain any ranking, nor shall the ranking be used for any subsequent purpose except as described in Annex III para 2 (14)

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1. Introduction

This document describes the Energy System Wide Cost Benefits Analysis (ESW-CBA) Methodology developed by ENTSOG under the Regulation. The present methodology is based on the experience of TYNDP, the feedback received on this report and the opinions received on the initial methodology published by ENTSOG in November 2013. The latest feedback is composed of the formal opinion from the ACER, European Commission, Member States and stakeholders, received in 2014.

Stakeholders and institutions have brought an overall support to the document published in November 2013, even if they expected more clarity on the structure of the methodology and illustration through case-studies. The adaptation process and the resulting methodology aim at answering these expectations.

This integrated ESW-CBA methodology is composed of two steps:

- The **TYNDP–Step**, providing an overall assessment of European gas system under different level of development of infrastructures
- The Project-Specific Step **(PS-Step)**, providing an individual assessment of each project impact on the European gas system based on a common dataset defined through the TYNDP-Step and project specific data

The first step is to be applied by ENTSOG and will constitute the major part of next TYNDP edition. It will serve as a basis for the second step (PS-Step) under project promoter responsibility. Both steps are fully consistent through the use of a single dataset, the same modelling tool, identical indicators and the same approach to monetization. The two steps will be repeated every second year following the TYNDP Report cycle.

2. General considerations on the ESW-CBA Methodology

2.1. The structure of the ESW-CBA Methodology

The ESW-CBA is based on a combined methodology supported by a model of the gas network and market. It is run on a wide range of cases in order to capture the uncertainty of the evolution of the gas market on a 21-year time horizon. This methodology is designed to measure for each PCI candidate the degree of fulfilment of the General and Specific Criteria set by the Regulation.

The combined methodology is structured along a quantitative analysis, based on a set of indicators, a monetary analysis, based on the evaluation of the cost for gas, coal and CO_2 emissions, and a qualitative analysis covering the analysis of previous steps of the methodology and the description of additional benefits.

The modelling approach follows the market structure defined by the Third Energy Package of adjacent entry-exit zones. Flows between zones are shaped by the input data (demand, supply, cost information) and an objective function. Resulting feeds into the calculation of modelled-based indicators and the monetary analysis.
The cost of gas, coal and CO_2 emissions resulting from modelling, together with financial project-specific data (CAPEX, OPEX, depreciation period) enable promoters to compute the Economic Performance Indicators (EPIs) of their projects.

For efficiency reasons in the implementation of the methodology and the respect of confidentiality of project costs the ESW-CBA methodology in structured in two steps:

1) The TYNDP-Step to be applied by ENTSOG in TYNDP report and assessing different levels of development infrastructure
2) The PS-Step to be applied by promoters for the assessment of their own projects and based on the output of the TYNDP-Step

In that process the primary role of the TYNDP-Step is to gather all data necessary for the implementation of the whole ESW-CBA and especially project-specific data resulting from the call for candidates launched ahead of each TYNDP. The financial project-specific data (CAPEX, OPEX and depreciation period) are the only data items not collected as part of TYNDP.

On top of this inventory of input data, the TYNDP-Step provides assessment results that will be factored in the PS-Step for the calculation of the incremental impact of each PCI candidate. These results will be part of the Annexes of TYNDP report in order to ensure their availability to promoters of PCI candidate projects. The TYNDP report will also include a methodology chapter further detailing the implementation process of the TYNDP-Step and the sources of each input data.

The whole process of the ESW-CBA and the articulation between the TYNDP- and PS-Step of the methodology are illustrated in Figure 1:

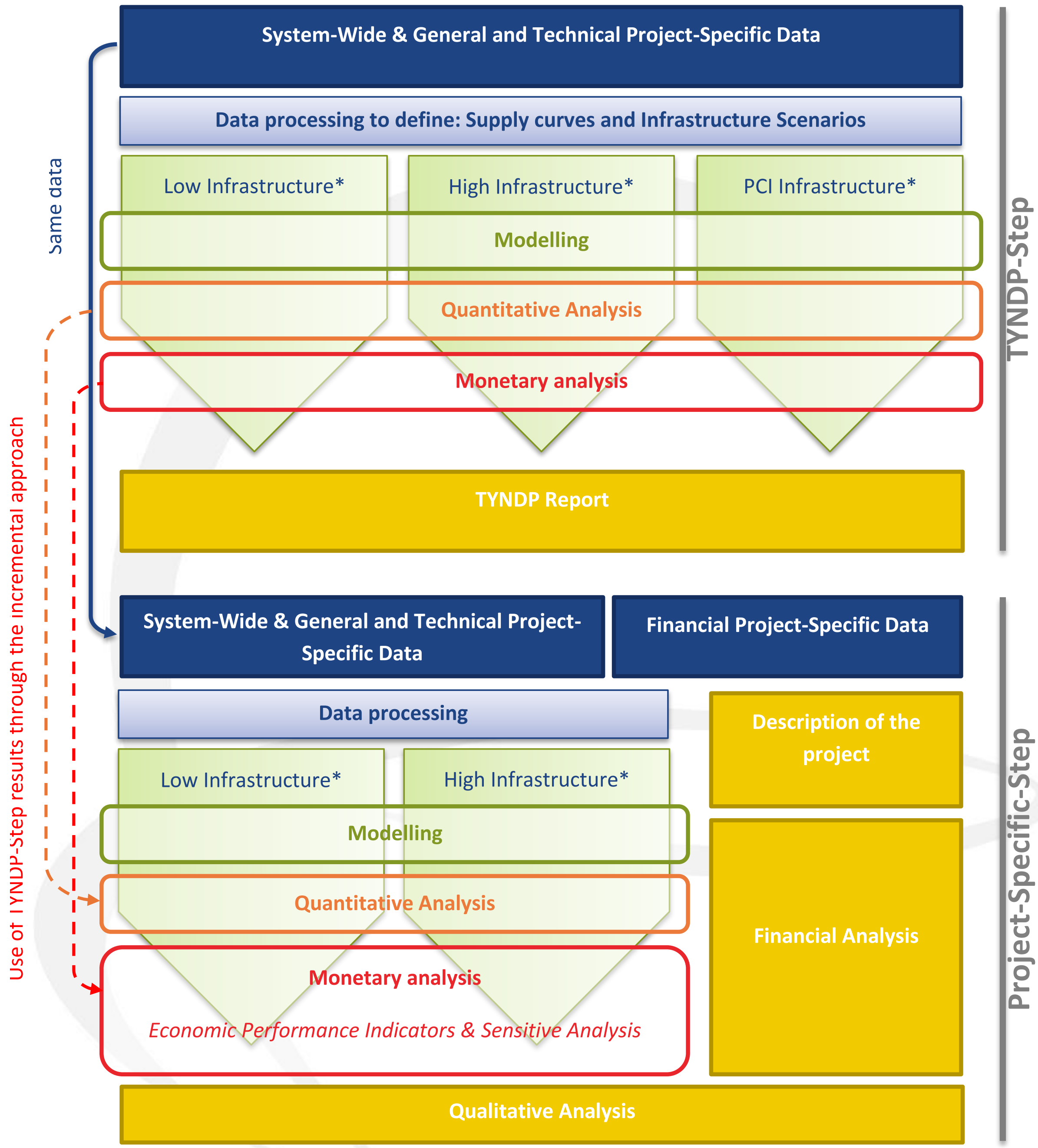

Figure 1 - Overall ESW-CBA process

(*) Level of development of infrastructures as defined under chapter 3.6.2

2.2. Instances of application

According to the Regulation, the obligation to carry out a PS-Step only applies projects having reached sufficient maturity[2] according to each Promoter indication as part of the Call for PCI Candidates. In addition to this maturity constraint, the completion of the PS-Step requires the availability of reliable project-specific data (capacity increment, date of commissioning, FID Status, PCI status, CAPEX, OPEX, Financial Discount Rate and amortisation period).

A Promoter of a mature project shall provide the results of the PS Step in the following instances:

- When submitting the application for selection as a PCI to the Regional Groups, even if the project has already been labelled as PCI in the previous selection round[3]
- When submitting the investment request including the cross-border cost allocation request[4]
- When requesting European financial assistance for works[5]

The Figure 2 illustrates the different instances of ESW-CBA drafting and utilisation:

[2] Annex III para 2 of the Regulation "for projects having reached a **sufficient degree of maturity**, a project-specific cost-benefit analysis in accordance with Articles 21 and 22 based on the methodologies developed by the ENTSO for electricity or the ENTSO for gas pursuant to Article 11"

[3] As above footnote

[4] Art. 12 para 3(a) of the Regulation "a project-specific cost-benefit analysis consistent with the methodology drawn up pursuant to Art. 11 of the Regulation and taking into account benefits beyond the borders of the Member State concerned"

[5] Art. 14 para 2(a) of the Regulation "the project specific cost-benefit analysis pursuant to Article 12(3)(a) provides evidence concerning the existence of significant positive externalities, such as security of supply, solidarity or innovation"

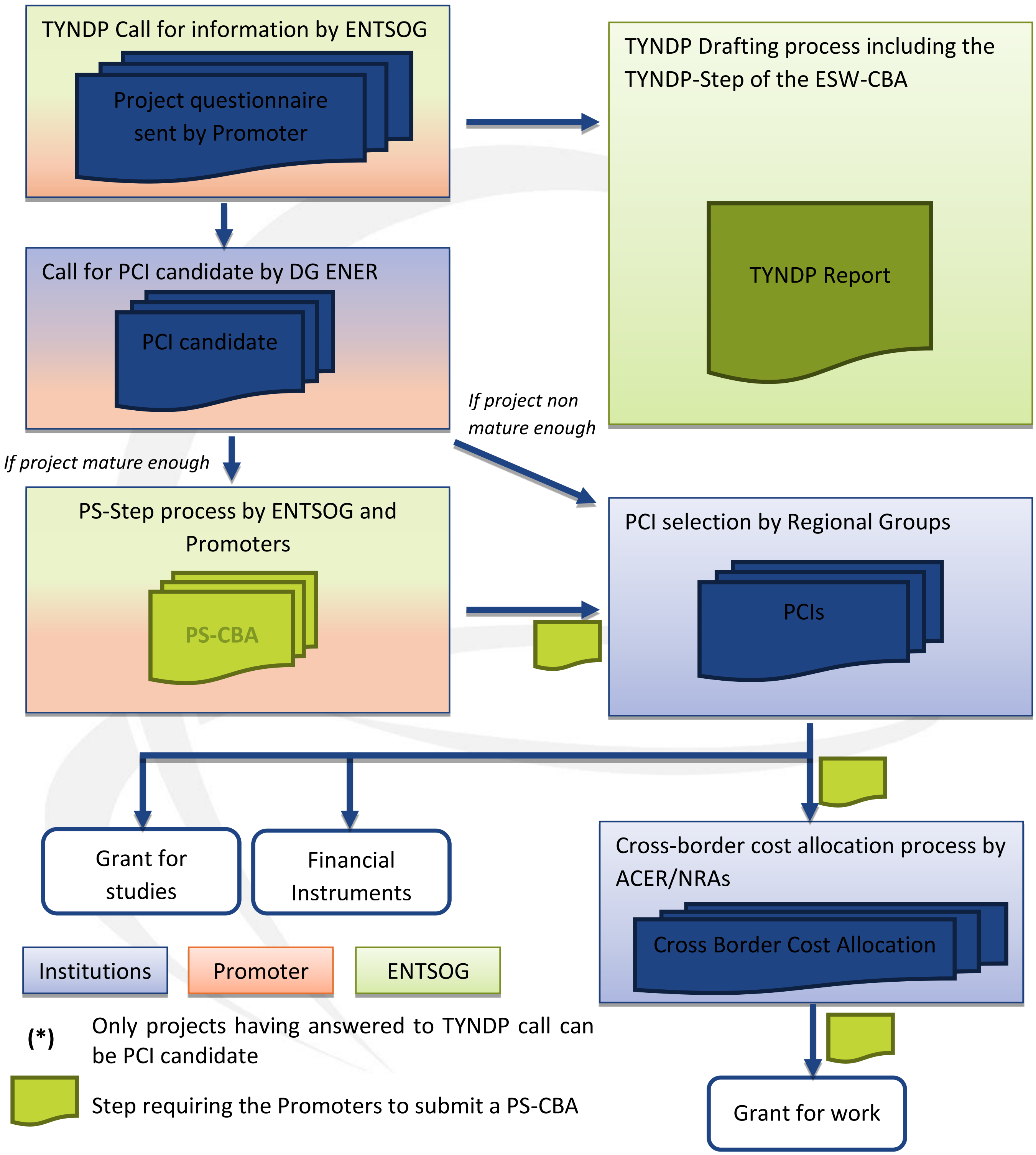

Figure 2 - Instances of ESW-CBA drafting and application

2.3. General Criteria

The Regulation[6] stipulates that each PCI candidate shall meet **each** of the 3 following criteria:

1. the project is necessary for at least one of the energy infrastructure priority corridors and areas;
2. the potential overall benefits of the project, assessed according to the respective specific criteria outweigh its costs, including in the longer term; and
3. the project meets any of the following criteria:
   a) involves at least two Member States by directly crossing the border of two or more Member States;
   b) is located on the territory of one Member State and has a significant cross-border impact[7] as set out in Annex IV.1 of the Regulation;
   c) crosses the border of at least one Member State and a European Economic Area country.

2.4. Specific Criteria

In addition to the above General Criteria, the Regulation[8] stipulates that each PCI candidate shall meet **at least one** of the following criteria:

1. **market integration**, inter alia through lifting the isolation of at least one Member State and reducing energy infrastructure bottlenecks; interoperability and system flexibility;
2. **security of supply**, inter alia through appropriate connections and diversification of supply sources, supplying counterparts and routes;
3. **competition**, inter alia through diversification of supply sources, supplying counterparts and routes;
4. **sustainability**, inter alia through reducing emissions, supporting intermittent renewable generation and enhancing deployment of renewable gas.

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[6] Art. 4 para 1 of the Regulation

[7] (c) for gas transmission, the project concerns investment in reverse flow capacities or changes the capability to transmit gas across the borders of the Member States concerned by at least 10 % compared to the situation prior to the commissioning of the project;
(d) for gas storage or liquefied/compressed natural gas, the project aims at supplying directly or indirectly at least two Member States or at fulfilling the infrastructure standard (N-1 rule) at regional level in accordance with Article 6(3) of Regulation (EU) No 994/2010 of the European Parliament and of the Council

[8] Art. 4 para 2 of the Regulation

3. Common Input data for the ESW-CBA

This chapter identifies the data to be used in the TYNDP- and PS-Steps. Considering the high dependence of the benefit of infrastructure projects on the long term development of the gas market, the data set considers several scenarios for the relevant data series. This data set results from a market consultation process as most of the data included are beyond ENTSOG/TSO remit.

3.1. Time Horizon for the input data

The set of input data being part of the ESW-CBA methodology covers a 21-year time horizon starting from the year of analysis (*n*) up to (*n+20)*.

3.2. List of input data

The following table identifies every data item to be used as part of the implementation of the TYNDP and PS-Step of the ESW-CBA methodology. They are structured in two categories:

> System-wide data: related to existing infrastructures, gas demand and supply, power generation and coal.

> Project-specific data: related to each project as provided by its promoter and including:

- General and technical data: as part of the call for infrastructure projects launched by ENTSOG ahead of each TYNDP report
- Financial data: used by the promoter in the last stage of the PS-Step (including CAPEX, OPEX, Financial Discount Rate and Amortization period)

This Financial Project-Specific data consists of Commercially Sensitive Data that cannot be collected and used in the TYNDP-Step as they would then be publicly released as part of TYNDP report.

The Table 1 identifies each input data of the ESW-CBA methodology to be defined on years n, n+5, n+10, n+15 and n+20:

Category	Type	Data item	Level of definition
System-wide data	Gas demand for power residential, commercial and industrial	Yearly	Zone
		Average Summer Day	
		Average Winter Day	
		14-day Uniform Risk	
		1-day Design Case	
	Thermal gap	Average Summer Day	Country

		Average Winter Day	
		14-day Uniform Risk	
		1-day Design Case	
	Global Context	Yearly average import price of gas	Europe
		Yearly average price of coal	
		Yearly average price of oil	
		Yearly average price of CO_2 emission	
	Supply potential from import sources	Maximum historical deliverability on one day	Source
		Maximum historical deliverability on 14 days	
		Minimum	
		Intermediate	
		Maximum	
	Existing Infrastructures (capacity)	Transmission	Zone
		UGS	
		LNG Terminal	
	CO_2 emission factor of primary fuels	Gas	Europe
		Coal	
		Oil	
	Efficiency of power plant	From gas	Country
		From coal	
		From oil	
	Range of use for fuel in power generation	For gas	Country
		For coal	
	Other	Social Discount Rate	Europe
Project-specific data	General and technical	Capacity increment	Project
		Expected commissioning date	
		FID status	
		PCI status according latest selection	
	Financial	CAPEX per country	Project
		OPEX	
		Financial Discount Rate	
		Depreciation period	

Table 1 - List of input data

3.3. Scenarios for Global Context

Certain input data are dependent from each other and at the same time they are beyond the direct control of Europe. That has been defined as global context and applies to:

- Yearly average price of imported gas
- Yearly average price of coal and oil
- Yearly average price of CO_2 emission quotas

These above prices have a direct influence over:

- The balance between the use of gas and coal in power generation
- The monetization of project benefits

Two different settings of the global context have been defined for the ESW-CBA in order to cover opposite coal versus gas balance in power generation:

- Green: the price scenarios correspond to the "Gone Green" projection in the UK Future Energy Scenarios[9] document which is consistent with:
  - a high price of CO_2 emissions due to the introduction of a carbon tax
  - a continuous reduction in the oil-price linkage mitigating the increase of gas price
- Grey: the price scenarios correspond to the Current Policies Scenario from the IEA WEO 2013[10] which is consistent with:
  - lower price of CO_2 emissions as no new environmental political commitments are taken
  - high energy prices following higher energy demand in absence of new efficiency policies but with prices still too low to trigger the development of renewables

3.4. Demand scenarios and climatic cases

3.4.1. Demand scenarios

The level of demand in each Member State is the main driver of gas market development and flow patterns between balancing zones. The uncertainty about the gas demand evolution is captured through two demand scenarios for residential, commercial and industrial sectors. The two scenarios are defined for opposite general circumstances and macro-economic parameters:

- Scenario A covers favourable economic and financial conditions, with higher CO_2 emission prices and lower energy prices than in Scenario B. This results in higher electricity demand and lower carbon heating solutions than in scenario B
- Scenario B covers non-favourable economic and financial conditions, with lower CO_2 emission prices and higher energy prices than in Scenario A. This results in a lower electricity demand and higher carbon heating solutions than in scenario A.

[9] nationalgrid – July 2014
[10] International Energy Agency – World Energy Outlook 2013

The inclusion of the price data for gas, coal and CO_2 emissions in the modelling approach enables the calculation of the gas demand for power-generation as the main source of short term price elasticity. The associated input data for the modelling are defined by ENTSOG's elaboration on the basis of the installed capacities and electricity consumption in ENTSO-E visions 1 (Slow progress) and 3 (Green transition) from ENTSO-E TYNDP 2014, and includes the country detail of:

> The thermal gap (part of electricity demand to be covered by gas- and coal power generation)
> The power generation capacities from gas and coal
> The ranges of use and the average efficiencies of the above capacities.

In order to strike the right balance between the number of cases and the robustness of the assessment, the Table 2 defines two combinations of Gas Demand scenario, Global Context and ENTSO-E Visions are considered in the ESW-CBA:

Combination	Global Context	Gas Demand	ENTSO-E Vision
1	Green	A	Green transition
2	Grey	B	Slow progress

Table 2 - Combination of Gas Demand, Global Context and ENTSO-E Visions

The main features of selected ENTSO-E visions are defined in Table 3:

	Vision 1 (Slow progress)	Vision 3 (Green transition)
Economic and financial conditions	Poor	Favourable
Energy policies and R&D plans	National focus	
Nuclear decision	National decision	
CO_2 prices	Low	High
Primary energy prices	High	Low
Electricity demand	Low	High
Demand-response	As today	Potential partially used
Electricity plug-in vehicles	No commercial breakthrough	Commercial breakthrough with flexible charging
Heat-pumps	Not even spread across Europe	Not even spread across Europe
Level of back-up generation	Low	High
CCS	Not commercially implemented	
Storage	As planned today	Decentralised and in limited amount
Smart grid solutions	Partially implemented	

Table 3 - Main features of ENTSO-E Visions

3.4.2. Climatic cases

In order to capture the seasonality of the gas market different levels of gas demand and thermal gaps are considered along the year. These climatic cases and the associated levels of demand are defined as following:

> **Average Summer day**: Total demand of an average summer divided by 183 as a proxy for the season

> **Average Winter day**: Total demand of an average winter divided by 182 as a proxy for the season

> **14-day Uniform Risk (14-UR)**: aggregation of the level of demand reached on 14 consecutive days once every twenty years in each country to capture the influence of a long cold spell on supply and especially storages

> **1-day Design Case (1-DC):** aggregation of the level of demand used for the design of the network in each country to capture maximum transported energy and ensure consistency with national regulatory frameworks.

3.5. Supply, from scenarios to curves

3.5.1. Supply scenarios

For a given level of demand, the use of gas infrastructures will depend on the share of each supply source and the import routes selected by the network users. In that respect the availability of each supply source is an important element. At the same time Europe is an importing market in a global environment which introduces a significant uncertainty on the supply side. The Table 4 provides the definition of three Supply Potential scenarios per source:

Source	Minimum	Intermediate	Maximum
National Production Conventional	TSO best estimate		
National Production Shale gas	Shale gas is not developed in Europe	TSO best estimate	The “some shale“ scenario from Poyry*
National Production Biogas	20% Green Gas Grid scenario	TSO best estimate or average between min and max scenario	80% Green Gas Grid scenario
Algeria (pipe)	ENTSOG‘s elaboration on the basis of IEA production & demand projections, considering maximization of	ENTSOG’s elaboration on the basis of IEA production & demand projections, considering an intermediate	ENTSOG’s elaboration on the basis of the MEDPRO** production and demand projections with a pipe vs.

	Algerian Liquefaction capacity	split of pipe and LNG	LNG split according to Sonatrach prevision to balance LNG and pipe exports
Azerbaijan (pipe)	80% of the intermediate scenario	10 bcm/y to Europe starting from 2022	Increase over the intermediate up to 16 bcm/y by 2028
Libya (pipe)	ENTSOG's elaboration on the base of the low case from Mott Mac Donald's "Supplying the EU Natural Gas Market" November 2010	Average of Minimum and Maximum	95% of the existing transmission capacity (Green Stream)
LNG	Average LNG supplies to EU in 2011-2013	Average of Minimum and Maximum	ENTSOG's elaboration on the basis of the projected world LNG supplies and their split between basins
Norway (pipe)	Minimum daily production as provided by GASSCO, with extrapolation beyond 2028	Average of maximum and minimum scenario.	Maximum daily production as provided by GASSCO, with flat level beyond 2028
Russia (pipe)	According to the "Minimal contractual quantities" as included in a presentation by the Energy Research Institute of the Russian Academy of Sciences.	Average of maximum and minimum scenario.	Extrapolation of "Gas Export to Europe" from the Institute of Energy Strategy.
Turkmenistan** (pipe)**	No supplies to Europe from Turkmenistan	IEA production projections minus the consumptions and minus ENTSOG's elaboration on export projections to Russia, China and Iran. Average projections.	IEA production projections (high case) minus the consumptions (low case) and minus ENTSOG's elaboration on export projections to Russia, China and Iran.

Table 4 - Definition of supply scenarios

(*) The Macroeconomic effects of European shale gas production from Pöyry of November 2013
(**) MEDPRO (Mediterranean Prospects) project, see www.medpro-foresight.eu
(***) http://www.eriras.ru/
(****) to be used in case an import route project is submitted during the TYNDP call for projects

3.5.2. Supply ranges

For each climatic case and each import supply sources, a range is defined as:

> Average Summer day:
  - **Minimum**: the minimum of the Minimum Supply Potential scenario and 60% of the Intermediate Supply Potential scenario
  - **Maximum**: the Maximum Supply Potential scenario

> Average Winter day:
  - **Minimum**: the minimum of the Minimum Supply Potential scenario and 60% of the Intermediate Supply Potential scenario
  - **Maximum**: 110% of the Maximum Supply Potential scenario

> 14-day Uniform-Risk for each import source:
  - **Minimum**: the minimum of the Minimum Supply Potential scenario and 60% of the Intermediate Supply Potential scenario
  - **Maximum for each pipe import source**: the highest delivery of the source on 14 consecutive days as observed from 2011 to 2013, multiplied by the ratio between the average yearly delivery of the source and the Intermediate Supply Potential scenario. For these sources without historical records, it will be applied the average ratio between maximum delivery and capacity for the remaining sources.
  - **Maximum for LNG for each terminal**: the highest level of send-out that could be sustained on the period assuming:
    - LNG tanks are 50% full at the beginning of the period
    - LNG tank levels cannot go below 15%
    - Cargo delivery rate equivalent to 110% of the Maximum Supply Potential scenario

> 1-day Design Case for each import source:
  - **Minimum**: the minimum between the Minimum Supply Potential scenario and 60% of the Intermediate Supply Potential scenario
  - **Maximum for pipe imports**: the highest delivery of the source on a single day as observed from 2011 to 2013 multiplied by the ratio between the average yearly delivery of the source and the Intermediate Supply Potential scenario. For these sources without historical records, it will be applied the average ratio between maximum delivery and capacity for the remaining sources.
  - **Maximum for LNG for each terminal**: 100% of send-out capacity

3.5.3. Definition of the supply curves

Within the modelling tool, each supply source is described as a supply curve based on the Supply Potential and Global Context scenarios. It represents the increasing supply cost on the long run when demand is increasing (to be distinguished from the constant price compared to volume once gas has been contracted). The curve is built on:

> The yearly average import price of gas as defined in the Global Context Scenario (P_{GC})
> The Supply Potential Scenarios of each source

The Figure 3 illustrates the construction of the curve of given source on a given year:

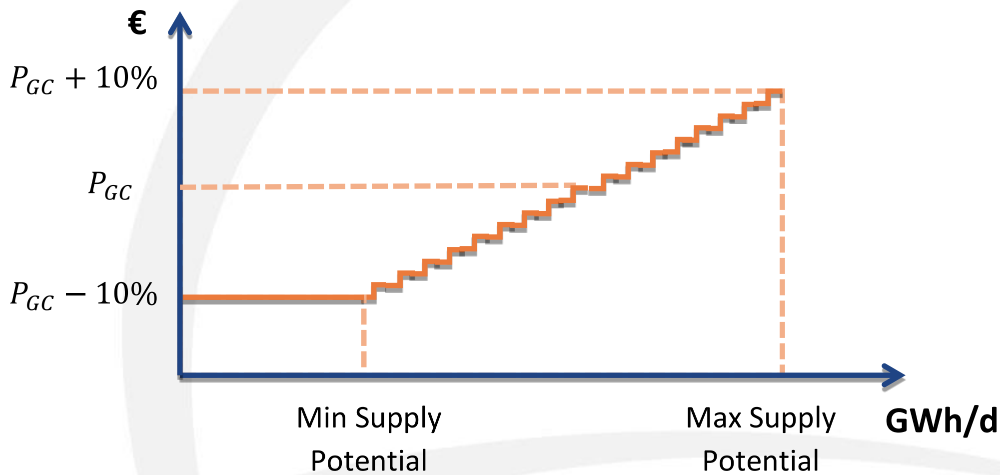


Figure 3 - Supply curve

3.6. Infrastructure scenarios

3.6.1. Definition of criteria for the infrastructure scenarios

The FID status has been identified as the most robust criteria for aggregation of planned infrastructure projects. FID is defined according to Regulation (EC) 256/2014[11]; Art.2.3 as follows:

"'final investment decision' means the decision taken at the level of an undertaking to definitively earmark funds for the investment phase of a project;"

[11] Regulation (EU) 256/2014 of the European Parliament and of the Council of 26 February 2014 concerning the notification to the Commission of investment projects in energy infrastructure within the European Union, replacing Council Regulation (EU, Euratom) 617/2010 and repealing Council Regulation (EC) 736/96

In order to be considered as FID status, the promoter shall have taken the Final Investment Decision of its project by the last day of the infrastructure project collection launched by ENTSOG ahead of each TYNDP.

By comparison, all those projects for which the FID has not been taken are considered to have a non-FID status. The PCI label granted during the latest selection is used as additional criteria for aggregation.

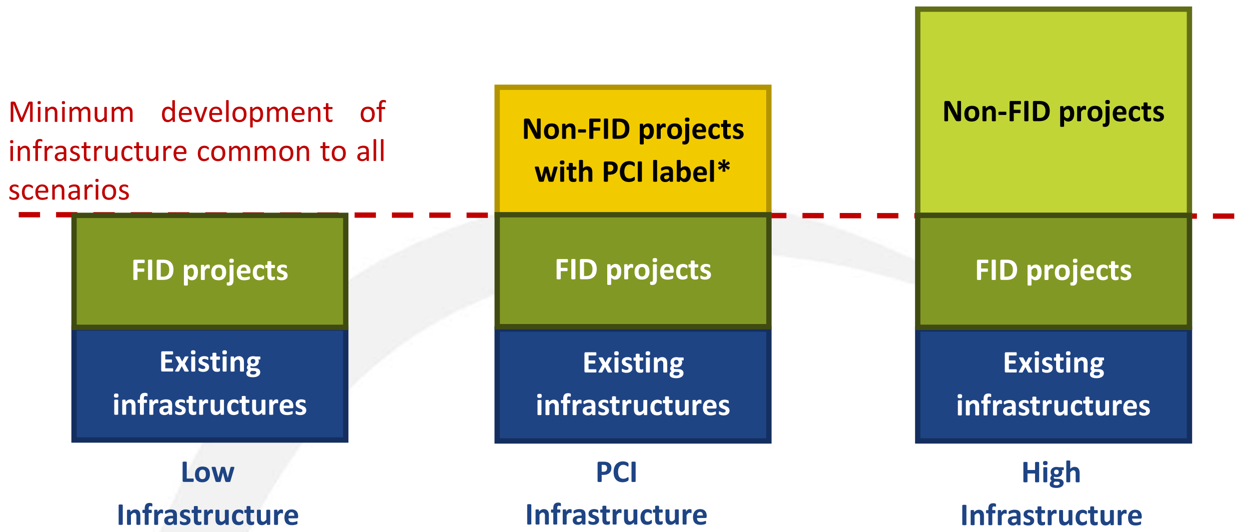
3.6.2. Infrastructure scenarios

Based on the above criteria, three infrastructure scenarios have been defined representing different levels of project implementation. This will support a robust assessment as project impact depends on the level of development of infrastructures.

- **Low Infrastructure Scenario (LI)**: Existing Infrastructures + Infrastructure projects having a FID status (whatever their PCI status is)
- **PCI Infrastructure Scenario**: Existing Infrastructures + Infrastructure projects having a FID status (whatever their PCI status is) + labelled PCIs according to the previous selection (not having their FID taken)
- **High Infrastructure Scenario (HI)**: Existing Infrastructures + Infrastructure projects having a FID status (whatever their PCI status is) + Infrastructure projects not having a FID status (whatever their PCI status is)

The Existing Infrastructures are defined as the firm capacity available on yearly basis as of 1 January of first year of the TYNDP-Step.

The Figure 4 illustrates the difference in the level of infrastructure development of each scenario.



(*) as labelled in the previous list selected before the current TYNDP step for ESW-CBA

Figure 4 - Infrastructure Scenarios

The assessment of the European gas system under Low and High Infrastructure Scenarios will show different levels of project interaction according to the degree of development of infrastructure. The assessment of the European gas system under the PCI Infrastructure Scenario is used separately only within the TYNDP Step to measure the benefits from a full implementation of the latest PCI list. Its role is to provide a feedback loop to Regional Groups.

3.6.3. Capacity increment considered in the Economic Analysis

The incremental approach is at the core of the cost-benefit analysis. It is based on the differences of indicators and monetary values between the scenario "with the project" and the scenario "without the project". The inclusion of a capacity increment associated to an infrastructure project depends on the status of infrastructure on both sides of a flange. The Table 5 indicates which increment is used in the Economic Analysis:

Flange A	Flange B	Infrastructure Scenario in which the capacity increment is considered
Existing or FID	FID	Low and High
	Non-FID	High
	None	None
Non-FID	Non-FID	High
Non FID	None	None

Table 5 - Considered capacity increment per scenario

4. Approach of network/market modelling

4.1. Infrastructure-related market integration

Within TYNDP 2013-2022, ENTSOG has defined the infrastructure-related market integration as a physical situation of the interconnected network which, under optimum operation of the system, provides sufficient flexibility to accommodate variable flow patterns that result from varying market situations. In addition to its embedded value, market integration sustains the pillars of the European energy policy (Security of Supply, Competition and Sustainability). These four aspects define the specific criteria under this Regulation.
A thorough assessment of these criteria shall be based on modelling in order to capture the network and market dimensions of the European gas system. These dimensions are not limited to capacity and demand but are strongly influenced by supply availability, the location of the source and gas price.

4.2. Rationales for the perfect market approach

When assessing the physical layer of market integration it is important to assume a well-functioning commercial layer (e.g. full implementation of Network Codes). The consideration of market constraints (e.g. a minimum flow between 2 zones deriving from commercial arrangements) within the EU would lead to investment signals that bear the risk of future stranded assets under the situation that the market constrains are alleviated. Therefore the model follows a single–user perspective, shipping gas within a multi-TSO European gas system.

4.3. Topology

ENTSOG has developed since 2010 a modelling approach based on a specific structure facing the need to consider simultaneously network and market dimensions.

ENTSOG model applies the methodology of "Network Flow Programming[12]" to:

> the capacity figures obtained through hydraulic simulations performed by TSOs
> the power-generation capacity figures derived from ENTSO-E visions
> the demand and supply approach defined in the input data section of the current methodology.

[12] Network Flow Programming is a methodology used in the Operational Research (study of logistic networks to provide for decision support at all levels). The term network flow program includes such problems as the transportation problem, the assignment problem, the shortest path problem, the maximum flow problem.

Considering the seasonal aspect of the gas market and in particular the seasonality of some gas storages, it is necessary to proceed to yearly modelling considering simultaneously the summer, winter and peaks constraints.

The following graphs illustrate the main features of the topology used in the modelling approach supporting the present methodology:

> Yearly structure

The modelling of a year is composed of the simultaneous simulation of four climatic cases each one represented with the topology of the European gas system. The main difference between each layer is the level of gas demand and thermal gap. This structure (illustrated in Figure 5) enables the model to take into consideration annual constraints such like the minimum and maximum import from a supply source or then working gas volume of storages.

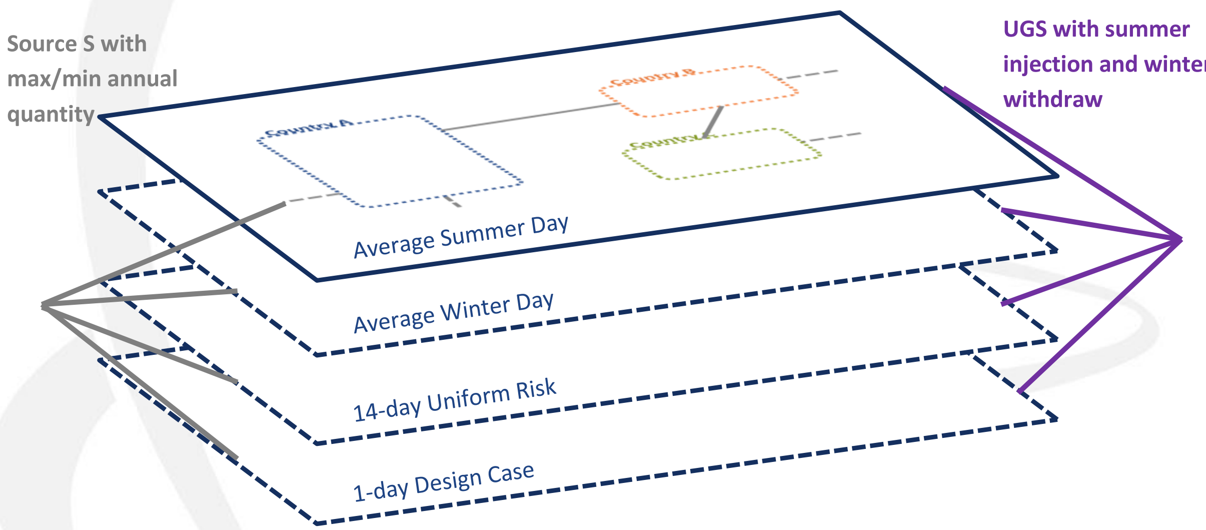


Figure 5 - Yearly structure of the topology

The considered supply sources in the modelling approach are:

- gas (whatever the use) from Algeria, Azerbaijan, Libya, LNG, Norway, Russia and Turkmenistan (if import route projects submitted)
- coal (only for power generation) from global market

> Entry/Exit model (Figure 6)

The basic block of the topology is the balancing zone (or Zone) at which level demand and supply shall be balanced. The Zones are connected through arcs representing the sum of the capacity of all Interconnection Points between two same Zones (after application of the "lesser of" rule). Interconnectors with specific regime (e.g. BBL or Gazelle) are represented by Zones with no attached demand.

In order to avoid extreme flow patterns (e.g. most of the arcs empty or fully used) where it is not necessary to balance demand and supply, each arc is subdivided into ten arcs each one representing ten percent of the total capacity between the two Zones with an increasing weight. The more sub-arcs are used between two Zones, the higher is the resulting value of the objective function.

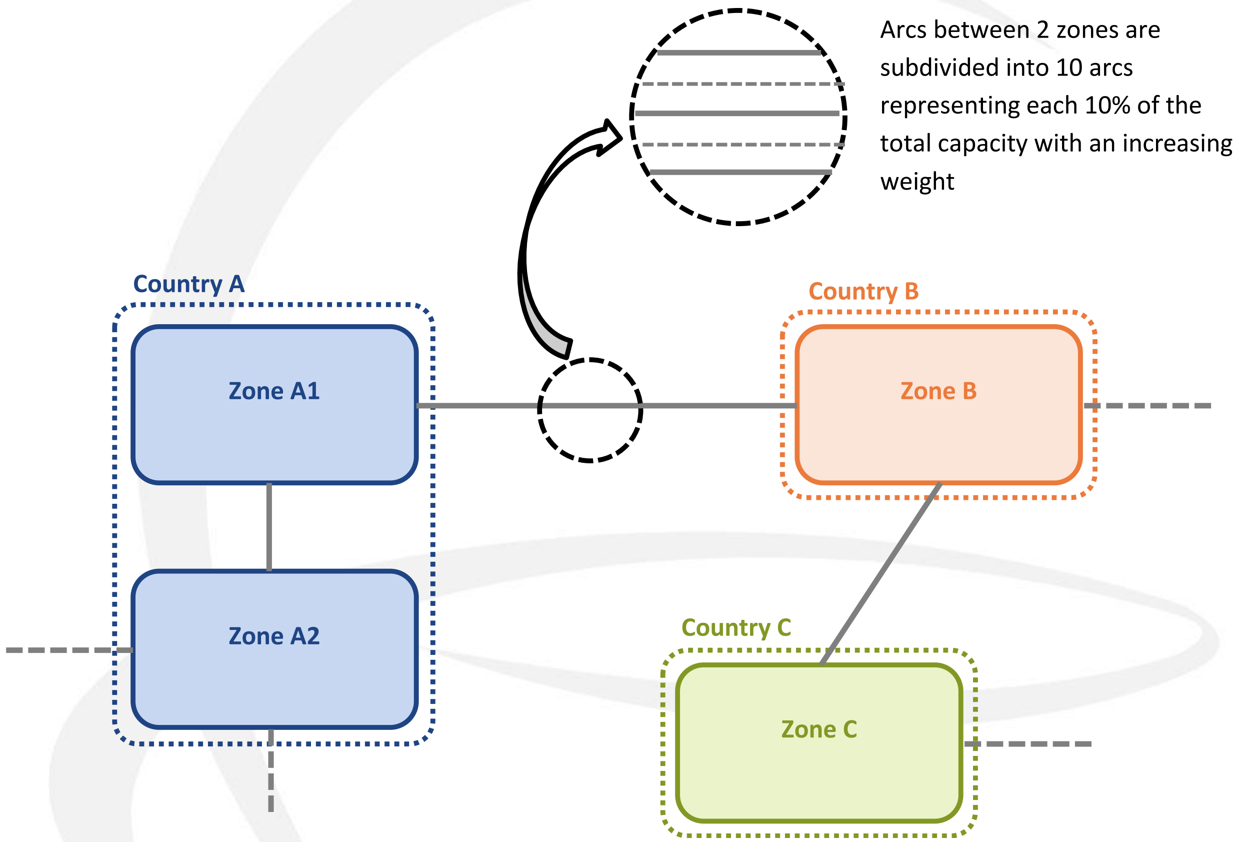


Figure 6 – Links between adjacent Zones

> Focus on a Zone (Figure 7)

The supply and demand balance in a Zone depends on the flow coming from other Zones or direct imports from a supply source. Gas may also come from national production, underground storage and LNG facilities connected to the Zone. The sum of all these entering flows has to match the demand of the Zone, plus the need for injection and the exit flows to adjacent Zones.

In case the balance is not possible, the missing gas comes from the disruption arc (3) used as a last resort virtual supply. This approach enables an efficient analysis of the disrupted demand.

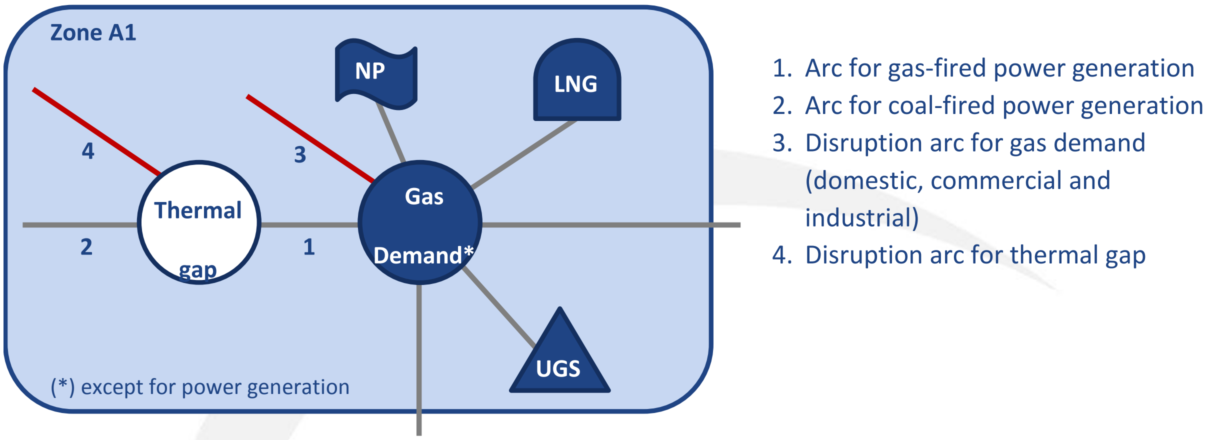


Figure 7 - Content of a Zone

The gas demand of a give Zone is split between one node for the domestic, commercial and industrial sectors and another node for the thermal gap defined as the electricity demand to be covered by coal or gas.

Therefore the arc (1) between the two nodes represents the gas-fired power generation capacity of the Zone. Another arc (2) represents the coal-fired power generation capacity. These two arcs are characterized by the range of use of the power-generation capacity, the efficiency of the electricity production and the CO_2 emission factor. In order to model the range of efficiency of the generation units of each fuel, the arcs are subdivided into arcs of different efficiency.

In case the balance of the thermal gap is not possible, an additional disruption arc (4) has been introduced.

4.4. Marginal price and objective function

The primary objective of the modelling is to define a feasible flow pattern to balance for every node supply and demand using the available system capacities defined by the arcs. In addition the use of price assumptions relative to gas and coal supply together with CO_2 emissions supports the definition of a feasible flow pattern minimizing the objective function[13] representing costs to be borne by the European society.

This optimum differs from national optimums which are potentially not reached through the same flow pattern.

[13] Use of the Jensen solver as developed by Paul Jensen for the Texas University in Austin (https://www.me.utexas.edu/~jensen/ORMM/index.html)

The minimization of the objective function is based on the concept of marginal price of a node. It is defined as the cost of the last unit of energy used to balance the demand of that node.

The overall objective function used in the methodology is the following:

$$\boldsymbol{Commodity\ Cost\ + Weight\ of\ infrastructure\ use}$$

The optimization is done on the commodity cost and the weight of infrastructure use (the last being of second order) to define a realistic flow pattern.

$$Commodity\ Cost = Cost\ of\ gas\ supply + Cost\ of\ Coal\ supply + Cost\ of\ CO_2\ emissions$$

$$Weight\ of\ infrastructure\ use = Weight\ of\ transmission + Weight\ of\ storage + Weight\ of\ regasification$$

Each component is defined as the sum for each arc of the flow through the arc multiplied by its unitary cost or weight.
Each commodity item is defined as below:

$$Cost\ of\ gas\ supply = \sum_{S}^{Gas\ sources} \sum_{n}^{Arc\ from\ source\ S} Flow_n \times Cost_n$$

$$Cost\ of\ Coal\ supply = \sum_{j}^{Arc\ from\ Coal\ source} Flow_j \times Cost_j$$

$$Cost\ of\ CO_2\ emissions = \sum_{k}^{Arc\ to\ Thermal\ gap} Flow_k \times Cost_k$$

Where:

- $Cost_n$ is the cost per unit of gas supply as resulting from the supply curves defined under chapter 3.5.3
- $Cost_j$ is the cost per unit of coal as defined under chapter 3.3
- $Cost_k$ is the cost per unit of CO2 emission as defined under chapter 3.3

Each infrastructure item is defined as (the weight of each arc is in monetary unit for addition reason of the overall objective function but does not represent any kind of proxy of the infrastructure fee):

$$Weight\ of\ transmission = \sum_{t}^{Arc\ between\ Zones} Flow_t \times Weight_t$$

$$Weight\ of\ storage = \sum_{w}^{Arc\ from\ storage} Flow_w \times Weight_w + \sum_{i}^{Arc\ to\ storage} Flow_i \times Weight_i$$

$$Weight\ of\ regasification = \sum_{l}^{Arc\ from\ LNG\ terminal} Flow_l \times Weight_l$$

If all above cost and weight items are used to define the flow pattern through modelling only part of them are used for the monetization of project benefits. Table 6 defines the role of each item:

Type of costs and weights	Costs or weight used in the definition of flow pattern	Costs considered for the Monetization of project benefits
Commodity costs		
Gas supply	X	X
Coal supply for power generation	X	X
CO_2 emissions from power generation	X	X
Infrastructure weights		
Transmission	X	
UGS	X	
LNG	X	

Table 6 - Use of costs and weight in modelling

The infrastructure weights are used to model market behaviour when defining flow pattern (e.g. ensuring a reasonable use of storage to cover winter demand). Nevertheless the high- or low use of gas infrastructures influences only slightly the cost for society (it is mostly an internal transfer between users and operators). Therefore these weights are ignored when monetizing Project benefits.

4.5. Evaluation of the social welfare

Within the ESW-CBA the social welfare has to be understood within the framework of the Regulation. Its geographical scope is the European Union and other countries part of the

European Economic Area. It includes all benefits coming along the gas chain including suppliers, infrastructure operators and end-consumers. For example it does not include items such as the shadow value of the work necessary to build and operate an infrastructure.

Based on the economic theory the European social welfare is defined as the yellow area between the supply and demand curves. The change in social welfare induced by a project is then additional red striped area resulting from the change of the supply curve where there is a better access to cheap source (additional red part at the bottom of the curve) as shown in the Figures 8a and 8b (also defining the marginal price as the intersection of the two curves):

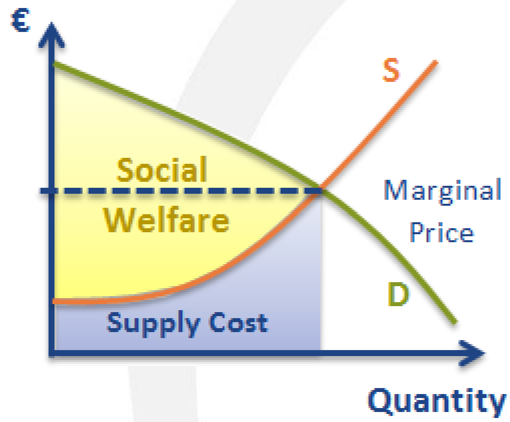


Figure 8a - Social Welfare before the project

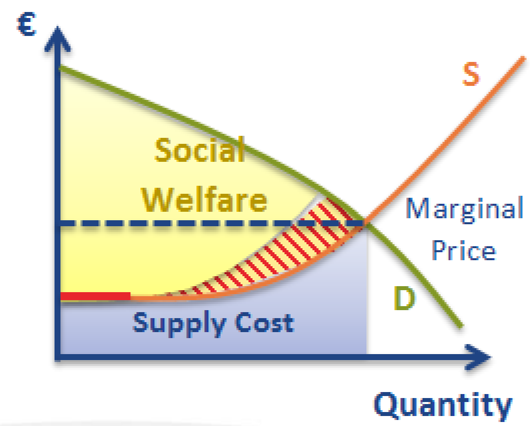


Figure 8b - Social Welfare after the project

Applying this approach to the ESW-CBA modelling approach with an inelastic gas demand for residential, commercial and industry, the change in Social Welfare is equivalent to the change in Supply Cost as shown in the Figures 9a and 9b:

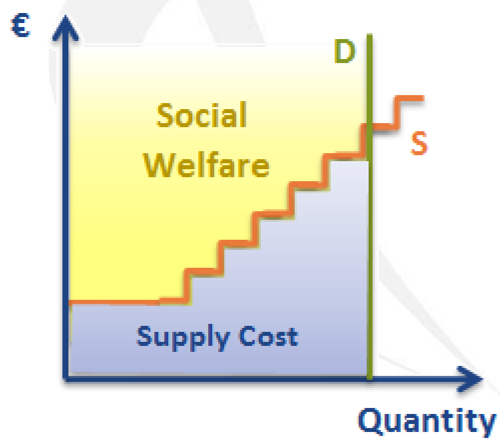


Figure 9a - Social Welfare with inelastic demand before the project

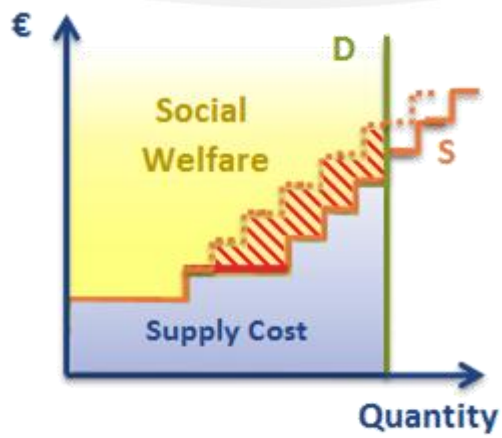


Figure 9b - Social Welfare with inelastic demand after the project

- European social welfare

  The below part of the objective function measures the European social welfare resulting from a given case:

$$SW_{EU} = Cost\ of\ gas\ supply + Cost\ of\ Coal\ supply + Cost\ of\ CO_2\ emissions$$

- Social welfare at Member State level

The value of this European social welfare is then split per Zone in order to calculate the net benefit of the project on impacted Member States as required by the Regulation.

This process requires the definition of the supply and demand curves of each Zone. The demand curve is an input of the methodology through the definition of the gas demand for domestic, commercial and industrial sectors and the thermal gap. Apart from National Production, the supply curves are defined by source and not at Zone level. The supply curve of each Zone is through successive modelling as below:

1. Modelling of the European gas system with gas demand and thermal gap at 10% of the normal level
2. Identification of the resulting marginal price of each Zone
3. Repetition of the steps 1 and 2 increasing the gas demand and the thermal gap by 10% until they reach the normal levels
4. Interpolation of the supply curve of each Zone based on the marginal prices defined in steps 2 and 3
5. Definition of a proxy social welfare for each Zone Z (SW'_Z) based on the demand curve of each Zone and the interpolated supply curve from step 4
6. The social welfare for each Zone Z (SW_Z) is derived from the European one according to the following formula:

$$SW_Z = \frac{SW'_Z}{\sum_i^{all\ Zones} SW'_i} \times SW_{EU}$$

This definition of the Social Welfare per Member State is dependent on the way the supply curve is built at country level. Therefore another approach (e.g. in the step 3 the demand and thermal gap could be increased by constant steps and not relative ones) would result in another split between Member States.

4.6. List of cases to be modelled

The modelling approach previously described is to be applied to all the cases supporting the calculation of indicators and monetization of gas supply, coal consumption and CO_2 emissions.

The following table defines the cases to be modelled and their purposes. They have to be modelled for each Infrastructure Scenario, Global Context, Demand Scenario and the years n, n+5, n+10, n+15 and n+20 (n being the year of analysis).

<table>
<tr><th>Climatic Case</th><th>Price configuration</th><th>Supply stress</th><th>Purpose</th></tr>
<tr><td rowspan="4">Whole year* together</td><td>Neutral</td><td>No</td><td>Monetization</td></tr>
<tr><td>Each source cheaper one-by-one</td><td>No</td><td>Monetization</td></tr>
<tr><td>Each source more expensive one-by-one</td><td>No</td><td>Monetization</td></tr>
<tr><td>Defined under each indicator</td><td>No</td><td>Indicators</td></tr>
<tr><td rowspan="2">Design Case & 14-day Uniform Risk</td><td rowspan="2">Neutral</td><td>No</td><td>Remaining Flexibility
Disrupted Demand</td></tr>
<tr><td>Disruptions</td><td>Remaining Flexibility
Disrupted Demand</td></tr>
<tr><td rowspan="3">Whole year* with results per climatic case</td><td>Neutral</td><td>No</td><td>Price convergence</td></tr>
<tr><td>Each source cheaper one-by-one</td><td>No</td><td>Price convergence</td></tr>
<tr><td>Each source more expensive one-by-one</td><td>No</td><td>Price convergence</td></tr>
</table>

(*): as the temporal optimization of the succession of one Average Summer Day, one Average Winter Day, 1-day Design Case and 14-day Uniform Risk

Table 7 - List of cases to be modelled

In the previous table different possible supply mixes have been considered through 13 price configurations where each source price is changed in both directions, source by source. This approach does not cover all possible configurations but helps to identify the link between a project and each source.
The supply curves of the different price configurations are built as following:

- **Neutral**: the supply curve of each source is based on the same average import price of the selected Global Context scenario.
- **Source S cheap** the supply curve of the source S is move downward along the price axis by 20% of the Yearly average gas import price
- **Source S expensive**: the supply curve of the source S is move upward along the price axis by 20% of the Yearly average gas import price

As in previous TYNDP reports the methodology considers some major supply stress against which the European gas system should be assessed. Depending on the source one or two potential complete disruption events have been defined:

- Russian transit through Ukraine
- Russian transit through Belarus
- Langeled pipeline between Norway and UK

- Franpipe pipeline between Norway and France
- Transmed pipeline between Algeria and Italy
- MEG pipeline between Algeria and Spain (including supply to Portugal)
- TANAP pipeline between Azerbaijan and Greece
- Import route from Turkmenistan[14]

No specific disruption event is considered for LNG given the global dimension of the market preventing large scale effect of a political or technical disruption along the gas chain.

4.7. Output of the modelling

As output, modelling enables for each case the identification of a feasible flow pattern minimizing the objective function. Such flow pattern then supports the calculation of modelling-based indicators and monetary analysis.

5. Indicators

A set of indicators has been defined in order to cover all specific criteria of the Regulation and to ensure comparability of project assessments. According to the way the indicators are calculated, two types can be distinguished:

- Capacity-based indicators which reflect the direct impact of infrastructures on a given country as their formulas are limited to capacity and demand of a country
- Modelling-based indicators which reflect in addition the indirect cross-border impact of infrastructure as their formulas also consider the availability and nature of flows resulting from the modelling of the European gas system.

Both types of indicators are used in an incremental approach in order to evaluate the contribution of an infrastructure project along the specific criteria set by the Regulation.

5.1. Capacity-based indicators

5.1.1. **Import Route Diversification (IRD)**

This indicator measures the diversification of paths that gas can flow through to reach a zone. Together with the Supply Source Price Diversification, it provides a proxy to the assessment of counterparty diversification.

[14] if this project is submitted by its promoter as part of the call for projects for TYNDP Report

IRD =

$$\sum_{l}^{Xborder}\left(\sum_{k}^{IP} \%\, IP_k\ Xborder_l\right)^2 + \sum_{j}^{Source}\sum_{i}^{IP}\left(\%\, IP_i\ from\ source_j\right)^2 + \sum_{m}(\%\, LNG\ terminal_m)^2$$

Where the below shares are calculated in comparison with the total entry firm technical capacity into the Zone from each adjacent EU zone, import source and LNG terminal:

> **IP_k $Xborder_l$**: the share of the firm technical capacity of the interconnection point IP_k belonging to the cross border with the zone *l* (or country in the case of transit through Belarus, Ukraine and Turkey)

> **IP_i from $source_j$**: the share of the firm technical capacity of the import point IP_i coming directly from the source *j* (e.g.: offshore pipeline).

> **LNG $terminal_m$**: the share of the firm technical send-out capacity of the LNG terminal *m*

For Interconnection Points between European Zones or a same transiting country, capacity is first aggregated at zone level as those physical points are likely to largely depend on common infrastructures. LNG terminals are considered as completely independent infrastructures.

The lower the value, the better the diversification is.

5.1.2. N-1 for ESW-CBA (N-1)

Under REG (EC) 994/2010, this indicator is calculated by the Competent Authority on a two year range. The use of such an indicator within the ESW-CBA on country level will be based on the same formula, using the ESW-CBA data set:

$$N-1 = \frac{IP + NP + UGS + LNG - I_m}{Dmax} * 100$$

Where:

> **IP:** technical capacity of entry points *(GWh/d)*, other than production, storage and LNG facilities covered by NP_m, UGS_m and LNG_m, means the sum of technical capacity of all border entry points capable of supplying gas to the calculated area.

> **NP:** maximal technical production capability (GWh/d) means the sum of the maximal technical daily production capability of all gas production facilities which can be delivered to the entry points in the calculated area; taking into account their respective physical characteristics.

> **UGS:** maximal storage technical deliverability *(GWh/d)* means the sum of the maximal

technical daily withdrawal capacity of all storage facilities connected to the transmission system which can be delivered to the entry points in the calculated area, taking into account their respective physical characteristics.

> **LNG:** maximal technical LNG facility capacity *(GWh/d)* means the sum of the maximal technical send-out capacities at all LNG facilities in the calculated area, taking into account critical elements like offloading, ancillary services, temporary storage and re-gasification of LNG as well as technical send-out capacity to the system.
> **I_m** means the technical capacity of the single largest gas infrastructure *(GWh/d)*. The single largest gas infrastructure is the largest gas infrastructure that directly or indirectly contributes to the supply of gas to the calculated area. The application of the "lesser of " rule and the analysis on a 21-year time horizon may result in a different infrastructure than the one identified by Competent Authorities as part of the Risk Assessment under Regulation (EC) 994/2010.
> **D_{max}** means the total daily gas demand *(GWh/d)* of the calculated area during a day of exceptionally high gas demand occurring with a statistical probability of once in 20 years.

Only in case that a regional formula has been defined and agreed by the Competent Authorities of the corresponding region, the calculation shall be adjusted using the same ESW-CBA data set.

The higher the indicator is, the better the resilience.

5.1.3. Bi-Directional Project indicator (BDPi and BDPz)

The indicator measures the balance in the firm technical capacity offered in both direction of an interconnection. It shall be calculated at Interconnection Point (IP) and where applicable at cross-zone levels. As the formula of the indicator already reflects the project increment, it is to be calculated only at the PS-Step for projects creating or increasing bi-directional capacity.

The indicator is calculated according the following formula:

At Interconnection Point level:

$$\boldsymbol{BDPi = Min\left(1; \frac{Added\ Capacity\ at\ IP\ to\ other\ direction}{Existing\ \ capacity\ in\ prevailing\ direction}\right)}$$

Where:

> **Added Capacity at IP to other direction** (GWh/day)**:** firm technical capacity of the investment against the prevailing flow direction

- **Existing Pipeline capacity in prevailing direction** (GWh/day)**:** already existing capacity in the prevailing direction.

In case of a new bi-directional IP, the numerator shall be the smaller added capacity. In case the investment changes the prevailing flow, the new prevailing flow shall be the denominator.

At cross-zone level:

$$\boldsymbol{BDPz} = \boldsymbol{Min}\left(\boldsymbol{1}; \frac{\boldsymbol{Added\ Capacity\ at\ 'Cross-Zone'\ level}}{\boldsymbol{Sum\ of\ Existing\ capacities\ in\ prevailing\ direction\ at\ cross-zone\ level}}\right)$$

Where:

- **Added Capacity at cross-zone level to other direction** (GWh/day)**:** firm technical capacity of the investment against the prevailing flow direction
- **Sum of Existing Pipeline capacities in prevailing direction at Cross-Zone level** (GWh/day)**:** already existing capacity in the prevailing direction.

In case of a new bi-directional Cross-zone capacity, the numerator shall be the smaller added capacity. In case the investment changes the prevailing flow, the new prevailing flow shall be the denominator.

The maximum value of the Indicator is one; in case the project is a Reverse Flow, it will score above zero.

5.2. Modelling-based indicators

5.2.1. **Remaining Flexibility (RF)**

This indicator measures the resilience of a Zone as the room before being no longer able to fulfil its demand and the exiting flows to adjacent systems. The value of the indicator is set as the possible increase in demand of the Zone before an infrastructure or supply limitation is reached somewhere in the European gas system.
This indicator will be calculated under 1-day Design Case and 14-day Uniform Risk situations with and without supply stress.

The Remaining Flexibility of the Zone Z is calculated as follows (steps 2 and 3 are repeated independently for each Zone):

1. Modelling of the European gas system under a given climatic case
2. Increase of the demand of the Zone Z by 100%
3. Modelling of the European gas system in this new case

The Remaining Flexibility of the considered Zone is defined as 100% minus the percentage of disruption of the additional demand.

The higher the value, the better the resilience is. A zero value would indicate that the Zone is not able to fulfil its demand and a 100% value will indicate it is possible to supply a demand multiplied by a factor two.

5.2.2. Disrupted Demand (DD)

In case the Remaining Flexibility of a Zone is zero, the amount of disrupted demand for a given Zone is provided as:

- The unserved demand in energy
- The relative share of unserved demand

This amount is calculated under the flow pattern maximising the spread of the non-fulfilled demand in order to reduce the relative impact on each country.

5.2.3. Uncooperative Supply Source Dependence (USSD)

This indicator identifies Zones whose physical supply and demand balance depends strongly on a single supply source when each Zone tries to minimize its own dependence (the Zones closest to the considered source are likely to be the more dependent).
It is calculated for each Zone vis-à-vis each source under a whole year as the succession of an Average Summer, Average Winter, 1-day Design Case and 14-day Uniform Risk. Results are aggregated on a yearly basis.

The Supply Source Dependence of all Zones to source S is calculated as follows (steps 1 to 4 are repeated for each source):

1. The availability of source S is set down to zero
2. The availability of the other sources is not changed
3. The cost of disruption is set flat and at the same level for each Zone
4. Modelling of the European gas system under the whole year

The Uncooperative Supply Source Dependence of the Zone Z to the source S is defined as:

$$USSD = \frac{DD^{Z}_{Adjusted}}{Demand^{Z}_{Adjusted}}$$

Where:

> $DD^{Z}_{Adjusted}$ is the disrupted gas demand for residential, commercial and industry plus the disrupted share of the thermal gap divided by the gas-fired power generation efficiency
> $Demand^{Z}_{Adjusted}$ is the gas demand for residential, commercial and industry plus the share of the thermal gap which cannot be covered by coal and divided by the gas-fired power generation efficiency

The lower the value of USSD is, the lower the dependence.

5.2.4. Cooperative Supply Source Dependence (CSSD)

This indicator identifies Zones whose physical supply and demand balance depends strongly on a single supply source when all Zones together try to minimize the relative impact (the flow pattern resulting from modelling will spread the dependence as wide as possible in order to mitigate as far as possible the dependence of the most dependent Zones).
It is calculated for each Zone vis-à-vis each source under a whole year as the succession of an Average Summer, Average Winter, 1-day Design Case and 14-day Uniform Risk. Results are aggregated on a yearly basis.

The Supply Source Dependence of all Zones to source S is calculated as follow (steps 1 to 4 are repeated for each source):

1. The availability of source S is set down to zero
2. The availability of the other sources is not changed
3. The cost of disruption is escalating by step of 10% of demand with the same price steps for each Zone
4. Modelling of the European gas system under the whole year

The Cooperative Supply Source Dependence of the Zone Z to the source S is defined as:

$$CSSD = \frac{DD^{Z}_{Adjusted}}{Demand^{Z}_{Adjusted}}$$

Where:

> $DD^{Z}_{Adjusted}$ is the disrupted gas demand for residential, commercial and industry plus the

disrupted share of the thermal gap divided by the gas-fired power generation efficiency

- $Demand^{Z}_{Adjusted}$ is the gas demand for residential, commercial and industry plus the share of the thermal gap which cannot be covered by coal and divided by the gas-fired power generation efficiency

The lower the value of CSSD is, the lower the dependence.

5.2.5. Supply Source Price Diversification (SSPDi)

This indicator measures the ability of each Zone to take benefits from an alternative decrease of the price of each supply source (such ability does not always mean that the Zone has a physical access to the source).
It is calculated for each Zone under a whole year as the succession of an Average Summer, Average Winter, 1-day Design Case and 14-day Uniform Risk. Results are aggregated on a yearly basis.

The Supply Source Price Diversification of all Zones to source S is calculated as follow (steps 2 to 5 are repeated for each source):

1. All sources have their price curves set flat at the considered Global Context level
2. The price level of the curve of the source S is decreased by 20% ensuring that the source S is maximised
3. The residential, commercial and industrial gas bill of each Zone is measured ($Gas\ Bill_{Step3}$)
4. The curve of the source S is further decreased by 10%
5. The updated residential, commercial and industrial gas bill of each Zone is measured ($Gas\ Bill_{Step5}$)

The ability of a Zone to access the source S is defined as the difference of the gas bills measured in steps 3 and 5 through the following formula:

$$SSPDi = \left(\frac{Gas\ Bill_{Step3} - Gas\ Bill_{Step5}}{Gas\ Bill_{Step3}}\right) \times \frac{1}{10\%}$$

The bigger the difference is, the better the access from a price perspective.

Finally the diversification of a Zone is characterized by both:

- the number of sources resulting in a price decrease in the considered zone
- the magnitude of this decrease

5.2.6. **Supply Source Price Dependence (SSPDe)**

This indicator measures the price exposure of each Zone to the alternative increase of the price of each supply source.
It is calculated for each Zone under a whole year as the succession of an Average Summer, Average Winter, 1-day Design Case and 14-day Uniform Risk. Results are aggregated on a yearly basis.

The Supply Source Price Dependence of all Zones to source S is calculated as follow (steps 2 to 5 are repeated for each source):

1. All sources have their price curves set flat at the considered Global Context level
2. The price level of the curve of the source S is increased by 20% ensuring that the source S is minimized
3. The residential, commercial and industrial gas bill of each Zone is measured ($\boldsymbol{Gas\ Bill_{Step3}}$)
4. The curve of the source S is further increased by 10%
5. The updated residential, commercial and industrial gas bill of each Zone is measured ($\boldsymbol{Gas\ Bill_{Step5}}$)

The price exposure of a Zone to the source S is defined as the difference of the gas bills measured in steps 3 and 5 through the following formula:

$$\boldsymbol{SSPD} = \left(\frac{\boldsymbol{Gas\ Bill_{Step5} - Gas\ Bill_{Step3}}}{\boldsymbol{Gas\ Bill_{Step3}}}\right) \times \frac{\mathbf{1}}{\mathbf{10\%}}$$

The bigger the difference is, the higher is the exposure from a price perspective.

Finally the dependence of a Zone is characterized by both:

- the number of sources resulting in a price increase in the considered zone
- the magnitude of the bill increase

5.2.7. **Price Convergence (PC)**

This indicator measures the difference between the marginal prices of gas supply of each Zone. For each climatic case, the marginal price of gas supply of a Zone is a direct output of the optimization used in modelling.
It is calculated for each Zone under a whole year as the succession of an Average Summer, Average Winter, 1-day Design Case and 14-day Uniform Risk. Results are provided for each climatic case.

The lower the difference between the marginal prices of two Zones is, the better the convergence.

6. TYNDP step of the ESW-CBA (TYNDP-Step)

This step builds a bridge between the previous selection of PCIs and the upcoming one. It is carried out by ENTSOG as part of its Union-Wide TYNDP to be published every other year. It provides an overall assessment of the European gas system under the three Infrastructure Scenarios for the development of gas infrastructures as defined under chapter 3.6.2.

The TYNDP-Step sets the framework for the selection of Projects of Common Interests through:

- the collection of infrastructure projects as all future candidates to PCI label have to be part of the latest available TYNDP at the moment of the selection
- the definition of all data necessary for the implementation of the ESW-CBA (except financial project-specific data)
- the assessment of the cumulative impact of Projects of Common Interest (PCI Infrastructure Scenario) as resulting from the previous selection and taking into account the interaction between infrastructures
- the assessment of gas infrastructure under two extreme scenarios (Low and High Infrastructure Scenarios) providing the input necessary for the completion of the PS-Step to be carried out by promoters

The assessment of the European gas system carried out as part of TYNDP-Step on the years n, n+5, n+10, n+15 and n+20 (where n is the year of analysis) is composed of:

- the modelling of the European gas system under all cases necessary to support the quantitative and monetary analyses
- a quantitative analysis based on the calculation of the set of indicators defined under chapter 5
- a monetary analysis based on the calculation of the cost of gas supply, coal consumption and CO_2 emissions related to power generation

6.1. TYNDP-Step modelling

The cases defined in chapter 4.6 shall be modelled on the years n, n+5, n+10, n+15 and n+20 (n being the year of analysis) for the PCI, Low and High Infrastructure Scenarios.

6.2. Quantitative Analysis

The quantitative analysis is based on the calculation of indicators measuring the completion of the Specific Criteria defined by Regulation.

The Table 8 defines the list of indicators to be calculated as part of the TYNDP-Step for each Infrastructure (Low, High and PCI), Global Context and Gas Demand Scenario:

	Indicator	Climatic Case	Without Supply Stress	With Supply Stress
Capacity-based	N-1	1-DC	N/A	N/A
	Import Route Div.	N/A	N/A	N/A
Modelled-based	Remaining Flex.	1-DC & 14-UR	X	X
	Disrupted Demand	1-DC & 14-UR	X	X
	Cooperative Supply Source Dependence	Whole year*	X	
	Uncooperative Supply Source Dependence	Whole year*	X	
	Supply Source Price Diversification	Whole year*	X	
	Price Convergence	Whole year	X	

(*): as the temporal optimization of the succession of one Average Summer Day, one Average Winter Day, 1-day Design Case and 14-day Uniform Risk

Table 8 - List of indicators part of the TYNDP-Step

The numerical value of each indicator will be reported for each Zone in an annex of the TYNDP Report.

6.3. Monetary Analysis

The monetary analysis is based on the calculation of costs for Europe measuring the completion of the Specific Criteria defined by Regulation.

The Table 9 defines the cost items to be calculated as part of the TYNDP-Step for each Infrastructure (Low, High and PCI), Global Context and Gas Demand Scenario:

Cost item	Climatic Case	Without Supply Stress	With Supply Stress
Gas supply	Whole Year*	X	
Coal for power generation	Whole Year*	X	
CO_2 emission from power generation	Whole Year*	X	

(*): as the temporal optimization of the succession of one Average Summer Day, one Average Winter Day, 1-day Design Case and 14-day Uniform Risk

Table 9- Cost items monetized as part of the TYNDP-Step

In order to support the definition of economic cash-flow for each project within the PS-Step, the monetization of cost items for each year from n to n+20 (n being the year of analysis) is done through linear interpolation of the modelled years.

The numerical value of each cost item will be reported for each Zone and the whole EU in an annex of the TYNDP Report.

7. Project specific step of the ESW-CBA (PS-Step)

This step is carried out by promoters for each of their projects and builds on the TYNDP-Step. It provides an assessment of the project under the Low and High Infrastructure Scenarios.

The PS-Step provides robust and consistent analysis of all PCI candidates in order to inform decision-makers during the different instances of application of the ESW-CBA. This is achieved through a common data set and methodology.

The assessment of each project carried out as part of PS-Step on the years n, n+5, n+10, n+15 and n+20 (where n is the year of analysis) is following the same stages as the TYNDP-Step with the following additions:

1. The calculation of the bi-directional indicator as part of the quantitative analysis
2. The addition or removal of the considered project following the incremental approach
3. The calculation of Economic and Financial Performance Indicators

4. A sensitivity-analysis on project-specific data
5. A qualitative analysis commenting on the previous results and justifying potential additional benefits of the project (especially for project connecting new areas to the European gas market)

The assessment of projects bringing gas in new areas within the European Union differs as the incremental approach cannot apply to Member States before the project. In such case only the last three steps apply. In addition the calculation of Economic Performance Indicators shall cover the replacement of more polluting or expensive fossil fuels (e.g. oil or LPG) by natural gas. The same applies to small-scale LNG terminals not connected to the European gas system and which benefits are mostly linked in replacing other transportation fuels more polluting or expensive.

This section also defines the respective roles of ENTSOG and Promoters in the implementation of the PS-Step as an interim process for the second selection of PCIs. The responsibility of each stage is indicated in the title of the respective chapters.

7.1. Field of Application

This methodology is to be applied by promoters for their mature projects having been submitted to the latest available TYNDP. The concerned categories of infrastructures[15] are:

- transmission pipelines for the transport of natural gas and bio gas that form part of a network which mainly contains high-pressure pipelines, excluding high-pressure pipelines used for upstream or local distribution of natural gas;
- underground storage facilities connected to the above-mentioned high-pressure gas pipelines;
- reception, storage and regasification or decompression facilities for liquefied natural gas (LNG) or compressed natural gas (CNG);
- any equipment or installation essential for the system to operate safely, securely and efficiently or to enable bi- directional capacity, including compressor stations;

In parallel to the maturity criteria, it is necessary to have sufficiently accurate Project-Specific Data along the time horizon per country where the project is built.

7.2. Financial Project-Specific Data

[15] Regulation, Annex II para(2)

The quantification and monetization of an infrastructure project benefits through the PS-step requires several input data items in addition to the ones defined under the TYNDP-Step.
These data items are project-specific and of financial nature. Therefore they should be used by the Promoter himself at this step of the methodology ensures a confidential processing of these data.

Table 10 defines the required Financial Project-Specific data:

Financial Project Specific Data		
Data Item	**Comment**	**Field of Application**
Promoter revenues	As generated by the project	Financial Analysis
CAPEX	Distributed along the time horizon and per country*	Monetary analysis/Financial Analysis
OPEX	Along time horizon and per country*	Monetary analysis/Financial Analysis
Depreciation period	To be used in the calculation of the Residual Value	Monetary analysis/Financial Analysis
Financial Discount Rate	Reflecting the specific regulatory framework or the specific cost of capital	Monetary analysis/Financial Analysis

(*) where costs are spent

Table 10 - List of Financial Project-Specific data

On the basis of the above data, the promoter shall calculate the Residual Value of the asset corresponding to the project.
This value represents the ability of an infrastructure to generate future costs and revenues beyond the first twenty years of operation and until the end of its technical life. Considering the long life of such an asset, its potential to generate future benefits, is supposed to be at least equal with its remaining non depreciated value.
The Residual Value will be reflected differently in the financial analysis and the economic analysis according to the discount factors to be applied. It is calculated according to the following formula:

$$Rv = (A_v - D)$$

Where:

- **Rv** is the Residual value
- $\mathbf{A_v}$ is the Initial value of the asset
- **D** is the depreciation of the asset during the 20 years of operation (or less for the multi-phase projects) based on the respective national regulatory framework

The Residual Value of the asset shall be included in the Financial and the Economic Analysis for the end year of the time horizon of the analysis as an inflow using the following discount rate:

- the Financial Discount Rate for the calculation of the Financial Performance Indicators
  the Social Discount Rate for the calculation of the Economic Performance Indicators

When calculating the performance indicators, the Promoter shall consider the CAPEX and OPEX spent before the year of analysis (*n*). In order to ensure consistency throughout the time horizon, these already incurred costs shall be considered as constant prices for the year of occurrence. The application of the SDR/FDR will bring their value to the present year of analysis.

The Table 11 shows an example of application of discount rate to the CAPEX of a project:

Year	n-2	n-1	n year of analysis	n+1
SDR or FDR	4%			
CAPEX	80	80	80	80
Discounted CAPEX	86.53	83.2	80	76.92

Table 11 - Example of application of Discount Rate

The formulas of performance indicators in chapters 7.8 and 7.10.3 ensure the application of the above concept.

7.3. Time Horizon for the calculation of the Performance Indicators

The TYNDP-Step and the quantitative analysis of the PS-Step cover the same 21-year time horizon starting from the year of analysis[16].

Considering the long technical life and the possible late date of commissioning of gas infrastructures, the calculation of Economic and Financial Performance Indicators is based on an extended time horizon. This extended time horizon covers the period[17] from the year of analysis (first year of the TYNDP-Step) until the twentieth full year of operation. In case of multi-phase projects the period of operation is considered to start with the first capacity increment, the

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[16] *Annex V para 1 "The methodology shall be based on a common input data set representing the Union's electricity and gas systems in the years n+5, n+10, n+15, and n+20, where n is the year in which the analysis is performed."*

[17] *The cost-benefit analysis shall be based on a harmonised evaluation of costs and benefits for the different categories of projects analysed and cover at least the period of time referred to in point (1)" (see above footnote).*

depreciation period for the calculation of the Residual Value of later stages shall start with the commissioning of the respective stage.

Considering *n* as the year of analysis and *c* as the first full year of operation, the performance indicators of a project shall be calculated on the '*n* to *c*+19 years' time horizon (same number of years of operation).

For each year beyond n+20 and up to *c*+19, the saved cost used when calculating the Economic Performance Indicators, are considered equal to their average value between the years *n+16* to *n+20* (5 years) as illustrated in Table 12:

TYNDP-Step	n	…	n+4	n+5	n+6	n+7	…	n+16	…	n+20	*The average of n+16 to n+20*			*Input for residual value (yrs.)*
PS-Step	**Single phase project**			**c**	c+1	c+2	…	c+11	…	c+15	c+16	…	c+19	**20**
	Multiphase project – Phase 1			**c**	c+1	c+2	…	c+11	…	c+15	c+16	…	c+19	**20**
	Multiphase project – Phase 2					**c**	…	C+9	…	C+13	C+14	…	C+17	**18**
				Common time horizon of 20 years of operation for EPI calculation *For multi-phase projects the Time Horizon for the whole project ends with the 20 years of operation of the first phase*										

(*) n is the Year of Analysis
(**) c is the First Full Year of Operation
(***) number of years of operation to be considered for the depreciation of the asset in the calculation of the Residual Value

Table 12 – Illustration of interpolation of saved cost from n+16 to n+20

7.4. Treatment of project costs

Both monetary input and output data of the TYNDP-Step are defined in constant prices. In order to ensure a consistent cash-flow, Promoters shall use constant prices (not impacted by the inflation rate) for the OPEX, CAPEX and Residual Value of their project.

Given the use of constant prices, the Promoters shall apply the real Financial Discount Rate when carrying out a Financial Analysis. The Social Discount Rate defined below is also to be understood as a real value, not including the inflation rate.

7.5. Discount Rates

There are two types of discount rates to be used when applying the methodology:

- Financial Discount Rate - FDR
- Social Discount Rate – SDR

The **FDR** is a Financial Project-Specific Data to be applied when performing the Financial Analysis, as it reflects the financial environment of the project and the cost of capital. It can be also impacted by the regulatory framework in each country. It shall be used when discounting the financial cash-flow for the calculation of Financial Performance Indicators. The FDR shall be applied clean of inflation (real).

The **SDR** is a common data for all projects to be applied when performing the Economic Analysis, as it supports the evaluation of the social welfare induced by a project. A single rate is used to provide a fair basis for the comparison of projects and to avoid any bias introduced by the location of the projects.
A 4% rate has been defined considering the opinion of institutions on the methodology.

7.6. Overview of PS-Step stages

The implementation of the PS-Step is composed of 9 stages to be carried out by project promoters and ENTSOG. The Table 13 provides an overview of the stages:

Combined approach	Stages of PS-Step		Responsibility	Source for Input Data	Output data
	1	Description of the project	Promoter	Project promoter (the same data to be found in the latest available TYNDP)	na
Financial analysis	2	Financial analysis	Promoter	Financial Project specific data	Financial Performance Indicators
Economic analysis	3	PS- Step modelling	ENTSOG	TYNDP- Step	Flow patterns
	4	Quantitative Analysis	ENTSOG	TYNDP-Step	Value of indicators (capacity- and modelled-based)
	5	Calculation of saved costs	ENTSOG	TYNDP-Step	Cost items for Europe
	6	Net Social Welfare per country and for Europe	Promoter	TYNDP- Step &PS-Step	The Social Welfare change induced by the project at EU aggregated and country levels based on the incremental approach

	7	Economic cash flow	Promoter	Stage 6 &Financial Project Specific Data	Economic Performance Indicators
	8	Sensitivity analysis	Promoter	Project specific data	Sensitivity of Economic Performance Indicators values
Qualitative Analysis	9	Qualitative analysis	Promoter	Results from Economic Analysis	Reflection on other benefits of a project

Table 13 - Stages of the PS-Step

7.7. **Stage 1** – Description of the Project *(Promoter)*

For all types of infrastructure, the Promoters shall identify their projects based on the following data:

> Their technical scale and dimension by describing the engineering features of the infrastructures[18] as highlighted in Table 14:

Project Types[19]	Data Description per project phase
Transmission	Name of the pipeline section
	Type of pipeline project (Interconnector[20]/Internal Project)
	Length of the pipeline in km
	Diameter (in mm)
	Compressor Power (in MW)
	Interconnected balancing zone and TSOs by the project
	Capacity created by the project per interconnection point and direction
LNG and CNG Terminal	Name of the terminal
	Send out capacity (GWh/d)
	Maximum Size of the ship (m3 of LNG or CNG)
	Storage capacity (m3 LNG or CNG)
	Interconnected balancing zone and TSOs by the project
UGS	Name of facility
	Type of storage
	Withdrawal Capacity (GWh/d)
	Injection Capacity (GWh/d)
	Working Volume (GWh)
	Interconnected balancing zone and TSOs by the project

Table 14 - Description of Projects

[18] *Please note that Nm^3 refers to m^3 at 0°C and 1.01325 bar (as defined in the EASEE gas CBP 2003-001/01)*
[19] *Annex II para 2 of the Regulation*
[20] *Bi-directional and mono-directional Interconnection Points*

- Provide rational and background of the projects
- Define the objective of the projects, indicating which criteria they comply with, as described in Art.4 of the Regulation.

7.8. **Stage 2** – Financial Analysis *(Promoter)*

The purpose of this stage is the calculation of indicators providing a view on the financial performance of the project. The definition of a common set of indicators ensures the comparability between projects and reflects their commercial viability.
Each performance indicator provides specific information on the financial aspect of the project. They should be analysed altogether not giving undue priority to one of them. They are sensitive to the time horizon, the discount factor applied and therefore to the distribution of revenues and costs within the time horizon of the analysis.

Project Promoters shall calculate the following Financial Performance Indicators on the 'n to c+19' time horizon as defined under chapter 7.3 using their Financial Project-Specific Data.

7.8.1. **Financial Net Present Value (FNPV)**

This indicator represents the discounted financial cash-flow of the project. It shall be calculated according to the following formula:

$$FNPV = \sum_{t=f}^{c+19} \frac{R_t - C_t}{(1+i)^{t-n}}$$

Where:

- ***c*** is the first full year of operation
- $\mathbf{R_t}$ is the promoter revenue generated by the project on year *t* (on year c+19 it also includes the Residual Value of the project)
- $\mathbf{C_t}$ is the sum of CAPEX and OPEX on the year *t*
- ***n*** is the year of analysis
- ***i*** is the Financial Discount Rate of the project
- ***f*** is the first year of revenue or cost

If FNPV is positive the project generates a net benefit.
The FNPV is an indicator reflecting the commercial viability of a project. It is a reflection of the performance of a project in absolute values and it is considered the main performance indicator.

7.8.2. **Financial Internal Rate of Return (FIRR)**

This indicator represents the commercial viability of the project being its ability to generate revenues remunerating its investment and operational costs. The indicator is defined as the discount rate that produces a zero FNPV.

Therefore a project is considered financially desirable if the FIRR exceeds its Financial Discount Rate.

7.8.3. **The Financial Benefit/Cost ratio (FB/C)**

This indicator is the ratio between the discounted benefits and the discounted costs.

$$FB/C = \frac{\sum_{t=f}^{c+19} \frac{R_t}{(1+i)^{t-n}}}{\sum_{t=f}^{c+19} \frac{C_t}{(1+i)^{t-n}}}$$

Where:

- ***c*** is the first full year of operation
- R_t is the promoter revenue generated by the project on year *t* (on year c+19 it also includes the Residual Value of the project)
- C_t is the sum of CAPEX and OPEX on the year *t*
- ***n*** is the year of analysis
- ***i*** is the Financial Discount Rate of the project
- ***f*** is the first year of revenue or cost

If FB/C exceeds 1, the project is considered as financially efficient as the benefits outweigh the costs on the time horizon.
This performance indicators should be seen as complementary to FNPV and as a way to assess/compare projects of different sizes (different level of costs and benefits).

7.9. Economic Analysis *(Promoter/ ENTSOG)*

This part of the methodology describes the way economic impact of a project is assessed based on the requirements of the Regulation[21]. It is based on the Combined Approach intending to

[21] Art. 11 para 1 of the Regulation

capture the widest range of benefits with a particular focus on the cross-border dimension as a prerequisite for Projects of Common Interest.
It consists of:

- The Quantitative Analysis
- The Monetary Analysis
- The Qualitative Analysis

The Quantitative and Monetary Analyses are essentially based on the incremental approach being the assessment of Specific Criteria with and without the project. The difference between the two assessments measures the impact of the project.

7.9.1. The incremental approach

The incremental impact of a project is highly dependent on the level of infrastructure development it is compared against.
For that purpose, the incremental approach shall be carried out measuring project benefits under the High and Low Infrastructure Scenarios.

This means that for each of the Infrastructure Scenarios there shall be two sets of analysis performed:

- one with the project data included in the scenario (**Including Project Data [IPD]**)
- one with the project data excluded from the scenario (**Excluding Project Data [EPD]**)

Given the structure of the infrastructure scenarios, the incremental approach is to be applied differently depending on the Final Investment Decision (FID) status of each Project.

- **For FID projects**

  The project data is included in the Low Infrastructure (LI) scenario and also in the High Infrastructure (HI) one. The analysis reflecting the incremental approach should therefore be carried out as illustrated in Figure 10 and Table 15:

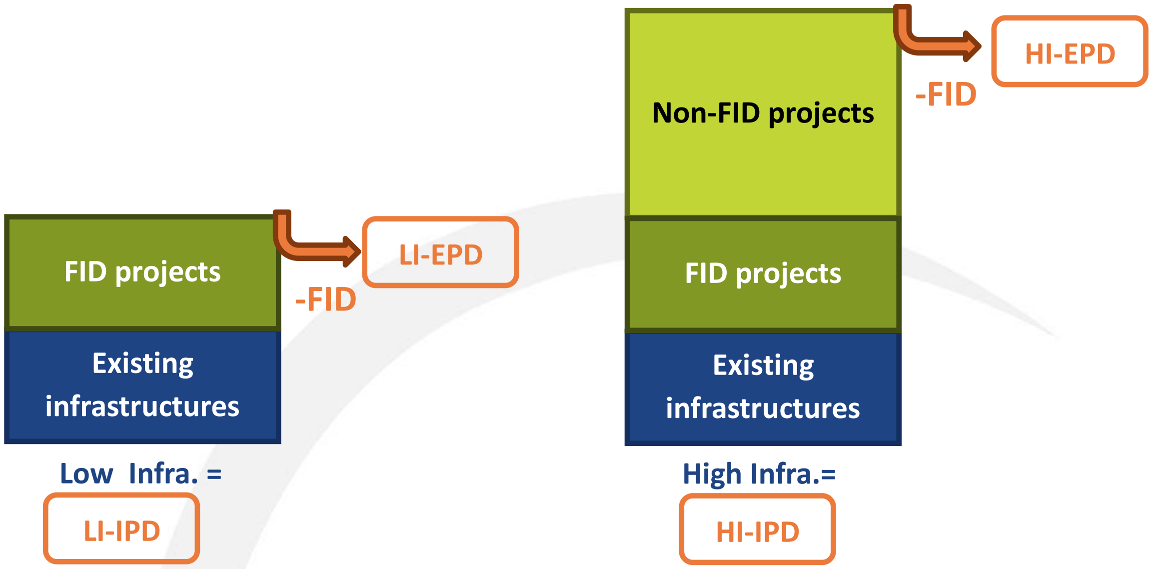

Figure 10 - Incremental approach applied to FID Projects

TYNDP-Step	PS-Step analysis	Comment
LI	LI-IPD	Already included in TYNDP-Step as LI
	LI-EPD	Additional analysis requiring the subtraction of the project from the LI Infrastructure Scenario
HI	HI-IPD	Already included in TYNDP-Step as HI
	HI-EPD	Additional analysis requiring the subtraction of the project from the HI Infrastructure Scenario

Table 15 - Incremental approach applied to FID Projects

> **For Non-FID projects**

The project data is not included in the Low Infrastructure (LI) scenario but it is included in the High Infrastructure (HI) one. The analyses reflecting the incremental approach should therefore be carried out as illustrated in Figure 11 and Table 16:

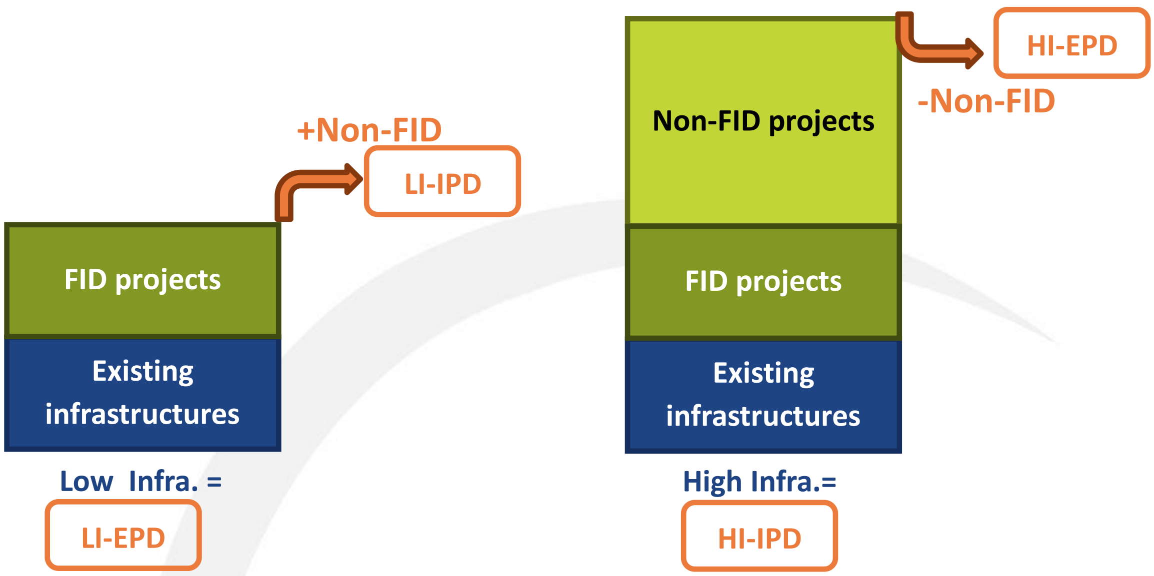

Figure 11- Incremental approach applied to Non-FID Projects

TYNDP-Step	PS-Step analysis	Comment
LI	LI-IPD	Additional analysis requiring the addition of the project to the LI Infrastructure Scenario
	LI-EPD	Already included in TYNDP-Step as LI
HI	HI-IPD	Already included in TYNDP-Step as HI
	HI-EPD	Additional analysis requiring the subtraction of the project from the HI Infrastructure Scenario

Table 16 - Incremental approach applied to Non-FID Projects

7.9.2. **Stage 3** – PS-Step modelling *(ENTSOG)*

The same cases as in the TYNDP-Step and defined in chapter 4.6 shall be modelled on the years n, n+5, n+10, n+15 and n+20 (n being the year of analysis) for the Low and High Infrastructure Scenarios. The only difference will be the addition or the subtraction of the project based on the incremental approach, described in chapter 7.9.1.

7.9.3. **Stage 4** – Quantitative Analysis *(ENTSOG)*

The quantitative analysis as part of the PS-Step is based on the calculation of the same set as in the TYNDP-Step with the addition of the Bi-directional one. Calculation shall be carried out on the years n, n+5, n+10, n+15 and n+20 (n being the year of analysis).

The Table 17 defines the list of indicators to be calculated as part of the PS-Step for each Global Context and Gas Demand Scenario and applying the incremental approach to the Infrastructure Scenarios:

	Indicator	Climatic Case	Without Supply Stress	With Supply Stress
Capacity-based	N-1	1-DC	N/A	N/A
	Import Route Div.	N/A	N/A	N/A
	Bi-directional	N/A	N/A	N/A
Modelled-based	Remaining Flex.	1-DC & 14-UR	X	X
	Disrupted Demand	1-DC & 14-UR	X	X
	Cooperative Supply Source Dependence	Whole year*	X	
	Uncooperative Supply Source Dependence	Whole year*	X	
	Supply Source Price Diversification	Whole year*	X	
	Price Convergence	Whole year*	X	

(*): as the temporal optimization of the succession of one Average Summer Day, one Average Winter Day, 1-day Design Case and 14-day Uniform Risk

Table 17 - List of indicators part of the PS-Step

The numerical value of each indicator and the incremental value as the difference between the values with and without the project shall be reported for each Zone in the PS-Step Outut Table.

7.10. Monetary Analysis *(ENTSOG/Promoter)*

7.10.1. **Stage 5** - Calculation of saved-costs (ENTSOG)

This part of PS-Step monetary analysis is based on the calculation of costs for Europe in the same way as for the TYNDP-Step. Calculation shall be carried out on the years n, n+5, n+10, n+15 and n+20 (n being the year of analysis).

The Table 18 defines the cost items to be calculated as part of the PS-Step for each Global Context and Gas Demand Scenario and applying the incremental approach to the Infrastructure Scenarios:

Cost item	Climatic Case	Without Supply Stress	With Supply Stress
Gas supply	Whole Year*	X	
Coal for power generation	Whole Year*	X	
CO2 emission from power generation	Whole Year*	X	
Other fossil fuels in isolated areas**	Whole Year	X	

(*): as the temporal optimization of the succession of one Average Summer Day, one Average Winter Day, 1-day Design Case and 14-day Uniform Risk
(**) only applies to project connecting new areas to gas market

Table 18 - Cost items part of PS-Step

Replacement of other fossil fuel in isolated areas

This evaluation is based on the monetization of the replacement of more expensive and/or polluting fossil fuels by natural gas. The associated saved-cost is defined as the difference on the time horizon between:

- The CO_2 emission and import price in the area of fossil fuels on the time horizon if gas is not available
- The CO_2 emission and import price in the area of fossil fuels on the time horizon when gas is available

The import price of fossil fuels and CO_2 emission factors are the one defined as part of the System-Wide data. The conversion factor to natural gas is the one provided by the Promoters but it has to be validated by the concerned Member States.

In order to support the definition of economic cash-flow for each project, the monetization of cost items for each year from n to n+20 (n being the year of analysis) is done through linear interpolation of the modelled years.

In case the first full year of operation of a project is not overlapping (e.g. n+13) with a modelled year (n, n+5, n+10, n+15 and n+20), the definition of the economic cash-flow for each year between the First Full Year of Operation and the next modelled year will be done the following way and according to Table 19 example:

- When simulating the PS-Step cases, the project having its First Full Year of Operation within a period of two simulated years (e.g. n+13) will be included in the previous modelled year (n+10) as if it had already been commissioned
- The EU Social Welfare for the purpose of cash flow of the EPIs will be interpolated between the First Full Year of Operation (n+13) and th next simulation (n+15) based on the available simulation results (n+10 and n+15)

Steps	n+10	n+11	n+12	n+13	n+14	n+15
1	Modelled year adding or subtracting the Project*			First Full Year of Operation of the Project		Modelled year adding or subtracting the Project*
2	Calculated Social Welfare					Calculated Social Welfare
3				Social Welfare by linear interpolation based on years n+10 and n+ 15		

(*) according to the incremental approach and the FID status of the Project

Table 19 - EU Social Welfare for the First Full Year of Operation

As an output of this stage, the following values shall be reported in the PS-Step Output Table for each year from n to n+20:

- Value for each cost item at EU aggregated and country levels before the project
- Value for each cost item at EU aggregated and country levels after the project
- The Social Welfare change induced by the project at EU aggregated (ΔSW_{EU}) and country (ΔSW_C) levels as the difference of the above cost items

7.10.2. **Stage 6** - Net Social Welfare per country (Promoter)

The Net Social Welfare induced by the project on country C is measured as the difference between:

- the Social Welfare induced by the project in country C (ΔSW_C) as calculated above
- the CAPEX and OPEX of the project spent the country C

7.10.3. **Stage 7 -** Economic Performance Indicators *(Promoter)*

The purpose of this stage is the calculation of indicators providing a view on the economic performance of the project. The definition of a common set of indicators ensures the comparability between projects and reflects in an aggregated form of their impact on the European social welfare.

Each performance indicator provides specific information on the economic aspect of the project. They should be analysed altogether not giving undue priority to one of them. They are sensitive to the time horizon, the Social Discount Rate applied and therefore to the distribution of revenues and costs within the time horizon of the analysis.

Project Promoters shall calculate the following Economic Performance Indicators on the 'n to c+19' time horizon as defined under chapter 7.3 using their Financial Project-Specific Data and the European Social Welfare change induced by the project (ΔSW_{EU}) as calculated under chapter 4.5. The European Social Welfare induced by the project for the years n+21 to c+
19 is considered as being equal to the average value of the last five years (n+16 to n+20) unless the commissioning year is later than n+16 as shown in the table of chapter 7.3 on time horizon.

For discounting the economic cash-flow promoters shall use the common Social Discount Rate defined under chapter 7.5.

> **Economic Net Present Value (ENPV)**

This indicator represents the discounted economic cash-flow of the project. It shall be calculated according to the following formula:

$$\boldsymbol{ENPV = \sum_{t=f}^{c+19} \frac{R_t - C_t}{(1+i)^{t-n}}}$$

Where:

- ***c*** is the first full year of operation
- **R_t** is the European Social Welfare induced by the project (ΔSW_{EU}) on year *t* (on year c+19 it also includes the Residual Value of the project)
- **C_t** is the sum of CAPEX and OPEX on the year *t*
- ***n*** is the year of analysis
- ***i*** is the Economic Discount Rate of the project
- ***f*** is the first year of induced social welfare (ΔSW_{EU}) or cost

If ENPV is positive the project generates a net benefit.

The ENPV reflects the performance of a project in absolute values and it is considered the main performance indicator.

> **Economic Internal Rate of Return (EIRR)**

This indicator represents the economic viability of the project being its ability to generate social welfare higher than its investment and operational costs. The indicator is defined as the discount rate that produces a zero ENPV.

Therefore a project is considered economically desirable if the EIRR exceeds its Social

Discount Rate.

> **The Economic Benefit/Cost ratio (EB/C)**

This indicator is the ratio between the discounted benefits and the discounted costs.

$$\boldsymbol{EB/C} = \frac{\sum_{t=f}^{c+19} \frac{\boldsymbol{R_t}}{(\boldsymbol{1}+\boldsymbol{i})^{\boldsymbol{t-n}}}}{\sum_{t=f}^{c+19} \frac{\boldsymbol{C_t}}{(\boldsymbol{1}+\boldsymbol{i})^{\boldsymbol{t-n}}}}$$

Where:

- ***c*** is the first full year of operation
- $\mathbf{R_t}$ is the European Social Welfare induced by the project (ΔSW_{EU}) on year *t* (on year c+19 it also includes the Residual Value of the project)
- $\mathbf{C_t}$ is the sum of CAPEX and OPEX on the year *t*
- ***n*** is the year of analysis
- ***i*** is the Economic Discount Rate of the project
- ***f*** is the first year of induced social welfare (ΔSW_{EU}) or cost

If EB/C exceeds 1, the project is considered as economically efficient as the benefits outweigh the costs on the time horizon.

This performance indicators should be seen as complementary to ENPV and as a way to assess/compare projects of different sizes (different level of costs and benefits).

7.11. **Stage 8** - Sensitivity Analysis *(Promoter)*

The uncertainty related the European gas market is already captured through the scenario-approach used for the System-Wide Data. It results in the modelling of hundreds of cases.
The uncertainty related to Project-Specific Data has to be handled separately in order to capture the influence of these data on the Economic Performance Indicators. Table 20 defines the variables and ranges to be considered:

	Range compared to the Reference Project-Specific Data					
CAPEX	-30%	-20%	-10%	10%	20%	30%
OPEX			-5%	+5%		
First full year of operation*	+ 1 year	+ 2 years	+ 3 years			

(*) for multiple phase projects, all phases are shifted together

Table 20 - Range of data for Sensitivity Analysis

In order to limit the complexity of this analysis both in terms of number of assessments and interpretability of results, key input data shall be tested one-by-one, leaving everything else unchanged.

7.12. **Stage 9** - Qualitative Analysis *(Promoter)*

The qualitative analysis is the last part of the combined approach. The Promoter shall:

- Comment the results of the Quantitative and Monetary Analyses
- Monetization of demand disruption
- Describe additional benefits that would not have been sufficiently captured
- Identify the significantly impacted country as part of the Area of Analysis
- Identify the environmental impact of the project and associated mitigation measures
- Describe the complementarity of his Project with other projects

7.12.1. Comment on Quantitative and Monetary Analyses

The Quantitative and Monetary Analyses result in a wide variety of information related to project impact. In particular they illustrate the benefits that can be expected from a project under very different scenarios for each input data.
These scenarios are likely to define a range of situation wide enough to cover the assumptions of each Promoter when defining his project. It is nevertheless valuable for the promoter to indicate how his assumptions are compared to the System-Wide Data of the present methodology.
The promoter shall also build a synthesis of the quantitative and monetary results.

7.12.2. Monetization of demand disruption

The modelling approach quantifies the amount of Disrupted Demand per Zone as an indicator of the Quantitative Analysis defined under chapter 5.2.2. Therefore the benefit of a project regarding the mitigation of demand disruption is measured through the incremental approach as the reduction of Disrupted Demand (ΔDD in GWh)

The ESW-CBA methodology does not put an obligation on promoters to monetize this quantity as it would require the consistent definition for each Member State of a Cost of Disruption per Unit of Energy (CoDU – EUR/GWh) standing for the average loss of social welfare when one unit of demand is not supplied. The definition of a CoDU for each Member State is beyond ENTSOG remit and has a clear political dimension. In addition from a technical point of view such a unitary cost depends on the magnitude, duration and occurrence of such an event. Any inconsistency in the definition of such data would introduce a strong bias in the comparability of projects.

In the absence of definition of a CoDU for each Member States, Promoters can voluntarily monetize the reduction of Disrupted Demand resulting from the Quantitative Analysis. For that purpose they would have to:

- Define and justify the CoDU of each impacted Member States
- Multiply the ΔDD by CoDU which would result in the change of Cost of Disruption (ΔCOD – EUR) reflecting the beneficial monetary effect of the project in decreasing the loss of social welfare linked to the disruption

In case a Promoter carries out such monetization it should be done under the 1-day Design Case and 14-day Uniform Risk case with Supply Stress. This can also be done under situation with no Supply Stress for Member States not being able to meet their peak demand under normal circumstances.
Resulting monetary values could be used for an additional calculation of the Economic Performance Indicators. This should not be in substitution of the normal calculation as defined under chapter 7.10.3 as it would not ensure the comparability of projects.

7.12.3. Description of additional benefits

The ESW-CBA methodology is defined prior to the identification of the projects to which it has to be applied. It also has to ensure the consistent treatment of all projects. Therefore some potential benefits may not be captured.
This might be the case in particular for:

- Emission reduction other than CO_2
- Support to RES intermittency
- Bunkering facility associated to LNG terminal supporting the development of cleaner transport
- Opening of foreclosed markets (the use in the ESW-CBA of a single price curve for a given source does not enable to capture the market power of predominant supplier in term of price setting)

Each of the additional benefits declared by Promoters should be justified.

7.12.4. Identification of the Area of Analysis

According to the Regulation, promoters shall identify the Area of Analysis[22] concerned by their project. This area is composed of:

> Member States and third countries on whose territory the projects is to be built
> All directly neighbouring member States if directly connected by gas infrastructure
> All other Member States significantly impacted by the Project as identified through the application of the incremental approach to indicators and the Social Welfare of each country. The meaning of significant impact is to be defined by Regional Groups based on the guidance given under chapter 9.6.

7.12.5. Environmental Impact Indicator

Any gas infrastructure has an impact on its surrounding. This impact is of particular relevance when crossing some environmentally sensitive areas. Mitigation measures are taken by the promoters to reduce this impact and comply with the EU Environmental acquis[23].
In order to give a comparable measure of project effects, the Table 21 shall be filled in by the promoter.

Section of the project	Stage of the project	Type of infrastructure	Surface of impact	Environmentally sensitive area	Mitigation measures
Section 1					
Section 2					

Table 21 - Environmental impact and Mitigation Measures of a Project

Where:

> The section of the project is used to geographically identify the concerned infrastructure
> Stage of the project identifies the phase of implementation of the project (e.g. FEED, construction…) considering that the accuracy of information provided in the matrix is linked to the progress of the project
> Type of infrastructure identifies the nature of the section (e.g. compressor station, pipes…)
> Surface of impact is the area covered by the section in square meters and in linear meters and nominal diameter for pipe. It is used as a proxy as the actual impact may exceed this

[22] Regulation, Annex V para (10)
[23] Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programs on the environment

surface but its definition is too much dependent from national framework to ensure comparability.

> Environmentally sensitive area is described by the relevant legislation as defined below:
  - EIA Directive (2011/92/EU) Annex 3 and its amendment (2014/52/EU) which is to be transposed in 3-year time horizon by Member States
  - SEA Directive (2001/42/EC)
  - Natura 2000 (Habitats Directive (92/43/EEC)[24] and Birds Directive (2009/147/EC))
  - Water Field Directive[25]
  - RAMSAR Convention[26]
  - IUCN key biodiversity areas[27]

> Mitigation measures are the actions undertaken by the promoter to compensate/minimize the impact of the section (e.g. they can be related to the Environmental impact assessment[28] carried out by the promoter)

7.12.6. Interaction with other projects within the Area of Analysis

The impact of a project is linked to the level of development of surrounding infrastructures. This is the reason why the assessment is carried out against the Low and High Infrastructure Scenarios.

As part of this chapter for the qualitative analysis, the promoter is invited to elaborate about the interaction between his project and the ones of other promoters in the Member States included in the Area of Analysis.

This interaction could be of three types:

> Neutral meaning that the project brings benefits of another nature than the other projects

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[24] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora

[25] Directive 2000 /60/EC of the European parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy

[26] The **Ramsar Convention** (formally, the **Convention on Wetlands of International Importance, especially as Waterfowl Habitat**) is an international treaty for the conservation and sustainable utilization of wetlands,[1] i.e., to stem the progressive encroachment on and loss of wetlands now and in the future, recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value. It is named after the city of Ramsar in Iran, where the Convention was signed in 1971.

[27] The **International Union for Conservation of Nature (IUCN)**, is an international organization dedicated to finding "pragmatic solutions to the most pressing environment and development challenges". The organization publishes the IUCN Red List of Threatened Species, which assesses the conservation status of species

[28] Environmental impact assessment means a national procedure for evaluating the likely impact of a proposed activity on the environment (Convention on environmental impact assessment in a trans boundary context-ESPOO/25th February 1991)

- Synergy meaning that the commission of other projects in the area will increase the value of the project of the promoter and vice-versa
- Competition meaning that the commission of other projects in the area will decrease the value of the project of the promoter and vice versa

8. Tools for consolidation of PS-Step

Based on the experience of the first implementation of the TYNDP-Step as part of TYNDP 2015, ENTSOG will develop the tools necessary for the consolidation of PS-Step results. This will ensure a common presentation of results supporting the interpretation of PS-Step by the Regional Groups. These tools will consist of:

- The Output Table for PS-Step: gathering all Project-Specific Data, modelling results provided by ENTSOG and the template for the calculation of Financial and Economic Performance Indicators including the sensitivity analysis
- The Synthesis document: gathering the Description of the Project and the different elements of the Qualitative Analysis.

These tools will be released after the publication of the ESW-CBA methodology and presented during a public workshop ahead of the PCI selection process.

9. Guidance to the Regional Groups

This chapter describes guidance to be considered by members of the Regional Groups when selecting projects or in further stages of the PCI process such as the potential cross-border cost allocation.

They aim at taking full benefit from the width of the ESW-CBA assessment when taking a decision in an uncertain environment. For example the scenario-based approach does not define any reference scenario derived from the current situation in order to avoid introducing a bias in the selection. Indeed the perpetuation of the current situation is not more likely than other evolution.

In order to ensure a fair selection of infrastructure projects, Regional Groups should apply the following guidance in a consistent way at least at regional level.

9.1. Selection of relevant price configurations

When selecting projects each Regional Group should only consider the price configurations relevant for the area among the thirteen being part of the TYNDP-Step. This relevance is based on the potential influence of a supply source in the region.

As part of its support to Regional Groups, ENTSOG will identify through the TYNDP report the relevant price configurations for each group.

9.2. Aggregation of EPIs

Despite the selection of relevant price configurations per region, the PS-Step will result in a high number of indicators and monetary values as a consequence of the scenario-approach. This is also true for the Economic Performance Indicators. The value of EPIs under each case will be provided through the PS-Step Output Table.
In order to facilitate the decision of the Regional Groups, this table will also enable the aggregation of the Economic Performance Indicators of different cases. Such aggregation should be done only after having analysed the individual cases and should be the same for each project within a given region.

9.3. Guidance for the interpretation of indicators and monetization

9.3.1. Analysis of Specific Criteria

The combined approach intends to capture the different facets of the Specific Criteria defined by the Regulation while mitigating the risk of double counting.
The Table 22 provides guidance for the interpretation of results establishing the link between each element of the Economic Analysis and the Specific Criteria. It also highlights the fact that the same indicator may reflect different criteria confirming that the pillars of the EU Energy Policy are closely linked rather than in opposition.

	Assessed aspects	Addressed Specific Criteria			
		SoS	Sust.	Comp.	Mkt. Int.
Capacity-based indicators	« N-1 »	X			
	Bi-directional	X			X
	Import Rte Diversification	X		X	X
Modelling based indicators	Supply Source Price Diversification	X		X	X
	Supply Source Dependence	X		X	
	Remaining Flexibility	X			X
	Disrupted demand	X			
	Price convergence			X	X
Monetization	Gas supply			X	X
	Coal for power generation		X		
	CO_2 emission from power generation		X		

Qualitative analysis	Commenting and developing on project benefits	X	X	X	X
	Infrastructure Environmental Impact		X		

Table 22 - Link between Combined approach and Specific Criteria

9.3.2. Scope of the Monetary Analysis

When interpreting the Economic Performance Indicators, Regional Groups shall consider that the methodology does not lead to a full monetization of all project benefits (e.g. the cost of disruption will be monetized only for some projects at Promoter' initiative). Therefore a negative Economic Net Present Value does not always mean that a project has a net negative impact.

9.3.3. Split of Social Welfare per Member States

The use of supply curves may result in the decrease of Social Welfare of some countries when a project improves the ability of Europe to offtake more gas from the cheapest source. This will result in making this source more expensive.

This may lead to a situation where the benefits for some poorly integrated countries are not perceivable through the European Social Welfare. Therefore Regional Groups should also pay attention to the split per country for projects not increasing the European Social Welfare.

In addition, when the results of the PS-Step are used for a cross-border cost allocation, regulators should keep in mind that the split of Social Welfare per country results from a pre-defined algorithm (as defined under chapter 4.5) and that other ones could result in different repartitions.

9.4. Project Interaction

As part of the Qualitative Analysis promoters are invited to identify the projects interacting with their own ones. Table 23 illustrates how the comparison of the PS-Step results under the Low and High Infrastructure Scenarios provides a robust basis to identify the level of interaction between projects within a given area:

Type of interaction	Low Infra. Scenario	High Infra. Scenario	Comment
Synergy	+	+++	Cumulative effect of projects higher than the sum of their individual impact
Neutral	+	+	Cumulative effect of projects identical to the sum of their individual impact
Competition	+++	+	Cumulative effect of projects lower than the sum of their individual impact

Table 23 - Types of Project interaction

It has to be noted that the interaction may differ from one Specific Criteria to the other (two projects may be in competition when measuring the Remaining Flexibility but in synergy when measuring the Supply Source Diversification).

9.5. Guidance for the interpretation of possible monetization of disruption by promoters

If Promoters monetize Disrupted Demand as part of the Qualitative Analysis (see), Regional Groups should ensure that the Cost of Disruption per Unit of energy (CoDU) is applied consistently (e.g. the CoDU value for a given country and year should be the same for all projects).

Such Promoters are calculating the EPIs with and without monetization of disruption. The comparability of projects is basically ensured through the version without monetization. The version with monetization may help to better illustrate benefits of projects whose main driver is the Security of Supply. Nevertheless Regional Groups should pay attention to the definition to the CoDU.

9.6. Guidance for significantly impacted countries

As the Regulation does not define any threshold about the significance of the impact of a project, this evaluation should be done by Regional Groups. The Quantitative and Monetary Analyses provides all results necessary for that purpose.

The definition of thresholds by Regional Groups should consider the following parameters:

- Magnitude of the incremental impact of a project on indicators and saved-costs
- Number of cases under which an impact is observed
- Number of years when an impact is observed

Such thresholds should be defined in a consistent way for all Projects within a Region.

9.7. Consideration of countries part of the EEA

The Regulation being of EEA relevance[29] Regional Groups should also consider the benefits to non-EU EEA countries and in particular Norway. Such benefits occur when a project enables additional total export to EU from this source especially under the price configuration “Norway cheap”.

[29] Art. 4 para 1 (a)(iii) of the Regulation

10. Glossary

1-DC means 1-day Design Case as defined under chapter 3.4.2

14-UR means 14-day Uniform Risk as defined under chapter 3.4.2

BDPi means Bi-Directional Project indicator at Interconnection Point level as defined under chapter 5.1.3

BDPz means Bi-Directional Project indicator at Cross-Zone level as defined under chapter 5.1.3

Call for PCI Candidates: process managed by European Commission through which Promoters declares their willingness to have their projects participating to the next PCI selection

Capacity-based Indicator: category of indicators not using modelling output in their formula, however their values change with time, depending on the change of the input data.

CAPEX (Investment Costs) means all those costs that are incurred in view of the effects that will accrue beyond the period in which the relative disbursements were made.

CBA (Cost-Benefit Analysis) means a conceptual framework to define in what extent a project is worthwhile from a social perspective; such CBA is carried out according to a CBA methodology

CoDU means Cost of Disruption per Unit of energy as defined under chapter 9.5

Commercially sensitive information[30] means information of either qualitative or quantitative character whose exposure to non-authorized third parties could incur damage on the party concerned by the information or on its commercial partners; authorized third parties can be either authorities having the right of access to Commercially sensitive information embedded in national or European legislation or third parties, notably consultants, who have signed a confidentiality agreement with the owner of the information.

Constant prices are those prices as expressed in real value, not affected by the inflation rate.

Cross-border cost allocation means a procedure, as well as the results of such procedure, through which concerned authorities take a decision on where the costs of a project should be allocated.

CSSD means Cooperative Supply Source Dependence indicator as defined under chapter 5.2.4

DD means Disrupted Demand indicator as defined under chapter 5.2.2

Discount rate means the rate used in discounting future cash flows in order to reflect how the benefits and costs are to be valued against the present ones.

EB/C means Economic Benefit/Cost ratio indicator as defined under chapter 7.10.3

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[30] According to the Regulation, Article18 para(c) : "The Commission shall establish by six months after the date of adoption of the first Union list an infrastructure transparency platform easily accessible to the general public, including via the internet. This platform shall contain the following information… :
…the main results of the cost-benefit analysis on the basis of the methodology drawn up pursuant Article 11 for the projects of common interest concerned, except for any commercially sensitive information"

Economic analysis means the analysis based on and complementary to the financial analysis aiming at assessing a project's externalities and as such its contribution to the economic welfare of a region or country according to specified criteria;

EEA means the European Economic Area which covers Iceland, Liechtenstein and Norway in addition to EU Member States

EIRR means Economic Internal Rate of Return indicator as defined under chapter 7.10.3

ENPV means Economic Net Present Value indicator as defined under chapter 7.10.3

EPI means Economic Performance Indicators as defined under chapter 7.10.3

ESW-CBA Methodology means the Energy System-Wide Cost-Benefit Analysis Methodology developed by ENTSOG on the basis of the Regulation and consisting of the TYNDP-Step and Project Specific-Step

FB/C means Financial Benefit/Cost ratio indicator as defined under chapter 7.8.3

FID (Final Investment Decision) means the decision taken at the level of an undertaking to definitively earmark funds towards the investment phase of a project, the investment phase meaning the phase during which construction or decommissioning takes place and capital costs are incurred (*definition taken from Regulation EU No 256/2014 concerning the notification to the Commission of investment projects in energy infrastructure within the European Union, replacing Council Regulation (EU, Euratom) No 617/2000 and repealing Council Regulation (Ec) No 736/96*);

Financial Discount Rate which means the discount rate considered as appropriate by the Promoter and to be applied to the financial cash flow in order to calculate the present value of the future cash flows.

FIRR means Financial Internal Rate of Return indicator as defined under chapter 7.8.2

First Full Year of Operation means the first year (from the 1st of January until the 31st December) of commercial operation of the project. For multi-phased projects, the First Full Year of Operation is the one of the first phase.

FNPV means Financial Net Present Value indicator as defined under chapter 7.8.1

HI means High Infrastructure Scenario as defined under chapter 3.6.2

HI-EPD means High Infrastructure Scenario excluding Project data as defined under chapter 7.9.1

HI-IPD means High Infrastructure Scenario including Project data as defined under chapter 7.9.1

IRD means Import Route Diversification indicator as defined under chapter 5.1.1

LI means Low Infrastructure Scenario as defined under chapter 3.6.2

LI-EPD means Low Infrastructure Scenario excluding Project data as defined under chapter 7.9.1

LI-IPD means Low Infrastructure Scenario including Project data as defined under chapter 7.9.1

LNG Terminal means a facility to receive LNG cargo, store and regasify gas

N-1 means N-1 indicator for ESW-CBA as defined under 5.1.2

National Production means a source of gas which is produced or extracted on the territory of an EU Member States.

NRA means national regulatory authority

OPEX (Operating costs) means all those costs that are incurred after the (partial)[31] commissioning of an asset and which are not of an investment nature, such as: direct production/operating costs, administrative and general expenditures, sales and distribution expenditures, etc.

PC means Price Convergence indicator as defined under chapter 5.2.7

PCI (Project of Common Interest) means a project which meets the general and at least one of the specific criteria defined in Art. 4 of the Regulation and has been granted the label of PCI project according to the provisions of the Regulation

Project means the infrastructure project to which the PS-Step is applied

Promoter means the project promoter carrying out the PS-Step for its Project

Regulation means the Regulation (EU) 347/2013 of the European Parliament and of the Council on 17 April 2013 on guidelines for trans-European energy infrastructure and repealing Decision (EU) 1364/2006 and amending Regulations (EU) 713/2009, 714/2009 and 715/2009

RF means Remaining Flexibility indicator as defined under chapter 5.2.1

Rv means Residual Value as defined under 7.2

Sensitivity analysis means the analysis aiming at determining the critical variables or parameters of the model whose variations, positive or negative, have the greatest impact on a project's financial and/or economic performance.

Social Discount Rate which means the discount rate used for the economic analysis, which reflects the social view on how future benefits and costs are to be valued against present ones and could derive from the predicted long term growth in the economy.

SSPDe means Supply Source Price Dependence indicator as defined under chapter 5.2.6

SSPDi means Supply Source Price Diversification indicator as defined under chapter 5.2.5

Ten-Year Network Development Plan (TYNDP) means the Union-wide report carried out by ENTSOG every other year as part of its regulatory obligation as defined under Article 8 para 10 of Regulation (EC) 715/2009.

UGS means underground gas storage

USSD means Uncooperative Supply Source Dependence indicator as defined under 5.2.3

Zone means a balancing zone at which level market shall balance gas demand and supply

[31] When applicable.