Developing a CBA methodology for Projects of Common Interest (PCIs)

Scoping Document for the Informal Public Consultation

Brussels,

20.03.2013

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1. Background

It is anticipated that the Regulation of the European Parliament and of the Council on guidelines for trans-European energy infrastructure[1] (hereafter Infrastructure Guidelines Regulation or Regulation) will enter into force in May 2013.

The purpose of this Regulation is to facilitate investment in the energy infrastructure in order to achieve the Union's energy and climate policy objectives.

The Regulation establishes rules for identifying projects of European significance. Such Projects of Common Interest (PCI) will benefit from streamlined permitting procedures within Member States and where applicable cross-border cost allocation. PCIs will also be potentially eligible for European financial support in the form of financial instruments or direct grants through the Connecting Europe Facility.

The Regulation defines 12 European energy priority corridors and establishes Regional Groups to assess PCI candidate projects in the respective regions. The following four corridors have been identified for gas projects:

- North-South Gas Interconnections in Western Europe (NSI West Gas),
- North-South Gas Interconnections in Central-Eastern and South-Eastern Europe (NSI East Gas),
- Baltic Energy Market Interconnection Plan in gas (BEMIP Gas),
- Southern Gas Corridor (SGC).

Each group shall be composed of representatives of the Member States (MSs), National Regulatory Authorities, transmission system operators as well as the Commission, the Agency and the ENTSO for Gas.

Each Group shall adopt a regional PCI list and subsequently, a Union-wide PCI list shall be adopted by the Commission through a delegated act. For the first list, the selection process of the Regional Groups is assisted by a Consultant, selected by the Commission. In order to develop the first lists, the consultants have developed a methodology to analyse the impact of candidate projects. Those candidate PCI projects do not have to be a part of the current ENTSOG TYNDP for the initial PCIs list.

For the enduring process, a new Union list shall be established every two years. Projects of common interest that are completed or that no longer fulfil the relevant criteria and requirements as set out in the Regulation should not appear on the next Union list.

In order to be included in the enduring PCI application process, candidate projects will be part of the latest available ENTSOG Ten-Year Network Development Plan (TYNDP). Following

1Regulation of the European Parliament and of the Council on guidelines for trans-European energy infrastructure and repealing Decision No 1364/2006/EC and amending Regulations (EC) No 714/2009 and 715/2009 their inclusion into the adopted Union list, PCI projects shall become part of the relevant regional investment plans and of the relevant national Network Development Plans.

2. Objective of the Informal Consultation

Once the Regulation has entered into force, ENTSOG has six months to develop a methodology that will be used to articulate the costs and benefits of proposed Projects of Common Interest.

Given the accelerated development period ENTSOG has decided to initiate a preliminary, informal public consultation in order to provide the broadest opportunity for stakeholders' feedback and engagement prior to formal adoption of the Regulation.

This document describes the scope of the Regulation, the major steps in the Cost Benefit Analysis (CBA) methodology development and the approach and assumptions that inform our draft outline of the CBA methodology. Each section is accompanied by a series of questions which focus on the most significant issues of the methodology development.

As the timescale for formal development and consultation is very tight, it is important that stakeholders indicate their intentions to play a full and active role through this informal consultation.

The informal consultation will be later followed by an ENTSOG's formal public consultation on the CBA methodology which will be based on our established best practices. This formal public consultation process will enable all stakeholders an open opportunity to provide feedback and clarify any aspects of the CBA methodology.

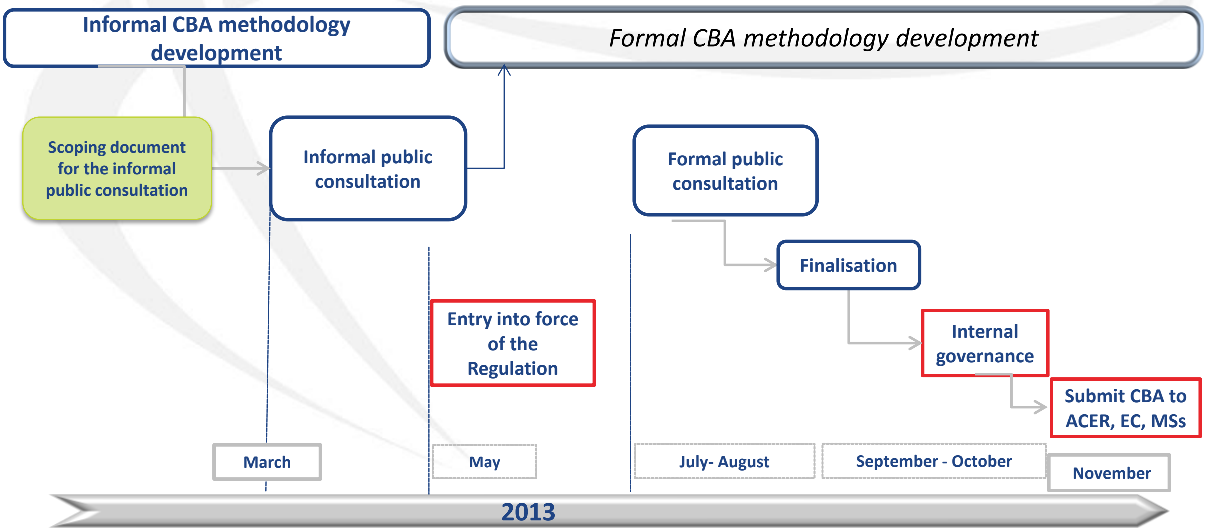

Figure 1. Indicative Timeline for the 1st PCI Selection

The indicative timeline figure XX identifies the formal development timeline for the CBA and compilation of the first Union-wide PCI list. All the dates are indicative and are based on the assumption that the Regulation enters into force in May 2013. In the event of a later entry into force, all subsequent timings will alter accordingly.

3. Approach to CBA methodology development

The scope of the consultation is to support the development of a Cost Benefit Analysis methodology. This will comprise an Energy System Wide Analysis based on the ENTSOG TYNDP and a standardized Project Specific Analysis for project promoters to apply to their projects. For both elements of the methodology, the approach ENTSOG proposes to take is to:

Equitability

- Ensure that all gas infrastructure Project promoters have every opportunity to be included within the process by submitting their project into the TYNDP
- Ensure that there is no inherent bias in the methodology that could induce undue discrimination between categories of gas infrastructures
- Ensure the minimum distortion of market based solutions - no bias in terms of market based or publicly funded projects

Consistency

- Ensure that the methodology used is applied consistently based on reliable and uniform use of the input data and the same reference sources
- Ensure that the project specific analysis builds upon the energy system wide analysis

Robust justifiable analysis

- Ensure modeling used in the energy system wide analysis is applied consistently
- Develop and apply indicators that are clear and relevant in reflecting the requirements of the Regulation
- Ensure that the benefits will not be double counted within the Project Specific CBA
- Ensure that the results of the methodology provide logical results in line with the Regulation
- Ensure robustness by performing sensitivity analysis of the most important input to the model

Efficient and reflective

- Enable project promoters to have a clear understanding of the Project Specific Analysis required by the Regulation for sufficiently mature projects
- Develop an effective framework for project specific CBA supported by indicators that demonstrate the societal value of infrastructure projects

Q.1. Do you agree with the approach taken by ENTSOG to the development of the methodology? Which additional elements should be included in the ENTSOG approach?

The methodology and the approach are exhaustive and complete.

4. CBA Methodology

4.1. Pillars of the Cost Benefit Analysis Methodology

ENTSOG will develop the Cost Benefit Analysis (CBA) methodology for Projects of Common Interest building in particular on the Union-wide Ten-year Network Development Plan and the related consultation process. ENTSOG proposes to develop a holistic methodology with an Energy System Wide analysis based on the TYNDP and a complementary Project Specific Analysis applicable by the project promoter. The CBA methodology should:

- enable an efficient assessment of the Europe wide impact of the PCIs as a whole, in line with the relevant objectives of the Regulation, and
- provide a consistent, methodological basis for Project promoters to undertake their own project analysis in support of their submission for the PCI selection and any investment request for cross-border cost allocation and/or financial support to the respective authorities.

For the Project Specific analysis, ENTSOG will develop a CBA coupled with a quantitative assessment[2]. ENTSOG will utilise internationally agreed references to specific prices. Where such prices and reference costs are not available to support monetization or monetization is not possible *per se* then quantitative indicators will be used in the assessment.

At the core of the proposed CBA methodology is differential analysis of the Project. This approach means, that the project promoter will evaluate their project on the basis of differences in the costs and benefits between the cases with the project and without the project

4.2. Objective of the CBA Methodology

The CBA Methodology should provide a tool to reflect the contribution of the candidate PCI projects to meet the criteria requested by the Regulation. These criteria represent the societal benefits of the planned projects.

4.2.1. General criteria (Article 4.1 of Regulation)

ENTSOG's approach to reflect the Cross-border impact in the Energy System Wide analysis is

2 In line with to the DG Regio CBA Guideline 2008, a Cost Benefit Analysis consists of monetary reflection of benefits. Methodology developed by ENTSOG however will be a combined methodology, including CBA and complementary quantitative assessment. In addition qualitative assessment can be presented by the Project Promoters to the Regional Groups to support their projects. These elements are to be seen as complements to CBA, not as substitutes.

to measure the effect of PCI candidate project clusters[3] along the criteria defined by the Regulation using the assessments defined in TYNDP[4].Building upon this assessment, project promoters will prove the cross-border impact of their project on the European gas infrastructure through project specific assessments. ENTSOG foresees the application of project specific indicators along the criteria defined in the Regulation.

> The project is necessary for at least one of the priority corridors and areas identified in the Regulation and
> The potential overall benefits of the project outweigh its costs including on longer term and
> The project has cross-border impact[5]

Q.2. Considering the obligation to prove a project's cross-border impact, what information could the project promoters provide to demonstrate this?

Regulators and institutional representative should provide their opinion on internal member state and cross border member state impacts.

4.2.2. Specific criteria: (Article 4.2 of Regulation)

The specific criteria described by the Regulation in article 4.2[6] are as follows:

> Market integration, inter alia through lifting the isolation of at least one Member State and reducing energy infrastructure bottlenecks; interoperability and system flexibility
> Security of supply , inter alia through appropriate connections and diversification of supply sources, supplying counterparts and routes
> Competition, inter alia through diversification of supply sources, supplying counterparts and routes
> Sustainability, inter alia through reducing emissions, supporting intermittent renewable generation and enhancing deployment of renewable gas

4.3. The Energy System Wide CBA (ESW CBA)

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[3] Means a combination of Infrastructure Projects based on a parameter or a set of parameters. Currently, the TYNDP 2013-2022 applies a single parameter, namely the FID status (FID/Non-FID

4 TheTYNDP currently contains an assessment of the resilience of the European gas network, the Supply Source Dependence, network adaptability to Supply Evolution and the capability for Supply Source Diversification.

5 Involves at least two MSs, by directly crossing the border of two or more MSs or is located on the territory of one MS and has a significant cross-bored impact impact (ie, for gas transmission, the project concerns investment in reverse flow capacities or changes the capability to transmit gas across the border(s) of the concerned Member States by at least 10% compared to the situation prior to the commissioning of the project; 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) or crosses the border of one MS and an EEA country.

[6] See Annex A for further details on the development of some of these criteria in the TYNDP 2013-2022 Methodology Chapter

4.3.1. General Approach: Building on TYNDP

The Regulation links the development of the methodology with the existing TYNDP process. In this context, ENTSOG will build upon the TYNDP methodology that analyses at an EU level the overall impact of clusters of projects on the gas system.

Currently the TYNDP is based on 2 infrastructure clusters:

- FID cluster including existing projects + FID projects) and
- Non-FID cluster including existing projects + FID projects +non FID projects.

Our initial analysis shows that two additional clusters, “PCI FID projects” and” PCI non-FID projects”, could be introduced to assess the PCIs impact at the ESW level.

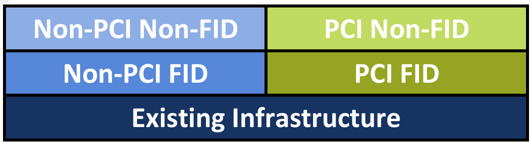


Figure 2. Proposed new clusters for PCIs

The ESW CBA methodology will include:

- Description of the network model applied by ENTSOG
- Definition of the scenarios and cases for *n+5, n+10, n+15* and *n+20* year time horizons, where *n* is the year of the analysis
- Data extrapolations for *n+15*, *n+20* year time horizon, based on the TYNDP 10-year data and executed specifically for the scope of the CBA,
- Definition of parameters for the Sensitivity analysis
- Definition of indicators

Q.3. Should we consider any additional information for the ESW modelling in order to reflect the impact of candidate PCI projects?

Is the market development scenario considering also latest assumption, such as potential demand deriving from transportation’s sector analysis that consider LNG as the most probable substitute to traditional fuel for land and sea vehicles (2015 SECA etc.) or USA exporter from 2016?

4.3.2. Assessment of the specific criteria within the ESW CBA

The ESW CBA will build upon TYNDP and its methodology. Currently, ENTSOG use the Network Modelling tool (NeMo tool) to assess the role of the gas infrastructure in sustaining the pillars of the European energy policy, in particular Security of Supply and Competition. The results of the assessment give an overall indication of the level of infrastructure-related Market Integration.

Sustainability is a specific criteria defined in the Regulation. This is not yet assessed in detail within the TYNDP. Going forward some broad assumptions can be made to assess the impact on sustainability. For instance, due to the commissioning of new gas infrastructure, the incremental volumes particularly for power generation could replace the consumption of alternative fuels with higher CO2 emissions and costs. It is noted that the assessment of the contribution of gas infrastructure projects to sustainability may be based on different assumptions than the ones used in assessment of electricity infrastructure projects.

Q.4. What assumptions should ENTSOG make for the ESW CBA on the sustainability criterion?

Q.5. How should the CBA methodology reflects the contribution of Gas infrastructure to sustainability, for instance by replacing other fossil fuels plants by gas-fired power generation or through micro-cogeneration and transportation?

Is the project useful for alternative usage for example an LNG terminal has the technical characteristics to provide LNG bunkering? This could give a better overview on LNG terminals in providing additional contribution in anti environmental pollution.

Q.6. What assumptions should ENTSOG make for the ESW CBA on the competition criterion considering the existing TYNDP[7] methodology?

4.3.3. Input Data

The majority of the input data identified within the Regulation for the ESW CBA is already available within the TYNDP. Moving forward, important additional information will need to be collected:

- Reference for CO2 prices and emissions per fuels
- Reference prices for oil, gas, coal

The data used for the development of price scenarios will be based on internationally recognized sources and, according to the Regulation shall be the result of coordination with ENTSO-E and consultation with Member States and stakeholder organisations.

4.4. The Projects Specific CBA (PS CBA)

According to the Regulation, all project promoters applying for PCI label, shall submit a CBA analysis in the following instances:

- when applying for PCI status to the Regional Group (Annex III.2) and having reached sufficient degree of maturity
- when submitting the cross-border cost allocation request (Art.13.4.)

[7] See Annex A (TYNDP 2013-2022 Methodology Chapter)

- when requesting financial assistance (Art.15.2.)

Q.7. According to the Regulation (Annex III. 2), the project promoters of potentially eligible PCIs shall submit, as a first step, to the Regional Groups an analysis on the fulfillment of the relevant criteria defined by the Regulation

Considering that for projects not mature enough, the promoters will not have to submit a PS CBA, do you consider useful to have guidance on how such an analysis should be carried out by the project promoters in a consistent way across the Regional Groups? If yes, please provide details on what such guidance should include.

4.4.1. General Approach

A Project Specific CBA is an essential tool for assessing the socio-economic and financial benefits of projects. Commonly[8], this includes 6 steps, which are the following:

1. context analysis and project objectives,
2. project identification,
3. feasibility and option analysis,
4. financial analysis,
5. economic analysis and
6. risk assessment

The ENTSOG CBA methodology will focus on the economic analysis and provide references to standard guidelines for the other elements mentioned above.

The objectives of the ENTSOG methodology for the project specific analysis are:

- To enable Project promoters to carry out a detailed analysis of their projects according to a robust and agreed methodology, ensuring consistency between results of different projects, and between the projects and the ESW CBA,
- To assess the foreseeable impact of the project on the European gas infrastructure system through, inter alia, project specific indicators to identify externalities.

4.4.2. Structure of the PS CBA

In developing the PS CBA ENTSOG methodology will cover at least the following sections:

- Description of the project including identification of the member states and priority corridors affected by the project
- Identification of the project's objectives, according to the criteria described by the Regulation

[8] DG Regio CBA Guidelines 2008

- Economic analysis
- Sensitivity analysis of the main parameters
- Guidance on discount rates to be used for the analysis

The scenarios and cases to be used by the Project promoters in applying the CBA methodology should be consistent with the TYNDP, to ensure coherent and compatible results.

Most of the criteria to be fulfilled by the PCIs cannot be captured through the financial analysis, thus they should be assessed within the economic analysis. For this reason, the methodology developed by ENTSOG will focus on the economic analysis. Project Promoters will apply the methodology developed by ENTSOG. To offer a comprehensive CBA methodology, ENTSOG will make reference to best practice such as the DG Regio *Guide to CBA of investment projects* (2008) for those sections of the CBA, not directly developed by ENTSOG. These, should be considered integral part of the methodology.

4.4.3. Economic analysis

The economic analysis appraises the project's contribution to the economic welfare of the region or country. It should reflect the impact for the society in addition to the benefits for the investor.

Where possible, the economic analysis should give a monetary / quantitative view of the criteria defined in the Regulation. In this respect, the methodology for the project specific analysis will provide the necessary tools to assess the externalities and the magnitude of their impact on the society. These tools consist of project specific indicators assessing the economic performance of the project.

Q.8. In addition to the approach described by ENTSOG in developing CBA, what other elements do you consider to be relevant for the development of the Methodology?

Q.9. Which effects, related to the Regulation criteria, do you consider to be the best for quantification and/or monetisation within the PS CBA? For example, in assessing security of supply as one potential effect of implementing a project, do you consider appropriate to assess the impact of a disruption? If yes, please explain your answer.

It is not any more an exception to face disruption in the EU gas supply, therefore an assessment have to consider this kind of impact and evaluate the possibilities each new infrastructure can give to the system.

Q.10 According to the Regulation, UGS and/or LNG Terminals may have cross border impact. What recommendations would you give for such assessment of this type of infrastructure along the specific criteria requested by the Regulation? Which should be the

main parameters for such analysis

UGS and LNG terminals do not have a direct impact on other member state but only an indirect effect (reducing the import's needs for the member state in which the project will be executed) and giving diversification and security of supply; for this reasons they should not be affected by this parameter i.e. should only be considered the impact on the origin member state and evaluate first the national impact and secondly the EU impact. May be could be better evaluate UGS and LNG terminals on a different assessment from the pipeline.

4.4.4. Sensitivity Analysis

According to the Regulation Annex V. (11), each cost-benefit analysis shall include sensitivity analyses concerning the input data set, the commissioning date of different projects in the same area of analysis and other relevant parameters

The methodology will enable the project promoters to carry out a sensitivity analysis on selected critical variables for the individual project:

- The methodology shall define a set of critical variables, considered to be relevant for the application of a sensitivity analysis. The critical variables of the project are those parameters whose variations -positive or negative- have the greatest impact on a project's financial and economic benefits or lead to a switching of the sign of the performance indicators
- The analysis is carried out by varying one element at a time and determining the effect of that element on the performance indicators. (Internal Rate of Return, Net Present Value, etc.)
- For example, if gas demand is considered as a critical variable, the Project promoter will increase/decrease its initial value by X % and then the economic indicators for the new cash flow will be recalculated reflecting the new demand value keeping all the other parameters unchanged. In case the X % change of the demand, leads to a variation of at least X % in the value of the economic indicator, it can be considered as a significant impact. This is an iterative exercise, each time it is necessary to assign a new value (higher or lower) to each variable and recalculate the performance indicators, noting the differences compared to the base case.

Q.11 Which are, in your opinion, "other relevant parameters" (as referred to in the Regulation) to be considered within a sensitivity analysis?

Create a benchmark for projects in order to have a referral parameter.

4.4.5. Project Specific input/output data

In addition to the data already provided for the ESW CBA, project promoters will need the following input data to carry out the project specific CBA .

- Inputs are:

- Investment costs (CAPEX)
- O&M costs (OPEX)
- Replacement costs
- Residual value
- Social Discount Rate

> Outputs are the following basic economic performance indicators:

- Economic Net Present Value (ENPV)
- Economic Rate of Return (ERR)
- Cost benefit ratio (C/B)

The analysis is to be based on the project's Cash Flow forecast, in order to calculate suitable Net Return indicators (economic IRR, economic NPV, economic Cost-Benefit Ratio).

Q.12 According to the standard approach described in the DG Regio CBA Guidelines, the economical flow derives from the financial flow. Do you consider this translation as applicable considering the lack of some necessary data? For the purpose of creating the economical flow, how do you consider that the externalities can be reflected?

4.5. Indicators for both ESW- and PS CBA analysis

The indicators ENTSOG develops are likely to play an important role in assessing the value of individual projects. The development of indicators will be based on the premise that the criteria in the Regulation are closely interlinked (in particular market integration, competition and security of supply). Indicators should thus not be directly related to any particular criterion. Each indicator will be defined with regards to the information it provides on the system and/or individual project and will contain sufficiently detailed methodology/formula to allow for clear applicability. The example below highlights that an indicator can reflect more than one criterion. This is one of the reasons ENTSOG should be prudent when monetizing the benefits along the specific criteria requested by the Regulation.

For instance, the diversification of sources and routes can have a beneficial impact on all criteria. Firstly it adds added value to market integration by enabling new market entrants or new connections to neighbouring countries and markets. Security of supply is improved, as having an increased diversification of sources enabling systems more able to cope more with extreme conditions. Diversification of sources attracts more players to the market and thus increases competition. Having diverse sources and routes can increase the flexibility of the network, enabling greater flexibility in the power generation sector to manage intermittent generation.

Some indicators are defined specifically by the Regulation. For instance, HHI is a measure for the level of competition on a market, measuring the relative share of market players to the size of the market. Named after economists Orris C. Herfindahl and Albert O. Hirschman, it is an economic concept widely applied in competition law, antitrust law and also technology management. The Regulation foresees an HHI indicator calculated at capacity level for the area of analysis. It is open to interpretation how to understand 'capacity level' for the purpose of calculating HHI. In case that 'capacity level' is understood as contractual capacity, the project promoter cannot have reference data for calculating the index, due to the fact that the capacity booking is volatile depending on the examined timeframe.

Q.13. An indicator can demonstrate a beneficial effect across a number or all the criteria defined in the Regulation. To what extent do you agree with this assessment?

Q.14. How do you see the applicability of HHI indicator at the capacity level? Please explain.

4.6. Interactions with other CBA methodologies or Guidelines

ENTSOG will build its CBA methodology according to the provisions of the Regulation taking into consideration the principles described in the DG Regio *Guide to CBA of investment projects* (2008), the experience of member TSOs, the feed-back of the public consultation and also available academic studies.

5. Challenges for the CBA development and its application

Developing the CBA Methodology according to the Regulation and meeting the extended market and legislator expectations is a complex process. When analysing the framework of the Regulation ENTSOG identified certain provisions which are open to interpretation, such as:

- 'Sufficient degree of maturity' of the project is not defined with regard to the submission of the project specific CBA
- Significantly impacted Member States or area of analysis
- HHI index calculated at capacity level for the area of analysis
- Discount Rates
- Price convergence

Further uncertainties have been identified in connection with the lack of some external data or references:

- Cost of disruption
- Restricted access to possibly necessary information, due to its commercially sensitive nature, or out of scope for project promoters or ENTSOG

> Infrastructure standard (N-1 rule) at regional level

ENTSOG is to provide guidance on discount rates to be applied. Different discount rates may apply to financial and economic analysis in a CBA Methodology. The discount rate applied on the economic cash flow, to calculate the economic Net Present Value (NPV), should reflect the perception of the society on how future benefits and costs are to be valued against present ones. It has a significant effect on the level of the economic indicators. The higher the discount rate, the lower the value of the performance indicators in the future will be. Ideally, the social discount rate should reflect the socio-economic circumstances of the countries within the Regional Groups. However, the application of different social discount rates may lead to inconsistencies in the evaluation, in particular for projects with cross-border effects spanning across countries/regions where such different discount rates would be used.

Within the ENTSOG TYNDP, Market Integration is understood 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.

The Regulation specifies that Market Integration shall be measured by calculating the additional value of a project to price convergence. Price convergence is a macroeconomic phenomenon which occurs only when markets are integrated. According to ENTSOG understanding, higher level of market integration facilitates the distribution of social welfare between the market players and the markets themselves. However, higher level of price convergence does not necessarily lead to higher level of social welfare in a given country. .

We encourage all stakeholders to help identify and mitigate the risks and uncertainties associated with the process in order to ensure that by the time the six months of the formal development process have elapsed, ENTSOG is able to present a methodology supported with the broad consensus of stakeholders.

Q.15. Considering the crucial importance of choosing the correct discount rate to be applied for the economic analysis, what factors do you consider important to be included in the guidance?

Q.16. What references to discount rates could be used in the methodology?

Q.17. How do you consider that price convergence[9] effect could be reflected for the different types of projects (Pipeline, UGS, LNG)?

6. CBA development process

9A sub-criteria for both Market Integration and Competition

To allow maximum opportunity to take account of all views when elaborating the CBA methodology, stakeholders are encouraged to be involved early in the development process to ensure that their positions are well understood. Major changes and proposals late in the process will be difficult to accommodate. This is why ENTSOG aspires to create a genuine collaborative effort early in the process. Our goal is to identify approaches that deliver on the policy objectives but which also attract the broadest support possible amongst all participants.

It is essential that stakeholders are interactively involved in the CBA methodology development process, including the Stakeholder Joint Working Sessions.

6.1. Context of the CBA methodology development

The graph below reflects the CBA development process within the legislative framework. It also highlights the parallel first PCIs selection process run by the COM assisted by an external consultant.

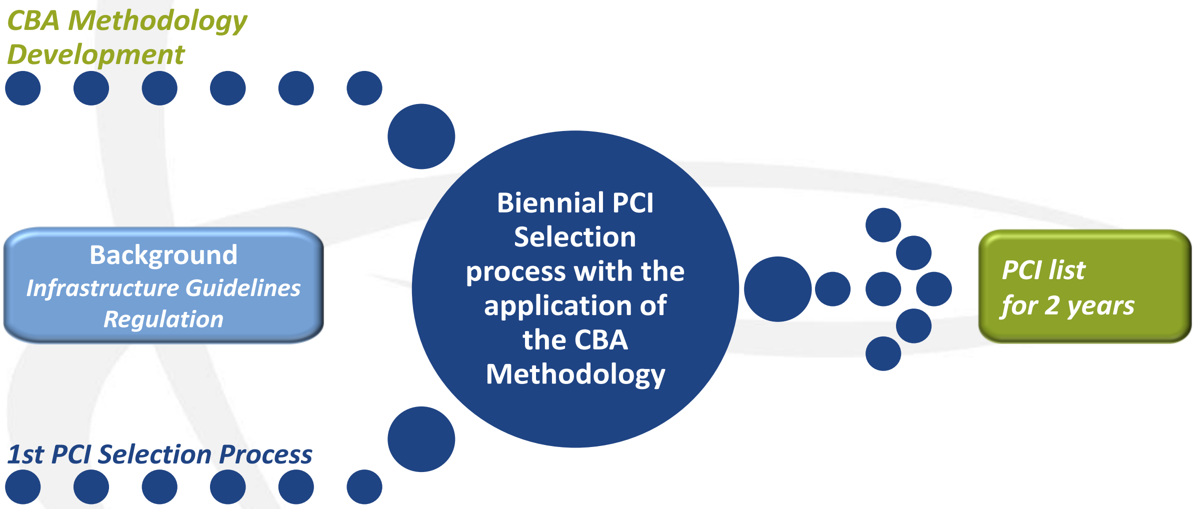


Figure 3. Overview of the initial PCI Selection Process and CBA Methodology Development

6.2. CBA Development – steps and the process

The following graphic highlights the consultation process and parallel activities. The current timeline is provisional. The anticipated date for the entry into force of the Regulation is end of April-/ beginning of May 2013. From this date, ENTSOG has 6 months timeframe for the development of the CBA methodology, including consultation with stakeholders. This period will foreseeably run from May till November 2013. From this point onwards, ACER and the Commission have three months each to review the CBA and deliver their respective opinions to ENTSOG. Member States may also deliver their opinions to ENTSOG, along with the Commission opinion. It is anticipated that by end of August 2014 ENTSOG will have adapted its methodology, reflecting the opinions of the Commission, ACER and Member States and will have passed the finalised CBA to the Commission for approval.

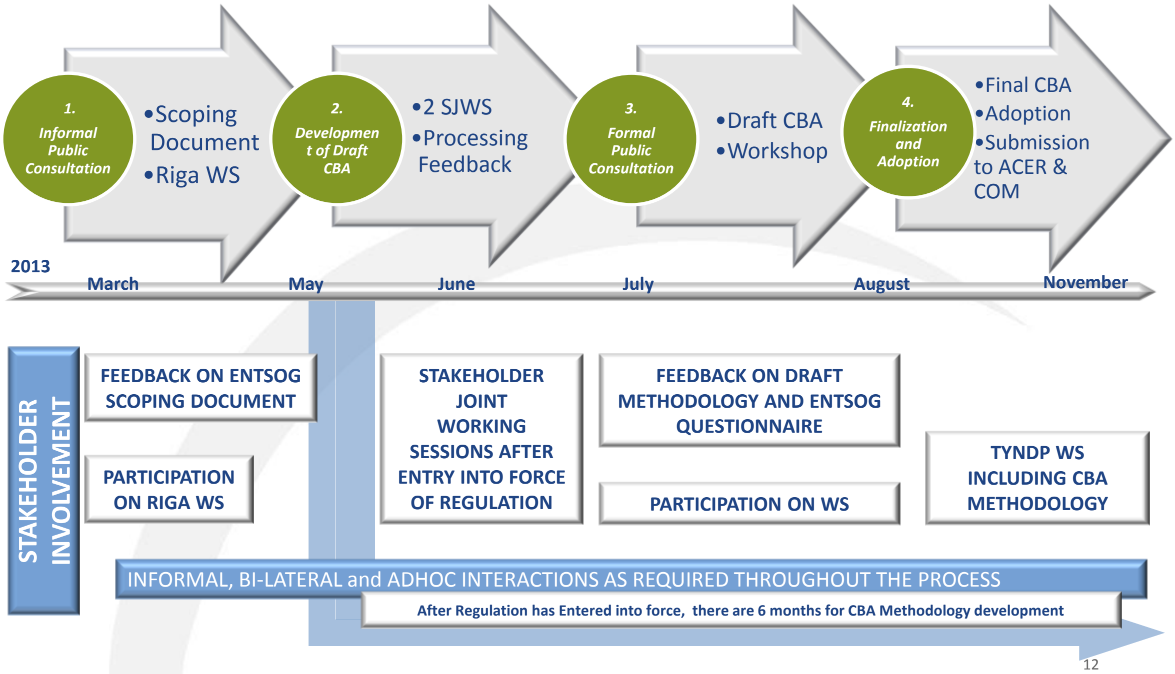


Figure 4. Stakeholder engagement process

6.3. Informal Public Consultation

<u>Start:</u> 21 March 2013

<u>End:</u> 15 May 2013

<u>Key Deliverable:</u>

- Feedback on CBA methodology Scoping document

<u>Associated activities:</u>

- Collection of feedback based on this Scoping document
- Riga TYNDP WS as kick - off meeting

Robust feedback is expected from the market which will support the CBA methodology drafting. The results of the Informal Public Consultation will also serve as an input for the preparation of Stakeholder Joint Working Sessions planned to be held after the Regulation has entered into force.

6.4. Public Consultation – indicative

The public consultation will consist of two parts: a Formal Public Consultation and two Stakeholder Joint Working Sessions. The first SJWS is planned for the beginning of June, shortly after the entry into force of the Regulation, whereas the second is planned approx. 3 weeks later.

For the SJWSs, ENTSOG expects market players, who identify themselves as Stakeholders (SH) to the PCI and/or CBA process, to register themselves as such with ENTSOG for the purpose of participating in the SJWSs.

6.4.1. SJWS

Planned date: 1 June 2013

Planned date: 21 June 2013

Key Deliverable:

- Agreement on the key elements of the CBA methodology

Associated activities:

- Intense, workshoplike discussion based on this document and the feedback received

6.4.2. Formal Public Consultation - indicative

Planned start: 1 July 2013

Planned end: 15 August 2013

Key Deliverable

- Feedback on Draft CBA methodology

Associated activities

- Workshop upon the publication of CBA methodology

6.5. Stakeholder involvement during the Public Consultations

Stakeholders are well encouraged to prepare questions and comments on the material prepared by ENTSOG and to respond to the questions. ENTSOG is determined to take into account the opinion of the market for the CBA development while keeping the methodology within the legal framework of the Regulation.

For the SJWSs, ENTSOG expects the expression of interest by Stakeholders who are willing to play a Prime Mover role and the Active SJWS Participant role in the CBA development process. ENTSOG is ready and open to accept intellectual and methodological assistance for the development of the CBA methodology. As Prime Mover or SJWS participant, a Stakeholder has significantly more opportunity to influence the shaping of the CBA methodology. The below table highlights the different possible roles a Stakeholder can play in the development process.

Prime Movers	Active SWJS Participants	Consultant Respondent	Observer
• To identify themselves by the Riga WS • Commited to work on bilateral basis • Dedicate resources • Most engaged in methodology development on bilateral basis	• Attend all SJWSs • Play active role during the intensive SJWS discussions • Read, review and prepare SJWS documents	• Detailful answer received for the Questionnaire	• No active contribution expected • Participation on TYNDP Workshops • Oral commentary during WSs possible

Figure 5. Types of Stakeholder engagement

6.6. Workshops

ENTSOG will utilize its regular, biennial TYNDP Workshops to cover the topics of the CBA methodology. The Riga Workshop will serve as an Introduction for the informal Public Consultation Process. whereas another WS in October/November will be used to present the results of the CBA development process. During the Workshops, ENTSOG will inform participants about the latest developments and the current status of the CBA development process and answer any questions from the participants.

6.7. Stakeholder Joint Working Session

The SJWS are working sessions which will enable exchange and development of ideas for inclusion in the CBA Methodology. During this phase of the CBA development activity, ENTSOG envisages wide interaction with all participants.

Q.18. ENTSOG has defined the development process in line with its Best Practices that have also been appreciated by Stakeholders in previously run processes like Network Code and TYNDP Development. Considering the very tight timeline allowed for the CBA methodology development, do you have any suggestions for the improvement of the consultation process?

7. Document management

According to this plan and to the Guidelines on Stakeholder Engagement Process, ENTSOG will conduct the CBA development project in a fully open and transparent manner. Stakeholders' involvement both during the informal- and the formal consultation phase secures the openness of the process. Other means of assuring a transparent process consist of comprehensive publication of all discussed and developed material throughout the process.

ENTSOG has and will continue to extensively make use of its website to make available all CBA relevant material, at the following location: http://www.entsog.eu/publications/tyndp

The website is structured according to the different phases of the process, all documents remaining available at all times, but the most relevant ones at a given point in time being put forward.

8. Responses to Consultation

Responses should be sent to CBA-methodology@entsog.eu and Adela.Comanita@entsog.eu no later than 15 May 2013.

The Stakeholders are encouraged to share any other comments with ENTSOG regarding the CBA Methodology development.

We look forward to hearing from you and to working together with you in the CBA Methodology development process.

The responses to this document will be made publicly available on the ENTSOG website.

Annex A

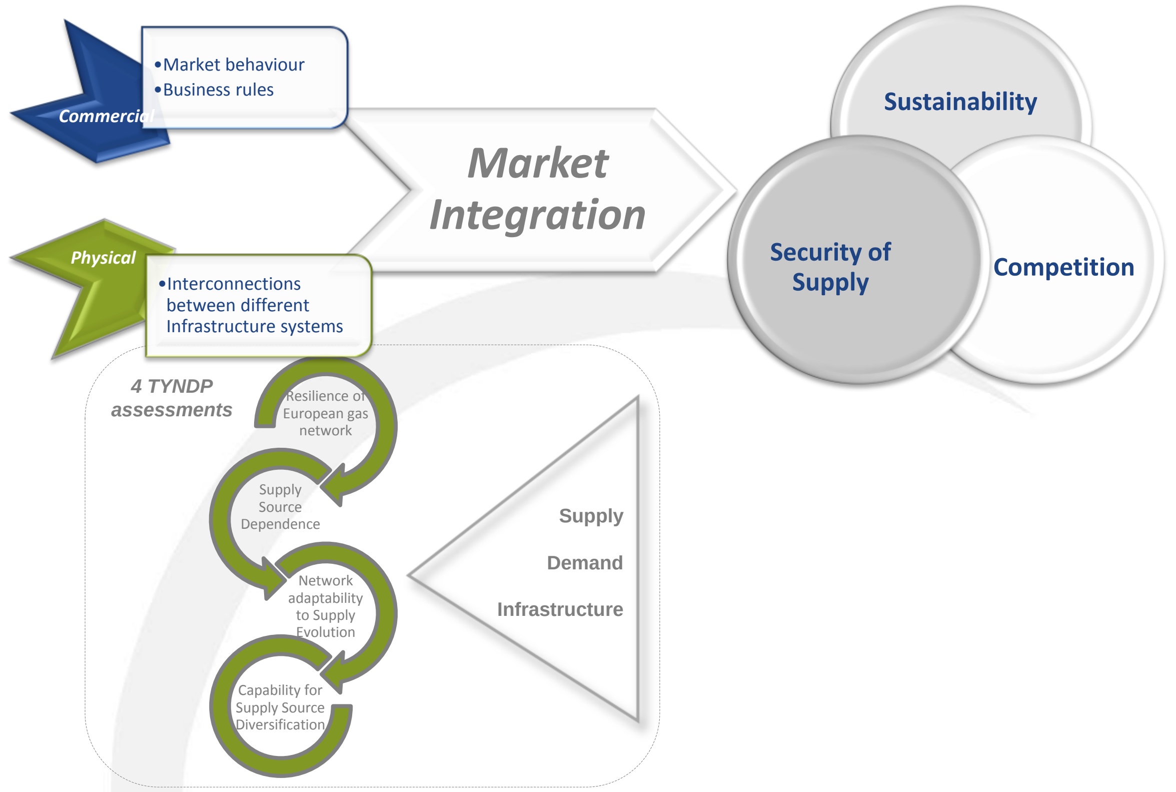
TYNDP 2012-2013 Methodology

1. Introduction

The methodology of the TYNDP 2013-2022 builds on the principles used in the TYNDP 2011-2020. ENTSOG has significantly improved the Network Modelling tool and the definition of supply and demand situations compared to the TYNDP 2011-2020. ENTSOG has used the ‘upgraded’ Network Modelling tool (NeMo tool) to assess the role of the gas infrastructure in sustaining the pillars of the European energy policy, in particular Security of Supply and Competition. This assessment is carried out through an analysis of the resilience of the European gas network, the Supply Source Dependence, network adaptability to Supply Evolution and the capability for Supply Source Diversification.

In addition, new capacity-based indexes have been introduced aiming at measuring the import route diversification and import dependency.

The results of the assessment give an overall indication of the level of infrastructure-related Market Integration. For the purpose of the TYNDP, Market Integration is defined 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. Sufficient flexibility may be perceived differently by different market participants; some aspects may be also determined through the legislation (cf. Security of Supply Regulation). Where necessary, the TYNDP sets arbitrary values against which the results of the simulations are measured for the sake of the assessment.



The achievement of the desired level of Competition, Security of Supply and Sustainability is enabled through the achievement of the desired level of market integration.

Market Integration can be measured at two levels:

- *Commercial (determined by the market behaviour and business rules applicable on the respective market)*
- *Physical (determined by level of physical interconnection between the different infrastructure systems of the respective market)*

The TYNDP assesses the physical layer of Market Integration through 4 assessments which analyse the way infrastructure can sustain the supply-demand balance under various supply-demand situations and infrastructure configuration.

Figure 3.1. Graphical representation of the relationship between Energy policy pillars and Market Integration, and the role of the TYNDP in their assessment

The high uncertainty linked with the future of the gas market favours a case-based approach combined with sensitivity analyses. This approach has to strike the right balance between the likelihood of the occurrence and the stress they induce. By including FID and/or Non-FID project clusters in the network model along the existing infrastructure, the modelling results provide information on the potential of the planned projects to close potential investment gaps and determining the limiting factors to further Market Integration.

In this chapter the specifications of the NeMo tool used by ENTSOG are described. In addition, this chapter gives an overview of the more than 200 cases developed by ENTSOG to assess Security of Supply (the resilience of the system and source dependency) and *the potential of* infrastructures to support Market Integration. The results of the network modelling are presented in section 4 of the Results Assessment chapter.

2. Network Modelling Tool (NeMo)

The current NeMo tool is the result of a multi-annual internal development process, with continuous improvement that goes back to 2008 and the first publication of European Winter Outlook by TSOs. The functionalities of the tool allow for consideration of firm capacity, Zones, and hub-to-hub products as established in the current regulatory frameworks. The functionality of the NeMo tool also allows for the focus of the analysis to be on the supply demand balance in the European gas infrastructure system and the identification of potential investment gaps. For this, the modelling tool is able to assess the ability to bring the gas from defined supply sources to the consumption points within any relevant case.

L-gas IPs are not separately modelled in this TYNDP but are part of the total modelling of the EU gas network. L-gas flows have been considered as the minimum flows between Netherlands, Belgium, Germany and France based on the historical values of 2009, 2010 and 2011. The reason for this is that the future need for L-gas substitution is not a matter of resilience of the system nor can L-gas be imported from somewhere else, which is the core focus of this TYNDP. The final outcome will be the result of on-going intensive interaction between governments and TSOs. Currently, evaluations are carried out regarding the possibilities for the substitution of L-gas; the impact this may have on infrastructures has not yet been determined. Due to its regional character the topic of L-gas will be covered by the upcoming Northwest Gas Regional Investment Plan.

2.1. Network & Market Topology

ENTSOG builds its model on the the results of hydraulic simulations performed by TSOs using the methodology of the "Network Flow Programming[10]". The ENTSOG tool for simulating the European Gas Network combines the capacity figures obtained through hydraulic simulations with a common approach to the assessment of European supply and demand balance.. When assessing the resilience of the European gas system, ENTSOG uses linear modelling of the market (based on energy) with:

- nodes representing Zones. Nodes are the points characterized by a certain demand, representing an off-take that the model tries to balance with supply

[10] 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.

> arcs representing cross-border or hub-to-hub capacity between nodes. Arcs are the paths carrying the gas from one node to another, characterized by a lower and an upper flow limit, defining the possible range for the calculated flows. The upper limit may represent a Supply Potential of a given source or the capacity of infrastructures.

The linear approach enables the NeMo tool to compute a great number of cases in short time, and focus is thus on the analysis of the results.

The combination of arcs and nodes provides a very flexible architecture that can be easily updated with additional infrastructure, while the flow ranges between the nodes can be used to control the simulated flow pattern. The modelling tool considers cross-border net flows between Zones as a way to combine network and market characteristics.

The graphic below illustrates the complexity of the architecture of the European gas system as modelled in the NeMo tool.

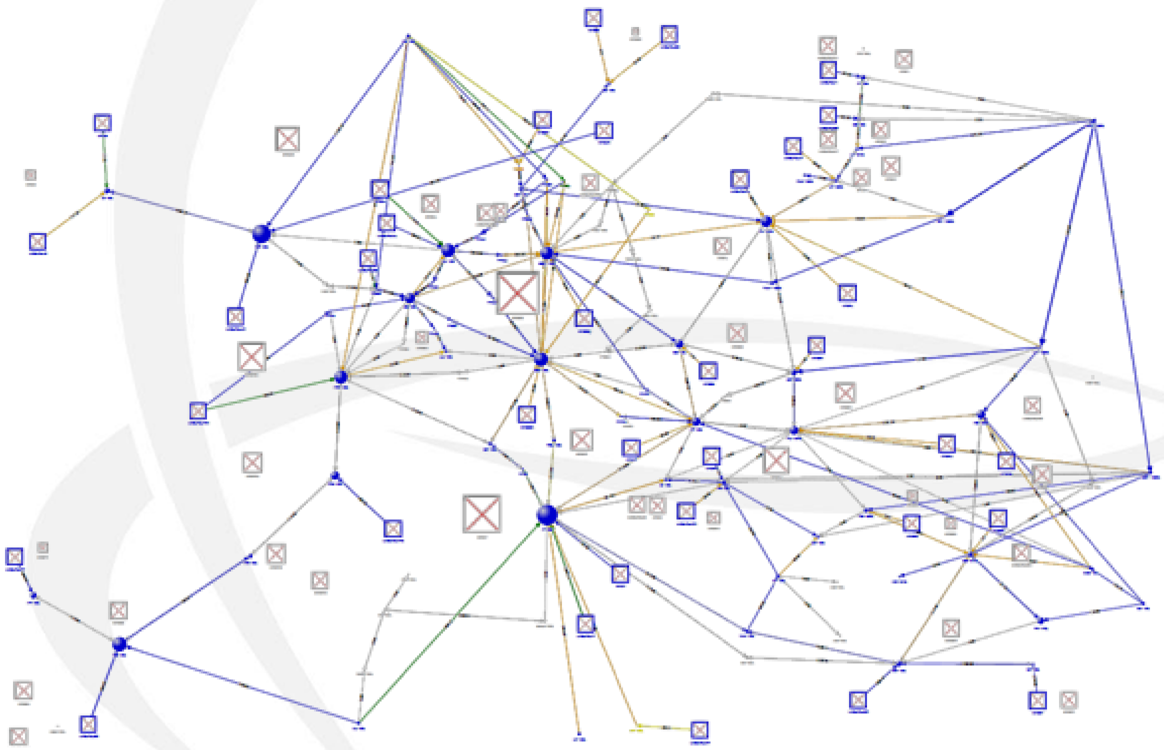


Figure 3.2. Architecture of the European gas system in the ENTSOG Network Modelling tool

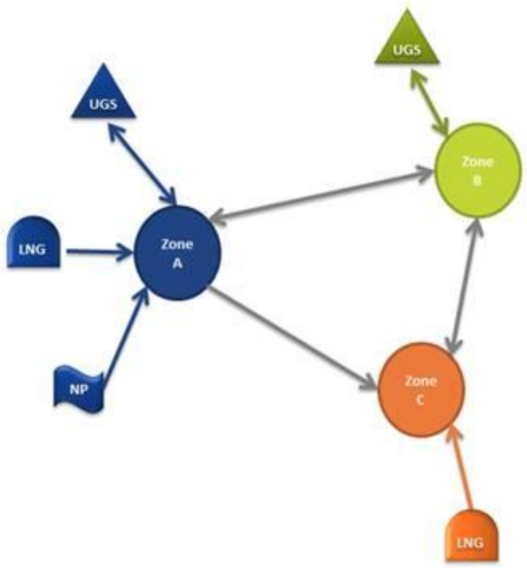


Figure 3.3. General representation of the Zones (nodes) and interconnections between them (arcs) in the ENTSOG Network Modelling tool

Where a physical congestion has been identified from the top down approach, TSOs collaborate further through the GRIPs to identify potential mitigating measures.

Each Zone in Europe is represented by a node in the model where supply (National Production, LNG send-out, other imports and storage withdrawal) and demand (end consumption, storage injection, and exports) have to be balanced. This Zone thus represents a balancing zone for which the model uses as input one demand figure

Cross-border capacities between two Zones are represented by arcs where the maximum flow limit in the model is determined by aggregating the capacities of Interconnection Point capacities, after applying the lesser rule on each side of the flange. The firm capacity on both sides of one Interconnection Point is the result of hydraulic Entry/Exit capacity simulations performed by the respective TSOs; this means there is no additional need to consider hydraulic simulation at the European level. Capacity calculation under the 3rd Energy Package could be considered as the translation by TSOs of a physical network into an Entry/Exit commercial offer. The basic principle of Entry/Exit capacity calculation is thus to carry out a hydraulic simulation of demand and supply patterns TSOs cover.

Interconnections between the transmission system and LNG terminals, storage facilities and National Production facilities within a market area are based on the same node and arc approach as the cross-border interconnections. Supply sources are defined per producing country. Supply sources are characterized by a Supply Potential representing the upstream volumes that can be imported into Europe. The different routes connecting a supply source to Europe are limited by the capacity of the respective import pipelines.

In the majority of cases Underground Gas Storage (UGS) is considered as a supply of last resort to cover excess demand. Relevant injection or withdrawal capacities are linked to the stock level applicable in the simulated case. LNG send-out is split up into an import and storage layer. Unlike UGS, LNG tank level has no impact on send-out capacity, except that stock level should remain in a given range.

The simulations of the diverse cases are done by giving different weights to certain arcs, i.e. some priority to specific sources, routes or interconnections, to achieve the objective of the assessment underlying the definition of the respective cases.

2.2. Perfect gas mix

The functioning of the tool assumes a perfect mix of gas at every node which is consistent with the assumption of a perfect market. The supply source composition of gas exiting a node is the same for every arc and equals the weighted average of entering gas composition. This approach fits perfectly with a market approach, results are however likely to deviate from the actual physical composition of gas depending on the level of interconnectivity of the respective network.

2.3. Tool functioning

The primary objective of the tool is to find a feasible flow pattern to balance supply and demand defined for the considered case whilst using the available system capacities defined by the arcs. UGS and LNG (partially) act as last resort supply to cover the gap between demand and supply, namely import sources and National Production. This is done by using a solver designed for linear network programming giving by default priority to the closest supply to meet demand. Each case calculation is based on a daily supply demand situation.

The considered infrastructure cluster is deemed sufficient for a given situation of demand and supply if the solver is able to find a flow pattern under which each node is balanced and all flows are within the limits defined for each arc. It is noted that this flow pattern is one among several possible ones as some regions of Europe always show sufficient flexibility to flow the gas through alternative routes. Where no feasible flow pattern can be found for a given case, this may be an indication of insufficient supply or network congestion. In this later case an investment gap may be identified by investigating the limits to finding a feasible flow pattern. This TYNDP also shows in a neutral way which projects are able to close such investment gaps.

2.4. Output

The first and principal output of a simulation for a specific case is the tool finding a feasible solution consistent with each node and arc constraint. If a solution is found, meaning the network is showing enough resilience and sufficient supplies are available, flows through all arcs are provided as an output of the model. For each capacity arc, the simulated flow is compared to the technical capacity defined by the TSOs. For each Entry/Exit Zone, the Remaining Flexibility indicator is calculated as the aggregated relative Entry Capacity not used by the solver. It should be noted that the output represents one of possibly many flow patterns respecting all boundary conditions. As a result modelled flows should not be considered to be a forecast of flow patterns to be expected.

Where the model identifies investment gaps, planned infrastructure projects contributing to their mitigation are identified. In this way FID and Non-FID Clusters of future projects are tested on their impact on the resilience of the European gas network. This can provide useful information to third-party project promoters. The TYNDP does not in any way prioritise infrastructure projects.

3. Definition of case elements

ENTSOG developed more than 200 cases. Each case is determined by:

- a year (see subheading X+X),
- an infrastructure cluster (see subheading X+X),
- a demand situation (see subheading X+X),
- a supply situation (see subheading X+X).

The considered settings of each of the above elements are described below.

3.1. Modelled years

To capture the dynamics of the next 10-years, all cases mentioned are simulated for 2013, 2017 and 2022. 2013 acts as the reference year. Most of capacity, demand and supply data are provided for all of the 10-years in the annexes.

3.2. Infrastructure clusters

All cases include two infrastructure clusters:

- FID Cluster: existing infrastructure + infrastructure with FID status
- Non-FID Cluster: existing infrastructure + infrastructure with FID status + infrastructure with non- FID status

With regards to infrastructure, the three years represent different gas infrastructure configurations which always cover the existing infrastructure and the planned infrastructure projects in accordance with their FID status. FID status has been identified as the most robust parameter for clustering planned infrastructure projects. All projects were considered eligible for modelling in the first year in which the capacity is available on 1 January 2013, 2017, 2022. Detailed description of those projects is available in Annex A.

The process is to first include only-FID projects in the modelling. Subsequently, the modelling of the same cases with the Non-FID Cluster shows how Non-FID projects could improve the level of Market Integration.

In the case of Network Resilience testing, modelling the two infrastructure clusters and comparing their results makes it possible to identify investment gaps and examine how Non-FID projects covered by TYNDP help to mitigate such gaps. The process ensures non-discriminatory treatment where multiple projects are able to produce such effect.

3.3. Demand situations

The different demand situations and their use in the modelling are summarized in the table below:

Demand situations	**Network Resilience / Supply Source Dependence**	**Supply Evolution Adaptability / Supply Source Diversification**
1-day Design-Case Situation	X	
1-day Uniform Risk Situation	X	
14-day Uniform Risk Situation	X	
1-day Average Situation	X	X

Table 3.1. Demand Situations

3.3.1. Demand under 1-day Design-Case Situation

The 1-day Design-Case Situation is the national peak demand per day as calculated by TSOs and laid down in National Development Plans and TSO capacity outlooks where existing. This demand is the demand included in the TSOs' investment calculations and therefore referred to as the Design-Case Situation. This Demand Situation is the most burdensome as it shows the effects on the European gas system under the occurrence of all national peak demands at the same time.

In addition to this situation, two Uniform Risk Demand Situations (as described below) were developed by ENTSOG upon specific request by ACER to develop a harmonised approach to demand. These situations shall be considered for comparison purposes.

3.3.2. Demand under 1-day Uniform Risk Situation

The starting point for ENTSOG was to develop a common demand situation in terms of the probability of uniform risk occurrence across Europe. Therefore ENTSOG has chosen to include a 1-day Uniform Risk Situation based on a common definition of climatic conditions. This common definition of climatic conditions consists in the harmonisation of the level of risk of climatic occurrence.

The climatic conditions are represented by the effective temperature, understood as the parameter correlated with increases in the demand level due to heating consumptions driven by weather conditions. The effective temperature keeps consistency with the formulas developed by some TSOs, considering the temperature heterogeneity within the country, the accumulative effect of cold days on consumers' behaviour in terms of gas demand, as well as any other factors related to gas consumptions as wind velocity.

The 1-day Uniform Risk Situation has been defined as described below, addressing a climatic occurrence close to 1-in-20 years:

- Period to be considered: minimum of 37 years (from 1 January 1975 to 31 December 2011). For those TSOs having no access to sufficient historical weather/temperature data through their own sources, daily average temperatures coming from a Commission's temperature database (average values by country and day) were used.
- Relevant daily temperatures to be considered: yearly minimum effective temperatures by calendar year.
- 1-day Uniform Risk temperature defined by the percentile 0.05 of the relevant daily temperatures.

It should be noted that not all TSOs have climatic demand models, meaning that it was not possible to apply the Uniform Risk Situations methodology perfectly.

In addition, climatic conditions have a direct effect on the heating driven gas demand; nevertheless this link cannot be extrapolated to gas demand from the electricity sector. This sector in general doesn't have a strong relationship with climatic conditions. Hence demand under the 1-day Uniform Risk Situation only provides harmonised definition for the heating-driven gas demand.

Moreover, in several not yet mature markets, the demand estimation depends not only on the climatic conditions assumptions but also on the assumptions regarding the penetration of gas in the various consumption sectors.

3.3.3. Demand under 14-day Uniform Risk Situation

A 14-day Uniform Risk Situation has been included in the analysis in order to capture the volume effect such duration may have on supply, especially with regard to UGS and LNG terminals. The 14-day demand levels are considered through the assessment of the last day of such a period. This last day is the most stressful moment as the supply availability from the storage (UGS and LNG) at this point may be undermined by high deliverability in the previous 13 days following the high consumptions.

For consistency reasons, ENTSOG used the same statistical approach as for the 1-day Uniform Risk Demand Situation, replacing the daily effective temperatures by the 14-day average effective temperatures in the data set. The inclusion of two full weeks in the 14-day period doesn't take into account possible lower demand levels during weekends or holidays for the average demand on a 14-day period.

As noted above, considering the decreasing deliverability of UGS and LNG terminals on the period, for a given level of demand, the last day is the most stressful one. As the volume of supply used over the period is independent from the demand profile, a flat average demand profile has been considered.

The graphs below show the volume equivalence between a possible profile and its considered equivalent. This transformation makes it possible to limit modelling to the last day of the period.

Possible demand/supply profile **Equivalent demand/supply profile**

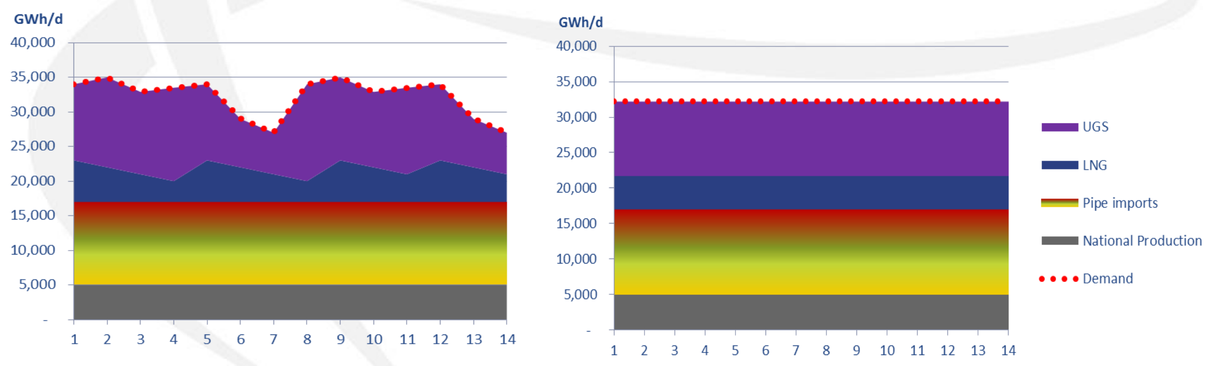


Figure 3.4. Illustration of the volume equivalence between a possible profile and its considered equivalent

3.3.4. Demand under 1-day Average Situation

There are certain types of cases that fit better with a lower demand level compared to the 1-day and 14-days situations. For that purpose a 1-day Average Situation has been included in order to simulate a yearly average situation. Demand on that day is defined as the ENTSOG annual volume demand scenario based on individual TSO data divided by 365. This Average Situation is used to assess the Supply Source Dependence and network adaptability to Supply Evolution and the Supply Source Diversification. The yearly average is considered as more suitable for such type of flexibility analysis. Moreover, if the analysis were carried out in connection with a high demand situation, the supply penetration assessment would be limited due to the consumption of the additional volumes in the region closest to the supply.

3.4. Supply situations

For each of the demand situations defined above, a supply situation has to be built in order to define how much gas is available and from which source. These levels and locations will influence transportation needs and hence infrastructure assessment.

The starting point in the analysis is always a specific Reference Supply Situation corresponding to the considered demand situation, as described below. Variations on these Reference Supply Situations are strongly correlated to the specific cases considered, and are further detailed in the next sub-chapter 4. on the European gas system and supply assessment.

The table below summarizes the setting of all supply sources in the Reference Cases. The period defined as last 3 years references supply in the years 2009, 2010 and 2011. Supply sources imported by pipe are Algeria, Azerbaijan, Libya, Norway and Russia.

	Supply sources		
Situations	**Pipe imports**	**LNG**	**UGS**
1-day Design-Case	The maximum reached on one day during the last 3 years	Import component is equal to the Average Daily Supply based on the last 3 years plus 10% (to factor in the winter swing) The remaining send-out is used as last resort	Last resort supply
14-day Uniform Risk	The highest average of 14 consecutive days during the last 3 years	Import component is equal to the Average Daily Supply based on the last 3 years plus 10% (to factor in for the winter swing) Additional send-out based on the maximum use of stored LNG	
1-day Average	Average shares by source of the different supply import sources in the European yearly balance of last 3 years, applied to the required imports. When the supply coming from one source is limited by the Intermediate Potential Supply scenario, the corresponding missing volume, is divided between the remaining sources proportionally to their ability to increase their level i.e. how far they are from reaching their own Intermediate Supply Potential scenario.		Not used

Table 3.2. Supply Situations

Under every situation, aggregated National Production at European level is set in the 90-100% range of its maximum deliverability.

3.4.1. Reference Supply under 1-day Design-Case and Uniform Risk Situation

From 2013 onward where there is no increase in imported pipeline capacity compared to 2009-2011 the supply assumption is set as the daily maximum achieved in the period 2009-011. Where an infrastructure project increases the import capacity from one source, the supply from that source is increased proportionally. The supply through the new route is calculated first, as the average peak ratio of the other routes coming from the same source. This amount is subsequently added to the original daily maximum to determine the new total.

Flows at import route level are kept as far as possible within a range defined by:

- The maximum reached through the route over 2009-2011, potentially increased pro-rata to consider the project increasing the route capacity
- The average flow through the route over the winters 2009/10 and 2010/11

LNG is first used as an import source at Average Daily Supply level, based on the years 2009-2010-2011, which is increased by 10% to consider the winter swing.

Demand is balanced using the remaining LNG send-out capacity (on top of import source use) and UGS deliverability. This is referred to as supply of last resort. In order to consider the influence of stock level on storage availability, UGS deliverability has been decreased by 3%. This decrease is consistent with the minimum stock level observed mid-January on the 2009-2011 period on the AGSI platform and the European aggregated UGS delivery curve as established by GSE.

3.4.2. Reference Supply under 14-day Uniform Risk Situation

Regarding each source imported through pipes, the same approach has been used as for the above 1-day Situation. The only difference is that the source and import route maximum has been observed on a 14-day rather than a 1-day period.

On a 14-day period, LNG terminals are not designed to be able to sustain maximum deliverability. A specific approach has been developed by ENTSOG based on a GLE study. For every LNG terminal, send-out is defined as the addition of 2 parameters:

- The downloading of ships linearized at Average Daily Supply level for the years 2009-2010-2011 increased by 10% to consider the winter swing
- The maximum use of LNG tank considering the initial and the usual minimum stock level as defined by GLE and LSOs

Demand is balanced using UGS as last resort supply. In order to consider the influence of stock level on storage availability, UGS deliverability has been decreased by 5%. This decrease is consistent with the minimum stock level observed at the end of January on the

2009-2011 period on the AGSI platform and the European aggregated UGS delivery curve as established by GSE.

3.4.3. Reference Supply situation under 1-day Average Situation

The Reference Case is based on the average shares by source of the different supply import sources (AZ, NO, RU, DZ, LY, LNG) in the European yearly balance of 2009-2010-2011. This average share is applied to the required imports (i.e. Demand minus National Production). Where the resulting supply volume required to come from each source exceeds the respective Intermediate Potential Supply scenario is used as an upper limit for the Reference Supply. The corresponding missing volume is allocated between the remaining sources in proportion to their ability to increase their level i.e. how far they are from reaching their own Intermediate Supply Potential scenario. Flows at import route level are kept in a ±10% range around a reference value. This value is derived from the three-year historical average flow through the route.

It is noted that storage supply is not considered in the cases pertaining to Supply Source Dependence, the network adaptability to Supply Evolution, and the Supply Source Diversification as it is considered neutral from the whole year perspective.

4. Assessment of the European gas system

In addition to the Reference Cases, additional cases bringing more stress to the EU gas network have been defined. They define the scope of the sensitivity study of the assessment. This assessment is based on an analysis of the level of physical interconnection between different infrastructures to capture aspects of Security of Supply and Competition and, at the same time, assess the level of Market Integration.

4.1. Infrastructure Resilience assessment

The Infrastructure Resilience assessment looks at the ability of the infrastructure to transport large quantities of gas under high daily conditions (Supply Stress). This assessment is used for identification of investment gaps and potential remedies.

The Supply Stress cases defined are extensions of the Reference Cases covering 1-day Design-Case and 14-day High Risk Situations. By comparing these Supply Stress cases with the relevant Reference Cases, the effects of a specific disruption or Extreme LNG Minimisation are identified.

The considered supply stresses are:

- Complete disruption of Norwegian supply to France (failure of Franpipe) – NO 1
- Partial disruption of Norwegian supply to United Kingdom (failure of Langeled) – NO 2
- Complete disruption of Russian supply through Belarus - BY

> Complete disruption of Russian supply through Ukraine- UA
> Complete disruption of Algerian supply to Italy (failure of Transmed) – DZ 1
> Partial disruption of Algerian supply to Spain (failure of MEG) – DZ 2
> Complete disruption of Libyan supply to Italy – LY
> Extreme LNG Minimisation

In the network modelling, LNG is not considered to be disrupted, but minimisation is simulated. To define a realistic LNG disruption of European impact is difficult because globalisation and flexibility of the LNG chain allow for the rerouting of LNG ships, including between terminals, in response to price signals. This opens the possibility to replace a specific LNG source by another one. Due to the fact that it is impossible to determine what the reaction of the market will be in the long term and to determine how many cargoes would be replaced in an emergency event, ENTSOG investigates how far the LNG deliverability can be reduced without the occurrence of network congestion. This approach, for long term assessment under the infrastructure perspective, helps picture the level of dependence on this source for each country and/or how Europe could be impacted by a major move of global LNG supply to another region. It also pictures the impact of a technical disruption of an LNG terminal in a Zone having a single facility (e.g. Greece in 2013) or maritime conditions impacting all facilities of a given Zone (e.g. Fos Cavaou and Fos Tonkin located in GRTgaz South Zone).

The missing gas supply derived from the Supply Stress is managed by rerouting supply of the interrupted sources through alternative routes (if any) and, finally, as a last resort, by additional gas from UGS and LNG. For the 14-day case, the ability of LNG terminals to supply additional gas is made possible through the use of a lower minimum tank level compared to the Reference Case (such levels have been defined by GLE/LSOs).

This assessment results in the identification of the Remaining Flexibility of each Zone and of the different types of infrastructure located in the Zone. This indicator is defined according the below formulae:

Infrastructure level:

$$Remaining\ Flexibility = 1 - \frac{Flow}{Capacity}$$

Zone level:

$$Remaining\ Flexibility = 1 - \frac{\sum Entering\ Flow}{\sum Entry\ Capacity}$$

The indicator at Zone level considers both the gas staying in the Zone to face demand and the gas exiting to adjacent systems.

The identification of investment gaps is based on the level of the Remaining Flexibility at Zone level. Investment gaps are identified when the indicator is:

- below 5% under Reference Cases
- below 1% under Supply Stress cases as part of the flexibility has been used to face the Supply Stress.

Disruption scenarios simulated in the current TYNDP are assuming a lack of gas flows from the concerned supply source at the relevant EU borders. Capacity at EU cross-border IPs is considered technically available, although not always fully exploitable, taking into consideration the proximity of the IPs to the disrupted source and the underlying infrastructure. This is reflected in the model by the fact that, in case of a disruption, the use of Entry Capacity of each Zone is impacted by the flow decrease starting from the disruption and then spread according to transmission capacity level. After crossing a few Zones, the impact becomes strongly diluted.

Should the concerned disruption occur, flows actually transmitted at the concerned EU cross-border IPs could result in different Remaining Flexibility levels than those shown in the Report considering, among other reasons, the prevailing flow sources at those IPs, market dynamics or other SoS measures possibly undertaken under crisis conditions.

4.2. Supply Source Dependence assessment

Supply Source Dependence assessment aims at the identification of Zones whose balance depends strongly on a single supply source.

This assessment has been carried out under the 1-day Average situation in order to identify the strong dependence of some Zones on a single supply source throughout the year. This is achieved through the Full Minimisation of each supply source separately, and the replacement of the corresponding volume by the remaining sources.

The supply situation under the Full Minimisation cases reflects, source by source, the ability of the remaining sources to replace a specific supply. For that purpose each import source has been reduced alternatively down to the minimum required to balance each Zone. In order to identify the potential dependence of all Zones in a single modelling, no limit has been set to the alternative supply sources apart from their technical capacity as it is assumed that all Zones will not minimize the predominant supply at the same time. Indigenous production has been kept at Reference Case level and LNG terminal send-out limited to 80% of their capacity.

Zones requiring at least a 20% share of a given source are identified as source dependent.

4.3. Infrastructure Adaptability to Supply Evolution

The assessment of the Adaptability to Supply Evolution looks at the European infrastructure's ability to face very different supply mixes as resulting from short-term signals or long-term trends.

This assessment has been carried out under the 1-day Average demand situation in order to identify the ability to balance every Zone when one of the supply sources move from the Reference Supply to Maximum Potential supply or Minimum Potential Supply scenarios. Where no flow pattern enables to reach the Potential Supply scenarios, the limiting factor is identified.

4.3.1. Even Maximisation

The supply situation under the Even Maximisation cases reflects, source by source, the reach of the Maximum Potential scenario by each of the sources. In each case, the maximisation of one source up to its Maximum Potential scenario comes along with the reduction of the others proportionally to their shares in the Reference Case keeping them above the Minimum Potential scenario. In the Even Maximisation, the reduction of each route is done proportionally to its share in the Reference Case.

4.3.2. Even Minimisation

The supply situation under the Even Minimisation cases reflects, source by source, the ability of the remaining sources to replace a specific supply going down to its Minimum Potential scenario. The increase of the replacing sources has been approached through the Even Minimisation, where the increase of each supply source and import route are done proportionally to their shares in the Reference Case still being limited by their Maximum Potential scenario.

4.4. Supply Source Diversification

The assessment of the Supply Source Diversification at Zone level aims at determining the ability of each Zone to access each identified supply source. It has been carried out under the 1-day Average demand situation through Targeted Maximisation.

The supply situation under the Targeted Maximisation cases reflects, source by source, the geographical reach of the Maximum Potential scenario. In order to identify a flow pattern enabling the reach of Zones further downstream, more freedom has been given to the flow ranges authorized for each import route compared to the Even Maximisation. Therefore each case requires several simulations in order to test the supply reach in all directions at the level of 5% and 20% share of total supply (including indigenous production) in each Zone.

4.5. Import Route Diversification and Import Dependence indexes

This part of the assessment introduces indexes aiming at quantifying the diversification of routes bringing gas to a Zone, and a Zone's dependence on imports as compared to UGS and National Production.

ENTSOG had considered the development of a capacity-based indicator assessing the diversification of routes as mentioned in the draft Energy Infrastructure Guidelines. Such indicator should picture the ability of a Zone to substitute one route of gas by another one when facing some technical disruption for example.

The definition of the appropriate formula should value both the number of entry points and their relative weight, the best situation being when they all have the same capacity. First, the following formula had been considered (the lower the value, the better the diversification):

$$\sum_{l}^{\text{Xborder}} \sum_{k}^{\text{IP}} \% \, IP_k \, \text{Xborder}_l^{\,2} + \sum_{j}^{\text{Source}} \sum_{i}^{\text{IP}} \left(\% \, IP_i \, from \, source_j\right)^2 + \sum_m (\% \, LNG \, terminal_m)^2 + \sum_n \left(\% \, UGS \, facility_n\right)^2 + \sum_p (\% \, NP \, facility_p)^2$$

Where (% xx) represents the share of xx in the total Entry Capacity into the considered Zone. Each term corresponds to a single facility being a physical Interconnection Point with an adjacent Zone, a direct import point, a LNG terminal, a storage facility or a production facility.

Calculation of such formula is made challenging as capacity of single storage or production facility is often not available and capacity is only provided in an aggregated form. The same situation also occurs at the border between some Zones where virtual Interconnection Points have been introduced.

As the replacement of such individual values by aggregated ones would distort the formula it has been decided to define two indexes rather than one. The first Index captures the diversification of paths that gas can flow through to reach a Zone, the second Index captures the need of imports to balance demand throughout the year

4.5.1. Import Route Diversification Index

Aggregated values are used directly for Interconnection Points between European Zones as those physical points are likely to largely depend on common infrastructure. Import points for non-EU gas are considered individually as upstream infrastructures are often much more independent.

This leads to the definition of an Import Route Diversification index:

$$\sum_{l}^{\text{Xborder}}\left(\sum_{k}^{\text{IP}} \% \, IP_{k} \, \text{Xborder}_{l}\right)^{2} + \sum_{j}^{\text{Source}}\sum_{i}^{\text{IP}}\left(\% \, IP_{i} \, from \, source_{j}\right)^{2} + \sum_{m}\left(\% \, LNG \, terminal_{m}\right)^{2}$$

4.5.2. Import Dependence Index

Aggregated shares of storage and National Production deliverability, expressed as a percentage of the Average Daily Demand of a Zone, are used to measure the dependence on imports (the 1+ term is introduced to obtain the value of 1 for a country completely dependent on imports throughout the whole year). A factor 0.5 has been introduced for the UGS component as it is assumed that storage has a neutral balance over the year. A Zone having enough National Production to cover exactly its demand will score 0.5.

Aggregated share of storage and National Production deliverability (expressed as a percentage of the Average Daily Demand of a Zone) are used to measure the dependence on imports (the 1+ term is introduced to obtain the value of 1 for a country completely dependent on imports all over the year). A factor 0.5 has been introduced for the UGS component as it is assumed that storage has a neutral balance over the year. A Zone having enough National Production to cover exactly its demand will score 0.5.

This leads to the definition of an Import Dependence index:

$$\frac{1}{1 + (\% \, National \, Production) \quad + \; (0.5 \times \% \, UGS)}$$

4.6. List of cases defining the scope of the assessment

The table below gives an overview of all the cases that were modelled under the Infrastructure Resilience assessment (Reference Cases in **bold**).

Case	Year	Infrastructure Cluster	Demand Situation		Supply Situation	
			Duration	Occurrence	Supply Stress	UGS deliverability
1	2013 2017 2022	FID / Non-FID	1 day	Design-Case	**None (Reference Case)**	Not limited
2					NO 1	
3					NO 2	
4					BY	
5					UA	

6					DZ 1	
7					DZ 2	
8					LNG	
9					AZ	
10					**None (Reference Case)**	
11					NO 1	
12					NO 2	
13					BY	
14					UA	
15					DZ 1	
16					DZ 2	
17					LNG	
18				Uniform Risk	AZ	
19					**None (Reference Case)**	
20					NO 1	
21					NO 2	
22			2 weeks		BY	
23					UA	
24					DZ 1	
25					DZ 2	
26					LY	

27					LNG	
28					AZ	

Table 3.3. Cases modelled under Infrastructure Resilience assessment

For Supply Stress definition, please refer to sub-chapter 4.1.

The table below gives an overview of all the cases that were modelled under Supply Dependence assessment (Reference Cases in **bold**).

Case	Year	Infrastructure Cluster	Demand Situation		Supply Situation	
			Duration	Occurrence	Import mix	UGS deliverability
1	2013 2017 2022	FID / Non-FID	1 day	Yearly average	**Reference Case**	Not used
2					Full Minimisation NO	
3					Full Minimisation RU	
4					Full Minimisation DZ	
5					Full Minimisation LY	
6					Full Minimisation LNG	
7					Full Minimisation AZ	

Table 3.4. Cases modelled under Supply Dependence assessment

The table below gives an overview of all the cases that were modelled under the Infrastructure Adaptability to Supply Evolution assessment (Reference Cases in **bold**).

Case	Year	Infrastructure Cluster	Demand Situation		Supply Situation	
			Duration	Occurrence	Import mix	UGS deliverability
1	2013 2017 2022	FID / Non-FID	1 day	Yearly average	**Reference Case***	Not used
2					Even Maximisation NO	
3					Even Maximisation RU	
4					Even Maximisation DZ	
5					Even Maximisation LY	
6					Even Maximisation LNG	
7					Even Maximisation AZ	
14					Even Minimisation NO	
15					Even Minimisation RU	
16					Even Minimisation DZ	
17					Even Minimisation LY	
18					Even Minimisation LNG	
19					Even Minimisation AZ	

Table 3.5. Cases modelled under Infrastructure Adaptability to supply evolution assessment

The table below gives an overview of all the cases that were modelled under the Supply Source Diversification at Zone level assessment (Reference Cases in **bold**).

Case	Year	Infrastructure Cluster	Demand Situation		Supply Situation	
			Duration	Occurrence	Import mix	UGS deliverability
1	2013 2017 2022	FID / Non-FID	1 day	Yearly average	**Reference Case***	Not used
8					Targeted Maximisation NO	
9					Targeted Maximisation RU	
10					Targeted Maximisation DZ	
11					Targeted Maximisation LY	
12					Targeted Maximisation LNG	
13					Targeted Maximisation AZ	

*Reference Case is identical to the one of the Supply Source Dependence assessment

**Targeted Maximisation; it may require multiple simulations for the assessment

Table 3.6. Cases modelled under Supply Diversification assessment

Annex B

Glossary of Terms

CBA (Cost-Benefit Analysis) means a conceptual framework applied to any systematic, quantitative appraisal of a public or private project to determine whether, or to what extent, that project is worthwhile from a social perspective; such CBA is carried out according to a CBA methodology

CBA methodology means the Cost-Benefit Analysis methodology developed by ENTSOG on the basis of the Regulation and covering the Energy system-wide analysis and Project-specific analysis

Regulation means the Regulation of the European Parliament and of the Council on guidelines for trans-European energy infrastructure and repealing Decision no 1364/2006/EC

Draft Regulation means the Commission's proposal for the Regulation of the European Parliament and of the Council on guidelines for trans-European energy infrastructure and repealing Decision no 1364/2006/EC as submitted on 19 October 2011

TYNDP means the Ten-Year Network Development Plan as developed by ENTSOG in accordance with Regulation (EC)715/2009.

Energy system-wide analysis means an analysis of the European gas infrastructure as a whole aiming at assessing the overall impact of all TYNDP projects along the criteria of market integration, competition, security of supply and sustainability taking into consideration the energy infrastructure priority corridors defined in the Regulation; this analysis will be carried out by ENTSOG within the TYNDP, once the Regulation has entered into force

Project-specific analysis means a cost-benefit analysis of a TYNDP project aiming at assessing the impact of a specific project on the European gas infrastructure along the criteria of market integration, competition, security of supply and sustainability taking into consideration the energy infrastructure priority corridors defined in the Regulation; this analysis is carried out by the project's promoter according to requirements of the PCI process

Project of Common Interest (PCI) 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

Network model means an analytical tool for the assessment of the European gas infrastructure along multiple criteria as developed, operated and managed by ENTSOG and used for the production of ENTSOG reports and analysis according to Regulation (EC) 715/2009 or Regulation (EU) 10/994

Stakeholders means parties and authorities directly or indirectly affected by the PCI process

Final Investment Decision (FID) 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. The investment phase excludes the planning phase, during which project implementation is prepared and which includes, where appropriate, a feasibility assessment, preparatory and technical studies, obtaining licences and authorisations and incurring capital costs (*definition taken from Council Regulation (EU) 617/2010 concerning the notification to the Commission of investment projects in energy infrastructure within the European*)

Externality means a non-market impact that does not occur in the transactions between the producer and the direct users/beneficiaries of the project services but falls on uncompensated third parties. Externality is thus any cost or benefit that spills over from the project towards other parties without monetary compensation

Differential approach means the analysis of differences in the costs and benefits between cases with the project and cases without the project (Business-As-Usual; BAU) considered in the option analysis

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

Operating costs (OPEX) means all those costs that are incurred after the 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.

Financial analysis means the analysis using the cash flow forecasts to calculate net return indicators especially the Financial Net Present and Financial Internal rate of return

Financial Net Present Value (FNPV)/Economic Net Present Value (ENPV) means the result obtained from the deduction of the expected investment and operating costs of a project (suitably discounted) from the discounted value of the expected revenue from the project

Financial Rate of Return (FRR)/ Economic Rate of Return (ERR) means the discount rate that produces a zero FNPV /ENPV

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.

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. It may differ from the financial rate of return because of market failure in financial markets.

Financial Discount Rate which means the appropriate discount rate applied to the financial cash flow in order to calculate the present value of the future cash flows; the financial discount rate reflects the opportunity cost of capital, defined as the "expected return forgone by bypassing other potential investment activities for a given capital".

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; it is made on behalf of the whole society instead of just the project promoters as in the financial analysis by using appropriate conversion factors in order to reflect the social opportunity costs of inputs and outputs

Sensitivity analysis means the analysis aiming at determining the critical variables or parameters of the assessment whose variations, positive or negative, have the greatest impact on a project's financial and/or economic performance. The sensitivity analysis is to be run differently at the level of ESW- and PSA CBA.

Critical variable means those parameters of a project whose variations -positive or negative- have the greatest impact on a project's financial and economic benefits or lead to a switching of the sign of the performance indicators

Extrapolation means a projection of input data figures for an additional time horizon.

An indicator means a tool that quantifies a trend or phenomenon; it simplifies information in a manner that promotes the understanding of problems.