ACER-PAEC

AEC Method and Process

FINAL REPORT D04

APPENDIX

FINAL

2025-12-11 ver V1.0

Disclaimer

This is the Appendix to a technical report prepared by SUMICSID GROUP and Swiss Economics on behalf of ACER and in collaboration with ACER and national regulatory authorities (NRAs), for guidance in completing the ACER Cost Efficiency Comparison (AEC), starting in 2024 and to be published for the first time by 5 August 2027. However, this report reflects the views of SUMICSID GROUP and Swiss Economics and does not necessarily represent the views of ACER. ACER may adapt, modify, or deviate from the methodology, recommendations, or processes proposed in this report.

The report takes into account the proposals presented at a public workshop in Brussels on 9-10 July 2025, which was complemented by a public consultation between 17 June and 17 July 2025 and a review by an independent group of experts commissioned by ACER. The final revised document has been prepared solely by SUMICSID GROUP and Swiss Economics, who assume full responsibility for any errors of fact or logic. ACER is not liable for any consequence resulting from the use of information contained in this report.

Title: Appendix AEC Final Report D04

Final report, Appendix, open. Project: PAEC
Version: V1.0
Release date: 2025-12-11

Sumicsid Group
Rue Maurice Lietart 56
B-1150 Brussels, BELGIUM
www.sumicsid.com

Table of Contents

Appendix A: Public consultation questions

Public consultation questions for Workshop 2

ACER
European Union Agency for the Cooperation of Energy Regulators

Public consultation

on

the ACER efficiency comparison for natural gas TSOs

PC_2025_G_04

Consultation period:

17 June 2025 – 17 July 2025

1. Objective

The objective of this consultation is to gather views and information from stakeholders on the objectives and design of the ACER efficiency comparison (AEC) for natural gas TSOs. The design to be used to complete this task will be finalised by 4 October 2025. Two additional phases of the project will follow to request and validate the TSO data (phase II) and to complete the modelling work (phase III). The input from the consultation will be used by the Agency's when completing the design phase.

The Agency is consulting on two documents providing the objectives and design of the AEC:

- **D02: AEC Objectives and Criteria**
- **D03: AEC Method, Data and Process.**

Stakeholders are invited to read this material. Complementary to these two files, the Agency provides in this consultation document several questions requesting input on specific topics discussed under D02 and D03. Stakeholders who wish to submit input can provide it via the EU Survey tool displays input fields for each of these questions.

2. Target group

This consultation is addressed to stakeholders, including end consumers (household, industrial, power generation, etc), shippers, environmental and consumer associations, academics and TSOs.

3. Stakeholder input to the consultation and deadline

Replies to this consultation should be sent using the EU Survey tool:
https://ec.europa.eu/eusurvey/runner/ACER_efficiency_comparison

In addition, stakeholders can provide input related to the consultation documents D02 and D03 that is not covered in the questions. For this purpose, they can submit their input as pdf or word file in a dedicated section of the survey.

Stakeholders can contact ACER in relation to the public consultation using the email: AEC@acer.europa.eu.

The maximum size for submitting files using the EU Survey tool is 1 MB. Larger files can be submitted to this functional mailbox.

The deadline for providing input to the public consultation is **17 July 2025, 23:59 hrs (CET)**.

4. Identification data and confidential information

The answers should be submitted via link:
https://ec.europa.eu/eusurvey/runner/ACER_efficiency_comparison

When submitting any information to ACER by email. the following information should be included on the top of the answer sheet: name, company, contact email and country.

Any confidential information should be marked clearly as such, including the word 'CONFIDENTIAL' in the subject of the e-mail, as the Agency will not treat e-mails which contain only a general disclaimer (usually automatically added) as containing confidential information. If respondents want to claim confidentiality, they should provide an explanation of their confidentiality interests and a non-confidential version of their response for publication.

Where submitting confidential information, the respondent have to claim confidentiality according to Article 27 of ACER's Rules of Procedure.

How to do it:

1. download a PDF version of the submission;
2. redact (blacken) confidential information and provide descriptions of the deleted information. The description must enable any party applying for public access to the documents to determine whether there are sufficient grounds to request ACER to grant access to the information claimed to be confidential. The respondent may use a PDF editor or print out their submission and manually replace confidential information with descriptions.
3. upload the (i.e. non-confidential) version of the submission;
4. upload a separate document with the justification for the redacted (blackened) information to be treated as confidential.

5. Publication of responses and privacy

The Agency will publish all non-confidential responses, and it will process personal data of the respondents in accordance with Regulation (EU) 2018/1725 of the European Parliament and of the Council of 23 October 2018 on the protection of natural persons with regard to the processing of personal data by the Union institutions, bodies, offices and agencies and on the free movement of such data, taking into account that this processing is necessary for performing the Agency's consultation task. For more details on how the contributions and the personal data of the respondents will be dealt with, please see the Agency's Guidance Note on Consultations and the specific privacy statement attached to this consultation.

6. Background on the ACER efficiency comparison

The internal market for natural gas aims at delivering competitive prices and higher standards of service, and to contribute to security of supply and sustainability. In this context, gas networks play a crucial role by facilitating the reliable transmission of natural gas across Member States and allowing the integration of renewable energy sources into the system. The existing gas infrastructure was built over several decades and is operated by regulated transmission system operators (TSOs). The principle of regulation is based on the provision of third-party access to the infrastructure and tariffs are used to recover network costs. In addition to energy security and environmental sustainability, energy systems also face the challenge of providing accessible and affordable energy. In relation to the affordability of the energy infrastructure, NRAs ensure that the revenue granted to TSOs covers only the costs corresponding an efficient and structurally comparable TSO. In this context, the AEC is a key tool to measure the efficiency of costs across TSOs. The tool is additionally expected to support NRA decisions in the context of decarbonisation, where network utilisation is expected to decrease, potentially leading to tariff increases in the future.

NRAs set the allowed or target revenue of TSOs which is an input for calculating tariffs for transmission networks. The Network Code on Harmonised Transmission Tariff Structures for Gas[1] (NC TAR) establishes requirements for NRAs when setting tariffs for transmission services at network points of an entry-exit zone. Such requirements include transparency, cost-reflectivity, non-discrimination as well as the limitation of cross-subsidies between categories of network users. Tariffs are set to collect the allowed or authorized revenues of TSOs which are aimed at covering the capital and operational expenses (CAPEX and OPEX).

A key element in the calculation is the regulated asset base (RAB) which is comprised of the regulated value of all assets operated by TSOs. TSOs' revenues and remuneration are thus proportional to the value of the RAB. As the decarbonisation and the energy transition will make a lasting impact on the natural gas market leading either to the reduction of transported volumes and/or to the removal of assets for the purpose of transporting other commodities ("repurposing") – such as hydrogen or CO2 – or to the decommissioning of assets, they will have an important impact on tariff setting.

The likely decrease of gas consumption will require recovering the costs of the system among a smaller number of users. This could lead to a significant increase of transmission tariffs for final consumers, possibly, making the recovery of transmission infrastructure costs more challenging. Therefore, it is of great importance to promote greater transparency regarding the allowed or target revenue methodologies compensating TSOs. The actual costs that TSOs incur shall be closely monitored and their efficiency assessed, in particular, where some margins exist in terms of efficiency gains. Moreover, future decisions related to natural gas networks that determine the transfer of transmission assets from a natural gas TSO to a hydrogen transmission network operator (HTNO), or those with a clear cross-border relevance such as the implementation of inter-TSO compensation (ITC) mechanisms could benefit from

[1] Commission Regulation (EU) 2017/460 of 16 March 2017 establishing a network code on harmonised transmission tariff structures for gas, OJ L 72, 17.3.2017, p. 29–56.

an overarching efficiency comparison.

Article 30 of the Network Code on Harmonised Transmission Tariff Structures for Gas (NC TAR) already sets specific consultation and transparency obligations on NRAs and TSOs on tariffs and on the allowed revenue of TSOs. These requirements are extended in Annex I of Regulation 2024/1789. In addition, the Agency had published in 2018 a study on the methodologies for setting the allowed and target revenue of natural gas TSOs.[2]

Up to 2025, a regular cost efficiency benchmark has been carried out by the Council of European Energy Regulators[3] (CEER) for both gas and electricity networks (TSO Cost Efficiency Benchmark, 'TCB'). Participation has been established as voluntary and some Member States decided not to participate. Three assessments have been delivered in 2016 (E2Gas)[4], 2019 (TCB18)[5] and 2025 (TCB21)[6].

7. ACER efficiency comparison

Article 19 of Regulation (EU) 2024/1789 tasks the Agency to carry out an efficiency comparison of gas TSOs, the results of which should then be taken into account by NRAs when periodically setting the allowed or target revenue. The ACER efficiency comparison (AEC) is a mandatory benchmark for all European gas TSO. The goal of the benchmark is to provide an efficiency comparison for each EU gas TSO.

To ensure proper coordination in collecting and interpreting data for a transparent and reproducible efficiency comparison study, the relevant NRAs and the TSOs shall provide the Agency with all the data necessary for that comparison. Article 19 of Regulation (EU) 2024/1789 establishes:

> *The costs of the TSOs shall be subject to an efficiency comparison between TSOs. ACER shall carry out that efficiency comparison. By 5 August 2027 and every four years thereafter, ACER shall publish a study comparing the efficiency of TSOs' costs, subject to the protection of data considered by ACER to be commercially sensitive. The relevant regulatory authorities and the TSOs shall provide ACER with all the data necessary for that comparison. When periodically setting the allowed or target revenue of TSOs, the relevant regulatory authorities shall take into account such comparison and national circumstances.*

When taking into account the results of the ACER efficiency comparison, NRAs should comply with the requirement under Article 17 of Regulation (EU) 2024/1789 which establishes that "*tariffs, or the methodologies used to calculate them* […] shall *reflect the actual costs incurred,*

[2] https://www.acer.europa.eu/sites/default/files/documents/Media/News/Documents/Future%20Regulation%20of%20Natural%20Gas%20Networks%20-%20Final%20Report%20DNV.pdf
[3] https://www.acer.europa.eu/sites/default/files/documents/Publications/ACER%20Report%20Methodologies%20Target%20Revenue%20of%20Gas%20TSOs.pdf and https://www.acer.europa.eu/sites/default/files/documents/Publications/Consultant%20Report.pdf
[4] https://www.ceer.eu/publication/e2gas-benchmarking-european-gas-transmission-system-operators/
[5] https://www.ceer.eu/wp-content/uploads/2024/04/TCB18_final_report_gas_190717.pdf
[6] https://www.ceer.eu/publication/tso-cost-efficiency-benchmark-tcb21-model-specification-gas/

insofar as such costs correspond to those of an efficient and structurally comparable network operator".

The AEC will additionally support NRAs to meet the requirement under Article 19(3) of Regulation 2024/1789 to assess the long-term evolution of transmission tariffs. For this task, NRAs should consider the expected changes to the allowed or target revenue of the TSOs and in natural gas demand within the relevant regulatory period, and, where available until 2050. To conduct this assessment, the regulatory authority shall include the information about the strategy described in the integrated national energy and climate plan of the Member State concerned and the scenarios underpinning the ten-year network development plan as developed in accordance with Article 55 of Directive (EU) 2024/1788. The AEC can provide valuable information on the development and relative efficiency of TSO costs over time.

Additional transparency on cost efficiency will support NRA regulatory decisions in the context of decarbonisation including repurposing for the transport of hydrogen, potential decommissioning, reinvestments and network planning.

The AEC will benefit from the work that has already been carried out by CEER (i.e. TCB18 and TCB21). While the participation on the TSO benchmarks carried out by CEER was voluntary, the TSO benchmark to be carried out by the Agency requires a mandatory participation by all EU TSOs.

The work to complete the benchmark will be built up gradually. The first phase has been planned between December 2024 and October 2025 and Sumicsid (consultant performing the earlier CEER studies) will support the Agency in designing the AEC methodology. A second phase will start in 2025Q4 on the data request and validation. Finally, a third phase will be completed between 2026H2 and August 2027 where the modelling will be carried out. The Agency will tender the consultancy service to carry out phases II and III. This process is summarised in the figure below:

8. Objectives and methodology design

The Agency is opening for public consultation the two documents:

- **D02: AEC Objectives and Criteria**
- **D03: AEC Method, Data and Process.**

Building on the results of D02, the synthesis document, D03, establishes the methods for assessing efficiency and outlines the necessary variables and parameters to define requirements for collecting and verifying data, as well as the proposed process to follow.

The D02 synthesis starts by identifying **the main changes in the natural gas market** affecting natural gas transmission networks: (1) the road to a zero-net economy will lead to a decrease in natural gas volumes consumed and transported; (2) the growing importance of new forms of gas, biogas and LNG will potentially lead to network reinforcements; (3) the planned development of hydrogen networks will possibly result in the removal of existing gas assets and will make others obsolete; finally (4) the maintenance of existing networks will require extending or replacing assets that reach the end of their technical operating life.

Based on these challenges, the D02 synthesis document discusses the **potential uses of efficiency** that can be implemented in the context of decarbonisation. Efficiency can relate to the planning and execution of network services (*planning and execution focus*) or to the utilization of specific assets (*utilisation focus*). A utilisation focus penalizes the TSO when demand is growing more slowly or decreasing compared to other countries, exposing the TSO to regulatory risk and disincentives for early investments. For these reasons, most regulatory benchmarking in Europe is execution-based, meaning that the efficiency does not relate to the utilisation of the infrastructure.

The **AEC focusses on measuring the efficiency over planning, construction, operation and maintenance** of network assets put at the users' disposal. A TSO that makes poor planning, costly and ineffective tendering and inadequate maintenance interventions will show an execution-based inefficiency compared to best-practice TSOs. For many TSOs, the primary source of inefficiency lays in planning and procurement, leading to high equipment, installation, and siting costs due to choices of kits, standards, timing, suppliers and locations.

Based on this objective, the main result of the AEC is a **static (one-year) efficiency model** which will use asset-based outputs instead of utilisation-based outputs to compare like with like. The main efficiency metric will be cost efficiency (CE) for all operators, which requires a standardized definition of inputs across operators. Technical efficiency (TE) is proposed as a secondary metric, which can be computed on partial inputs (Opex and Capex).

These analyses will additionally allow to compare the static results over time and to derive the **technological progress from catch-up** of TSOs. Efficient operators will push the frontier and achieve performance that were previously unattainable. Other operators will catch-up, adopt best practices and improve their efficiency. In a world where technologies are continuously changing, it is important to identify, in a dynamic model, the impact of technological progress on the frontier and how the relative efficiency of the TSOs evolves over time.

At the same time the Agency acknowledges that the sizing of the network in view of the utilisation of the network (*utilisation focus*), is a key assessment in the context of decarbonisation. The AEC will therefore include **dynamic analysis**, including evolution of Capex, Opex and Totex as a function of volume and peak load, including contextual and environmental factors over time. For the dynamic analysis, it is necessary to use several years of data for the benchmark (the so-called time series or panel data).

The D03 synthesis document proposes to use both data envelopment analysis[7] (DEA) and stochastic frontier analysis (SFA) in the efficiency analysis for AEC. DEA is a strong reliable methodology for heterogenous deterministic data of medium size, without a priori assumptions on cost functions. **DEA** is proposed as the primary method for the static (one year) efficiency calculations, using primarily deterministic, asset-based model(s).

SFA is a powerful analysis tool to understand the causes and development of efficiency in a sector, requiring somewhat larger datasets and analysis resources. **SFA** is proposed as primary method for the dynamic (multi-year) analysis using stochastic models with both assets, usage and contextual-environmental factors included.

The two methods complement each respective analysis by acting as secondary methods for cross validation: The results from SFA as a secondary method contribute to validate the DEA method results and the environmental adjustments therein. Dynamic results from DEA (Malmquist productivity indexes[8]) serves as a secondary method to validate the dynamic SFA analysis. In dynamic productivity analysis, the improvement of each firm from one year to another is measured, but also how the best-practice has improved over time. The SFA models permit more in-depth analysis of the sources for these changes.

As an additional complement, the AEC proposes index number approaches (unit cost, and key performance indicators -KPIs) to be reported for use by NRAs and TSOs.

Each TSO operates in an environment that is specific as they are exposed to different market conditions, including different national regulatory environments. It is essential for the benchmarking exercise to take into account of these specificities and to propose solutions to make a proper **comparison between the different TSOs**. Member States have different methodologies to determine the cost of capital (WACC) and the regulatory asset base (RAB). The AEC foresees option to control for this heterogeneity in the regulatory environments and in the accounting practices.

Regarding the **cost of capital**, the AEC proposes to use standardized methods across all TSOs. In relation to the **RAB**, NRAs have different treatments for different categories of assets (working capital, assets under construction and leased assets and assets partially financed by third parties). As a result, the composition of the RAB varies from one country to another. For the benchmarking exercise, it is necessary to have a uniformized measure for the RAB and define what should be and what should not be included in the RAB since it is the basis for the comparable Capex input. To address these issues of comparability across TSO, the AEC defines (1) a method to evaluate real annuities (Capex), (2) the scope of investments considered in the perimeter of the benchmark and (3) a method to ensure comparability of investments included in the perimeter.

[7] For an overview of scientific literature, see e.g. Afsharian, M., Ahn, H., & Kamali, S. (2022). Performance analytics in incentive regulation: A literature review of DEA publications. *Decision Analytics Journal*, *4*, https://doi.org/10.1016/j.dajour.2022.100079 .

[8] The methods involved are explained with examples in Bogetoft, P., & Otto, L. (2010). *Benchmarking with DEA, SFA, and R* (Vol. 157). Springer Science & Business Media.

The **data** used of the AEC will be based on the data request used in TCB21, potentially amended with variables for assets under repurposing for hydrogen or low-carbon gas infrastructure. In addition, selected properties related to the capacity of assets are added. These advantages must be weighed against the possible burden placed on TSOs, the proposed offline processing system, and the availability of such data across TSOs.

The experience of TCB21 was that an uneven effort was exerted by NRAs when validating the TSO data. To ensure a **high-quality dataset** for use in benchmarking, a careful and multi-level data validation is necessary including a financial audit of the data submitted and several validation rounds by the NRAs and the consultant responsible for carrying out this second phase of the AEC. The validation carried out by the consultant will allow a cross-validation analysis in addition to technical validation performed by engineering support. The validation process can be complemented with a brief final report that documents the final cross validation steps, findings and corrective actions.

Finally, **transparency** is a key priority of the exercise. Article 19 of Regulation 2024/1789 requires that ACER assess the commercially sensitive status of the data prior to the publication of the AEC. The Agency will approach the publication using a two-tier transparency model:

- All the data used to compute the AEC results (T1 dataset) will be publicly disclosed, including the final efficiency results for each TSO.
- A second dataset, including commercially sensitive, data will not be made public (T2 dataset).

With this approach, the Agency intends to avoid a black-box effect for which prior benchmarking rounds have been criticised. A full disclosure of the modelling data will allow TSOs scrutinising the AEC calculations across peers, in addition to stakeholders further understanding the efficiency of TSO costs.

9. Consultation Topics and Questions

9.1. Topic 1: Transparency and publication requirements

The Agency will promote transparency on the AEC to ensure access to the TSO data used in the modelling, transparency on NRA decisions and availability of the data to stakeholders.

Without a transparent process for data collection, methodology, calculations and reporting, the process value for NRA would be low. To ensure transparency, AEC should maintain the following principles:

1) Clear established data definitions and data specifications prior to the data collection.
2) Independent audits of financial and asset data for each TSO
3) Open access to all T1 data (non-commercially sensitive)
4) Full references and access to any non-TSO reported parameters (T0 data)
5) The methodology should be documented in a reference document that is independently validated by experts prior to calculations
6) Calculations and reporting of results should be independently audited by third party.

7) The individual reporting should specify each step in the process as to enable each NRA to reproduce the input data.

By combining a sound method and model selection, adequate choice of efficiency metrics, regulatory alignment, transparency, due process, and adaptations to new tasks, NRAs can trust the AEC as a legally robust, fair, and enforceable source of information about the economic, quality and capacity performance of their TSO. This strengthens the credibility and acceptance of the efficiency results while minimizing legal risks.

At the same time, the Agency will ensure that the information published is not commercially sensitive for TSOs.

Transparency is discussed in reports D02: section 7.2 and D03: section 5.1. Annex A of D03 contains a list of variables and parameters that would likely be made public as part of the T1 dataset.

No.	Consultation questions
1.	How do you value transparency across the different stages and results of the AEC?
2.	What are the elements of a TSO benchmark where transparency is most important?
3.	What other approaches to transparency should ACER consider when designing and publishing the AEC?

9.2. Topic 2: Challenges for natural gas transmission networks in the context of decarbonisation

The synthesis document D02, establishing the objectives of the AEC, identifies the key challenges that natural gas transmission networks will face in the future (see sections 2.1 – 2.3). These include (1) the likely decrease in natural gas transported volumes; (2) the CAPEX additions resulting from new forms of gas, biogas and LNG connections; (3) the removal of assets for repurposing and, potentially, decommissioning; and (4) the extension or replacement of assets reaching the end of their technical operating life.

No.	Consultation questions
1.	What are the key factors that will affect natural gas transmission networks, which ACER should consider when designing a methodology to measure the efficiency of natural gas TSO infrastructure?
2.	How should the decrease in network utilisation be considered when measuring the efficiency of TSOs.

9.3. Topic 3: Legacy investments

The efficiency of natural gas TSOs is largely impacted by legacy investments carried out prior to the liberalisation of the EU gas natural gas sector. Past investments, prior to deregulation, were not always undertaken with an efficiency focus. For instance, pre-deregulation decisions may have been prompted by other owners and for national or non-economic reasons. Furthermore, investments in transition states prior to EU-membership are in some cases subject to hyperinflation or non-market prices for labour or equipment

These observations, which are valid for gas TSOs and are important for incentive regulation of future investments and operations, call for a periodized analysis of the past capex. The relevance of determining the exact investment efficiency for assets that date more than 30 years ago (i.e. prior to the First Directive) and to assure the comparability of their market conditions is likely less important than the comparability of recent investments and new assets. The Agency considers informative to analyse the impact of **legacy investments** in the AEC by providing results with and without legacy investments. For the latter, the Agency proposes to control for these costs using standardized values to, as discussed in section 6.6 of document D02. The Agency proposes the year 1998 as the cut-off date to identify legacy investments, when Directive 98/30/EC[9] (First Gas Directive) entered into force.

The AEC will include all the legacy investments and, as a sensitivity analysis, the AEC will calculate the same model but with legacy investments neutralized to standardized values to understand the impact on efficiency. When legacy investments are included in the modelling, their value should be reassessed for the purpose of comparison (see 6.5). Opex is not affected by this sensitivity analysis as all assets in use are part of the physical output.

The AEC results calculated with and without legacy investments should be considered by the NRAs when taking a decision on the allowed or target revenue of the TSOs.

No.	Consultation questions
3.	Is the proposal to address the comparability problem of legacy investments acceptable and effective for the purposes of the AEC?
4.	Do you consider the entry into force of the First Gas Directive in 1998 to be an adequate cut-off point to identify legacy investments?
5.	How should different efficiency levels pre- and post- liberalisation be considered by NRAs when setting the allowed revenue methodologies for TSOs?

[9] Directive 98/30/EC of the European Parliament and of the Council of 22 June 1998 concerning common rules for the internal market in natural gas.

9.4. Topic 4: Comparability of TSO costs

The AEC proposes several measures to enable the comparability of TSO cost and performance, which are described in sections 6.1-6.7, 7.3 of document D02.

The AEC is proposed to ensure comparability through means of defining a strict functional and asset scope, controlling for joint ownership or operation of assets, structural and organizational differences, standardizing asset depreciation, asset ages for used installations, standardizing capital costs, labour cost corrections, controlling for overhead cost allocation, inflation adjustments, opening balances, price and currency differences, environmental heterogeneity with respect to land use and cover, slope, soil properties, wetness based on spatial asset locations, as well as excluding costs and investments that relate to out-of-scope or exceptional events.

No.	Consultation questions
6.	Are the comparability measures proposed in the documentation effective and necessary? Is there redundancy or inadequate measure among the instruments?
7.	Are there other measures that ACER should consider to ensure the comparability of TSO costs?

9.5. Topic 5: Static efficiency

The proposed efficiency metrics are described in chapter 4 of document D02 and the choice of efficiency analysis methods is discussed in chapter 2 of document D03. The main result of the AEC is a static modelling carried out with DEA. SFA will provide secondary results used for validation.

A static deterministic model is focusing on a single year and uses variables that are not subject to random effects, primarily execution-based outputs and services directly derived from installed assets. The analysis is not sensitive to cost changes over time across Europe. DEA is a method that uses a minimal set of assumptions and delivers scores also for smaller sample of operators.

The use of DEA for benchmarking TSOs is well established and has been used in TCB (TCB18, TCB21 and E2GAS) and also in the German benchmark for natural gas TSOs[10].

[10] Swiss Economics, Sumicsid, 4Management (2018) *Kostentreiberanalyse und Effizienzvergleich der Gasfernleitungsnetzbetreiber EFG3*, Final report for Bundesnetzagentur.

No.	Consultation questions
8.	Do you consider the proposed approach to provide the primary efficiency measure of the AEC adequate?
9.	Do you agree that a static model could provide useful input for NRA regulatory rulings? If not, what other options you would propose?

9.6. Topic 6: Dynamic efficiency

The energy transition is expected to result in lower demand for natural gas. The evolution of demand and entry points depend on many factors, most of them being uncontrollable by the TSO which networks are sized to match the peak network use.

In this context, TSOs with older assets are likely to have over-capacity in a context of decreasing demand while TSO with more recent assets can dimension the assets to the actual demand. In an efficiency analysis, the use of actual demand (gas volume or entry point) used as an output would lead to TSOs with more recent assets appearing as more efficient, as their asset capacity more closely match the actual output.

In an environment of decreasing use of infrastructure having utilisation metrics in a benchmark implies that TSOs are rewarded (or penalized) for bringing the size/capacity of the network in line with decreasing demand.

For that reason, the static (one-year) efficiency model in AEC will use only asset-based outputs instead of utilization-based outputs to compare like with like.

However, to provide information on, and incentives for, the correct asset intensity facing fuel substitutions, AEC will also incorporate a dynamic efficiency model, covering several years of operations. In this case, to monitor the volume transported and peak load development in the natural gas sector and the adaptation of assets to outputs, usage-based outputs will also be used. The inclusion of usage-based outputs in the dynamic model will capture how TSO can adapt to changing circumstances.

For this calculation, the Agency proposes to use SFA as a primary method and DEA as a secondary method for confirmation.

The use of dynamic modelling considering network utilisation is discussed in sections 3.3 and 4.7 of document D02 and in section 2.5 of document D03.

SFA is not only the academically most used dynamic method, but also and foremost the relevant tool to explore and address random variables or data errors in the AEC, thereby providing a valuable validation of the correctness of the static model results.

No.	Consultation questions
10.	Do you consider appropriate to provide additional efficiency scores taking into account network utilisation? Please reason your answer.
11.	Do you consider the proposed method design appropriate (SFA as primary method and DEA and secondary method)? Please reason your answer.
12.	Is the use of two methods a strength for the analysis or a source of ambiguity in the interpretations? Please reason your answer.

9.7. Topic 7: Data quality

For the purpose of ensuring data quality, the Agency proposes several layers of validation, including:

- Asset system and audited financial statements.
- Clear guidelines and templates.
- NRA check of the data submitted by TSOs
- Financial auditing of the data submitted by TSOs.
- Cross-validation of all TSO datasets, including technical engineering validation.
- Data analysis by the consultant.

The processes for the validation of the data to ensure the quality of the dataset are described in chapter 4 of document D03.

The AEC proposes an integrated data validation strategy in six steps involving TSOs, NRAs, ACER, consultants and auditors to ensure maximum data quality.

No.	Consultation questions
13.	Do you agree with the data validation approach outlined? What other alternative measures should ACER consider to ensure the quality of the data?

9.8. Topic 8: Technical input on benchmarking

The AEC is an empirical assessment of total cost, actual and efficient levels, related to services performed by structurally comparable operators. Intrinsically, the mission is a methodological challenge requiring the mobilization of the best possible statistical, operations research and econometric methods that are relevant to the problem at hand.

In in chapter 7 of document D02 and chapters 2 and 3 of document D03 with references, some of the methods and techniques used are described and discussed. However, the documents

do not purport to provide a full technical description, for this the underlying documents and the references to this note could be consulted.

Some of the techniques have been discussed in past projects, we list some of the relevant aspects as consultation questions, without claim of exhaustiveness.

No.	Consultation questions
14.	The criteria in section 7.7 of document D02 list 'relevance' as a criterion for the model specification. However, data mining techniques such as principal component analysis or machine learning may derive good predictions of total cost without an explicit cost function. Do you agree that this criterion is sound and necessary for the AEC purposes? What measures can be taken to assure relevance of the results?
15.	The comparison of assets with different dimensions and material is partially based on a normalized grid metric (NormGrid). Is the use of such normalization acceptable and robust for the AEC?
16.	Service quality is not explicitly modelled among the parameters in chapter 3 of document D03. Should service quality be part of the benchmarked outputs? If so, how can it be measured?
17.	Do you agree with the output variable selection methods in section 3.2 of document D03? What improvements can be made?
18.	Do you agree that the environmental correction factors listed in section 3.3 of document D03 are relevant and important for the AEC? What improvements can be made?
19.	Do you consider it useful, in the analysis of the dynamic efficiency of TOTEX, to take national capital cost differences—particularly the WACC—into account when assessing the evolution of the optimal cost structure, especially the balance between OPEX and CAPEX?
20.	Are there missing structural or environmental factors that should be included in the analysis? Please reason your answer.

10. Related documents

The following documents provide the legal basis of the AEC.

- Regulation (EU) 2019/942 of the European Parliament and of the Council of 5 June 2019 establishing a European Union Agency for the Cooperation of Energy Regulators.
- Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (recast).

The Agency provides additional references for the readers interested in further understanding the topic of benchmarking.

- **Sumicsid (2016) E2GAS** – Benchmarking European Gas Transmission System Operators https://www.ceer.eu/wp-content/uploads/2016/06/Benchmarking_EU_Gas_TSOs_e2gas_final_report_160602.pdf
- **TCB 18 (2019):** Pan-European cost-efficiency benchmark for gas transmission system operators. https://www.acm.nl/sites/default/files/documents/sumicsid-ceer-project-ceer-

tcb18-pan-european-cost-efficiency-benchmark-for-gas-transmission-system-operators_0.pdf

- **KPMG (2020)** Post-run audit of the international transmission benchmarking TCB18 for gas. https://www.acm.nl/sites/default/files/documents/sumicsid-final-report-on-oxera.pdf
- **TCB21 (2024):** TSO Cost Efficiency Benchmark TCB21- Method and Calculations. https://www.acm.nl/system/files/documents/tcb21-method-note.pdf
- **TCB21 (2025):** TSO Cost Efficiency Benchmark TCB21- Model Specification Gas. https://www.ceer.eu/publication/tso-cost-efficiency-benchmark-tcb21-model-specification-gas/
- **Economic Insights (2017):** Topics in efficiency benchmarking of energy networks: Choosing the model and explaining the results: https://www.acm.nl/sites/default/files/documents/topics-in-efficiency-benchmarking-of-energy-networks-choosing-the-model-and-explaining-the-results_0.pdf
- **Economic Insights (2017):** Topics in efficiency benchmarking of energy networks: Estimating capital costs. https://www.acm.nl/sites/default/files/documents/topics-in-efficiency-benchmarking-of-energy-networks-estimating-capital-costs_0.pdf
- **Economic Insights (2020):** Frontier Shift for Dutch Gas and Electricity TSOs. https://www.acm.nl/sites/default/files/documents/rapport-economic-insights-frontier-shift-for-dutch-gas-and-electricity-tsos.pdf
- **Frontier Economics (2023)**: Benchmarking techniques and practices for electricity and natural gas network operators. https://www.acm.nl/system/files/documents/frontier-economics-benchmarking-techniques-stc-toegankelijk_0.pdf

Appendix B: Public consultation responses

Stakeholder Consultation on AEC

ACER EFFICIENCY COMPARISON FOR GAS TRANSMISSION SYSTEM OPERATORS

EVALUATION REPORT

2025-12-11 / ver V1.0

Table of Contents

1 Public Consultation Responses AEC-WS2

Prof. Per J. AGRELL, pja@sumicsid.com

1.1 Introduction

This appendix presents Sumicsid's evaluation of stakeholder responses received during the public consultation on the following documents:

- *AEC Objectives and Criteria*. Synthesis report D02, 2025-06-17, V1.0
- *AEC Method, Data and Process.* Synthesis report D02, 2025-06-17, V1.0

The structure follows ACER's evaluation format: each consultation question is presented first in bold, followed by the number of responses, then a two-column synthesis comprising (i) a neutral summary of stakeholders' replies and (ii) Sumicsid's response explaining how the comments have taken into account and the section of the AEC Methodology and Process report where relevant to the comment.

Stakeholders providing input to the consultation comprise: Gas Transmission System Operators (TSOG), TSOG associations, market participants and associations, consultants.

The goal of this summary of responses is to transparently capture areas of consensus and divergence and to explain the methodological choices made in the *AEC Methodology and Process* final report (AECr).

1.2 Process and Respondent Overview

The consultation PC_2025_G_04 was open between 17 June 2025 and 17 July 2025. A total of 22 responses were received from respondents coming from the categories listed in Table 1 and from the countries listed in Table 2 below, respectively. Unless noted, each question below reports the number of responses explicitly. The respondents provide inputs to the project objectives, metrics, methods, process and information mode in the topic of cost efficiency comparisons of gas transmission operators. Note that the TSOG associations (ENTSOG and FNG) represent a large number of members (partially overlapping with the TSOs responding separately). The full list of participants is given in Table 3 below.

Table 1 Respondents by category.

Category	#	Share (%)
Consultant / Other	1	5%
Industry associations	4	18%
Network operator (non-TSO)	1	5%
TSO	5	23%
TSO Associations	2	9%
Users / Market participant	9	41%
Total	22	100%

Table 2 Respondents by country.

Country	#
AT	4
DE	2
DK	1
ES	1
EU	3
FR	1
IT	3
LT	1
NL	3
NO	1
PL	1
SI	1
Total	22

Table 3 List of respondents.

Organisation	Category	Country
(Anonymous)	User / Market participant	(EU)
Amber Grid	TSO	LT
BBL Company	Network operator (non-TSO)	NL
Edison	User / Market participant	IT
Element NL	Industry association	NL
Enagás	TSO	ES
Energinet.dk	TSO	DK
Energy Traders Europe (ETE)	Industry association	EU
Eni	User / Market participant	IT
ENTSOG	TSO Association	EU
Equinor	User / Market participant	NO
FNB Gas	TSO Association	DE
GAZ-SYSTEM	TSO	PL
IFIEC	Industry association	EU
OMV	User / Market participant	AT
OMV	User / Market participant	AT
Plinovodi	TSO	SI
Proxigas	Industry association	IT
Uniper	User / Market participant	DE
Verbund AG	User / Market participant	AT
Vereniging Gasopslag Nederland	User / Market participant	NL
WECOM	Consultant / Other	AT

2 Responses and Comments

2.1 Transparency and publication requirements

Legal robustness of decisions made on the basis of cost comparisons require due diligence in terms of access to data and clear documentation of methods and processes deployed..

The consultation document included the following questions:

1. *How do you value transparency across the different stages and results of the AEC*
2. *What are the elements of a TSO benchmark where transparency is most important*
3. *What other approaches to transparency should ACER consider when designing and publishing the AECr ?*

Stakeholder responses (21 respondents)	Response to the stakeholder input
General consensus: Transparency is essential for the credibility and acceptance of the AEC. TSOs emphasize that transparency must not compromise commercially sensitive data; users and associations prioritised maximum openness and reproducibility. The following stages are identified as critical for transparency: • Data definitions and data collection templates; • Validation procedures and treatment of missing or inconsistent data; • Model specification, parameter values and statistical assumptions; • Publication of final efficiency scores and their interpretation. TSO positions: • Support for the publication of the methodology, model specifications and validation procedures. • Request that raw financial and asset data remain confidential and that aggregation rules be pre-agreed with NRAs.	AECr recognizes that transparency is a cornerstone for legitimacy and reproducibility. The AEC framework proposes a multi-stage transparency measures described in **Sections 5.1 and 7.2**, including: • Publication of all non-confidential input data (T1 dataset) and modelling parameters (T0); • Independent audit and documentation of validation and estimation procedures; • Open-access reference documentation on model design and variable definitions. On confidentiality: The two-tier disclosure system (T1 / T2) balances openness and commercial sensitivity. All data classified as commercially sensitive by NRAs or TSOs are proposed to remain protected under the T2 dataset, consistent with Article 19 of Regulation (EU) 2024/1789. It is not clear at this stage whether sensitive information, such as GIS data, will be requested. In the event of the AEC using sensitive information, it may be classified as T3 with even stricter access rights. On stakeholder access:

- Propose two-tier disclosure (public dataset T1 / restricted T2) similar to CEER's TCB21 approach.

Associations and users:

- Ask for full publication of the T1 dataset, including efficiency scores and key cost drivers.
- Recommend releasing anonymized or synthetic samples for reproducibility.
- Suggest publishing audit reports and metadata for all data fields.

Additional suggestions:

- Introduce independent external audit of model code and reproducibility testing.
- Establish a public documentation repository (methods, variable lists, sensitivity checks).
- Provide summary visualizations comparing national results.

Points of divergence:

- TSOs: concerned about confidentiality breaches, administrative burden, and risk of misinterpretation of partial data.
- Users: argue that withholding data undermines trust and limits peer review.

Consensus outcomes:

- Agreement on need for pre-defined data dictionaries, clear audit trails and publication of key modelling parameters.
- Broad support for ACER's two-tier disclosure concept (public T1 and restricted T2).
- Support for expert validation of the methodology prior to publication.

The AECr proposes that ACER maintain a public repository with datasets, reports, and methodological guides, and can organise public hearings on results from the AEC.

On external validation:

An independent post-run review of model code and assumptions is proposed before publication of each AEC cycle.

On further improvements:

AECr acknowledges the request for a single public "audit trail" document showing each step from data submission to published results.

Stakeholders broadly support ACER's transparency proposal. AEC proposes to reinforce the transparency and reproducibility provisions already detailed in **Sections 1.8, 6.3 (art 6.23), 12.2, 12.5 (art 12.17), and 15.2 (art 15.07)** ensuring both accountability and data protection.

2.2 Challenges for TSOG in the Context of Decarbonisation

The synthesis document D02 identifies key challenges facing natural gas transmission networks, including:

- a likely decrease in transported gas volumes;
- new CAPEX needs from biogas, LNG and renewable gas connections;
- repurposing or decommissioning of existing assets; and
- extension or replacement of assets reaching end-of-life.

Stakeholders were invited to indicate which of these factors are most relevant and how declining utilisation should be reflected when measuring efficiency.

The consultation document included the following questions:

1 *What are the key factors that will affect natural gas transmission networks, which ACER should consider when designing a methodology to measure the efficiency of natural gas TSO infrastructure?*

2 *How should the decrease in network utilisation be considered when measuring the efficiency of TSOs?*

Stakeholder responses (21 respondents)	Response to the stakeholder input
Broad agreement about decarbonization profoundly reshaping gas network operations and investment planning. Most respondents expect reduced throughput and asset re-use for hydrogen, CO_2 or biogas transmission. **Key influencing factors identified** - Evolving gas demand, driven by electrification and fuel substitution. - Ageing infrastructure and replacement cycles; - Future regulation of repurposed assets and hydrogen interconnections; - Technological change (compression, metering, digitalisation); - Financing constraints and cost-of-capital evolution in a declining-volume environment. **TSO perspective** - Emphasised long-term capital recovery risks when utilisation drops faster than depreciation schedules.	AECr recognizes that decarbonization introduces structural shifts that no efficiency model can treat as purely short-term variations. Accordingly, AEC's approach in **Sections 1.5, 6.2 and 8.9 (Figure 1-1)** separates execution efficiency from utilization dynamics. Static benchmarking will evaluate efficiency conditional on network size and function, while dynamic analyses capture long-term adaptation. **On declining utilisation:** AECr acknowledges that demand reduction must not mechanically penalize TSOs. (**Section 5.1**) Therefore, utilization variables enter only the dynamic models as contextual drivers, not as primary outputs. This ensures cost-efficiency comparisons remain execution-focused, consistent with D04 **Section 6.2** (regulation needs).

- Argue for efficiency metrics focused on "execution quality" (planning, procurement and maintenance) rather than on utilization ratios.
- Propose introducing contextual variables (e.g. demand density, repurposing potential, regulatory maturity) to neutralise exogenous effects.

User and association perspective
- Support considering utilisation trends to prevent over-investment and to incentivise right-sizing of networks.
- Suggested the AEC to publish sensitivity results showing efficiency scores under varying utilisation assumptions.
- Encourage integrating forward-looking indicators, such as projected load decline or stranded-asset risk.

Points of divergence
- TSOs: Efficiency should be judged on controllable cost drivers; declining demand is exogenous.
- Users: Ignoring utilisation underestimates inefficiency and masks stranded-asset risk.

Consensus areas
- Efficiency assessment must distinguish controllable from uncontrollable factors.
- Need for contextual variables capturing demand and policy trajectories.
- Recognition that repurposing and decarbonisation objectives should appear explicitly in future benchmarking cycles.

Additional suggestions
- Develop a companion indicator set tracking utilisation and asset repurposing readiness.
- Coordinate with hydrogen infrastructure planning to align cost bases and avoid double counting.

On repurposing and decarbonization indicators:
AECr includes supplementary diagnostics linking asset age, repurposing status and decarbonization exposure, enabling NRAs to interpret efficiency outcomes within national transition contexts.

On forward-looking indicators:
While forecasting is outside the statutory scope of AEC, the report includes descriptive utilization trends (**Section 5.1**) and allows NRAs to assess progress by TSOs on their grid redeployment (**Section 6.3, art 6.22, art 8.146)**

On cross-sector coordination:
AECr supports stakeholder calls for alignment between gas and hydrogen efficiency frameworks and proposes to harmonize boundary definitions, for example, by investigating the adaptation costs for repurposing natural gas pipelines.

Conclusion:
The AEC approach effectively balances transparency and fairness: it safeguards TSOs against penalization for exogenous demand shifts while allowing NRAs and users to observe utilization trends through complementary metrics.

2.3 Legacy Investments

The AECr notes that the efficiency of natural gas TSOs is strongly influenced by legacy investments undertaken before market liberalisation. Many of these investments, made prior to the First Gas Directive in 1998, were guided by national policy objectives rather than efficiency principles and were often implemented under non-market conditions. The consultation invited views on how to address these historical assets and whether the proposed 1998 cut-off for "legacy" investments is appropriate.

The consultation document included the following questions:

4. *Is the proposal to address the comparability problem of legacy investments acceptable and effective for the purposes of the AEC?*
5. *Do you consider the entry into force of the First Gas Directive in 1998 to be an adequate cut-off point to identify legacy investments?*
6. *How should different efficiency levels pre- and post-liberalisation be considered by NRAs when setting the allowed revenue methodologies for TSOs?*

Stakeholder responses (20 respondents)	Response to the stakeholder input
Most respondents agree that legacy investments must be recognised as a structural factor when assessing efficiency. **TSOs and their associations** stress that decisions made before liberalisation reflected strategic or political imperatives rather than managerial performance, and therefore the associated capital costs should not distort today's efficiency comparison. They support ACER's proposal to maintain the historical asset base but to run sensitivity analyses excluding pre-1998 assets or substituting standardised replacement values. Some TSOs asked that revaluation procedures remain transparent and that depreciation profiles for legacy and new assets be kept distinct. **Users and associations** accept the need for comparability adjustments but express concern about excessive neutralisation erasing evidence of persistent over-capitalisation. Several respondents argue that any revaluation should remain visible in the published datasets so that NRAs and stakeholders can trace the effect of legacy corrections on efficiency scores. A few users suggest using a dual indicator system—	AECr acknowledges that legacy investments have long-lasting effects on measured efficiency and that their treatment must balance historical accuracy with present-day comparability. In accordance with **Section 10.2**, the modelling retains all capital stock values to ensure consistency with audited financial statements, but complementary sensitivity analyses are conducted using standardised replacement values for pre-1998 assets. This dual presentation allows NRAs to observe both gross and adjusted efficiency scores without rewriting asset histories. The 1998 cut-off is maintained as the principal demarcation point because it marks the formal entry into force of the First Gas Directive and the onset of regulated third-party access across Member States. AECr recognises, however, that Member State accession to the EU and national liberalisation timelines differed, and it therefore proposes that NRAs can report the accession year to the EU (**Section 10.5).** In dynamic efficiency analysis, legacy investments enter as contextual variables rather than as direct inputs, ensuring that they do not bias productivity trends. Depreciation schedules remain the standardized lifetimes, while annuity normalisation removes inflation and accounting-standard effects.

one including and one excluding legacy assets—to improve interpretability.

On the precise cut-off year.

TSOs and most associations endorse 1998 as a pragmatic regulatory milestone because it coincides with the First Gas Directive and the start of market liberalisation. A minority of respondents propose later dates (typically 2000 to 2004) to capture the gradual implementation period, while two users question whether any single cut-off can fairly represent the diversity of Member States' reforms.

On the regulatory implications.

TSOs encourage NRAs to focus future benchmarking and incentive regimes on post-liberalisation investment behaviour, using legacy-neutral efficiency measures only as a contextual reference. User groups reply that legacy and new-era efficiencies should both inform NRA judgements, arguing that the economic consequences of past inefficiency remain embedded in the current tariff base.

Overall, respondents agree that separating pre- and post-liberalisation capital should enhance comparability, provided that the methodology is applied uniformly and transparently.

The methodology described in **Sections 12.2 and 12.5** preserves transparency by documenting each valuation assumption and by publishing the standard coefficients used in the neutralisation exercise. AECr proposes both full-asset and legacy-adjusted results in runs R1 and R3 (**Section 8.16, Table 8-23**), accompanied by explanatory notes clarifying the differences.

In conclusion, AECr refers to the proposed treatment of legacy investments as both effective and proportionate. It maintains comparability across Member States, avoids retrospective rewriting of accounts, and allows NRAs to contextualise legacy costs when applying efficiency outcomes in revenue determinations.

2.4 Comparability of TSO costs

The AECr proposes several measures to enable the comparability of TSO cost and performance. These include establishing the functional and asset scope of the comparison; controlling for ownership structural and organizational differences; standardizing asset depreciation times, capital costs and labour cost; correcting for overhead cost allocation, inflation, opening balances, price and currency differences. As part of the instruments to ensure comparability, the AECr proposes to correct for environmental heterogeneity.

The consultation document includes the following questions:

3 Are the comparability measures proposed in the documentation effective and necessary? Is there redundancy or inadequate measure among the instruments?

4 Are there other measures that ACER should consider to ensure the comparability of TSO costs?

Stakeholder responses (12 respondents)	Response to the stakeholder input
General consensus There is an agreement about the need to have transparency, reliable data, reliable definitions and clarity on the rules used to prevent unjustified bias. **TSOs and associations** ENTSOG points to the list of corrections not being complete and specific enough on the treatment of TSO specificities. Similarly, FNB Gas points out that these measures do not account for the totality of heterogeneity across TSOs (also pointed out by Wecom). Amber Grid further supports the proposal as a reasonable attempt to create better comparability between TSOs. Enagas supports some continuity with the approach used in TCB21. **Users** Respondents (6) support the proposed approach, referring to it as robust and necessary (e.g. IFIEC, Element NL), very thorough (VGN) and fair (Wecom). **Proposals** Users call for a careful application ensuring transparency to prevent unintended biases.	AECr accommodates the broad consensus on comparability instruments covering definitions, accounting treatments and reporting conventions. AECr accommodates also a number of enhanced measures to improve comparability of costs. Labour costs are treated with explicit attention to national differentials and organisational arrangements as set out in **Sections 11.5 art 11.31 ff** where the construction of comparable labour aggregates and treatment of indirect staff. To address concern about alternative indexations, AEC prescribes a labour-cost sensitivity run referenced as SA-LC in **Section 8-16, Table 8-24**. Recognising that organisational form can shift recorded costs without altering underlying effort, AECr will require extended reporting on outsourcing so that externally procured activities are re-integrated to a consistent analytical perimeter, as specified in **Section 11.4, art 12.29**. Analogously, for capitalised labour, AEC will offer an extended reporting of capitalized labor for grid construction in **Section 12.7, art 12.30**. These provisions aim to neutralise differences that arise from structural choices rather than staff productivity. AEC also caters for a specific run R5 (**Section 8-16, Table 8-24**) with national WACC to facilitate close regulatory assessment without bias related to financial parameters (**Section 10.3 art 10.09**). Sumicsid does not see merit in

ETE and Equinor propose to use the actual RAB and WACC values of the TSOs.

OMV proposes to consider the energy-related Opex as a controllable parameter, hence, in scope of the comparison.

WECOM discusses additional parameters to take into account country- and TSO-specific differences.

Gaz-System calls for enabling the reproducibility of the calculation.

Edison calls clear reporting of subsidies and received by TSOs and hydrogen adaptation costs as some adapted pipelines might not be converted.

FNB-Gas proposes to treat decommissioning liabilities as non-controllable cost and deducts them from the "cost-in-scope".

incorporating each TSO's regulatory asset base directly into the benchmarking inputs, as these reflect national depreciation periods, subsidies and regulatory design rather than controllable efficiency. Therefore, a local RAB policy cannot be safely replicated on the reference set, which leaves the comparison potentially biased. Similarly, proposals to classify all energy-related operating costs as controllable are not adopted wholesale, because these items may depend on network configuration, fuel procurement rules and environmental constraints outside TSO discretion.

AECr accommodates the call for reproducibility by documenting the calibration of comparability factors, by publishing the reconciliation steps that map reported accounts to the analytical cost base, and by indicating, in each published run, the scope of corrections applied. Where respondents have pointed to potential omissions in the list of heterogeneity controls, AEC may screen the proposals against data availability and relevance tests and extend the lists.

2.5 Static efficiency

An efficiency analysis needs a temporal framework for its observations, either a single year (static) or over a time period (panel or time series). Often NRA require an assessment for a given year as the basis of an ex ante assessment of efficiency requirements. Another concern is the safeguard against idiosyncratic shocks in certain years that would make observations non-replicable across time, e.g. the COVID-19 crisis. One of the deliverables in AECr is therefore a static assessment for each year in the period.

The consultation document includes the following questions:

5 *Do you consider the proposed approach to provide the primary efficiency measure of the AEC adequate?*

6 *Do you agree that a static model could provide useful input for NRA regulatory rulings? If not, what other options you would propose?*

Stakeholder responses (11 respondents)	Response to the stakeholder input
There are different views across the respondents, with users supporting the proposed approaches and methods with a view to the application of the in regulatory decisions. TSOs question the proposed methods and their application in regulation. **TSOs** TSOs express scepticism about DEA as primary tool. ENTSOG expresses concerns about the impact of noise, applicability of confidence intervals and exogenous differences. Furthermore, FNB Gas refers to the heterogeneity of EU TSOs, arguing that standard statistics cannot be used to estimate error probabilities in a sample that is non-random. FNB Gas challenges the use of any benchmarking in methods in revenue regulation. Amber Grid supports the use of two methods and Enagas supports continuing with the approach used in TCB21. Gaz System points at the challenges interpreting the results. **Users** Users (5) Support DEA, frequent benchmarks and favour of multiple methods. Users consider the approach extensive and adequate (ETE, Equinor), based on well-established methods (IFIEC). The approach to static efficiency using DEA is supported (IFIEC, Element NL) as well as the objective of holding in court (Equinor).	The stakeholders differ between those generally negative towards benchmarking, where the AEC objective is refused, and those who have specific reserves to the metrics chosen. AECr is starting from the presumption that the statutory objectives of ACER for AEC are to be respected. Concerning the argumentation of models and methods, Sumicsid agrees that the distinction between primary and secondary methods was unclear. AECr is now clearly defining three core models (**Sections 1.5**) based on the needs defined for the regulatory purpose (**Section 6.2**), that is an execution, and a utilization focus. Methods that are adequate for the type of model and data are assigned to each model (**Section 8.7**): • Static execution ES (DEA and SFA). • Dynamic efficiency, execution ED (DEA) • Dynamic utilization model UD (SFA) AECr accommodates the view that the static efficiency model ES provides a useful benchmark when interpreted alongside contextual and dynamic information. The final methodology defines static efficiency as annual cost performance within a harmonised input-output framework, controlling for structural variables as detailed in **Section 15.1**. To enhance reliability, both DEA and SFA are applied to the same dataset, with comparative diagnostics and confidence intervals published in **Section 15.7**. This dual approach DEA-SFA is

Recommendations

Wecom proposes not to rely on a single method and to use DEA, Modified OLS and SFA. Wecom further proposes to extend the adapt the list of non-controllable costs to national specificities (e.g. legacy pension obligations, financial obligations, mandatory contributions to non-governmental organizations such as ENTSOG, etc).

Several users propose to complement the static model with a dynamic model taking network utilisation into account (ETE, IFIEC, VGN,

Element NL proposes a yearly frequency.

considered regulatory best practice **(Section 8.18)** and is supported by the Expert Review.

2.6 Dynamic efficiency

The energy transition is expected to result in lower demand for natural gas. The evolution of demand and entry points depend on many factors, most of them being uncontrollable by the TSO which networks are sized to match the peak network use. To measure these effects, the AECr consultation proposed a dynamic model using SFA and DEA as a secondary validation method.

The consultation document includes the following questions:

7 *Do you consider appropriate to provide additional efficiency scores taking into account network utilisation? Please reason your answer.*

8 *Do you consider the proposed method design appropriate (SFA as primary method and DEA and secondary method)? Please reason your answer.*

9 *Is the use of two methods a strength for the analysis or a source of ambiguity in the interpretations? Please reason your answer.*

Stakeholder responses	Response to the stakeholder input
General consensus Respondents acknowledge that utilization factors are outside the control of TSOs, however there are different views about whether such analysis should be considered as part of the AEC, with users supporting the approach and TSOs remaining critical. The use of multiple methods has a larger consensus, with some TSOs supporting the approach (FNB Gas) and other not (ENTSOG). **TSOs** ENTSOG points out that utilisation is an exogenous parameter outside the control of TSOs. FNB-Gas points how an efficiency benchmark focusing on cost-output-relationships cannot contribute cannot capture the complex interrelationships between decommissioning, repurposing and replacement investments. Individual TSOs do not support the use of utilisation parameters (Enagas, Gaz System and Amber Grid). ENTSOG points at the possible volatility resulting form taking utilisation into account. Furthermore, ENTSOG points to risks associated with model misspecification (e.g. multicollinearity).	The stakeholders have differing views on the use of utilization factors for cost comparisons in AEC, but largely supporting the combination of methods. Concerning the argumentation of models and methods, Sumicsid agrees that the distinction between primary and secondary methods was unclear. AECr is now clearly defining three core models (**Section 1.5**) based on the needs defined for the regulatory purpose (**Section 6.4**), that is an execution, and a utilization focus. Methods that are adequate for the type of model and data are assigned to each model (**Section 8.9**): • Static execution ES (DEA and SFA). • Dynamic efficiency, execution ED (DEA) • Dynamic utilization model UD (SFA) The utilization model is not intended for direct application in revenue regulation (**Section 1.5, art 1.30, Section 6.2, art 6.07**) but to address long-term development of the grid system for gas. A real-data example with US TSO has been added to illustrate the methodology and the type of results (**Section 8.12**), along with outlier (**Section 8.14**) and peer analysis (**Section 8.15**). The D04 report is also more explicit on the reason for selecting the methods DEA and SFA,

Users

Users (6) support the use of dynamic modelling, indicating several potential uses of the results, including informing NRAs of the efficiency of regulation (ETE, IFIEC), long-term system costs and affordability (IFIEC, Element NL, Equinor), network size optimisation (IFIEC) and Opex monitoring over time (VGN). OMV points out that a dynamic model should complement the static model to avoid concluding that a TSO with efficient investment execution but large declines in utilisation is fully efficient.

Users (6) support the proposed approach based on SFA.

Complementarity of methods

Users (ETE, IFIEC, Element NL, Equinor) support the complementarity of methods as it enhances credibility and robustness. This is further supported by FNB Gas and Amber Grid. ETE proposes guidance to prevent ambiguity in the interpretations. Discrepancies between results could require additional analysis (IFIEC). ENTSOG points out that two methods are insufficient to confirm results. FNB Gas requests additional justification for the choice of SFA and DEA and proposes to include COLS, MOLS, UC, EngM, StoNED as a best practice.

discarding e.g. COLS, MOLS and StoNED (**Sections 8.3 and 8.4**).

2.7 Data quality

Data quality is crucial to ensure a fair and reliable benchmark. In consistency with TCB benchmarks, ACER proposed a multi-layered validation approach.

The consultation document includes the following question:

10 Do you agree with the data validation approach outlined? What other alternative measures should ACER consider to ensure the quality of the data?

Stakeholder responses (11 respondents)	Response to the stakeholder input
General consensus There is a wide support of ensuring data quality, as laid out in the AEC proposal. At the same time, some respondents point that data quality cannot solve other issues, such as the use of benchmarking in regulation or other costs heterogeneities. **TSOs** FNB Gas points that not all data issues can be solved through validation and standardization (e.g. legacy investments). Individual TSOs further support the proposed approach (Enagas and Amber Grid). **Users** Users (5) support the proposed approach. **Recommendations** Element NL points to the importance of a timeline process to meet deadlines. IFIEC proposes additional steps for the data collection, including standarised IT platforms, training guidance for TSOs/NRAs, trial runs, mechanisms for outliers, anonymous peer review of data, regular reviews of the data request. Amber Grid emphasizes the need for clarity during the process on the side of the consultant.	Sumicsid agrees with the recommendations. data quality is a prerequisite for credible benchmarking. Standardized IT platforms etc. however come at additional cost, with ACER to decide if such platforms are worth the effort and cost. A general transparency policy is foreseen for T0 and T1 data, enabling (anonymous) peer-review of data . (**Appendix D, Sections 1.8, 6.3, 12.2**). The data requests are recommended to be reviewed every four years at least. (**Chapter 15**). The inputs of the stakeholders will be considered again in phase II on data collection and validation. (**Section 4.2**).

2.8 Relevance criterion for the model specification

The detailed model specification will naturally follow from data, although some principles for its derivation and argumentation should be established. It is important to explore the intrinsic tradeoffs that must be made between explanatory power and face-validity of any model.

The consultation document includes the following question:

11 The criteria in section 7.7 of document D02 list 'relevance' as a criterion for the model specification. However, data mining techniques such as principal component analysis or machine learning may derive good predictions of total cost without an explicit cost function. Do you agree that this criterion is sound and necessary for the AEC purposes? What measures can be taken to assure relevance of the results?

Stakeholder responses (11 respondents)	Response to the stakeholder input
General consensus Relevance is considered a valid criteria which should be assessed with further detail. The use of machine learning techniques is considered inadequate across the responses. **TSOs** ENTSOG points out that the proposed methods do not imply a causality check regarding efficiency measurement. FNB Gas points out that relevance and continuity in regulation therefore are relevant criteria for model selection. Amber Grid points that the "relevance" criteria has been one of the elements of the "black box" in previous benchmarking exercises **Users** Relevance is considered as a valid criteria across users. At the same time, ETE points to the need of a critical review of the variables and outputs will be key for making proper adjustments to the model. Wecom points that the AEC model must reflect true cost drivers, not just statistical fit. **On machine learning** The use of machine learning techniques is questioned (Element NL, ENTSOG) and considered unrealistic (FNB Gas). **Recommendations** Avoid black box effect and enable the interpretability (IFIEC, VGL).	The consensus rejects black-box models just aiming for cost prediction precision. The Expert group also agrees with the relevance criterion. AECr accommodates these positions by maintaining relevance as a core selection principle in model design. The final methodology defines relevance as the demonstrable economic and engineering coherence between input, output and environmental variables, as set out in **Section 12.8, art 12.39-12.40**. Variables must have a clear theoretical justification, measurable physical basis and stable relationship with total cost. AECr established also transparency and reproducibility criteria on models in in **Article 1.8.** To avoid the "black-box" effect mentioned by several respondents, the report includes a documented model selection process and diagnostic tests for relevance and stability presented in **Section 12.8**, highlighting the interpretability for peers (**Section 8.15**) and outliers (**Section 8.14**).

2.9 TSO comparability and use of scaling functions

Modelling a grid with assets of different dimensions and characteristics requires the use of *scaling functions* to aggregate the data for each operator for comparison. The use of scaling function is implied in the summation of assets, the question is whether it is made with non-unity weights or some functional form (square root, quadratic, etc).

The consultation document includes the following question:

12 The comparison of assets with different dimensions and material is partially based on a normalized grid metric (NormGrid). Is the use of such normalization acceptable and robust for the AEC?

Stakeholder responses (10 respondents)	Response to the stakeholder input
General consensus There are diverging views on the need and appropriateness of using the NormGrid, however, there is a general support to having transparency on its application. **TSOs** ENTSOG is skeptical about the use of NormGrid and explains that EU gas grid have dimensions, specificities, and context, that cannot be meaningfully captured in simple statistical models. Furthermore, ENTSOG recommends fully detailed transparency. FNB Gas and Amber Grid point that NormGrid could contribute to a black-box effect. Enagas points out that the use of a NormGrid, corrected with the appropriate environmental factors is a valid approach **Users** IFIEC points out that a normalized grid metric is acceptable and likely necessary as it addresses heterogeneity across TSOs, the provision of services capacity using different assets rather than just taking into account the physical characteristics of the assets. In addition, IFIEC points out that this is a common practice in benchmarking. The approach is further supported by Element NL, **Recommendations**	Stakeholder opinions diverged on the appropriateness of using a normalised grid metric (NormGrid) or similar scaling functions to compare networks of differing physical dimensions and configurations. TSOs and their associations expressed caution, arguing that pipeline systems vary so greatly that a single synthetic measure may oversimplify real differences. AECr accommodates the shared objective of ensuring comparability while maintaining methodological transparency. The final approach applies *scaling functions* based on measurable engineering parameters, calibrated against e.g. pipeline length, diameter and pressure class, as described in **Section 13.4.** The 'black-box' effect is addressed by introducing other established alternatives to the DNV(2024) Normgrid (**Section 13.4)** and also shows an example of their application in **Section 11.2 (Example A).** AEC will publish the functional form and coefficients of the scaling function so that stakeholders can reproduce and test the calculation. To address stakeholder requests for validation, the robustness of scaling metrics is examined through sensitivity analyses SA-NG reported in **Section 8.16, Table 8-24**.

Element NL points out at the need to takin into account the different needs for compressor stations in pipelines of different diameters.
IFIEC points out that its robustness depends entirely on the transparency, expert validation, and continuous refinement.
Equinor points out that the NormGrid should not difficult the interpretations of the results.
Wecom points to additional details for an adequate review.

Sumicsid does not see grounds to discard scaling functions entirely, as their controlled use enhances comparability and allows a fair aggregation of multi-dimensional assets. Contrary to earlier projects (esp. TCB18), the Normgrid has no privileged role and can be replaced by any scaling function.

2.10 Quality of service

The AEC consultation requested input on the use of indicators to measure quality of services. This is an important output in electricity benchmarking, however it is not clear how it could be used in gas.

The consultation document includes the following question:

13 Service quality is not explicitly modelled among the parameters in chapter 3 of document D03. Should service quality be part of the benchmarked outputs? If so, how can it be measured?

Stakeholder responses (11 respondents)	Response to the stakeholder input
General consensus Respondents generally point out the importance of quality of service, however there is a general consensus on the difficulty of measuring this factor. **TSOs** ENTSOG finds it challenging to measure quality of service. FNB Gas and Amber Grid consider quality of service potentially relevant but challenging to measure. **Users** Some users consider this parameter not relevant (ETE, Element NL, VGN), others IFIEC, OMV and Wecom support the use of quality of service and provide possible approaches.	AECr accommodates the principle that service quality should remain visible in the overall performance assessment but outside the quantitative benchmarking frontier at this stage. The Expert Review shares the consensus with the stakeholders and Sumicsid that quality in gas transmission is not readily measured in a relevant manner for benchmarking. The final report therefore treats service quality as a contextual indicator informing interpretation rather than as a determinant of efficiency scores. The conceptual treatment and rationale for this separation are presented in **Section 6.2**. AEC will continue monitoring data availability and methodological developments in related sectors.

2.11 Output variable selection methods

The model specification in a benchmarking is a crucial, data-driven process where the modeler must choose among many potentially equivalent collections of variables. Sumicsid has established a methodology classifying parameter candidates by supply tasks and exogeneity (output-focused, asset-based).

The consultation document includes the following question:

14 *Do you agree with the output variable selection methods in section 3.2 of document D03? What improvements can be made*?

Stakeholder responses (8 respondents)	Response to the stakeholder input
Summary The input received on this point is not conclusive. Some users support the approach, while TSOs refer to the use of utilization-based parameters, which are also discussed in other sections. Some also emphasized the importance of continuity with the variable definitions used in previous benchmarks, such as TCB21. **TSOs**, ENTSOG does not provide input specific to this topic and FNB Gas points out that the principle of "non-determinability" must be taken into account Some TSOs point out that utilisation based variables should not be considered (Amber Grid), and that keeping the approach used in TCB21 is positive (Enagas). **Users** 3 users and 1 association consider the proposed approach sound and comprehensive for selecting output variables. IFIEC points that this approach can be supported by the use of GIS-based variables, which is encouraged. IFIEC also refers to the inclusion of hydrogen readiness integration as a vital improvement critical to understand how TSOs are adapting their infrastructure for hydrogen.	AECr accommodates the majority position by maintaining a transparent, theory-based process for selecting outputs while controlling for exogenous variability. The final set of output variables is established according to statistical relevance, engineering plausibility and consistency with prior benchmarks, as detailed in **Section 13.3**. The procedures for testing and validation of candidate outputs, including multicollinearity and sensitivity diagnostics, are further illustrated in the examples in **Sections 8.10-8.12**. Sumicsid does not see justification for the systematic inclusion of utilisation variables as core outputs, given their dependence on demand-side factors beyond TSO control. Instead, these remain contextual factors in the dynamic analyses presented in **Section 8.9 art 8.85 and Section 8.12**

2.12 Environmental corrections

One of the key innovations in regulatory benchmarking has been the systematic inclusion of location-based environmental factors for network operators. This approach, drawing on public and frequently updated databases, provide an objective and techno-economically sound approach to control for residual cost differences among operators.

The consultation document includes the following questions:

15 Do you agree that the environmental correction factors listed in section 3.3 of document D03 are relevant and important for the AEC? What improvements can be made?

16 Are there missing structural or environmental factors that should be included in the analysis? Please reason your answer.

Stakeholder responses (10 respondents)	Response to the stakeholder input
General consensus on the need to provide transparency on the application of environmental factors and on the results, possibly with support of sensitivity analyses. **TSOs** ENTSOG considers the use of environmental factors subjective and an oversimplification of real-world factors. The impact on the results is unclear. FNB Gas points out that the TSO business is influenced by a variety of environmental factors and that past selections were subjective. In addition, FNB Gas points out that TSO businesses and the European gas network have dimensions that cannot be captured in simple statistical models. Amber Grid generally welcomes the use of environmental factors. **Users** There is a wide support of the use of environmental factors across users (ETE, IFIEC, Element NL, OMV). **On missing environmental factors** IFIEC, Element NL, VGN and Amber Grid refer to the current proposal as comprehensive. Amber Grid further points that it is not possible at this stage to conclude whether the list if complete. Enagas points out that some environmental factors weren't properly included in TCB21 and	AECr supports fully the consensus on the need for transparent and replicable environmental corrections. The final methodology retains environmental factors that show a statistically and technically justified relationship with total cost, as presented in **Section 11.6** . The data sources, variable definitions and normalisation procedures are described in **Section 13.6**, while robustness tests for these factors are included as SA-EN in **Section 8.16, Table 8-23.** AECr uses the ability to integrate environmental factors as one of evaluation criteria (**Section 8.7**) for methods. The Expert Review supports the approach proposed for AEC, underlining the need for GIS-data to accomplish the corrections effectively. Sumicsid does not see reason to remove environmental corrections, as they materially improve comparability across diverse geographies, but acknowledges that their design requires periodic expert review. Future updates will refine these factors as new geospatial and geological data become available to ensure ongoing relevance and methodological transparency.

that they should be taken into account in. In particular, the option chosen in TCB21 for environmental corrections was LLG, and Enagas proposed the use of zGravel parameters with the zSoil.dr, (depth to rock).
Enagas also points out that it is important to clarify what happens if a special structural or environmental factor affects more than one country, as happened with the volume of stone.

Recommendations
ENTSOG recommends ensuring transparency.
Element NL warns about the incentive of TSOs to question this element in order to reflect conditions that will improve individual results.
IFIEC proposes to have continuous enhancing of the environmental factors.
Amber grid wants to clarify what the impact is in the final scores

2.13 Capital cost differences across Member States

Harmonization of CAPEX is fundamental to the comparison of TSO with 80-90% of their cost basis in capital investments. Among analysts, there is a consensus that a real annuity methodology using harmonized parameters is the most adequate to achieve a fair comparison. However, this approach does not explore potential differences in the investment levels between countries with different capital cost levels and regulated returns.

The consultation document includes the following question:

17 Do you consider it useful, in the analysis of the dynamic efficiency of TOTEX, to take national capital cost differences—particularly the WACC—into account when assessing the evolution of the optimal cost structure, especially the balance between OPEX and CAPEX?

Stakeholder responses (11 respondents)	Response to the stakeholder input
General consensus Some respondents are supportive of the approach while the larger part of the respondents don´t have a view on the topic. **TSOs** The in from the TSOs associations does not provide details on this topic. Amber Grid considers there isn't sufficient information to assess this impact of national difference on the WACC. Enagas supports the use of a standardised WACC. **Users** There is support across some users (ETE, IFIEC, VGN) while others don't have a defined position (OMV, Element NL) **Recommendations** OMV points out that in relation to the CAPEX/OPEX split, it is paramount to draw a consistent line across the observation sample. It may be useful to set up rules to disincentivize smearing submitted costs into CAPEX when a clear allocation (CAPEX vs OPEX) is not possible	Stakeholders are divided on whether national differences in capital costs, particularly in the weighted average cost of capital (WACC), should be explicitly reflected in the efficiency analysis. Sumicsid is favouring a fair and harmonized approach with a single real cost of capital applied to all investment streams for comparability (**Section 10.3**). The sensitivity to the chosen real interest rate will be explored in SA-RA (**Section 8.16, Table 8-24**). However, NRAs and the Expert Review are favourable to an analysis with national WACC. AECr accommodates this request by an optional run R5 (**Section 10.3 § 10.09, Section 8.16, Table 8-23**) with full documentation.

Appendix C: Response to Expert Review

SUMICSID

Responses to the AEC Expert Review

ACER EFFICIENCY COMPARISON FOR GAS TRANSMISSION SYSTEM OPERATORS

EVALUATION REPORT

2025-12-10 / ver V1.0

Disclaimer

This is a technical report prepared by SUMICSID GROUP and Swiss Economics on behalf of ACER and in collaboration with ACER and national regulatory authorities (NRAs), for guidance in completing the ACER Cost Efficiency Comparison (AEC), starting in 2024 and to be published for the first time by 5 August 2027. However, this report reflects the views of SUMICSID GROUP and Swiss Economics and does not necessarily represent the views of ACER. ACER may adapt, modify, or deviate from the methodology, recommendations, or processes proposed in this report.

The report takes into account the proposals presented at a public workshop in Brussels on 9-10 July 2025, which was complemented by a public consultation between 17 June and 17 July 2025 and a review by an independent group of experts commissioned by ACER. The final revised document has been prepared solely by SUMICSID GROUP and Swiss Economics, who assume full responsibility for any errors of fact or logic. ACER is not liable for any consequence resulting from the use of information contained in this report.

Title: Reponses to the AEC Expert Review

Response file, open. Project: PAEC
Version: V1.0, final.
Release date: 2025-12-11

Sumicsid Group
Rue Maurice Lietart 56
B-1150 Brussels, BELGIUM
www.sumicsid.com

Version history

Version	Date	Status	Auth	Concerns
X0.1	2025-08-01	Draft	PA	Findings, plan of document
X0.2	2025-10-14	Draft	PA	Draft
X0.3	2025-10-15	Draft	PA	Appendix C in AEC Methods and Process
V1.0	2025-12-11	Final	PA	Update for main report references

Table of Contents

1 AEC Expert Review Responses

Prof. Per J. AGRELL, pja@sumicsid.com

1.1 Introduction

This appendix presents Sumicsid's evaluation of AEC Expert Review (ER) on the following documents:

- *AEC Objectives and Criteria*. Synthesis report D02, 2025-06-17, V1.0
- *AEC Method, Data and Process.* Synthesis report D03, 2025-06-17, V1.0

The structure follows ACER's evaluation format: each consultation question is presented first in bold, then a two-column synthesis comprising (i) a summary of the Expert Review (verbatim from their presentation) and (ii) Sumicsid's response explaining how the comments have taken into account and the section of the final report where relevant to the comment.

The Expert Review has produced the following material:

1. Müller-Kirchenbauer, Bjørndal, Jamasb, Neumann, Sanchez, *ACER efficiency comparison for natural gas TSOs (AEC): Expert Review*. Report, 2025-10-15.
2. Müller-Kirchenbauer, *ACER efficiency comparison for natural gas TSOs (AEC): Expert review*, presentation TAR TF.

The goal of this summary of responses is to transparently capture areas of consensus and divergence and to explain the methodological choices made in the *AEC Methodology and Process* final report (AECr), D04 final version V1.0, 2025-12-11.

References to the AECr are to Chapters, Sections and articles (§) as numbered in the final report.

1.2 Process and Expert Review Composition

The Agency for the Cooperation of Energy Regulators (ACER) is tasked by Article 19 of Regulation (EU) 2024/1789 on the internal markets for renewable gas, natural gas and hydrogen, to carry out a cost-efficiency comparison of natural gas transmission system operators (TSOs).

The work leading to the publication of the AEC Method and Process report includes an independent review by a group of experts selected by ACER. These experts are considered recognised European academics and/or professionals, with capacity on:

- Methodological skill in benchmarking (parametric and non-parametric).
- Energy regulation and application of benchmarking
- Knowledge of the energy sector, in particular in the EU gas sector, and on gas transmission.

The Expert Review was conducted by the following experts:

- Prof. Dr-Ing. Joachim Müller-Kirchenbauer, Technical University Berlin.
- Prof. Dr. Mette Bjørndal, Norwegian School of Economics and Management.
- Prof. Dr. Tooraj Jamasb, Copenhagen Business School.
- Prof. Dr. Anne Neumann, Norwegian University of Science and Technology.
- Prof. Dr. Luis Orea, University of Oviedo.

The group of experts was tasked to assess the AEC documents that were subject to public consultation in summer 2025[1]. The analysis completed assesses the adequacy of the draft AEC design proposal as a state-of-the-art approach in efficiency assessments for energy regulation in Europe considering regulatory, economic and legal constraints as well as the feasibility, correctness, applicability and usefulness of the proposal.

The experts incorporated multiple kinds of expertise and skills and provided their input to ACER. The experts have worked with full independence and autonomy to meet its task. The following report has been written by the group of experts and reflects their input accurately and objectively.

Between August and September 2025, the group of experts held exchanges with ACER and presented its results to ACER, national regulatory authorities (NRAs) and to Sumicsid[2], which ACER commissioned to design the AEC methodology and process.

[1] ACER Public consultation on the ACER gas TSO cost efficiency comparison draft methodology, PC_2025_G_04.Link: https://www.acer.europa.eu/public-consultation/pc2025g04-public-consultation-acer-gas-tso-cost-efficiency-comparison-draft-methodology

[2] Direct service contract ACER/NEG/GHR/22/2024.

The final report completed by Sumicsid, the AEC Method and Process report[3], takes into account the input provided in the Expert Review, as discussed in detail in Annex C of the AEC Methodology and Process report [4].

[3] AEC Method and Process. Final Report published on 12 December 2025. Link: https://www.acer.europa.eu/sites/default/files/documents/Publications/ACER-2025-TSOs-Efficiency-Comparison.pdf

[4] Annexes to the AEC Method and Process report including the Evaluation of Stakeholder Responses and the Sumicsid Response to the Expert Review. Link: https://www.acer.europa.eu/sites/default/files/documents/Publications_annex/2025-ACER-TSOs-Efficiency-Comparison-Appendix.pdf

2 Comments D02

This chapter presents Sumicsid's evaluation of AEC Expert Review (EGR) on the following document:

- *AEC Objectives and Criteria*. Synthesis report D02, 2025-06-17, V1.0

2.1 Transparency and publication requirements

The consultation document included the following questions:

1. *How do you value transparency across the different stages and results of the AEC*
2. *What are the elements of a TSO benchmark where transparency is most important*
3. *What other approaches to transparency should ACER consider when designing and publishing the AECr ?*

Expert Review summary	Response to the EGR
Summary comments General consensus: (1) Approach and improvements are thoroughly based on evidence and experience gained from previous international efficiency comparisons of energy networks in practice and scientific literature. (2) Overall sound and complete approach; reasonable and meaningful process steps and analytical layers for the treatment of specific challenges of an international efficiency benchmark, in particular different jurisdictions, large number of involved parties and decision-making units (ACER, NRAs, TSOs), potentially different ways how and when to use the results by NRAs (3) Decisive pre-conditions for successful implementation need to be highlighted: a. Data availability in high granularity is essential. (Cost drivers, NormGrid) b. Documentation (T0 to T4 very useful), transparency and justification of detailed steps in parameter selection, model design and/or exclusion/inclusion of additional models and/or measures is important. (4) We emphasize that complete traceability is crucial to ensure that the results can be applied for regulatory purposes.	**General response** Sumicsid agrees with the summary and the priorities mentioned. The AECr framework proposes a multi-stage transparency measures described in **Sections 1.8, 6.3, 12.2, 12.5 and 15.2**, including: • Publication of all non-confidential input data (T1 dataset) and modelling parameters (T0); • Independent audit and documentation of validation and estimation procedures; • Open-access reference documentation on model design and variable definitions. **On data availability** It is not clear at this stage whether sensitive information, such as GIS data, will be requested. In the event of the AEC using sensitive information, it may be classified as T3 with even stricter access rights, subject to ACER decision at Phase II. The transparency and reproducibility provisions in **Sections 12.2 and 12.5** are emphasized in AECr **Chapter 15.**

2.2 Challenges for TSOG in the Context of Decarbonisation

The consultation document included the following questions:

1 *What are the key factors that will affect natural gas transmission networks, which ACER should consider when designing a methodology to measure the efficiency of natural gas TSO infrastructure?*

2 *How should the decrease in network utilisation be considered when measuring the efficiency of TSOs?*

Expert Review summary	Response to the EGR
Summary comments (5) The [reports D02 and D03] correctly identify the core challenges for gas transmission networks in the decarbonisation context. (6) However, the decommissioning aspect deserves stronger emphasis, as the large majority of assets will exit gas service within the next two decades, due to demand collapse under EU targets reflected in TYNDP and a large number of energy systems analysis studies; in order to create direct incentives for the cost-efficient implementation of decommissioning, a separate incentive for decommissioning costs should be introduced, for example by means of a sharing mechanism in the sense of a budget/sliding scale approach with a reference value based on unit costs for decommissioning per asset category.	**General response** Sumicsid acknowledges the incentive aspects of the decommissioning of assets, as well as the long-term perspective that should be consistent with the benchmarking design. Thus, perverse incentives to maintain "good" pipelines and to transfer "bad" pipelines to other networks deserves attention. AECr now contains the following changes: • Extended asset reporting (**Section 14.3**) • Incentive problem (**Section 5.2 § 5.18**) • Rewrite of **Section 9.2** with introduction of a specific run (**R4 in Table 8-23**) using a flat deduction of the Capex for decommissioned asset which gives higher incentives for asset reductions. **(§ Section 9.2 § 9.08**) • Maintain of the investment-neutral policy in the base run R1 **(Section 6.3 § 6.21**)

2.3 Static efficiency

The consultation document includes the following questions:

3 *Do you consider the proposed approach to provide the primary efficiency measure of the AEC adequate?*

4 *Do you agree that a static model could provide useful input for NRA regulatory rulings? If not, what other options you would propose?*

Expert Review summary	Response to the EGR
Summary comments The proposed multi-year analysis is likely more useful for the regulators as it nests any static efficiency analysis that one can carry out in a particular year. For this reason, we do not see the usefulness of a pure single-year approach for the NRAs: Moreover, a multi-year analysis is always preferred as we have more degrees of freedom to estimate the key parameters of the model, the analyses are more accurate as the number of observations is increased, and it reduces the probability of gaming or the probability of focusing on a single year that compromises the benchmarking exercise (e.g. due to different 'timings of investments'). For these reasons, the use of a single year of data is unnecessarily restrictive and reduces the robustness of the analysis. **The multi-year efficiency analysis also facilitates examining the effect of exogeneous events and the cost effect of both usage-based outputs and environmental factors.**	**General response** Sumicsid acknowledges the value of using panel data and has emphasized the versatility of multi-year data for model specifications, calculation of scores and identification of outliers. AECr now contains the following changes: • **Section 8.8** specifies that the default data set is the panel **(§8.81**) • Specific attention to both multi-year applications **(§8.72-8.73**) and to panel data use **(§8.74-8.76**) with recommendations for AECr. • Model UD is explicitly devoted to analyze dynamic patterns with panel data (**Section 8.9, Table 8-10**) • Extraction of SFA estimates for the static model ES done from panel data runs **(§8.84)** • Benefits from combining methods in panel data **(§8.112**)

2.4 Dynamic efficiency

The consultation document includes the following question:

5 Do you consider appropriate to provide additional efficiency scores taking into account network utilisation? Please reason your answer.

Expert Review summary	Response to the EGR
Summary comments (20) Important conceptual separation between utilisation and dynamic efficiency. In the proposed static benchmark, outputs are formulated on an asset basis to ensure like-for-like comparison of production possibilities and managerial performance in the reference year; utilisation metrics (current peak load or transported gas volumes) are (correctly) excluded to prevent exogenous demand shocks and peak-load fluctuations from contaminating the static efficiency measure. In the dynamic analysis, by contrast, the model admits usage-based outputs (e.g., volumes, peak load) alongside environmental and contextual variables to identify how firms adapt asset intensity and cost structure over time as demand evolves. Hence, "dynamic utilisation" (a volatile, often declining driver) is treated as an exogenous state variable entering the panel model, whereas "dynamic efficiency" refers to the evolution of the distance to the frontier and the movement of the frontier itself. This distinction should be amended in the conceptual set-up and is central to a coherent empirical strategy.	**General response** Sumicsid acknowledges the difference between dynamic efficiency (related to relative performance in a given year) from dynamic analysis (sources and effects of any time-variant pattern on some variable). AECr now contains the following changes: • **Section 1.5** presents the dynamic utilisation model with its feeatures **(§1.30**) • Explicit paragraph differentiating dynamic utilisation model UD from the dynamic efficiency model ED **(Section 1.5 §1.31**). • Model UD is explicitly devoted to analyze dynamic patterns with panel data (**Section 8.9, Table 8-10**) • The needs and differentiated use of UD for regulation are restated in **(Section 6.4 §6.31)** • Summary before model choice **(Section 8.1 §8.03**)

2.5 Methods

The consultation document includes the following questions:

6 *Do you consider the proposed method design appropriate (SFA as primary method and DEA and secondary method)? Please reason your answer.*

7 *Is the use of two methods a strength for the analysis or a source of ambiguity in the interpretations? Please reason your answer.*

Expert Review summary	Response to the EGR
Summary comments (11) From an NRA application perspective, the requirement may be a single-year, operator-level efficiency result. Where NRAs require a tractable, transparent snapshot anchored in audited data and standardized input definitions, this can be delivered on the basis of a multi-year, all-TSO panel under SFA and/or DEA application (e.g. in Germany, §22 ARegV (Special provisions for efficiency comparison for TSOs) does neither include the strict provisions of audited costs in §14 nor the sequence of referrals §13(2) to §14(1) to §6(1/2) for the cost data of the base year). (12) Our recommendation is to maintain the dual methodology architecture – DEA with secured applicability and SFA application dependent on sufficient data availability (to be examined in the course of the procedure). (Dynamic efficiency ➔ decomposition with MPI based on SFA and/or DEA results). (18) Section 2 of DO3 introduces useful concepts for the measurement of TSO's (relative) performance. Several parametric (e.g. SFA) and non-parametric (e.g. DEA) frontier methods are summarized in the context of a single year and a single-output and single-input setting. We miss here a similar discussion regarding the implications of using aggregate inputs or outputs, as well as a discussion on the use of multi-output and multi-input representations of TSO's technology. (19) Another important discussion that is missed here has to do with the multi-year or panel data applications of DEA and SFA. This discussion is closely related to the use of Malmquist Productivity Indices (MPIs) for measurement of productivity change over time; MPIs can be used both in DEA and SFA.	**Methods** AECr acknowledges the support for the two selected methods and the suggestions to reinforce their combinations and use. AECr is now emphasizing the needs for a single-year output for the revenue cap, as well as the potential to use multi-year data in **Section 6.3** AECr now contains the following changes: • **Section 6.3** includes the need to set period incentives from dynamic analyses and reference positions from static observations **(§6.18**) • The NRA need for static models controlling for heterogeneity **(Section 6.4 §6.29**). • The requirement to deliver robust scores for shorter horizons (down to one year) and smaller data sets (**Section 6.4,§6.29**) • The strength of combining DEA and SFA in assessment **(Section 8.13 and §1.21, 1.26, 8.106, 8.107)** • Caveat for SFA with data availability **(Section 8.8 §8.75-8.76 and §8.36, §8.108**)

2.6 Options for comparability of TSOs

The consultation document includes the following question:

8 Do you agree with the data comparability measures proposed? What other alternative measures should ACER consider to ensure the comparability of the data?

Expert Review summary	Response to the EGR
Summary comments (13) The comparability instruments set out in D02 and the consultation (uniform functional and asset scope; standardized capital-cost and depreciation treatment (real annuities, opening balances); labour-cost and price/currency corrections; controls for joint ownership and overhead allocation and exclusion of out-of-scope or exceptional items) target the material sources of transition and cross-country heterogeneity and thus are suitable for restoring like-for-like conditions across TSOs. Overall, these issues are adequately covered in D02 and D03; the foreseen measures for their treatment require exact implementation and full transparency in order to deliver reliable results.	**General responses** AECr acknowledges the positive assessment by the Expert Review concerning the comparability measures and their processing AECr contains comparability measures in several chapters: • **Chapter 10** includes all measures to create comparability by standardizing capex. • **Chapter 11** treats structural comparability (scope of operations, assets and opex). • **Chapter 12** addresses comparability across time, role of transparency, control of uncertainty and measures for local conditions.

2.7 Legacy investments

The consultation document included the following questions:

4. *Is the proposal to address the comparability problem of legacy investments acceptable and effective for the purposes of the AEC?*
5. *Do you consider the entry into force of the First Gas Directive in 1998 to be an adequate cut-off point to identify legacy investments?*
6. *How should different efficiency levels pre- and post-liberalisation be considered by NRAs when setting the allowed revenue methodologies for TSOs?*

Expert Review summary	Response to the EGR
Summary comments (7) The proposed approach acceptably and effectively addresses the comparability problem of legacy investments for an EU-wide benchmark. Its disciplined use as a sensitivity, combined with NRA-led national evaluation and targeted adjustments, provides a robust and reliable basis for regulatory application. (8) We recommended limited amendments at the NRA "national evaluation" stage. Dealing with and correction for individual specificities (including legacy investments) can take place at least at two steps in the foreseen procedure: a. National validation (including legacy investments) b. Application of the AEC results according to the national legal frameworks, where we do not necessarily expect a mechanistic application (1:1)	**General responses** AECr acknowledges the positive assessment by the Expert Review concerning the new analysis approach for legacy investments. AECr acknowledges the proposal to reinforce the role of NRA in the national validation process considering the national specific conditions • **Section 14.7** outlines the evaluation of specific operating conditions. • **Section 14.7 §14.24** describes the NRA process of national validation of claims including the legacy investments.

2.8 Capital cost differences

The consultation document includes the following question:

9 *Do you consider it useful, in the analysis of the dynamic efficiency of TOTEX, to take national capital cost differences—particularly the WACC—into account when assessing the evolution of the optimal cost structure, especially the balance between OPEX and CAPEX?*

Expert Review summary	Response to the EGR
Summary comments Yes, this would be useful. There are differences in cost of capital across the countries affecting the WACC and much of this is due to differences in cost of borrowing and country risk premium. The implication is that the cost of a given project differs across countries. This is while an implicit assumption of benchmarking is that all firms have access to the best 'technology'. Likewise, one might have similar consideration with regards to labour cost differences	**General responses** AECr acknowledges the positive assessment by the Expert Review concerning the new analysis approach for national capital costs. AECr notes the suggestion for subnational labour cost differences, it will subject to further analyses in Phase III. • **Section 10.3** outlines the WACC process. • **Section 10.3 §10.09** describes the specific run (R5) listed in **Section 8.16 Table 8-23**.

2.9 Service quality

The consultation document includes the following question:

10 Service quality is not explicitly modelled among the parameters in chapter 3 of document D03. Should service quality be part of the benchmarked outputs? If so, how can it be measured?

Expert Review summary	Response to the EGR
Summary comments Although it may be desirable to include a specific quality indicator, there are limitations on i) what exactly this could be in gas transmission and ii) how to technically implement this. There is no well-established indicator in the scientific literature (as is the case in the electricity distribution sector). Achieving overarching goals such as ensuring security of supply are to the best of our knowledge not quantifiable. As an alternative one may consider safety and hazardous leakages (such as methane) which could be included in future regulatory periods if data is collected on a comparable basis.	**General response** The AECr agrees with the assessment of the Expert Review with respect to service quality: the lack of good indicators and potential to view it as a constraint rather than objective.

2.10 Relevance criterion for the model specification

The consultation document includes the following

11 The criteria in section 7.7 of document D02 list 'relevance' as a criterion for the model specification. However, data mining techniques such as principal component analysis or machine learning may derive good predictions of total cost without an explicit cost function. Do you agree that this criterion is sound and necessary for the AEC purposes? What measures can be taken to assure relevance of the results?

Expert Review summary	Response to the EGR
Summary comments An explicit cost function is needed for transparency of model and constructive theoretical and applied debate around modelling strategy and variables. PCA and AI will not have this property. However, composite measures such as PCA or supervised methods can be used to reduce the dimensionality of the data (for instance, if there are many environmental variables).	**General responses** AECr acknowledges the positive assessment by the Expert Review concerning model specification process. AECr notes the suggestion for variable reduction methods, it will subject to further analyses in Phase III.

2.11 Comparability of TSO costs

The consultation document includes the following questions:

12 Are the comparability measures proposed in the documentation effective and necessary? Is there redundancy or inadequate measure among the instruments?

13 Are there other measures that ACER should consider to ensure the comparability of TSO costs?

Expert Review summary	Response to the EGR
Summary comments (9) Section 4 of DO2 provides a good review of many of the possible empirical strategies that can be used in benchmarking the gas TSOs but should be amended for clarification. Recommendations for the real implementations are limited but important; AEC approach allows for a sound and reliable efficiency comparison: a. Clarify the role of DEA/SFA – clear distinction between the methodological approaches of DEA and SFA which make identical quantitative results extremely unlikely. b. These differences are methodologically coercive – and not arbitrary, but reasonable. (This enhances the importance of transparency at every step which is key to guarantee that the results can be reproduced and trusted.) (10) We strongly support/recommend a yearly efficiency comparison based on DEA – based on multi-year data-sets a. Yearly DEA provides flexibility for application – different application timing for NRA feasible b. Yearly monitoring important to observe the development of H2-repurposing and decommissioning c. Data evaluation should decide on SFA application	**General responses** AECr acknowledges the support for the chosen methods and the efficiency analysis. AECr now caters the following changes: • **Chapter 8** no longer addresses the methods as primary and secondary but describes them as complementary. • **Section 1.5 §1.19** describes the main features of DEA, **§1.20** analogously for SFA, the methodological differences are discussed in **§1.21**. • DEA is compared and discussed in **Section 8.3 §8.38-8.41** with the latter devoted to limitations, followed by **§8.61** for comparisons. • SFA is compared and discussed in **Section 8.3 §8.34-8.36** followed by **§8.67** for comparisons. • **Section 8.5** contains a new extended literature survey for efficiency work in gas transmission and distribution, including methodological work on method choice, process and data limitations. **Frequency of application** AECr follows the recommendations of the Expert Review, but recalls that the decision on the frequency stays with ACER

2.12 Use of scaling functions

The consultation document includes the following

14 The comparison of assets with different dimensions and material is partially based on a normalized grid metric (NormGrid). Is the use of such normalization acceptable and robust for the AEC?

Expert Review summary	Response to the EGR
Summary comments (14) NormGrid is a key element to convert heterogeneous physical networks into a common, "like-for-like" asset metric in the AEC. It appears as a core output concept in the AEC variable scheme yet the public material largely points readers to a separate TCB21 note rather than providing a full, self-contained specification in D03. For regulatory reproducibility and legal defensibility, ACER should therefore document NormGrid explicitly in the AEC package: definitions, unit structure, asset classes (e.g., DN/pressure bands), weight derivation, price base and indexation, annuity parameters, and audit steps. This follows the project's own selection criteria – verifiability, transparency, and parameter consistency – and its commitment to publish tractable, reproducible inputs and transformations.	**General responses** AECr notes the appreciation for the NormGrid versatility and the caveat concerning its documentation and justification. AECr addresses the latter concerns with a generalization of the concept of a *scaling function* for network assets, where the NormGrid is but one example. To provide more material on this point, AECr now caters the following changes: • **Section 13.4** is a new section devoted to scaling functions, using some other published cost functions for gas network systems as examples. Different options and limitations of their use are suggested. • **Section 8.16 Table 8-24** lists the sensitivity analysis of Normgrid (or other scaling function) parameters. • **Section 11.2** provides a practical example (A) of how scaling functions can help in comparability with maximum robustness. Sumicsid doubts the value of transforming the NormGrid into a fully-fledged cost function, replacing part of the rationale of the actual cost comparison. By limiting its use to scaling assets of different dimensions and basing the functions on published work, an effort comparable to its value can be maintained.

2.13 Model specification methods

The consultation document includes the following question:

15 Do you agree with the output variable selection methods in section 3.2 of document D03? What improvements can be made?

Expert Review summary	Response to the EGR
Summary comments (15) The sequential approach first estimating an average cost function and then defining environmental corrections is reasonable and should use an input-oriented DEA with some cost measure as input and, ideally, exogenous output variables that describe the tasks performed or services delivered from the transmission company, and which explain differences in cost (i.e. are "cost drivers", including environmental factors. (16) If there is a trade-off between increasing OPEX or increasing CAPEX to solve an issue in the grid, TOTEX is preferred as the cost measure in efficiency analyses (and not only OPEX for instance). If productivity remains stable over the lifetime of the grid assets (i.e. for instance operations and maintenance costs do not tend to increase with increasing age) using annuities for the CAPEX is a better choice (ref. discussion in Section 6.1-3 of D02). However, to do so, there is a need for keeping track of new values for existing assets, either the original investment values or price adjusted new values, if a real annuity is used. With annuity-based regulation, there may be a need for distinguishing between reinvestments and investments in new assets. Because of the special challenges of the natural gas transmission sector in decline, this may be easier, since there may be few investments in new infrastructure. (17) Even if the ideal is to have exogenous cost drivers for outputs, this may not always be possible because of lack of data and the need to limit the number of outputs. Asset-based outputs as a proxy can be a solution; however it entails an element of explaining cost with cost, and a high explanatory power may be obvious. With a NormGrid used as output it may be possible to assess both efficiency in volume and	**General responses** AECr notes the acceptance of the model specification sequence based on an average cost function, followed by additional tests for explanatory power through environmental factors. AECr is also in agreement with the superiority of TOTEX based on CAPEX annuities for efficiency analyses in regulatory benchmarking. Moreover, AECr shares the assessment that an extension of the data collection is necessary to cater all assets with initial or adjusted new values to be robust to the new initiatives for repurposing and decommissioning. To provide more material on this point, AECr now caters the following changes: • **Appendix E** now lists the individual original investment values per asset as input data for collection in tier T2. • **Section 12.7 §12.28** details an approach for handling local labour cost differences in procurement of essential local services to create neutrality to inhouse labour. • **Section 12.7 §12.29** details an approach for handling national labour cost differences in investments. AECr agrees with the evaluation that asset-based proxies for output may be safest and most effective policy for building the execution-focused models.

price. The problem of choosing outputs is well described in Figures 12 and in particular 16 (highlighting the importance of granular, GIS-based data) in D03. In addition and continuation of the current status of the investigation, detailed and disaggregated cost drivers should be examined in the further process. All possibilities to collect data for GIS-based exogenous output variables should be exploited.

2.14 Environmental corrections

The consultation document includes the following questions:

16 Do you agree that the environmental correction factors listed in section 3.3 of document D03 are relevant and important for the AEC? What improvements can be made?

17 Are there missing structural or environmental factors that should be included in the analysis? Please reason your answer.

Expert Review summary	Response to the EGR
Summary comments See our previous comments in particular on question 17. While the SFA model with environmental variables should be estimated in a single stage, the inclusion of environmental variables in DEA can be done in one or two stages. Both DEA and SFA analyses are relevant in order to analyse what conclusions can be drawn from the real database. The proposed method and listed factors for environmental correction factors is sound and complete, in particular in combination with the high granularity for both, the environmental factors and the GIS data addressed in Section 3.2 of D03, see question 20. Both DEA and SFA can accommodate second-stage analysis of the efficiency scores obtained. SFA can better guide as to whether environmental variables can be included in the primary model in parallel with other variables or in second-stage analysis as determinants of efficiency. An issue that should be considered more in detail once the real database is available is the noisy nature of both outputs and input variables. For instance, if we do not compute our DEA scores using contextual variables, TOTEX becomes clearly noisy due to the existence of omitted variables. If so, a deterministic technique is not appropriate.	**General responses** AECr notes the appreciation for the environmental factors included for analysis and the method proposed to estimate their relevance for the cost of the TSOG. AECr agrees with the caveat that estimation of impact of noisy factors directly in DEA is a poor empirical strategy and that SFA is the superior tool. Comments to that effect are listed in the sections listed before concerning SFA and DEA. •

2.15 Environmental cost factors

The consultation document includes the following question:

18 The TSO might request disclosed and verifiable information for norm-cost parameters, both for green-field and environmental corrections (e.g. landcover or slope categories). Given the dimensionality of the asset base and the potential environmental corrections, this is likely technically unfeasible. In this case, what approach would you recommend for asset normalization and environmental corrections?

Expert Review summary	Response to the EGR
Summary comments We do not consider disclosure and verification of norm-cost parameters and environmental corrections technically infeasible. While demanding, it is manageable with a pragmatic, staged design that focuses on a few transparent normalization metrics and uses widely available EU geodata: 1. Normalization: Using a small set of size/complexity drivers (e.g., pipeline DN/pressure bands per km, compressor MW, number/capacity of stations) and a modular green-field norm-cost library (€/km, €/MW), converted to annuities. 2. Environmental corrections: Derive exposure shares to a short list of factors (e.g., slope classes, land-cover classes, network/demand density) via reproducible GIS overlays; apply simple additive coefficients and introduce interactions only where material.	**General responses** AECr acknowledges the positive view of the exchange of impact parameters for scaling functions (such as NormGrid) and environmental factors. AECr notes the suggestion to use a subset of normalized metrics for the validation. However, Sumicsid prefers to wait until the end of the data collection in Phase II before pronouncing the exact methodology that will depend on the granularity and type of input data.

3. Data & transparency: Require minimal geometry (start/end points or polylines); allow optional TSO shapefiles for higher precision. Publish definitions, coefficients and scripts; hold sensitive geometries under a two-tier transparency model; validate via engineering review and standard audits.

Where indeed well-founded security concerns (in the light of already published data, see ENTSOG maps etc.) overweigh the transparency principle, this approach could be carried out by ACER and/or NRAs and only aggregate results be published.

2.16 Asset location (GIS)

The consultation document includes the following question:

19 The TSO might refuse to provide exact asset locations for pipelines. The environmental corrections proposed derive from GIS-data bases (CORINE, LUCAS, …) with a high resolution. In this case, what approach would you recommend for environmental corrections, if at all?

Expert Review summary	Response to the EGR
Summary comments In our assessment, **environmental correction factors can and should be applied without requiring disclosure of exact pipeline locations**. Publicly available GIS datasets (e.g., CORINE, LUCAS) already provide sufficient high-resolution environmental data, and asset / service-area mapping approaches for this purpose could either be applied, or carried out by ACER and/or NRAs. In such cases, **aggregated asset data combined with public GIS sources offer a robust, technically feasible, and reproducible basis for corrections**, ensuring comparability across TSOs while respecting legitimate confidentiality boundaries. At the same time, the principle of transparency remains paramount. The core elements of the gas TSO benchmark—particularly cost and efficiency inputs—are aggregate data essential for reproducibility and regulatory application. Given the natural monopoly position of TSOs, confidentiality arguments must be held to a much higher standard than in competitive sectors. Safety and security concerns must also be weighed carefully. **Only where data disclosure would go beyond what is already publicly available should exceptions be considered**. For the benchmark to be applied credibly in regulation, **full traceability of results is essential**. AEC data and methods should therefore be published in a way that allows stakeholders to reproduce and verify the outcomes, with environmental corrections based on standardized, transparent, and verifiable procedures.	**General responses** AECr shares the sense of criticality of the GIS data for the optimal precision of the heterogeneity corrections. The data collection strategy in **Chapter 15** is based on the obtention of GIS-locations, but the processing and storage of these data in tier T3 are assigned to ACER. Thus, AECr does not deepen the discussion on these aspects that will be settled in Phase II by the Agency.

2.17 Outlier detection methods

The consultation document includes the following question:

20 The detection of outliers is proposed to be performed through (econometrically) Cooks distance and (frontier estimates) super-efficiency (as in ARegV), Robust DEA (Simar & Wilson, 1998, 2000), cross efficiency analysis CEA (Sexton ea1986) and peeling (Adler e.a., 2002), after normal data validation rounds in 3 steps. Is this adequate and sufficient? Should different methods be applied?

Expert Review summary	Response to the EGR
Summary comments Replicability by NRA's and tractability by TSOs is mandatory to generate acceptability in this context. For this reason, using distinct methods to handle outliers is compulsory. The proposed methods are well-known in the literature. In this regard, it should be noted that Agrell and Brea-Solís (2017)[5] state that, despite its shortcomings as a clustering method, the latent class models could also be used as a method to detect outliers. This is another outlier detection method that can be used. The latent class models can be especially useful to capture 'masked' outliers because they are able to identify groups of TSOs that are similar to each other but significantly different from the rest of TSOs. On the other hand, we also suggest estimating a Zero Inefficiency Stochastic Frontier (ZISF) model using the available data. This latent class model, introduced by Kumbhakar, Parmeter and Tsionas (2013)[6], allows the identification of peers that can be used to validate the peers identified using DEA or any other non-parametric model.	**General responses** AECr shares the opinion that outlier identification is critical to the success of regulatory benchmarking. AECr addresses the latter concerns with a generalization of the concept of a *scaling function* for network assets, where the NormGrid is but one example. To provide more material on this point, AECr now caters the following changes: • The importance of outlier management is underlined in **Section 1.5 §1.34** with a list of methods and criteria. • **Section 8.14** addresses outlier analysis and also contains examples for the models ES and UD using real TSOG data. This analysis caters also out-of-model information to show the relevance of the outlier identification to find true atypical units and their reasons for deviations. • **Section 14.5** contains concretely the pre-run outlier identification criteria as part of the data validation process. • The suggestion by the Expert Review to use Latent Class Methods is retained in **Section 1.5 §1.22.**

[5] Agrell, P. J. & Brea-Solís, H. (2017)

[6] Kumbhakar, S. C., Parmeter, C. F. & Tsionas, E. G. (2013)

2.18 Control of bias in estimation

The consultation document includes the following question:

21 Bias in the results are to be reviewed through (1) SFA analyses with relevant indicators (non-model parameters), and (2) through second-stage Tobit regressions towards scores. Is this approach adequate and sufficient for the purpose? If not, what additional or different approaches should be used?

Expert Review summary	Response to the EGR
Summary comments The concern about the inclusion of environmental variables (also called contextual, non-discretionary or z-variables) has generated the development of several models either using parametric, nonparametric or semi-parametric techniques. Note that this issue is relevant regardless of whether we use DEA or SFA. That is, if we ignore the contextual and environmental factors in our analysis, our DEA and SFA efficiency scores would be likely biased in both cases[7]. For a detailed review of this topic in SFA, see Parmeter and Kumbhakar (2014)[8]. A brief summary of this issue in the non-parametric literature can be found in Johnson and Kuosmanen (2012)[9]. However, it should be highlighted that two-stage procedures might be problematic if the first- and second-stage variables are correlated with each other. This suggest carrying out correlation analyses between these two sets of variables to figure out the best strategy to control for environmental factors. In this case, the environmental factors should likely be	**General responses** AECr is raising awareness about bias in assessments through the estimation of impact, as well as the means to address it through proper choice of method. Sumicsid agrees here with the Expert Review in that the parametric models such as SFA are the most well suited to control for this bias and to estimate their impact. Given the dependency on the collected data, the technical nature of the material and the interest to provide some data-driven preliminaries on the AEC, the presentation of the method in AECr is intentionally non-technical and vague. A method document is proposed for Phase III in this matter. AECr also takes a more nuanced view on the semiparametric approaches than in the D02 and D03 drafts, leading to a longer section in the method selection chapter. AECr now caters the following changes: • The evaluation of the three "advanced: method DEA, SFA and StonED is now extended with help of the literature

[7] However, the SFA approach likely attenuates this problem as its effect would be captured by the noise term if the contextual and environmental factors are not correlated with the observed cost drivers. In a DEA exercise, the bias will always be present.

[8] Parmeter, C.F. & Kumbhakar, S.C. (2014)

[9] Johnson, A. L. & Kuosmanen, T. (2012)

treated as a cost driver alongside other cost drivers in the first step.

There is a much larger consensus in the SFA literature regarding the use of one or two stages to control for environmental factors. It is well-known in the SFA literature that second-stage Tobit regressions yield biased parameter estimates and efficiency scores. The efficiency determinants (or z-variables) should be incorporated directly into the SFA model, which is estimated in a single stage.

In addition, Johnson and Kuosmanen (2011) developed a stochastic semi-nonparametric envelopment of z-variables data (StoNEZD). In this sense, DO3 states on page 13 that StoNED lacks the large published academic body of knowledge and standard software packages for calculation and validation. In this sense, it should be pointed out that StoNED and CNLS are nowadays well-established methods to measure firm's efficiency. Moreover, Kuosmanen and his coauthors have also recently developed free statistical software to estimate several recent StoNED models and related methods (see Dai et al., 2024)10.

review in **Section 8.5** and a richer set of external evaluation criteria for regulation in **Section 8.6** followed by a final assessment in **Section 8.7**.

- The importance of environmental heterogeneity is discussed in **Section 11.6** although a full estimation method is not provides.

[10] Dai et al (2024). This paper presents a tutorial of the pyStoNED package and illustrates its application, focusing on estimating frontier cost and production functions.

3 Comments D03

This appendix presents Sumicsid's evaluation of AEC Expert Review (EGR) on the following document:

- *AEC Method, Data and Process.* Synthesis report D03, 2025-06-17, V1.0

3.1 Data request and validation

The consultation document includes the following question:

22 Do you agree with the data validation approach outlined? What other alternative measures should ACER consider to ensure the quality of the data?

Expert Review summary	Response to the EGR
Summary comments Section 4 of D03 describes a sound data compilation and validation process. (23) High value for an accurate depiction of environmental factors can (only) be achieved with a high granularity of data, i.e. application of GIS-based data-sets. (24) Data handling via ACER, NRA, Consultants should be scheduled for the treatment of all data where – in very restricted cases – confidentiality and/or security/safety reasons limit the feasibility of full transparency and publication. (25) Transparency requirements particularly include the stepwise development of the NormGrid parameter and the quantitative integration of environmental factors into its calculation. NormGrid is a key element to convert heterogeneous physical networks into a common, "like-for-like" asset metric in the AEC. We recommend a full, self-contained specification in D03. For regulatory reproducibility and legal defensibility, ACER should therefore document NormGrid explicitly in the AEC package: definitions, unit structure, asset classes (e.g., DN/pressure bands), weight derivation, price base and indexation, annuity parameters, and audit steps – in particular for the integration of environmental factors.	**General responses** AECr acknowledges the approval of the data validation process, the importance of GIS data (see above) and the need for transparency.

3.2 Process: workshops

The consultation document includes the following question:

23 A series of workshops are planned for the model specification process with TSO and NRA. To what extent is this a realistic and workable process to reach a timely result from the AEC? Could another approach be used?

Expert Review summary	Response to the EGR
Summary comments **The description of the entire process is sufficiently detailed,** particularly at key points, and does not give rise to any fundamental criticism. We are unable to assess whether the time estimates (e.g., three weeks for consultations) are sufficient for the further course of the process. Time delays may occur, particularly in the case of the repeated iterations mentioned above, which are often necessary. Appropriate time buffers should be planned for this. For the whole process, we highlight the following: Transparency is the principal mechanism by which credibility is established. The approach prescribes standardized variables and documentation, multi-layer data validation (TSO, NRA, financial audit, technical cross-checks), and publication of model choices and parameters sufficient to render results which are reproducible by stakeholders. **This commitment to disclosure – subject to proportionate confidentiality only where strictly necessary – provides trust in both the static and dynamic estimates and is integral to their use in regulation and legal defensibility**	**General responses** AECr acknowledges the approval of the data validation process and the need for transparency.

Appendix D: Tier information structure

Principle

There are four levels of data disclosure in the AEC, depending on the source and the character of commercially or security sensitivity of the information.

For efficiency and consistency, TSOGs only report the full dataset (T2) to the project; the disclosed information is extracted and aggregated from the full data into the disclosed transparency set (T1). Each TSOG can review the T1 variables prior to disclosure.

The following levels are distinguished:

T0

Public information from EUROSTAT or other databases relevant to the project for economic, environmental or technical parameters. No ownership or management is exercised over this data that can be freely accessed and is updated regularly by third parties.

Attached, an example from TCB21-GAS serves to illustrate this category

T1

A compilation made by the consultants from the T2 data that is disclosed

The category is listed below, and a hypothetical example is attached.

T2

TSOG-reported and audited data that is not disclosed for commercial reasons, potentially revealing costs, values and investments that may expose owners to economic risks and perils.

The category entails all data in the reporting sheets, an example from TCB21 is attached without prejudice to the final choice of parameters.

T3

TSOG-reported data related to the location of assets for calculation of operating complexity coefficients that cannot be disclosed due to security concerns.

For this category, a solution for decentralized calculation of the complexity coefficients may be defined where the NRA perform the calculations locally without disclosing the data.

Abbreviations

UoM = unit of measurement

= number of units

PCG = piece count, (gross, non-weighted)

PCN = piece count (net, weighted by usage share)

H = H-gas

L = L-gas

P = Pressure

LP: $P \leq 4$ bara

MP: $4 < P \leq 20$ bara

HP: $P > 20$ bara

Aggregation T1 data (disclosed)

Pipelines

Main aggregate	UoM	Subtype1	Subtype2	Notation
Length	km	/	/	yPipes_tot
Length	km	HP	/	yPipes.hp
Length	km	MP	/	yPipes.mp
Length	km	LP	/	yPipes.lp
Length	km	1 < P ≤ 40 bar	/	yPipes.v40
Length	km	40 < P ≤ 60 bar	/	yPipes.v60
Length	km	60 < P ≤ 75 bar	/	yPipes.v75
Length	km	75 < P ≤ 90 bar	/	yPipes.v90
Length	km	90 < P bar	/	yPipes.v200
Volume	km3	/	/	yPipes.vol_tot
Volume	km3	1 < P ≤ 40 bar	/	yPipes.vol.v40
Volume	km3	40 < P ≤ 60 bar	/	yPipes.vol.v60
Volume	km3	60 < P ≤ 75 bar	/	yPipes.vol.v75
Volume	km3	75 < P ≤ 90 bar	/	yPipes.vol.v90
Volume	km3	90 < P bar	/	yPipes.vol.v200
Surface	m2	/	/	yPipes.surface_tot
Length	km	Inland watercrossing	/	yPipes.km.watercrossing_tot
Length (H-gas)	km	/	/	yPipes.gas_H
Length(L-gas)	km	/	/	yPipes.gas_L
Length	km	Decommissioned	year	yPipes.decom_tot
Volume	km3	Decommissioned	year	yPipes.vol.decom_tot
Length	km	Reconfigured	year	yPipes.recfg_tot
Volume	km3	Reconfigured	year	yPipes.vol.recfg_tot
Length	km	Asset extended	year	yPipes.ext_tot
Volume	km3	Asset extended	year	yPipes.vol.ext_tot

Regulators

Main aggregate	UoM	Pressure/gas	Metertype	Notation
PCG	#	/	/	yRegulators_tot
PCG	#	LP	/	yRegulators.lp
PCG	#	MP	/	yRegulators.mp
PCG	#	HP	/	yRegulators.hp
PCG	#	H-gas	/	yRegulators.gas_H
PCG	#	L-gas	/	yRegulators.gas_L
Flow	nm3/h	/	/	yRegulators.flow_tot
Pressurediff	bar	/	/	yRegulators.pressurediff_tot

Compressors

Main aggregate	UoM	Subtype1	Subtype2	Notation
PCG	#	/	/	yCompressors.pc
PCG	#	MP	/	yCompressors.pc.mp
PCG	#	HP	/	yCompressors.pc.hp
Power	MW	/	/	yCompressors.power_tot
Power	MW	MP	/	yCompressors.power.mp
Power	MW	HP	/	yCompressors.power.hp
Power	MW	H-gas	/	yCompressors.power.gas_H
Power	MW	L-gas	/	yCompressors.power.gas_L

Connection points

Main aggregate	UoM	Subtype1	Subtype2	Notation
PCG	#	/	/	yConnectionpoints_tot
PCG	#	/	delivery	yConnectionpoints.ds_tot
PCG	#	/	injection	yConnectionpoints.ip_tot
PCG	#	H-gas	/	yConnectionpoints.gas_H
PCG	#	L-gas	/	yConnectionpoints.gas_L
PCG	#	/	metered	yConnectionpoints.meters
PCG	#	LP	/	yConnectionpoints.pc.lp
PCG	#	MP	/	yConnectionpoints.pc.mp
PCG	#	HP	/	yConnectionpoints.pc.hp

Metering units

Main aggregate	UoM	Subtype1	Subtype2	Notation
PCG	#	/	/	yMeters_tot
PCG	#	LP	/	yMeters.pc.lp
PCG	#	MP	/	yMeters.pc.mp
PCG	#	HP	/	yMeters.pc.hp
PCG	#	/	Hybrid	yMeters.type.hybrid
PCG	#	/	Orifice	yMeters.type.orifice
PCG	#	/	Turbine	yMeters.type.turb
PCG	#	/	Ultrasonic	yMeters.type.ultrasonic
PCG	#	/	Other	yMeters.type.other

Cost data

Main aggregate	UoM	Def	Subtype2	Notation
TOTEX	EUR	/	year	dTotex
OPEX	EUR	/	year	dOpex
CAPEX	EUR	/	year	dCapex
OPEX	EUR	Cost personnel	year	dOpex.staff
OPEX	EUR	Cost personnel TMP	year	dOpex.staff.tmp
OPEX	EUR	Decommissioning	year	dOpex.decom
OPEX	EUR	Refitting asset	year	dOpex.recfg
OPEX	EUR	Rehabilitation (lifetime extension)	year	dOpex.ext

Structure T2 data (not disclosed)

The data below in the reporting sheets are not for disclosure but subject to audit and crossvalidation in the project.

a) *Pipelines*
b) *Regulators*
c) *Compressors*
d) *Connection points*
e) *Metering units*
f) *Control centers*
g) *Cost data (investments, costs)*
h) *Staff data (FTE per function)*
i) *Indicators (quality, flow, transport)*

Structure T3 data (not disclosed)

The T3 data consists of GIS data (shape files) per relevant assets (pipelines and compressor stations) for mapping to environmental data and calculation of complexity coefficients.

Note that GIS data (including environmental conditions, etc. in Europe) collected from public sources are in category T0.

Appendix E: New data collection items

The draft data collection specification is formed by the TCB21 Data specifications for Gas Assets, Gas Financial Data and Indicators.

The following items are proposed to be included in the AEC data collection after adequate definitions, information tier assignment, validation levels and means, and data specification for collection.

NCU = National currency
Disc = discrete choice (predefined choices)

New data fields in AEC (preliminary)

Data.cat	Sub.cat	Main aggregate	Def	UoM	Info.tier
Assets	Pipes, compressor stations	Location	Location	GIS-coord	T3
Assets	Pipes	Parallel pipes	Single, double,	Integer	T2
Assets	All	Asset status (active, decom, repurposed, inactive)		Disc	T2
Assets	Pipes	Repurposing	NCE received	Real	T2
Assets	Pipes, compressors	Rehabilitation	Year, NCE for upgrade,		T2
Assets	Pipes	H2-readiness	Status	Binary	T2
Investment	Grid	Labor cost (capitalized) in investment, external and internal	NCE, fte, origin		T2
Investment	Grid	Investment (initial)	Nominal, NCU	Real	T2
Cost	OPEX	Labor cost in external services	NCE, (fte), origin		T2

Appendix F: FERC data example

The original data comes from Granderson and Linvill (1999) in personal correspondence with Prof. Granderson.

The data is based on statistics from the US Federal Energy Regulation Commission (FERC) for 20 major US Interstate gas transmission operators with complete data for 1977-1987, from different states under the same federal regulation. With 'major' is meant a carrier that transported at least 50 bcf (billion cubic feet) = 1,416 Mnm3 natural gas in each of the years 1985-1987. The data also contains adjusted data from Granderson and Linvil (1999), such as the estimate of pipeline capital from physical dimensions following Callen (1978).

Additional data on locations, regions, the transformation to real annuities and cost variables are made by the authors.

Table 0-1 Codes for US States (for FERC TSOG).

Code	State (HQ or major assets)
AR	Arkansas
CO	Colorado
FL	Florida
GA	Georgia
IL	Illinois
KY	Kentucky
LA	Louisiana
MN	Minnesota
MO	Missouri
TX	Texas
UT	Utah
VA	Virginia
WV	West Virginia

Table 0-2 Geographical regions for FERC TSOG.

Code	Region name	Typical members	Description
GLF	Gulf / Texas Core	El Paso, Trunkline, Tenneco, Texas Eastern, Transco, United Gas, etc.	Major long-haul pipelines based in TX/LA serving Midwest and East Coast.
MWD	Midwest / Central	Arkla, Miss River, Panhandle, Texas Gas, Northern, Nat Gas	Serve Midwest markets (Chicago, St. Louis); often Gulf-origin systems.
EAS	Eastern / Appalachian	Columbia Gas, Columbia Gulf, CNG	Appalachian-region pipelines serving Mid-Atlantic demand.
WST	Western / Mountain	Colorado Interstate, Northwest	Western Rockies and Pacific Northwest corridors.
SEA	Southeastern / Florida	Southern, Florida Gas	Southeastern and Florida-serving pipelines.

SUMICSID GROUP
Rue Maurice Lietart 56
B-1150 Bruxelles, BELGIUM
info @ sumicsid.com

http://www.sumicsid.com