Study on recommendable updates and improvements of the energy system-wide cost-benefit analysis for gas

Consultation document

We encourage stakeholders to write comments directly in this consultation document through track changes and send it via e-mail to nico.keyaerts@eui.eu.

The consultation document can be downloaded here: <http://fsr.eui.eu/gas-cba-consultation/>

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# Introduction

## Context and objectives of the study

Regulation 347/2013 has set out the guidelines regarding the identification and the analysis of Project of Common Interest (PCI). It requires that the European Networks of Transmission System Operators ENTSO-E and ENTSOG develop a methodology for an energy system-wide cost-benefit analysis (ESW-CBA) at Union level of PCI. The methodologies shall be reviewed by the European Commission and the Agency for Cooperation of Energy Regulators (ACER) based on the criteria of Annex V of the Regulation. They shall be applied for the preparation of Ten Year Network Development Plans (TYNDP) at the Union level, and their outputs shall be used as basis for the PCI selection process, cross-border cost allocation (CBCA) for eligible projects, and Union financial assistance for eligible projects. Regulation 347/2013 also provides for regular updates of the methodologies.

The first versions of the gas and electricity ESW-CBA methodologies were published by ENTSO-E and ENTSOG in 2015 and served as the basis for the adoption of the second PCI Union list. For the first time, all project candidates included in their application package a cost-benefit analysis based on the ENTSOs’ methodologies. This first application of ESW-CBA methodologies has enabled to identify paths for improvement.

As a result, both ENTSO-E and ENTSOG ESW CBA methodologies are due to be updated. For the gas methodology the updating process has started with the inclusion of some voluntary improvements to the TYNDP methodology for TYNDP 2017, which is used for the PCI selection process of 2017. The next step is to do an update of both the CBA and TYNDP methodologies for use in the TYNDP 2018 and PCI selection of 2019. The updates are to be based on an extensive dialogue with stakeholders, and in particular with the European Commission and ACER.

In this context, the European Commission has launched in September 2016 a study to better identify the limits of the current ESW-CBA methodology for **gas** projects and the possibilities for improvement. Deloitte Economic Consulting France (formerly Microeconomix), in collaboration with Monitor Deloitte and the Florence School of Regulation (part of the European University Institute, has thus been mandated to identify recommendable updates or improvements to the present ENTSOG methodology that would make it more suitable for the PCI selection and CBCA processes. The recommendations will be accompanied with an estimation of stakes and efforts to carry out the improvements. The study is destined to assist the European Commission in their dialogue with ENTSOG.

## Objectives of the public survey

The present public survey is intended to enable all interested parties to comment and react on the current version of the review and on the proposed recommendations. The reviewers are particularly interested on the perception of preferred or more urgent recommendations and improvements, as well as the related technical implications and available solutions.

To this end, this consultation document is conceived as a comprehensive draft document that serves as the basis for the final study that should be delivered to the European Commission. This draft describes the 2015 ESW-CBA methodology and the requirements of the Regulation (section 1), explains the scope and approach of the methodology review (in section 2) and provides a description of all recommendations along with the issues they address and their implication in terms of feasibility and responsibility (section 3).

The findings from the survey will be used to balance and refine the recommendations before the final process of calibration and selection of improvements by the European Commission. Beside the reactions to the document, the reviewers also welcome any additional input that would enable to identify extra-recommendations and other issues with the 2015 methodology. Feedbacks on the way the stakeholders are able to use the methodology and the related stakes will also be much appreciated.

The public survey will run from March 1st to March 24th. Reactions can be submitted through the webpage, or can be submitted to nico.keyaerts@eui.eu. They can be anonymized upon request.

# Scope and current features of the gas ESW-CBA methodology

## Regulatory dispositions concerning the ESW-CBA methodology in gas[[1]](#footnote-2)

The ESW-CBA methodology which has been developed by ENTSOG stems directly from the requirements of Regulation 347/2013. Under this Regulation, the formal objectives of the methodology are (article 11) to “*enable a harmonized energy-system wide cost-benefit analysis at Union level of projects of common interest […]”* and to be *“applied for the preparation of each TYNDP*”.

Beside these main objectives, the Regulation sets a number of features and criteria that the ESW-CBA should comply with.

### Use of CBA and CBA results

First, the sets the specific cases where the CBA methodology or results should be used, first for the establishment of the regional lists, second for cross-border cost allocation when needed, and request of financial assistance.

The CBA methodology is hence first a major entry point to the establishment of regional lists (Annex III.2). Hence, “*promoters of projects […] wanting to obtain the status of PCI shall submit an application for selection to the Regional Group, [which shall include the] assessment of the project regarding the priorities [(in Annex I)], [the] analysis of the fulfilment of criteria defined in Article 4, and, [above all for the matter of this review], the* ***project-specific cost-benefit analysis*** *[…] based on the* ***[ESW-CBA] methodology developed by ENTSOG***” (§1). Note that “the main results of the cost-benefits analysis on the basis of the [ESW-CBA methodologies] for PCI, **except for any commercially sensitive information should be published on an infrastructure transparency platform public accessible**” (article 18).

Besides, concerning cross-border cost allocation, *“the basis for the discussion on the* ***appropriate allocation of costs*** *should be* ***the analysis of the costs and benefits of an infrastructure project on the basis of a harmonised methodology for energy-system-wide analysis****.*” Note that “*[For a project of common interest with cross-border impacts] and sufficiently mature in its development, project promoters […] shall submit an investment request, [including]* ***the request for cross-border cost allocation to the national regulatory authorities […], in particular the project-specific cost-benefit analysis consistent with the [ESW-CBA methodology]***“ (Article 12, §3). As a consequence, “***in deciding to allocate costs across borders, the economic, social and environmental costs and benefits of the projects in the Member States concerned and the possible need for financial support shall be taken into account***” (Article 12 §4). CBCA thus essentially relies on the outputs of the ESW-CBA.

The CBA methodology is also used to identify projects of common interest with higher risks in terms of development, construction, operation or maintenance, in order to provide their promoters with appropriate incentives to be renting. “***The decision […] for granting those incentives shall consider the results of the [ESW-CBA], and in particular the regional or Union-wide positive externalities generated by the project***” (Article 13 §2).

The CBA results are also inputs in the process for investment requests and financial support, as the project-specific cost-benefit analysis is a basis of the discussions between TSOs and national regulatory authorities on these investment requests (context paragraph 37). Similarly, the CBA results are inputs for request of financial assistance. Hence, “***[PCI] projects […] are eligible*** *to the Union financial conditions [if among other criteria],* ***the project specific cost-benefit analysis [based on ESW-CBA methodology] provides evidence concerning the existence of significant positive externalities such as security of supply, solidarity or innovation***”.

### Technical requirements of the CBA methodologies

Regulation 347/2013 also states technical principles that the ESW-CBA methodology should satisfy. These principles are presented in Annex V of the Regulation. In particular, “*the methodology should give guidance for the development and use of both network and market modelling necessary for the CBA*” (§3), “*the cost-benefit analysis should be based on a harmonized evaluation of costs and benefits*” (§4) and “*the methodology should include a sensitivity analysis concerning the data set, the commissioning date of different projects and other relevant parameters*” (§11). Note that the Regulation does not specify which other relevant parameters to consider, thus requiring additional input from stakeholders to fix them. “*The methodology should [also] identify the Member States on which the project has net positive or negative impacts*” (§11). It also reminds that “*recipients [of project cost-benefit analysis] shall preserve confidentiality of commercially sensitive information*” (§2), not telling specifically which pieces of information it may concern.

The Regulation also establishes that “*national regulatory authorities cooperating in the framework of the Agency shall establish and make publicly available a set of indicators and corresponding reference values for the comparison of unit investment costs for comparable projects […] [and those] reference values may be used by [ENTSOG] for the cost-benefit analyses carried out for subsequent 10- year network development [plan].*”

The Regulation also specifies the indicators that the ESW-CBA methodology should enable to assess. These indicators are presented in detail in annex IV with a list of criteria to be evaluated for all PCI candidates (general criteria and specific criteria in the gas category, namely market integration, security of supply, competition and sustainability). For each criterion, the Regulation details the list of indicators that the methodology should enable to measure. However, regardless of exceptions (e.g., impact of new capacity on HHI index), it generally does not specify which measurement methods to consider to assess these benefits, nor does it specify the rules for further monetization. Instead, it specifies in Annex V that the methodologies should give guidance for the use of market and network modelling for the CBA analysis

Lastly, the Regulation also gives indications regarding the conditions for **ranking or not PCI candidates.** “*Each regional group shall [hence] assess each project’s contribution to the implementation of the same priority corridor or area in a transparent and objective manner. Each group shall determine its assessment method on the basis of the aggregated contribution to the criteria […]. This assessment shall lead to a* ***ranking of projects for internal use of the Group***” (article 4). Annex III.2(11) also states that “t*he Regional Group shall [then] rank the proposed projects taking into account the assessment of the regulators*”. Nevertheless, “**Neither the regional list nor the Union list shall contain any ranking.** A later ranking at the level of regional Group is only allowed “*if, based on the regional lists received, and after having taken into account the Agency opinion, the total number of PCIs on the Union list would exceed a manageable number, the Commission shall consider, after having consulted each Group concerned, not to include in the Union list projects that were ranked lowest by the Group concerned according to the ranking*” (Annex III.2(14)).

## Description of the 2015 methodology

#### General description

The gas ESW-CBA 2015 methodology was published in 2015 by ENTSOG and was applied a first time for the adoption of the second PCI Union list in 2015. It was also used, with some voluntary improvements, for the elaboration of TYNDP 2017 and the PCI selection process of 2017.

The objective of the methodology is to support the assessment of PCI candidates, by evaluating for each candidate its alignment with the General and Specific criteria set by the Regulation, and by supporting project promoters and other stakeholders (Regional Groups, NRAs) in their work related to the selection and subsequent financing and cross-border cost allocation of PCI. This support includes the methodology by itself and the related guidance as to how to model the European gas system and a project’s impact on it. It also includes a series of qualitative and quantitative outputs characterizing a PCI’s impact, which are provided by ENTSOG or by the project promoters through the direct use of the methodology.

As a simplified description, the methodology consists in an ensemble of guidance, assumption description and process requirement to be followed by ENTSOG and project promoters for their application of the methodology and for their running of the ESW-CBA. The methodology hence describes:

* Data requirement and the assumptions and sources related to all inputs
* The modelling assumptions to simulate the impacts of PCI candidates on the European gas system
* The expected delivery of outputs for each indicator and other deliverable
* The description of all scenarios and cases (climatic, supply, infrastructure, global context) under which the gas system will be simulated to assess PCI candidates
* Details on application of the methodology by its users.

The next paragraphs will describe briefly each of these dimensions. For more details, the readers can refer to the official methodology and all related documentation, available at: <http://www.entsog.eu/publications/cba-methodology>.

#### Inputs

The data set used for the modelling of the gas system and the assessment of PCI impacts consists of a series of inputs at their current level and forecast over a 21-year time horizon, possibly through different scenarios (see next subsection).

The data set is structured in the methodology into two categories depending on the responsibility for providing and validating them:

* System-wide data is provided and validated directly by ENTSOG. In particular, the data set is aligned with the process for elaborating the TYNDP report. It gathers: the gas demand, the part of electricity demand to be covered by gas or coal (the “thermal gap”), the yearly average prices of commodities (coal, gas, electricity) and CO2 emissions (“global context” data), the supply potential from import sources, etc.
* Project-specific data which has to be provided directly by project promoters, at both technical (development steps and commissioning, capacity …) and financial (costs, projected cash flows …) levels.

#### Modelling assumptions

The modelling assumptions described in the methodology correspond to the approach which is used by ENTSOG in its supply outlooks and TYNDP report. The approach, and the modelling tool on which ENTSOG bases its calculations, are grounded on the open-access Jensen solver developed for the Texas University of Austin.

This “Network Flow Programming” approach consists in modelling the physical capabilities of the European gas system by identifying the least-cost routes to ensure equilibrium between supply and demand at each node, with one node per balancing zone. The modelling looks to define a feasible flow patterns that can minimize the following objective function: ***total EU cost of commodities (CO2, gas, coal…)* + *weight of infrastructure use***, by using the available system capacities.

The optimum found through the simulation thus delivers:

* A flow pattern which should ensure equilibrium at the least cost
* The identification of bottlenecks and the quantification of unserved energy, if European countries looked to spread it across Europe
* The total cost of commodities associated with the supply of gas. Note that infrastructure costs are not included in the final gas bill calculated for the European system.
* The marginal price at each node. Note again that this marginal price only takes into account the cost of commodities.

Beyond the main modelling assumptions, one finds in particular:

* The assumption of perfect market functioning, with no strategic behavior
* The assumption of inelastic demand.

#### Outputs and indicators

The main output measured through the methodology is the so-called ‘European social welfare’ *ESW* resulting from a given combination of demand, supply, and infrastructure development parameters. It is a direct output of the modelling’s objective function and is calculated as: ***cost of gas supply* + *cost of coal supply* + *cost of CO2 emissions***. The monetized impact of a PCI candidate in terms of social benefits is then extracted by comparing the ESW for the situation with and without the project’s commissioning.

The other indicators assessed through the methodology cover all specific criteria of the Regulation regarding PCI assessment. They consist in:

* Capacity-based indicators, which deliver the direct impact of a given PCI on a given country. They only require capacity and demand data to be calculated. The indicators are ’Import Route Diversification’, ‘N-1 for ESW-CBA’ and ‘Bi-directional project indicator’.
* Modelling-based indicators which are assessed through the gas system simulation and reflect the “indirect cross-border impact of infrastructure” related to the impact of PCI candidates on gas flows. The indicators are ‘Remaining flexibility’, ‘Disrupted demand’, ‘Uncooperative supply source dependence’, ‘Cooperative supply source dependence’, ‘Supply Source price diversification’, ‘Supply Source price dependence’ and ‘Price convergence’.

Note that the 2015 methodology does not provide tools for the monetization of this second list of indicators, which thus remain quantitative and are transmitted as such for the PCI selection process and the investment requests.

#### Scenarios and future cases

The modelling approach supposes that several combinations of inputs and assumptions are simulated and compared to obtain a robust vision of each PCI candidate’s impact. Each of these combination represents a more or less likely future, and corresponds to a different set of assumptions on the forecast of inputs to the modelling. The compositions ultimately require the choice between:

* Three infrastructure scenarios,
* two global context scenarios (and the corresponding gas demand scenarios and visions on electricity generation),
* for each supply source, three supply potential scenarios and one supply stress scenario,
* thirteen price configuration scenarios,
* and two scenarios regarding the commissioning or non-commissioning of the assessed PCI candidate.

For each PCI candidate, a hundred different future cases are thus simulated through the modelling. This enables to reflect the uncertainty regarding the future values of all inputs. This also enables to calculate the indicators and outputs for the PCI candidate, as those are often obtained by comparing several scenarios.

#### Application and organization

Structurally speaking, the application of the methodology is divided into two steps.

First, in the TYNDP step, ENTSOG is responsible for gathering all the data sets necessary for running the ESW-CBA. Beyond all inputs and assumptions to characterize the gas system for a given year, ENTSOG is required to collect all relevant technical data related to PCI candidates, for use in the gas system modelling. Following this collection phase, ENTSOG is responsible for running the modelling and to assess the impacts of PCI candidates along each scenario and each indicator. The outcomes from the TYNDP step are twofold: on the one hand, at an aggregated level they serve for the elaboration of the TYNDP report. On the other hand, at a disaggregated and confidential level they are transmitted to each individual project promoter for the subsequent Project-specific step.

In the following Project-Specific “PS” step, project promoters build on the output data coming from the TYNDP step. The assessment of a project at this stage is done by the corresponding project promoter and comprises other indicators, and in particular economic and financial performance indicators which were not available before that stage. The final analysis also includes a qualitative analysis of the results and the appraisal of potential additional benefits. Note that the PS step is only compulsory for mature projects which have been already submitted to the TYNDP.

After that second step, ENTSOG is finally responsible to gather all output from the PS step (including CAPEX and OPEX) and to transmit them to Regional Groups as a “common presentation of results supporting [their] interpretation of the PS step”. In particular, the consolidation of results for a given PCI candidate includes an output table gathering all relevant data and results as well as a synthesis document containing the description of the project and the qualitative analysis.

# Review of the gas ESW-CBA methodology

## Scope of the review

The study has first consisted in an in-depth review of the existing 2015 gas ESW-CBA methodology. The review was done based on the contribution of the theoretical economic literature and the review of other practical experiences as well as the issues already identified by stakeholders (ACER, Regional Groups). It focused first on the best possible way to conduct a CBA of gas PCI and make it relevant, reliable and usable by stakeholders for the processes the methodology has been intended to address. This in-depth review has been complemented by inputs from ENTSOG on the details of the 2015 methodology and the proposed components for the next update[[2]](#footnote-3).

From this review, a series of 15 recommendations was extracted. The focus of these recommendations is on the most critical and relevant improvements that the update should address in terms of robustness, accuracy and usability. Through discussions with ENTSOG as well as other stakeholders solicited by the European Commission, the recommendations were refined and reorganized to incorporate the reviewers’ perception on their feasibility and their technical and organizational implications.

## Theoretical insight on the framework of a cost-benefit analysis applied to gas infrastructure projects

From a theoretical point of view, the aim of an ESW CBA methodology for European gas projects should be:

* To enable an accurate and thorough analysis of PCI: all projects should be assessed on a harmonised, comparable basis, and the CBA should enable to assess if the project investment leads to an increase of social welfare (social benefits are higher than social costs).
* To support the PCI selection process by Regional Groups, and in particular to enable a robust and analysable method to compare projects and to operate a selection if needed. This implies that the outcomes of the CBA for all projects are comparable and that net benefits can be objectively ranked.
* To provide necessary data to carry out CBCA and funding processes with regard to PCI.

Given the complexity of the European gas system, its supply configuration as well as the wide-range of investment projects and their impacts (in terms of access to supply, competition, system security…), a cost-benefit analysis at that scale is necessarily a complex exercise that goes further than a direct comparison of costs and benefits (see THINK, 2013). To be efficient from an economic point of view, the CBA methodology should therefore be based on a certain number of principles which will ensure its accuracy, its stability and its capacity to respond to the main objectives identified beforehand. Thus, from a theoretical perspective, this requires:

* A transparent, opposable and economically-robust modelling tool which enables to simulate the impact of a project within the time and spatial scopes that appear relevant, and based on verifiable series of inputs. The modelling tool must be coherent with the objectives of the CBA in terms of scope as well as with the characteristics of the European gas system, in particular physical and commercial constraints.
* The monetization of all (relevant) impacts and outputs of a project: internal and external costs and benefits, including the impact on security of supply (load disruption linked to supply stress or climatic hazard situations) or on competition and the price paid by the final consumer (market behaviour and market power). Monetization (and discounting of annual monetized outputs) is necessary to compare all impacts on an equal basis and to avoid the need for subjective, less accurate weighting in case of a multi-criteria analysis.
* The integration of uncertainty and risk in the evaluation, whether it is uncertainty linked with the project’s specific features (environmental impact, cost) or uncertainty regarding the occurrence of the global scenarios (including supply configuration, climate, demand, …) under which the project is assessed. Results from different scenarios should be aggregated so that they can be used in the next steps and so that their relative importance is assessable.
* A standardized process to compare and rank projects, with criteria and weights that are objectified and based on justified input (for example, outcome of the TYNDP or of the CBA). The methodology should enable rational choices from stakeholders (Clinch, 2013): project promoters, Regional Groups, the European Commission, … Although PCI selection and CBCA necessarily relies on arbitrage between strategic national or European policy, objectives and constraints, organisational processes linking main strategies to evaluation criteria help achieve a standardized assessment of all projects that is analysable and can be directly applied by Regional Groups. The process should also take into account in an objective manner the issues of coordination and competition between projects.
* And, finally, an arbitrage between the complexity and details of the methodology and the simplicity of the whole process (whether CBA, PCI selection, CBCA…). Stakeholders should be able to develop and/or use the modelling tool and/or its outputs and to draw direct conclusions and results in a way that is homogenous but also simple. The objective is to avoid too high a cost of running such exercises, and also to avoid the risk of errors and distortions of decision processes that could stem from a too complex methodology. With regard to the modelling, an arbitrage is also necessary between accuracy and computational complexity (Keyaerts and Glachant, 2014).

# Recommendations to improve the gas ESW-CBA methodologies

The recommendations drawn from the review cover the improvements which are necessary to cope with the main issues identified in the methodology. They are considered to be associated with the biggest benefit to improve the accuracy of the modelling and CBA and to enable standardised, efficient processes for PCI selection, CBCA and CEF. They are proposed along four dimensions/ 1) monetization of benefits, 2) general simplicity of the outputs for their interpretation, 3) alignment with the PCI selection process, CBCA and investment request, and 4) modelling assumptions

The following sections describe each recommendation by detailing the issue they address, the way they should or could address it, and the preliminary perception of the reviewers on:

* Their feasibility and the complexity of the efforts to be accomplished
* Their timing: some recommendations imply an in-depth reform that would require several years and back-and-forth rounds between stakeholders. At the most extreme, a complete overhaul could thus be worth considering
* Their interdependence

## Recommendation #1: reinforce monetization of benefits

The ESW-CBA methodology supports the selection of PCI for which the EU-wide benefits must outweigh the costs; it also supports the allocation of costs to the countries that are net beneficiaries. Both purposes require the comparison of all costs and all benefits.

The easiest way to compare things is to measure them with the same yardstick. In economics, that yardstick is money. For the cost indicators, there is no problem as investment costs are already expressed in money. For the benefit indicators, on the other hand, the situation is less clear. The benefits of a project can relate to any of the criteria listed in Annex IV of Regulation 347/2013, meaning that benefit indicators are needed to measure the positive or negative impact of a project on competition, on market integration, on security of supply and on sustainability. By expressing these indicators in monetary terms, a clear and unambiguous comparison of the costs and benefits is possible.

All benefits can normally be quantified and monetized through more or less complex modelling tools, which however requires to consider some difficult notions in terms of market power, shipper strategy and details on demand and supply curve at the national levels. Monetization also requires to put a price on physical quantities whose value is by nature variable or multiple and changes for each category of stakeholder. The monetization of benefits is thus possible, but is non-trivial.

These difficulties with monetization seem to have driven the 2015 ESW-CBA methodology, as the proposed set of benefit indicators appears under-monetized. Only four of the more than a dozen indicators are assigned monetary values: EU bill (corresponding to gas savings from substituting between suppliers thanks to new routes), CO2 emissions, disrupted demand under stress and disrupted demand.

This issue raises significant doubts on the effectiveness of the ESW-CBA methodology as a common approach to compare projects on an equal footing:

* In particular, the PCI selection process is based in theory on outputs which can be comparable, within and between each project. Monetization is particularly interesting in this respect, all the more so that it would enable a direct comparison of the benefits with project costs
* The issues are even more emphasized for processes in terms of CBCA and investment requests. Decision makers require monetized data to make their decisions. Monetization of direct benefits and of externalities and their distribution across countries is a pre-requisite that is not sufficiently achieved by the current methodology.

To deal with the limitations of the current methodology, several measures can be proposed to advance the number of monetized indicators and to advance the monetization of specific indicators. A first recommendation (R1A) is general and consists in a roadmap for improved and more focused monetization. The three others (R1B, R1C, R1D) deal with the monetization of specific indicators: market power, disrupted demand and CO2 emission impact.

### R1A: Classify the indicators according to the value and capacity to monetize them and propose a roadmap to advance the monetization of currently non-monetized indicators

#### Why?

The gas ESW-CBA methodology should be improved to ensure a better monetization of indicators in terms of European social welfare, and thus of related metrics quantified in the methodology. At the current stage, the decision making process is indeed based on an implicit monetization of non-monetized indicators, which is less transparent and therefore less desirable. When it comes to informing the decision makers for the purpose of cost allocation, non-monetized benefit indicators are of no use if they are not put on an equal footing with the monetized benefits to determine the net beneficiaries. When the indicators use different yardsticks, e.g. money and energy, the cost allocation will be imprecise.

The work on monetization should however be coherent with the complexities of such an exercise in terms of feasibility, efforts and input data requirement. When the indicators support the selection of projects of common interests, a combination of monetized and non-monetized benefits can inform best the decision makers and facilitate their work. It then implies to monetize the main indicators on which decisions are based and to have additional secondary indicators for informative purposes, to avoid double counting of the same benefit. Emission cost savings for instance should be monetized and the monetized indicator should be considered for decision making; a secondary indicator on the tonnage of saved emissions can be reported for informative purposes.

#### How?

The main recommendation is to make a clear distinction between a set of indicators that should and could be monetized, and another group of indicators for which monetization brings limited added value. The definition of two groups should be made according to the opinion of decision makers and the findings from previous PCI selection, CBCA and CEF processes. In particular, findings and elements regarding the risk of double-counting and the technical feasibility and options to monetize the different indicators should be considered. The list of to-be-monetized indicators should include all indicators which it is technically possible to monetize, and which monetization would be valued by decision makers.

Additionally, a roadmap should be put forward for monetizing the indicators that are marked as possible to monetize and regular advancements should be made in monetizing them or ENTSOG should offer an explicit justification why advancements were not possible.

#### Feasibility?

It should be technically feasible to have monetized indicators for all the benefits in the Regulation. However, some indicators require more complex modelling, for instance, the monetization of changes in market power. For some indicators, it might be politically difficult to agree on a number and ENTSOG might be uncomfortable with defining a value themselves. A consultation process could help in this regard.

### R1B: Propose a quantified indicator for market power and go toward monetization

*Note: this recommendation is complementary to recommendation R4D on the incorporation of strategic behavior in the modelling tool.*

#### Why?

While market power is included in the list of potential criteria in the Regulation, it is disregarded by both ENTSOs in their respective ESW-CBA methodologies. The rationale for not considering market power is similar for both sectors: infrastructure projects should not be assessed with regard to their capacity to cope with market-based issues, for which other (regulatory, market-based) solutions may exist that would be less expensive.

The reviewers do not agree with this perception in the case of the European gas system, where market power is exercised primarily in the context of a limited number of gas producers, either internal or external. Natural gas supply is undeniably an oligopoly where market players are able to manipulate the price through their import and production strategies. Furthermore, economic literature has shown that market power in the European gas system is exacerbated by transmission constraints, implying a high level of impacts in case a new route or a new LNG terminal are built. The most extreme cases even show projects which are beneficial despite being never used. Such projects do not change the actual physical gas flows but mitigate the strategic behavior of market players. In turn, this yields significant decrease in the deadweight loss caused by market power, as well as a welfare transfer from producers to European consumers.

#### How?

For projects in a region where competition has been marked as a priority issue, an indicator for changes in market power should be calculated. At the very least, HHI indicator might be calculated for transmission capacity bookings as suggested in the Regulation. A better approach would be to consider more accurately strategic behavior of producers in the modelling tool (see the complementary recommendation R4C). In any case, the capacity of PCI to mitigate market power and bring significant benefits should be recognized in the methodology, and a specific indicator should be added to the list of outputs as part of the supplementary analysis.

Given the significance of a market power indicator in regions where competition is an issue, and the capacity to monetize even the most simple of them (HHI) through a proxy[[3]](#footnote-4), the reviewers also recommend to place market power in the list of indicators to monetize (see recommendation R1A).

#### Feasibility?

The calculation of an indicator regarding market power could and should be implemented immediately. The monetization of HHI is also easy to implement. The definition of an indicator for a project’s impact on market power that relies on more complex modelling might be investigated for adoption in a later update. Such indicator could be part of the aforementioned roadmap.

### R1C: Improve the monetization of security of supply and disrupted demand

#### Why?

The “Disrupted demand under stress” and “disrupted demand” indicators are not monetized in the 2015 ESW-CBA methodology, as ENTSOG identified strong technical difficulties to assess the level of the Cost of Disruption per Unit of Energy (CoDU). In particular, the methodology expressed issues of consistencies in the assessment for each Member State on their own level of CoDU, and difficulties to cope with the variability of such a cost with regard to the type of customers impacted, the magnitude and the duration of disruption events considered.

As voluntary improvements for TYNDP 2017 and for the next update of the ESW-CBA methodology, ENTSOG now proposes to monetize these indicators through a uniform “VoLL” (for Value of Lost Load) unitary cost. The VoLL is fixed at EUR 600/MWh for the complete time horizon, and corresponds to a trivial division of the total EU28 GDP by the gross inland gas consumption in EU28.

This current assumption is simplistic and cannot in any case represent an accurate view of the impacts that gas disruption can have for Europe as a whole and for each Member State separately. As mentioned by ENTSOG in 2015, the cost of disrupted demand shows significant variation according to the Member State and the type of consumer (industrial, residential). It is also extremely sensitive to the characteristics of the disruption event: time of year, size and duration of the event, frequency, etc.

#### How?

The reviewers recommend a complete revision of the approach to monetize the CoDU. ENTSOG should order and realize a detailed study on the cost of disruption in Europe. The study should end by 2018 in order to be used as soon as the next TYNDP. It should enable to measure the willingness to pay or to accept disruption for different types of customers and for each Member State.

#### Feasibility?

Notwithstanding the political sensitivity of putting a value on unserved demand, improvements on VoLL can be implemented immediately. Several approaches to come up with possible VoLL numbers that are more refined than the current number are available to ENTSOG, from preference surveys to econometric approaches, and ENTSOG should motivate its final choice to estimate the CoDU in each European country.

### R1D: Improve the monetization of CO2 impacts

#### Why?

The 2015 methodology monetizes the impact on CO2 emissions by considering the IEA forecasts for CO2 quota market prices. The methodology thus wrongly assumes that the current design of the market price captures all environmental externalities and is a correct estimation of the marginal social cost of emitting carbon dioxides. Indeed, economic literature and empirical findings on quota schemes show that the current market prices are under-valued and are several times lower than the Social Cost of Carbon (SCC). This is due to market failures as well as the inherent limitation of quota schemes in terms of time and spatial scopes.

As a result, the current estimation of a CO2 emission cost by ENTSOG is underestimated and biased. The unrealism of related outputs is then only reinforced by the choice in the methodology to consider different price trajectories, each corresponding to a different global scenario. In a simplified way, the methodology hence currently assumes that the unit cost of emissions would increase more in the Green evolution scenario than in the Slow progression scenario, which is fully counterintuitive.

#### How?

The methodology should base the monetization of environmental impacts on the SCC[[4]](#footnote-5). Contrary to CO2 market price, the SCC is defined to reflect the full economic marginal cost of emitting one more ton of CO2 into the atmosphere. It is calculated by summing and discounting the estimated impact over a very long period (more than 100 years) and over the most extensive list of impacted stakeholders.

ENTSOG should motivate its estimation for a European SCC on the benchmark on existing reference studies on the subject. These studies (see the regulatory impact analysis by the US Federal Government, the Stern report commissioned in the UK, or the “tutelary” CO2 value report published by the French prime minister’s strategic committee) base their estimations on behavioral studies and surveys, and are used by government and regulatory agencies for their policy impact analyses. While their scope and intrinsic assumptions may vary, they all show the same influence on some major parameters (e.g., a social discount rate) and all reflect the current under-valuation of CO2 market prices. A preliminary suggestion of the reviewers would thus be to do all calculations (for all global scenarios) with a central value for SCC, and then to cope with the related uncertainty of measures in the sensitivity analysis stage of the methodology.

#### Feasibility?

Notwithstanding the political difficulty to define a value, the monetization of changes in CO2 emissions is immediately possible. However, one must be careful not to double count the benefit by using both the EU ETS value in the market modelling of fuel substitution and a tutelary value for a separate indicator.

## Recommendation #2: simplify the outputs

The 2015 CBA-ESW methodology provides three capacity-based indicators, seven modelling-based indicators and three more indicators for monetary analysis. These thirteen indicators are calculated considering different combinations of three infrastructure scenarios, two global context scenarios, two gas demand scenarios, two visions on electricity generation, three supply potential scenarios for each supply source (meaning tens of supply scenarios), thirteen price configuration scenarios, four climatic cases and one supply stress scenario per supply source. Each of these possible combinations represents a different set of assumptions on the forecast of inputs to the modelling, i.e. a possible future case for simulation. While some simplifications are undertaken in the methodology (in particular scenarios for electricity generation, global gas demand, global context are merged), each indicator is still calculated for up to hundreds of different combinations / future cases.

By considering these many future cases and indicators, the unfiltered output returns thousands of data points, many of which will be not relevant because they do not address the needs of a specific regional group or stakeholder. Another critical issue also concerns the actual ability of users of the methodology to process and balance these unfiltered outputs: for Regional Groups in particular, in order to make robust and accurate decision process, they need to grasp the level of uncertainty regarding each future as well as the correlation between each output and the need they have to address in priority. This requires an extreme level of data processing and analysis. It might also lead to an issue regarding harmonization of processes, results and decisions, as each user of the methodology will process these outputs in a different way.

A first way to improve the methodology in this respect is to make the outputs more manageable for its users upfront. This will reduce the risk of non-harmonization of the outputs treatment and will ensure a more robust and accurate analysis. Three recommendations are hereafter proposed: the methodology should reduce the number of calculated indicators (R2A), reduce the number of cases (R2B) and aggregate the remaining outputs (R2C) into meaningful indicators where possible.

### R2A: Reduce the number of indicators

#### Why?

The 2015 methodology defines thirteen indicators to reflect the impact of a project on market integration, competition, security of supply and sustainability.

Notwithstanding that there is no unequivocal answer on the right number of indicators, every (main) indicator should provide information that is not already captured by another one. The indicators currently proposed in the methodology do not follow this logic and several risks of double counting are identified. In particular, taking the example of the indicator on cooperative supply source dependence and on uncooperative supply source dependence, one can wonder if a project’s impact on source dependency is not sufficiently reflected by either one of those indicators. A higher number of indicators will frequently lead to double counting of effects which obscures the assessment of individual projects and their comparison.

#### How?

It is a good practice to critically review the contribution of each indicator to evaluate gas projects according to the requirements specified in the Regulation. The retained indicators need to be clearly defined, their meaning explained and for each indicator interdependencies with other indicators should be explicitly stated. Additionally, the retained indicators should be those indicators that are relevant for all projects. In motivated cases, project promoters can include additional indicators to signal a positive effect that is specific to some projects; those project specific indicators should be explicitly defined and motivated, and they should be used sparingly.

A minimum set of indicators, without specifying them, would include the surplus in socio-economic welfare, an indicator to reflect security improvements, and an indicator to reflect improvements in making the energy system more sustainable.

#### Feasibility?

A critical review and clarification of the output indicators can be implemented immediately. The definition of new or redefined indicators might require a sustained effort considering that modelling techniques improve over time.

### R2B: Highlight the relevant future cases

#### Why?

The ENTSOG methodology defines a large number of simulation cases to reflect different possible futures. These cases are based on combinations of scenarios regarding the global energy characteristics (gas demand, electricity system characteristics, CO2 price…), climatic extremes, supply scenarios, price configurations, supply failure occurrences, etc. On average, for each of the thirteen main indicators hundreds of future cases could be simulated and tested. In reality the methodology already operates some choices as to which combinations of scenarios it will use to assess each project. However, this still leads to tens or a hundred of different future cases for each quantified indicator.

A critical issue linked with the ability of the methodology’s users to manage the number of data hence appears. By crossing the number of indicators with the number of future cases, thousands of different outputs have to be regarded to extract exhaustive and robust findings and draw relevant decisions. One might then question whether those users are able to perform such a task of selecting and filtering this many data and whether the decisions eventually taken are accurate and robust enough.

As a particular concern, the stakeholders might not be able to assess the level of uncertainty linked with each specific scenario and with each future case that is built on it. By ignoring the probability of occurrence of these future cases, the stakeholders have to rely on their perception and exposition to risk to identify the future cases they want to prioritize. This leads to potentially inaccurate and counter-intuitive results.

Those identified issues will then only escalate by considering the number of different stakeholders who will use the ESW-CBA outputs: as each will have to interpret the series of outputs through its own methodological choices, there will be no harmonization between decisions taken at the European level, inducing for example severe risks of contradictory decisions being made simultaneously.

#### How?

The CBA is necessarily an evaluation of the future merits of projects. To capture the inherent uncertainty linked with this evaluation, the most likely cases need to be identified, investigated and highlighted for the following steps. It is vital that the methodology’s users are able to distinguish and separate which future cases matter the most for their needs, and which are the most likely to happen.

The selection and definition of a limited number of relevant cases therefore need to be agreed by ENTSOG and the stakeholders before the evaluation process begins. Discarding the output of cases that are considered not relevant afterwards is also an option to simplify the output. To avoid any issue regarding loss of information, one can envisage to still provide a separate file containing all the outputs, as is currently the case.

As a complement to a selection of the most relevant or probable future cases, ENTSOG could also attempt to a formal probability analysis of scenarios. By estimating the accurate probabilities of occurrence of each future case, the methodology would then enable to simulate each combination of scenarios by putting a global probability weight on them, thus enabling new, directly usable results for each indicator: highest probability, standard deviation, probability function … This could be achieved by running Monte-Carlo simulations through the modelling tool.

#### Feasibility?

It is not clear who has the responsibility or is best placed for the definition and identification of future cases. ENTSOG has a responsibility to define common input data sets, but these inputs should match the information needs of the institutions that make decisions based on the cost benefit analysis.

ENTSOG and ENTSO-E are making progress with the definition of scenarios by organizing extensive stakeholder consultations and moving to jointly defined scenarios. This is a useful progress which however only concerns global scenarios and parameters (gas demand, CO2 price, etc.). This could be extended to the other scenarios regarding climate cases, supply stress scenarios, etc. with similar tools and methodologies for consultation.

With regard to our proposal of a probability analysis, notwithstanding the issue regarding data collection for probability of occurrence, this raises a critical technical issue regarding the ability of the modelling tool to run a Monte-Carlo analysis and to deliver quickly enough the related results.

### R2C: Go toward aggregation of yearly results per indicator

#### Why?

The 2015 methodology is based on simulations being run only on round years for which common input are provided: n, n+5, n+10 … with n being the year the project is implemented. As a result, each indicator is calculated for all future cases considered and for all round years, which multiplies even more the amount of data that the methodology’s users have to process to extract robust and relevant findings.

The monetized indicators (project costs, EU bill indicator corresponding to the main economic social welfare) are however aggregated along years through discounting. The methodology first provides a linear interpolation of the modelled round years, and the yearly results hence calculated are discounted through the use of a social discount rate fixed at 4%. This discounting enables to take into account the lesser importance of a project’s impact in the long term and to provide a single, current valuation of impacts for those monetized indicators. These are useful to ensure aggregation of outputs as well as outputs usable for cost allocation procedures.

With regard to the other indicators, the methodology does not provide neither a smoothing of round years outputs nor discounting for the other indicators. The main reason advanced is that those are quantified but not monetized, and that discounting can only be done for monetized values. Still, from a pure economic perspective nothing should prevent to attempt a discounting of the annual physical indicators, assuming that their economic value will remain the same over the considered period. The literature provides plenty of examples of such cases and also shows the limitations of such an exercise.

#### How?

The reviewers therefore recommend, for every indicator for which it is technically possible and accurate, to perform a smoothing and a discounting even if those indicators are not monetized. This implies to define accurate methods for smoothing indicators over the years.

This also requires to investigate and consider in a transparent manner the conclusions of the economic literature on the relevance for discounting physical units. For each indicator, the methodology should then make sure that the main advised conditions are met, in particular regarding the temporal variation of the unit values for those indicators (in theory, to enable factorization in the discounting formula, only physical indicators whose corresponding unit values are constant through time can be directly discounted) and the probability of occurrence of future cases for which the indicator is assessed (following the same factorization reasoning).

#### Feasibility?

The aggregation of numbers should always be done with caution to avoid the loss of information. It is not trivial to discount or aggregate non-monetary values and therefore an extensive analysis of the economic literature and a consultation with stakeholders should precede any decision on the aggregation of yearly values.

## Recommendation #3: Alignment with purposes for PCI selection and CBCA

As specified in the Regulation, the ESW-CBA methodology is the first tool at the basis of many other processes regarding PCI candidates. PCI selection, cross-border cost allocation and financial assistance require exhaustive inputs in terms of impact assessment, costs and benefits, many of which should be directly provided by the TYNDP-step of the CBA analysis by ENTSOG or by the PS-step run by the project promoters.

For matters of accuracy, robustness and harmonization, it is necessary to ensure the coherence between the way these processes are performed, their outcomes and decisions, and also all their needed inputs regardless their source. Therefore, one field of improvement concerns the better alignment between the ESW-CBA methodology and the processes it is intended to serve. In other words, the methodology should be fit-for-purpose, and this should be the case notwithstanding of the actual allocation of responsibility to perform these subsequent purposes.

The next recommendations tackle these improvement fields. Recommendations 3A, 3B, 3C focus in particular on the achievement of the PCI selection process and on the ways the methodology could be better aligned in this respect. Recommendation 3D concerns the purposes related to CBCA and investment request.

### R3A: Formalization of a proposal fiche

#### Why?

The reporting of thirteen output indicators for hundreds of future cases and several reference years leads to thousands of outputs that reduces the usability of information by complicating their interpretation by Regional Groups.

Instead of aggregating directly these outputs, the current methodology encourages a story-telling approach to support PCI selection. Results and indicators for each project are analyzed with a series of infrastructure needs identified for each Regional Group. ENTSOG then extracts directly from the TYNDP step of the CBA the results deemed most relevant to the particular project, both with regard to the infrastructure needs and to the other PCI candidates, and reports them to Regional Groups.

This synthesis process and the reporting transmitted to Regional Group are based on ENTSOG’s own analysis of the methodology’s outputs. They remain non-standardized and they still seem not to present an overview of most relevant outputs that could be quickly used by Regional Groups in their discussions and decisions.

#### How?

The methodology should focus on a limited number of indicators and cases and report these singular values, meaning one value per indicator per case, in an informative format, such as a project fiche. The project fiche should follow the same format as proposed by ENTSO-E for the electricity PCI selection process and for the electricity TYNDP. It should highlight the indicators that are the most related to the pre-determined regional needs; for instance, highlighting the indicator for security of supply if a region identifies security projects as the main priority.

To support the PCI selection process, the CBA should provide information on the EU wide impact of the project through indicators that capture benefits and costs at the European level. Nevertheless, indicators that are disaggregated at the national level provide additional information to the Member States. Furthermore, disaggregated indicators are required to support the decision making with respect to cross-border cost allocation and requests for financial assistance.

The assumptions on the case to which an indicator value refers should also be made available in a clear document that outlines the applied input data and modelling assumptions to help the regional group with the interpretation of the information.

Note that ENTSOG seems to be in the process of implementing such an improvement. Its voluntary updates on TYNDP 2017 and the ESW-CBA methodology include the provision of project fiches for Regional Groups.

#### Feasibility?

The reporting of indicators in a project fiche requires no additional effort and can be implemented immediately. It is demonstrated by the work already done by ENTSOG to prepare for such an improvement. It is however important to remain meticulous on the formalization and usefulness of such project fiches: both their format and the underlying rationale should be validated with project promoters and Regional Groups.

### R3B: Verification of PCI input data

#### Why?

The assessment of PCI candidates by Regional Groups relies only partly on common datasets validated directly by ENTSOG or through consultation processes and the collaboration with ENTSO-E on the interlinked model. Several inputs are however project-specific and are directly provided by the project promoters. This concerns for example the investment and operating costs of the project, the estimated revenue streams and also the timeline for building and commissioning.

Both the common assumptions and the assumptions of the project promoters need a validation of their accuracy. Regional Groups indicate that at too many occasions they have to analyze or compare projects for which the indicated inputs are not reliable, in particular regarding the commissioning date, or are simply missing. The latter case concerns especially data on investment costs, which are often not delivered by the TYNDP-step of the methodology under confidentiality concerns while the Regulation states that unit cost could be used.

#### How?

A consistency check with national transmission plans, with reference unit costs and with other reference inputs should be performed. Official documentation from ACER and national regulators are already available and could be used to perform this task.

In addition, safeguards and criteria should be implemented in the methodology as to a minimum of details to be provided by the project promoters. It should foresee an ex-ante rejection or specific categorization for a project that does not satisfy those criteria. In any case, it is vital that, when comparing or selecting projects, Regional Groups can identify which projects are the most at risk of not being carried out even if they are in the most advanced infrastructure level.

#### Feasibility?

Besides including this check as part of the methodology, which also describes the process of the assessment, the responsibility for the check has to be clarified. The regional groups or the regulatory authorities could be made responsible.

The publication and use of the details on project costs should not be an issue in terms of feasibility. While the Regulation recognizes that recipients (regulators or regional groups) of project analyses must preserve commercially-sensitive information, it does neither limit their diffusion nor regard project costs as commercially-sensitive and therefore does not conclude on their confidentiality requirement. Regulatory authorities might thus require their provision and they should be considered an important indicator that belongs on the project fiche.

### R3C: Enable the identification of clusters and competing projects

#### Why?

The value of projects of common interest depends on all other infrastructure projects that are implemented. When selecting projects, it is important to understand which other projects need to be in place to capture the full potential and which projects should not be developed together in case of negative synergies.

The methodology foresees a rudimentary approach to signal potential project interaction by checking each project against different infrastructure development scenarios. This approach however does not identify which projects are interacting positively or negatively with each other.

As a result, the Regional Groups perform the identification of complementary and competing projects by hand, based on a pragmatic approach that disregards objective criteria in favor of a global perception on the issue. Note also that the methodology does not include any guidelines to assist Regional Groups in such an approach, thus resulting in serious risk of non-harmonization and errors.

A less visible issue concerns the case when a competing project is already included in the TYNDP. In such a case, and regardless of its application for PCI status, the project will distort the assessments in terms of marginal impact of all other projects through the cost-benefit analysis. This is particularly critical if the project included in TYNDP is eventually less likely to be implemented and is less serious than the projects still applying for the PCI list.

#### How?

The methodology should prescribe stricter grouping rules for investment items that take into account the maturity of investments and the common purpose of investment items.

For competing projects, project promoters should indicate alternative projects that could affect the project’s viability. Additionally, if the regional groups define the regional needs in the region before projects are to be submitted, project promoters can indicate which need the proposed project is addressing.

These measures complement the existing approach to signal project interaction, which can then lead to supplementary analysis for a subset of projects.

At a more complex level, the modelling tool could propose to run and identify automatically those interacting projects.

#### Feasibility?

The rudimentary approach based on the comparison of a project’s impacts for several infrastructure scenarios could be refined in the short term, but any structural approach to analyze project interaction is non-trivial. Modelling tools and automated analysis can help if resources are invested to do so.

Experiences on dealing with project interaction could be exchanged with ENTSO-E.

### R3D: (Monetized) indicators at Member State level for CBCA and investment requests

#### Why?

Like for PCI selection in the previous recommendations, the ESW-CBA methodology needs to enable an evaluation of PCI candidates that supports the regulatory authorities in taking decisions on investment requests and CBCA. At minimum, the methodology should clearly identify the countries which benefit from the project in terms of social welfare (including externalities in terms of security of supply and CO2 emissions) and the countries that are net cost bearers. A more advanced view on supporting cost allocation decision processes would call for as much as possible monetization of the indicators and they should inform on the regional distribution of costs and benefits at the Member State level.

The current methodology does not fully follow this approach. In particular, the indicators it measures do not report systemically at all levels: some focus on EU-wide effects, some on Member States and some on balancing zones.

More in detail, the EU-bill indicator, which accounts for the monetized part of social welfare, presents the largest problem as it is calculated for the EU as a whole without a correct way to divide it over the concerned countries. The methodology describes a method to reconfigure national supply curves, but the accuracy of that approach is questionable. For the other indicators, it seems that the absence of a full monetization or probability analysis prevents any allocation of monetized costs and benefits between Member States that could be used to assist the work of regulatory authorities.

#### How?

Notwithstanding the need for more monetization (already tackled with recommendation #1), the methodology should design proxies or introduce additional indicators at Member State level to support the cost allocation decision processes in addition to the indicators at EU-wide level, which are used for project selection.

These indicators could be reported using the same project fiche format as recommended for supporting the selection process by the regional groups but with data provided at the national level and not at the regional or European level. In any case, formalisation on the CBCA-related outputs reported by TYNDP and PS-steps of the ESW-CBA should be reinforced, to enable a harmonized, non-opposable methodology for cost allocation. The risk otherwise is that regulatory authorities disregard the results from the TYNDP-step in their entirety due to their lack of alignment with their purpose.

#### Feasibility?

Besides the efforts to push further monetization, the calculation of indicators at Member State level might require some changes to the modelling assumptions. Those changes imply some effort and depend on the capacity of ENTSOG to modify in depth the modelling tool.

In contrast, the methodology should quite easily be amended to include the model for a project fiche dedicated to cross-border cost benefit analysis, with potential economies of scale thanks to the project fiche for PCI selection.

## Recommendation #4: Improve (market) modelling assumptions

In a simplified way, the assessment of a PCI’s impact on the European gas system and of its compliance with the Regulation’s criteria requires to model the entire gas system and to simulate and compare two situations: one counterfactual where the project never takes place, and one scenario where the project is carried out on time. To be effective, such simulations must be carried out over the entire European gas system and its suppliers.

The accuracy of the simulations is vital to ensure the relevance and the reliability of the entire ESW-CBA and the next steps regarding PCI selection, CBCA and investment request. The ESW-CBA methodology should thus guarantee this objective by giving guidance on the correct modelling of the European gas market and network. The modelling tool that is built from that methodology should deliver a representative and realistic functioning on the gas markets, not only in terms of its technical capability but also in terms of flow patterns, marginal price, congestion situation, supply configurations and competition.

The current modelling tool used for the TYNDP-step of the ESW-CBA does not follow these criteria. It is a very simplified model that is used primarily to simulate the physical capabilities of the gas network and to identify bottlenecks and infrastructure needs. As its use is primarily destined at the elaboration of the TYNDP and not the ESW-CBA, it minimised the role of market-related assumptions and does not ensure a reliable forecast of the market parameters (level of demand, substitution between gas and other energies, actual flows, formation of price, interconnection pricing…) that nevertheless are critical for both cost-benefit analysis and cost allocation between Member States.

The recommendations provided hereafter address the identified limitations of the methodology in terms of modelling. They could then be seen as minimum standards for any model used by ENTSOG and others to calculate cost and benefit indicators.

Especially, they show that the market modelling needs to be more advanced, either by changing the modelling assumptions of the existing tools or by drawing from the many examples of gas market models that are commercially available, including models that capture strategic behavior. A complete overhaul and change of gas market model might even be envisioned to address all recommendations together.

### R4A: Support market modelling with more realistic demand assumptions

#### Why?

The current modelling tool relies on the assumption that gas demand is inelastic and that there is no cross-elasticity between gas and other energies. In particular, the substitution of coal and gas within the thermal gap, although introduced in the methodology, is not studied in the actual calculations.

These assumptions constitute oversimplifications considering that the horizon of analysis extends to at least twenty years and that the tested future cases can involve some significant variations of the gas commodity or retail price. This might lead to a distorted measurement of projects impacts in terms of energy bill, unserved demand, and marginal price convergence within the EU.

#### How?

Two measures can be taken. First, the methodology should introduce non-zero price elasticity of demand or justify why demand is assumed as inelastic. Economic literature provides for extensive information on the topic of gas demand elasticity, and the available gas market models generally integrate an assumption on demand elasticity. These could be the ground for the proposals in the methodology.

Second, the substitution between coal and gas under supply stress conditions needs to be revisited. At the very least, an out-of-the-box, separate analysis of the potential for substitution might be carried out and joined to the outputs of the CBA to indicate the limitations of the modelling tool and the risk (and scope) for such a substitution.

#### Feasibility?

It is feasible to introduce elastic demand, but the modelling would necessarily be more complex. There may be issues to collect data regarding customer preferences as well as the level of cross-elasticity between primary energies.

### R4B: Correct how commercial constraints and transportation costs impact flow setting

#### Why?

Market behavior and flows are heavily influenced by the market characteristics and the interconnection (commercial) costs. They impact not only the flow pattern but also the system ability to cope with extreme situations (e.g. supply disruption, high demand). These constraints are disregarded in the current models; however, it is vital that the drivers that influence commercial flows and the arbitrage between indigenous generation and several supply sources be analyzed.

Furthermore, pipeline interconnections are represented as several smaller connections with increasing weights (proxy for cost of use)[[5]](#footnote-6); this is a modelling trick to reflect a spread of gas disruption risk across all balancing zones. This is unrealistic and induces strong distortions.

#### How?

Transportation costs (based on SRMC, LRMC or existing entry exit tariffs) should be considered in modelling the commercial behavior of stakeholders. The use of weights added to slices of pipeline capacity would better be replaced by more explicit modelling of the market assumptions regarding demand, marginal cost of supply and marginal cost of using pipelines and contractual constraints. The objective should be to model transportation costs and tariffs which are as representative as possible and show the actual risk that they influence the final flows and the impacts of some projects.

#### Feasibility?

The inclusion of transportation costs is non-trivial. If one wants to consider the impact of network development on future tariffs it becomes even more challenging.

### R4C: Advance market modelling to include strategic behaviour as part of supplementary analysis

*Note: this recommendation is complementary to recommendation R1B on the monetization of market power.*

#### Why?

In some regions, the assumption of perfect competition made in the basic model applied to all PCI candidates is false and the addition of infrastructure could have a significant positive impact on strategic behaviour.

This is particularly true in the gas sector where gas supply is mostly an oligopoly influenced by external producers. In such a case, regulatory and market measures, that could be cheaper and more effective for more developed markets such as electricity, might still require specific infrastructure to be fully effective. As already exposed in recommendation 1B, theoretical and empirical literature even shows that those new infrastructure projects might lead to a decrease in gas price even without any impact on the actual gas flows: the simple threat of competition, e.g. through a new LNG terminal, is enough to deter gas producer from exercising their market power.

#### How?

For projects that address directly competition issues like strategic behaviour, as part of a supplementary analysis by the project promoter, the indicators could be re-calculated using a model that captures strategic behaviour. The indicators could then be reported for both assumptions: perfect competition and market power.

#### Feasibility?

The inclusion of market power and strategic behaviour requires additional modelling assumptions and more complex modelling tools. The basic model to be used for all projects could be kept simple with an assumption of perfect competition. For supplementary analysis, one could turn to several existing models that capture market power such as Gasmod[[6]](#footnote-7) or Gastale[[7]](#footnote-8).

### R4D: Advance the use of common models by all stakeholders

#### Why?

The ESW-CBA methodology allocates the responsibilities for calculating indicators without strictly defining how to calculate them. Some indicators are calculated by ENTSOG as part of the TYNDP assessment of projects using the TYNDP-step modelling tool, whereas other indicators are calculated by project promoters themselves, often using data resulting from the TYNDP step.

To ensure that all projects and outputs are comparable, whichever modelling tools are used and whoever uses them, the modelling assumptions need to be consistent, which in the current methodology is not guaranteed.

#### How?

A first step could be to prescribe minimum requirements on the different modelling tools, which could be to explicitly state the market and network assumptions and a reference to an existing modelling tool if applicable. This documentation, that should be self-standing, should be available to the concerned authorities and stakeholders. The documentation should allow the correct interpretation of results, which includes the justification of certain assumptions and simplifications, and the replication of the calculations by at least the project promoters and the regulatory authorities.

A second step could be to select one modelling tool and make it accessible to all project promoters and relevant authorities to do the calculations.

#### Feasibility?

Documentation on the ENTSOG modelling tool is already available, but it is spread over different documents. To bundle these should be easy to implement.

It is not clear either to what extent this documentation on the modelling assumptions used by project promoters is sufficient and clear enough. Also the comparison of a large number of documentations will be resource consuming, regardless of who should check the modelling assumptions.

In the long term, having a common set of modelling assumptions (common modelling tool) would provide better assurances that indicators are truly comparable.

# Conclusion and classification of recommendations

The methodologies for energy system-wide cost benefit analysis of project of common interest at Union level are key to the achievement of energy infrastructure objectives. They constitute preliminary steps to the elaboration of TYNDPs, to the selection of PCI and to their investment processes.

Given their central place in PCI related decision processes, the methodologies should produce non-opposable, reliable and exhaustive outputs that can support the Regional Groups and the regulatory authorities in their decisions. They should enable the analysis and comparison of PCI candidates on a comparable and harmonized basis, and they should particularly rely on a robust monetization of all benefits in terms of social welfare.

This is no easy task given the complexity of the European gas and electricity systems and the difficulty to implement and operate a modelling tool which would enable an exhaustive measurement of all relevant metrics based on realistic reproductions of the systems. Simplifications are necessary and the right arbitrage has to be found between complexity and accuracy on the one hand, and cost of modelling and tractability on the other.

Nevertheless, despite necessary arbitrages the methodology should still remain coherent with the purposes it is designed to address. Regulation 347/2013 specifies the criteria that the methodology should follow, and it also specifies how the PCI selection, CBCA and CEF processes rely on its outputs to draw their own outcomes and decisions.

In this respect, the analysis of the 2015 ESW-CBA methodology for gas infrastructure identifies some methodological choices and simplifications which limit the ability of the methodology to enable these purposes. An in-depth review of the methodology, based on the contribution from economic literature and the solicitation of stakeholders impacted by the methodologies, concludes that the current methodology could be better aligned with key CBA principles in terms of reliability and accuracy of results, monetization, uncertainty analysis, standardization and harmonization, and transparency and usability by the decision makers.

A series of recommendations are formulated in this report to cope with this issue and realign the methodology with its intended purposes in terms of PCI selection process, cross-border cost benefit analysis, and financial assistance but also with regard to the elaboration of TYNDPs. They aim to enable a standardized and non-opposable evaluation of cost and benefits that present an interest to decision makers.

This list of recommendation is structured around the key dimensions and stakes of the gas ESW-CBA methodology, namely: 1) monetization of benefits, 2) general simplicity of the outputs for their interpretation, 3) alignment with the PCI selection process, CBCA and investment request, and 4) modelling assumptions. A preliminary work has been performed to assess their estimated benefits on the one hand and their implications in terms of feasibility and technical efforts on the other. The table and the figure below provide a summary of all identified recommendations along these two axes. Through the survey, the classification will be refined and finalized to take into account the contribution and perspective of all parties.

|  |  |  |
| --- | --- | --- |
| **Recommendation** | **Estimated benefit** | **Feasibility perception** |
| **#1 – Reinforce monetization of benefits** |
| **R1A** | Classify the indicators according to the value and capacity to monetize them and propose roadmap | 5/5 | 5/5 |
| **R1B** | Quantified indicator for market power and go toward monetization | 3/5 | 3/5 |
| **R1C** | Improve the monetization of security of supply and disrupted demand | 5/5 | 4/5 |
| **R1D** | Improve the monetization of CO2 impacts | 2/5 | 5/5 |
| **#2 – Simplify the outputs** |
| **R2A** | Reduce the number of indicators | 3/5 | 2/5 |
| **R2B** | Highlight the relevant future cases | 5/5 | 2/5 |
| **R2C** | Go toward aggregation of yearly results per indicator | 3/5 | 3/5 |
| **#3 – Alignment with purposes for PCI selection and CBCA** |
| **R3A** | Formalize a project fiche | 5/5 | 4/5 |
| **R3B** | Verify PCI input data | 4/5 | 5/5 |
| **R3C** | Enable the identification of clusters and competing projects | 5/5 | 2/5 |
| **R3D** | Provide (monetized) indicators at MS level | 5/5 | 3/5 |
| **#4 – Improve (market) modelling assumptions** |
| **R4A** | Support market modelling with more realistic demand assumptions | 3/5 | 4/5 |
| **R4B** | Correct how commercial constraints and transportation costs impact flow setting | 5/5 | 2/5 |
| **R4C** | Advance market modelling to include strategic behaviour as part of supplementary analysis | 4/5 | 2/5 |
| **R4D** | Advance common models | 3/5 | 5/5 |



1. Note that similar dispositions apply to the electricity sector. [↑](#footnote-ref-2)
2. Note that the next update of the gas ESW-CBA methodology is planned to be implemented for 2018, to serve for TYNDP 2018 and the 4th PCI list. TYNPD 2017 which serves as input for the 3rd PCI list relied on the 2015 methodology but also included some voluntary improvements that could feature in the next methodology’s update. Therefore, while the review focuses on the 2015 methodology, the relevant voluntary improvements made to prepare TYNDP 2017 are also addressed when discussing the issues and recommendations. [↑](#footnote-ref-3)
3. For instance, HHI could be used to estimate the percentage of welfare losses PWL compared to a market with a pure and perfect competition. Assuming the market is symmetrical enough, the relationship between PWL and HHI is $PWL=\left(1+{1}/{\sqrt{HHI}}\right)^{-2}$. This value coupled with the estimation of social welfare allows the monetization of market power. [↑](#footnote-ref-4)
4. Even though improved monetization of CO2 emissions would be welcome, the impact of advancements in this regard should not be overestimated as most emission related benefits are to be found in the electricity sector. [↑](#footnote-ref-5)
5. The nominal physical pipeline capacity (100%) would be represented in the model by ten slices of ten percent of the nominal pipeline capacity ; the first slice would have weight of one, next slice would have a weight of two and so on. The objective function would then minimize the weights of the used pipelines to spread out the flows over all pipelines (and avoid unevenly distributed flow patterns). [↑](#footnote-ref-6)
6. Holz, F., Hirschhausen, C., Kemfert, C., 2008. A strategic model of European gas supply (GASMOD). Energy Economics, 30 (3), 766-788. [↑](#footnote-ref-7)
7. Boots, M. G., Rijkers, F. A. M. & Hobbs, B. F. 2004. Trading in the Downstream European Gas

Market: A Successive Oligopoly Approach. The Energy Journal, 25 (3), 73-102. [↑](#footnote-ref-8)