European Network of
Transmission System Operators
for Electricity

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Cost Benefit Analyses

ENTSO-E Guidance document for national implementation for network codes on grid connection

Output of Expert Group

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DESCRIPTION	
Summary	
Intention of Guidance Document	This Guidance Document provides general methodological principles and examples in order to guide Member States in the application of the Connection Network Code (CNC) provisions related to the CBA process. This IGD aims to facilitate and to harmonize the elaboration of a detailed CBA methodology to be applied when necessary within the remit of the NC RfG, NC DCC and NC HVDC national implementation processes. It addresses fundamental methodological principles and the main steps of a cost-benefit analysis to be applied to assess potential monetary impacts of retrospective applications of or derogations from DCC, HVDC and RfG CNC requirements for grid connection. As this process applies to a variety of cases explained below each Member State remains free to provide more detailed and appropriate methodological provisions at national level, in order to take into account all the typology of cases to be encountered, and to account for the wide variation in users' equipment, configurations or scenarios that could be subject to any assessment. Note that not all impacts are easily monetized. In this case a different type of analysis (multi-criteria assessment - MCA) can be performed. It allows multiple indicators (including non-monetary ones) to be taken into account also considering relative priorities. If applying a MCA, special care should be taken to avoid double counting of costs or benefits. Some illustrative examples of particular CBA settings are also addressed noting the need for pragmatism and that any example will probably be specific to the application and should not be treated as a gold standard. Where text is quoted from RfG, please note that to keep the document to a reasonable length, where similar provisions exist in DCC and HVDC these are referenced but not quoted.
What are the requirements in the CNCs for CBAs?	Each of the Connection Codes contains a chapter dedicated to Cost Benefit Analysis with two articles which specify how a CBA is to be applied. These are as follows: **RfG articles 38 & 39:** 38 - Identification of costs and benefits of application of requirements to existing power generating modules 39 - Principles of cost-benefit analysis **DCC articles 48 & 49:** 48 - Identification of costs and benefits of application of requirements to existing transmission-connected demand facilities, existing transmission-connected distribution facilities, existing distribution systems and existing demand units 49 - Principles of cost-benefit analysis

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HVDC articles 65 & 66:
65 - Identification of costs and benefits of application of requirements to existing HVDC systems or DC-connected power park modules
66 - Principles of cost-benefit analysis

The use of CBAs is required in the codes as follows. This table also specifies in which of these instances a public consultation is required.

Proposal in CNCs	Public Consultation	CBA	Articles in Network Code		
			RfG	DCC	HVDC
Application to existing equipment	Yes	Yes	4	4	4
To set 'type' thresholds in RfG	Yes	No*	5	-	-
To progress a derogation	Yes**	Yes	62 & 63	52 & 53	77 & 78

*Except where a revised threshold is to apply retrospectively
** In the case of a derogation proposed by a facility owner, no consultation on the CBA is required.

ACER FWGL

Further to the requirements set out in the CNCs, the ACER Framework Guideline on Electricity Grid Connections (July 2011) sets out the principles as expected to be detailed in the Connection Network Codes for CBAs on the occasion that it is proposed to either:

- Apply elements of the codes to existing equipment; or
- Seek a derogation from the codes for specific equipment

CBA for Retrospective Application of CNC Requirements to Existing Equipment

Each of the CNCs allows for the retrospective application of any of the code requirements to existing equipment. This is only allowed where the process as set out in the codes is followed which includes a cost benefit analysis carried out in two parts as described below.

Using the example of the application of requirements to existing power generating modules, article 4 in RfG sets out provisions as shown below; similar requirements for application to existing equipment are made in Article 4 of both DCC and HVDC with the difference being in the scope of each NC covers.

RfG Article 4
3. Following a public consultation in accordance to Article 10 and in order to address significant factual changes in circumstances, such as the evolution of system requirements including penetration of renewable energy sources, smart grids, distributed generation or demand response, the relevant TSO may propose to the regulatory authority concerned, or where applicable, to the Member State to extend the application of this Regulation to existing power generating modules.

For that purpose a sound and transparent quantitative cost-benefit analysis shall be carried out, in accordance with Articles 38 and 39. The analysis shall indicate:

a) the costs, in regard to existing power generating modules, of requiring compliance with [the considered requirements of] *this Regulation;*

b) the socio-economic benefit resulting from applying the [considered] *requirements set out in this Regulation; and*

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c) the potential of alternative measures to achieve the required performance.

4. Before carrying out the quantitative cost-benefit analysis referred to in paragraph 3, the relevant TSO shall:

a) carry out a preliminary qualitative comparison of costs and benefits;

b) obtain approval from the relevant regulatory authority or, where applicable, the Member State.

Note that the significant points here are that the CBA is to be carried out by the TSO in two stages (qualitative and then quantitative),the results of the second, quantitative stage being subject to public consultation and regulatory approval before being finalised.

Also, note as in […] above that the requirements to be applied retrospectively are generally selected from the code and are justified on this basis - and unless clearly specified would not by default be the code(s) in their entirety.

Process for retrospective application [all Connection Codes]

To apply specific code requirements retrospectively the process set out in figure 1 is to be followed in full.

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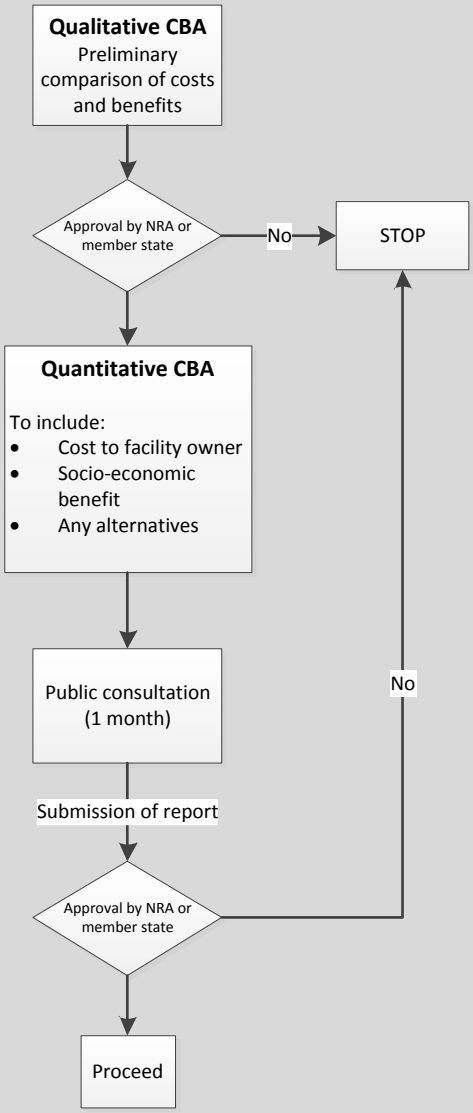

Figure 1 – retrospective application process

General principle
When conducting either stage of a retrospective CBA, the relevant system operator shall take into account the nature or range of installations that could be affected – so for example the age or remaining lifetime, technology, ease of modifications to equipment/compliance etc – and should seek to work with stakeholders on this.

Qualitative CBA
In considering retrospective application of requirements the TSO must first carry out a qualitative comparison of costs and benefits related to the requirement under consideration. This comparison shall take into account available network-based or market-based alternatives.

The relevant TSO may only proceed to undertake a more detailed quantitative cost-benefit if the qualitative comparison indicates that the likely benefits exceed the likely costs and if the TSO obtains approval from the relevant NRA or Member State. If, however, the

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cost is deemed high or the benefit is deemed low, then the relevant TSO shall not proceed further.

The TSO is not required to consult on the qualitative analysis although it is recommended that input from stakeholders should be sought in seeking to determine their approximate costs; this should take account of the age of the equipment involved and how achievable any updates to the specifications may be. As a minimum, informing stakeholders of the beginning of such a process such that they have an opportunity to assess and analyse the consequences is appropriate reflecting that there may be limited time to gather evidence at a later stage. Early engagement is also a useful opportunity for all parties to seek to influence the outcome and to seek a pragmatic and agreed view on the way forwards.

Quantitative CBA

After a qualitative assessment has been carried out and approved the case can then move on where approved to a sound and transparent quantitative cost-benefit analysis which shall be carried out for RfG in accordance with Articles 38 and 39, for DCC in accordance with Articles 48 and 49 and for HVDC in accordance with Articles 65 and 66. The analysis shall indicate:

(a) the costs, with regard to the affected facilities, of compliance with the specific requirements being analysed;
(b) the socio-economic benefit resulting from applying these requirements; and
(c) the potential and costs of alternative measures to achieve the required change in performance.

The difference between the quantitative and qualitative analysis is in the depth of evidence and justification required which for the quantitative analysis must be able to bear public scrutiny. The report summarising the results of the quantitative analysis and the consequent proposal (arts.38.3 RfG, 48.3 DCC, 65.3 HVDC) also are required to go through a public consultation and should thereafter incorporate where appropriate the views of stakeholders.

Consultation

As part of the quantitative analysis on proposals to extend the applicability of (parts of) this Regulation to existing facilities the TSO is required to run a public consultation. This is required to include stakeholders and the competent authorities of each Member State and shall last for a period of at least one month.

The views of stakeholders resulting from a consultation need to be assessed and taken into account prior to any submission for approval by the regulatory authority. In all cases, a sound justification for the way in which the views of the stakeholders are reflected or not shall be provided and published in a timely manner before, or simultaneously with, the publication of the proposal.

In terms of the timing of a consultation, this is to be after the quantitative analysis has been performed but before final submission. Exact timing may vary depending on the nature of the requirements under consideration, how well defined the case for these already is, and what level of engagement from stakeholders there has already been. It is generally better to involve stakeholders as early as possible noting though that a public consultation is likely to be broader than any prior engagement.

The codes specify a minimum duration for a public consultation of one month, noting the balance required between participation and the need to develop proposals in a timely

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	fashion. The relevant TSO should seek to engage with affected stakeholders during this process. **Specific Case - Retrospective Application of Banding Thresholds [RfG only]** TSOs can form proposals to set maximum capacity thresholds for type B, C and D power generating modules in two circumstances: • As a requirement during the initial national implementation of the code. • Following the national implementation, and at a minimum of three years after any previous proposals to change the settings previously adopted. In both cases a public consultation is required as set out in article 10. To be absolutely clear, however, a CBA is **not required** except very specifically where, as set out in article 5.5 of RfG, changing the thresholds leads to an existing generator qualifying for a different type and it is the intention that this change will be applied retrospectively. By default, changes to banding thresholds will not apply retrospectively, and therefore the band that any existing generator has previously qualified for will remain unchanged. If however it is the intention to apply a change in banding retrospectively the standard process as set out in RfG article 4.3-5 regarding the retrospective application of any RfG requirements to existing equipment is to be followed before any change is made.
CBA to support derogations from the requirement of the CNCs	The process to be followed to achieve a derogation from the CNCs is set out in each of the CNCs with the example below being for a derogation by a power generating facility owner which is in Article 62 of RfG; similar provisions are made for equipment owners in DCC article 52 and HVDC article 77, all of which are reproduced below. *RfG Article 62* *2. A request for a derogation shall be filed with the relevant network operator and include:* *d) detailed reasoning, with relevant supporting documents and cost-benefit analysis pursuant to the requirements of Article 39;* *DCC Article 52* *2. A request for a derogation shall be filed with the relevant system operator and include:* *d) detailed reasoning, with relevant supporting documents and cost-benefit analysis pursuant to the requirements of Article 49;* *HVDC Article 77* *2. A request for a derogation shall be filed with the relevant system operator and include:* *d) detailed reasoning, with relevant supporting documents, and cost-benefit analysis pursuant to the requirements of Article 66;* A derogation may also be sought by a relevant system operator or relevant TSO which is set out in Article 63 in RfG as shown; again, similar provisions being made in DCC article 53 and HVDC article 78 which are also reproduced below *RfG article 63*

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2. Relevant system operators or relevant TSOs shall submit their requests for derogation to the regulatory authority. Each request for a derogation shall include:
f) a cost-benefit analysis pursuant to the requirements of article 39. If applicable, the cost-benefit analysis shall be carried out in coordination with the relevant TSO and any adjacent DSO or DSOs.

DCC Article 53
2. Relevant system operators or relevant TSOs shall submit their requests for a derogation to the regulatory authority. Each request for a derogation shall include:
f) a cost-benefit analysis pursuant to the requirements of Article 49. If applicable, the cost-benefit analysis shall be carried out in coordination with the relevant TSO and any adjacent DSO.

HVDC Article 78
2. Relevant system operators or relevant TSOs shall submit their requests for a derogation to the regulatory authority. Each request for a derogation shall include:
f) a cost-benefit analysis pursuant to the requirements of Article 49. If applicable, the cost-benefit analysis shall be carried out in coordination with the relevant TSO and any adjacent DSO.

Regardless of the party raising a derogation request therefore, cost-benefit analysis pursuant to the requirements of the relevant articles (Article 39 in RfG, 49 and 66 in DCC and HVDC respectively) is necessary; but then only where raised by a system operator or TSO does consideration also need to be given to coordination with the relevant TSO and any adjacent DSO or DSOs, and also the running of a public consultation on the results of the CBA.

Within the derogation process therefore, both for an individual or a class derogation, the request for a derogation needs to include a CBA, as part of a global package that also includes: the identification of the applicant, the description of the affected equipment or facilities as in the CNCs, a reference to the requirement or requirements of the CNCs from which derogation is sought, a detailed description and reasoning, including all relevant documents and materials supporting the position that no or sufficiently limited adverse effects on cross-border trade arise. It is also recommended that any assessment should take into account any equipment specific criteria, such as the equipment configuration, the age of the equipment involved or how achievable any updates to the specifications may be.

Additionally, the regulatory authority can introduce (additional) criteria for granting derogations[1]. In so setting the criteria for a derogation, the process (including a CBA where applicable) will check if the criteria are met.

Concerning CBA, both the articles (art. 62 and 63 in NC RfG, art. 52 and 53 in NC DCC, art 79 and 80 in NC HVDC) handling an individual derogation and a class derogation refer to the same article on the principles of a CBA (art. 39 in NC RfG, art. 49 in NC DCC and art 66 in NC HVDC).

Both for a class derogation and for an individual derogation PGFOs (power generating facility owner), DFOs (demand facility owner), CDSOs (closed distribution system

[1] e.g. Ofgem (GB regulator)– decision on derogation criteria from connection codes

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operator), DSOs and TSOs have to assist (each other) and contribute to the CBA and provide relevant data or information as may be available to them. This relevant data may vary on a case by case basis.

In general, it is likely that in the case of an individual derogation more facility and/or site-specific detailed data might be available and/or needed[2], whereas for a class derogation another level of detail, including on forward-looking system-wide implications and future grid evolutions, might be available and/or needed.

The codes specify a minimum duration for a public consultation of one month, noting the balance required between participation and the need to develop proposals in a timely fashion. The relevant system operator should seek to engage with affected stakeholders during this process.

Finally, note that it may be pragmatic to conduct a single CBA for derogation requests for related requirements which could mean multiple requirements for one piece or class of equipment.

Table: Distinction between derogations based on typology

Topic	Class derogation	Individual derogation
Actor responsible for CBA	• TSO, DSO, CDSO • If a derogation is associated with a manufacturer (for an equipment type so likely to be in the case of a class derogation), the content of the CBA will obviously require their input and evidence	• PGFO (NC RfG) • DFO, CDSO, DSO (NC DCC) • HVDC system owners and DC-connected power park module owners, or prospective owners (HVDC)
Party initiating a derogation (non-exhaustive list)	• TSO, DSO, CDSO: To avoid multiple requests for derogation or because there is a clear case why an entire class should obtain a derogation	• PGFO, DFO, CDSO to avoid unjustified costs for their individual installation or site • DSO, CDSO to avoid unjustified costs for their installations at the CP with the

[2] Confidentiality issues related to data and information will be treated in a separate section of this IGD

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		relevant system operator. Note also that in some cases equipment will simply not be capable of fulfilling a requirement and this should also be indicated and evidenced.
Who should pay for a CBA?	• The party or group seeking the derogation have the primary responsibility for a CBA as set-out in the CNCs • System operators are obligated to assist in the provision of operational costs • Note that each of the codes does contain requirements for the provision of data • Any apportionment of costs should be decided by the NRA	• The party or group seeking the derogation have the primary responsibility for a CBA as set-out in the CNCs • Note that each of the codes does contain requirements for the provision of data • Any apportionment of costs should be decided by the NRA
Obligatory participation in CBA regarding data and information provision where not publicly available	• TSO, DSO, CDSO	• Relevant System Operator (RSO), PGFO or DFO initiating the derogation,

Performing a CBA could prove very time and resource intensive, which presents a risk of creating an additional barrier and delaying or presenting difficulties in completing investments on individual grid users' facilities. In the case of an individual user applying for a derogation and not being part of a general or class derogation, it is possible that obtaining all information sought by the RSO (either to validate its assessment or as part of a wider/class derogation) could prove challenging. As such, it is important that the principles applied and the requirements, including the level of detail sought with respect to any derogation, are proportionate and relevant to the derogation being sought to avoid restricting the ability of an individual party to seek or obtain a derogation.

Good practice within	According to the CNC provisions, the cost-benefit analysis is performed (i) in the frame of a retrospective Code application to existing facilities and facilities already at an

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preparation of CBAs	advanced stage of planning, or (ii) to support requests for both individual and class derogations for new or substantially modernized network connected assets. The main goal is to balance the expected costs of achieving the requested derogation and/or retrospective application (direct costs, O&M costs, cost of potential loss of opportunity), against its monetary benefits to the internal electricity market, notably in terms of secure system operation in a context of security of supply and fostering of cross-border trade. Based on the feedback from recent European cost-benefit analyses in the energy field[3], some good practices to be observed for ensuring the relevance of CBA studies are listed below. • CBAs assess **societal value**[4] of the requested derogation and/or retrospective application and include the costs and benefits to the affected facility owner and all other relevant involved stakeholders, noting that decisions made on the basis of societal benefit may affect some parties disproportionately which will need consideration within any NRA decision • Decision criteria that CBA provides include economic performance indicators, for example net present value (NPV), return on investment; rate of return or time needed to break even; • Clearly identifying to which parties the costs and benefits accrue is strongly advisable and/or may reasonably be sought by regulatory authorities under the auspices of assessing the proportionality of the requested derogation and/or retrospective application. • CBA outcomes can support the assessment of how costs and benefits of a requested derogation and/or retrospective application are shared or allocated between all relevant involved parties and may be subject to agreement, including by the regulatory authority, on sharing of any burden. • CBAs are generally carried out on an **incremental basis** when the objective is to determine the relative merit of different outcomes, **comparison** between a base case ("Business as Usual" or "Reference") and **counterfactual** ("Alternative") **scenarios**;

[3] In this respect, several reference documents may be mentioned: European Commission, "Guide to cost-benefit analysis of investment projects", 2014 (available on http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf); ENTSO-E, Frontier Economics and CONSENTEC, "Cost Benefit Analysis for Electricity Balancing – general methodology", 2015 (available on https://consultations.entsoe.eu/markets/eb-cba/supporting_documents/150223_NCEB_General_CBA_methodology_for_consultation.pdf); RTE, "Socioeconomic assessment of smart grids", 2015 (available on http://www.rte-france.com/sites/default/files/rei-synthese_gb.pdf); ENTSO-E, "Guideline for Cost Benefit Analysis of Grid Development Projects", 2016 (available on https://consultations.entsoe.eu/system-development/cba-2-0/supporting_documents/160407_CBA 2 0_for web consultation_25 April_31 May 2016.pdf).

[4] Generally speaking, the societal value (called also "social welfare" or "economic surplus") represents the value that a given project (a derogation and/or retrospective application, for example) can create for the society as a whole. The "societal value" indicator is different from the "private" or "project" value indicator that reflects the economic performance of a given project from the project promoter's point of view in isolation, which will also be essential in the case of an individual derogation request.

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- **Sensitivity analyses** may be essential and are generally of significant merit to help address uncertainty, inconsistencies in data and a range of assumptions which may warrant consideration;
- **Alternative scenario impacts** on both relevant asset(s)[5] and relevant power system processes[6] should be explicitly identified by the requesting party. Identifying potential impacts of an alternative scenario does not presume that all of them must be assessed by the requestor (noting that cooperation will be required from the system operator(s)), subject to advice from the NRA. In the case of an individual derogation, assistance from relevant system operators and/or relevant DSO/TSOs may be needed to assess the impact against certain criteria, for example such as future grid operation or planning. In clearly identifying the impacts associated with different parties, care must be taken to avoid omission or double counting of costs and/or benefits;
- **Transparency of the CBA** is a key success factor. The greater detail provided regarding in particular the assumptions, scenarios, the detailed methods adopted in cost and benefit quantification, assessment outputs and data sources, the more self-apparent a decision on a CBA will be, however noting that the level of detail required may differ between individual derogation, class deration and retrospective application cases.
- The more robust and transparent a CBA is, the more likely it is that the assessing parties will agree with its determination. Sharing of provisional findings with affected parties before finalizing is also recommended.

[5] Assets directly affected by the retrospective application of the CNC or the derogation.
[6] Here are some examples of power system process (not exhaustive list): primary and secondary frequency regulation, voltage control (on transmission and/or distribution grid), power system balancing, power generation operation and planning, …

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General principles of a CBA

A schematic diagram of a CBA process is presented below. The main steps are then described in more detail.

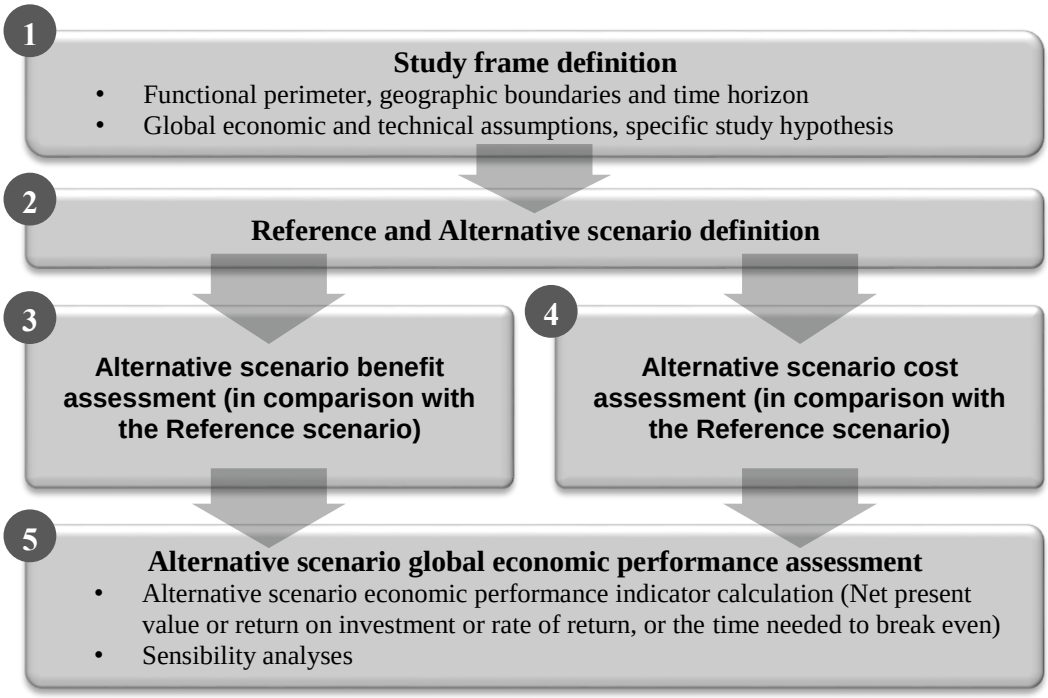

Figure 2 – General schematic of a CBA process

Study framework definition

This task is one of the key elements to allow CBA transparency. It includes five elements to be defined:

- Functional perimeter;
- Geographic boundaries;
- Time horizon;
- Global economic and technical assumptions;
- Specific study hypothesis.

Functional perimeter refers to the addressed CNC provisions and covers the asset's technical characteristics and, by extension, its components affected by the retrospective application or derogation request.

A properly defined functional perimeter is also needed to establish a list of expected significant impacts of requested retrospective applications or derogations on the power system and market. This task is **particularly critical in the case of derogation requirements**, as it is shown below (see "alternative scenario's benefit assessment" paragraph).

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Based on the impact list, **adequate geographic boundaries** of the study may be defined.

> *When the expected impacts are essentially local (e.g. changes in the reactive power profile) the study's geographic boundaries may be aligned with the affected part of the grid.*
>
> *However, if the expected impacts may affect the whole power system operation (e.g. changes in the primary frequency reserves), the national or even European perimeter may be necessary to accurately assess relevant impacts.*

An appropriate definition of the **study time horizon** is crucial for the correct economic impact assessment. It strongly depends on the nature of the request.

> *In the case of a retrospective CNC application or of an unlimited derogation request, the time horizon must allow to assess all relevant costs and benefits for the whole duration of the scenario. Taking into account a relatively high asset's lifespan in the power domain, a similar long-term perspective could be recommended in this case.*
>
> *On the other hand, when a time-limited derogation to the CNC provision(s) is requested, the CBA time horizon may be set in accordance with its duration.*

Global economic and technical assumptions are relative to the whole power system operation and economics. They are usually defined based on verifiable and possibly consensual data. They may include (as a non-exhaustive list):

- The discount rate;
- The generic asset's costs and performances (if relevant);
- The energy cost assumptions (if relevant);
- The frequency containment reserve's needs (if relevant);
- The ancillary and balancing services costs (if relevant);
- The value(s) of lost load (if relevant)

Collaboration between all involved parties (including network users, TSO, DSOs, manufacturers etc) in the early stages of the CBA study is advisable to successfully undertake this task.

Specific study hypotheses concern the local conditions of the asset(s) and power system operation and are likely to require collaboration with system operators. They may include (non-exhaustive list, not all elements might be relevant for each CBA):

- The expected operation profile(s) of addressed asset(s)[7];
- The expected voltage profile(s) of the local and/or regional grid (if relevant);
- The potential technical and economical characteristics of alternative measures to achieve the required performance[8] (if relevant);

[7] The operation profile define inter alia the availability of required asset's capabilities for the power system. That can be crucial in the case where the asset is operated on a discontinued basis.

[8] This point may for example be relevant in the case: - where alternative measures in the grid make requirements on assets unnecessary (e.g. installing fast, state of the art grid protection instead of extreme FRT requirements or installing reactive power sources in (sub) stations) or - where individual derogation to

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- The probability of occurrences where the derogation or the retroactive application would have an impact on involved asset

As for other aspects and considerations pertinent to CBA, communication and information exchange on this issue between all relevant involved parties (network users, TSO, DSOs, manufacturers) in the early stages of the CBA study are likely to support the success of the task.

Reference and alternative scenario definition

As stated above, a CBA is based on a comparison between factual ("Business as Usual" or "Reference") and counterfactual ("Alternative") scenarios;

- The factual scenario reflects the situation where no requested derogation and/or retrospective application (retrospective application of or derogation to the CNC provisions) has been applied;
- The counterfactual scenario characterizes a specific case of the requested derogation and/or retrospective application.

These scenarios are established based on the outputs of previous stage of study.

It is worth noting that:

- In the case of retroactive application of the CNC, alternative solutions on the grid side must be considered;
- In the case of derogation requirement for grid connected assets, it may be relevant to consider alternative scenarios which take into account if possible other generation and / or grid assets or demand facilities which are not subject to the derogation requirement but may be affected by it. This may require support from the system operator.[9]

In some circumstances and if added value is identified for such an approach, more than one alternative scenario can potentially be established.

Alternative scenario benefit assessment

Benefit identification task

As stipulated in Article 39 of RfG, Article 49 of DCC and article 66 of HVDC Connection Network Codes, benefits of requested derogation and/or retrospective application should be assessed considering, within the following categories:

- **Benefits in terms of improvement in security of supply** including at least:

the CNC provisions, when a generating module has not sufficient capability to fulfil some of its requirements (on reactive power for example), but the local conditions of the power system operation allow the use of the non-compliant assets without sensible impact on the security and the quality of supply (so no additional costs for the system are engaged).

[9] In this situation the benefit assessment may be performed with assumption that another asset is allowed to deliver the missing part of the considered requirement.

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- The associated reduction in probability of loss of supply over the lifetime of the modification;
- The probable extent and duration of such loss of supply;
- The societal cost per hour of such loss of supply;

- **Benefits to the internal market in electricity, cross-border trade and integration of renewable energies**, including at least:

  - The frequency response;
  - The balancing reserves;
  - The reactive power provision;
  - Congestion management;
  - Defence measures.

While the general logic of CBA use in the case of retrospective CNC application to existing facilities is noted in the provisions of the relevant CNC, exhaustive detail on the CBA methodology application in the case of derogations is difficult to achieve in this document due to the greater range of possible drivers taking into account the potential variety of cases.

Indeed, in this case, some of the above-mentioned categories of benefits may not be relevant or could even result in costs.

> *For example, where a derogation to the reactive power provision capability requirement may not have significant impact on frequency response, balancing reserves or congestion management indicators, it may negatively impact system voltage management and might in the worst case result in increasing the average cost of system reactive power support.*

On the other hand, some specific types of derogations **may create a positive economic value** for power system processes.

> *For example, a derogation to the active power frequency response related provisions may liberate additional capacity that could be offered to the markets.*

In summary, in the case of CNC retrospective application or class derogation, it would be recommended to establish a list of power system and market processes that may be positively or negatively affected by the requested retrospective application or class derogation.

An agreement between all involved parties on this list and on the selection of impacts to be assessed is highly recommended at an early stage of the CBA study.

Benefit monetisation task

Defining adequate methods for impact quantification and benefit monetization is crucial for the relevance of CBA conclusions. In many cases, each impact on power system processes could be assessed with several methods, distinguished by the model complexity and the amount of data needed. The final choice of method is often a trade-off between the desired level of output precision and the quantity and quality of input data.

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- *On the one hand, **advanced methods** can provide precise and robust outputs, but require detailed data that may not be available (from public sources) and may result in over proportionate costs for the CBA itself.*
- *On the other hand, **simplified methods** requesting less detailed data and costs for the CBA itself often lead to less output precision*

The final choice of methods, leading to an acceptable and proportionate balance between costs and quality of the CBA reveals the need for diversified, cutting-edge expertise coming from both regulated and deregulated sectors of the power system.

From a practical perspective, identifying the data needed for to quantify and monetise impact, as well as the parties that could provide it (from grid users, system operators, equipment manufacturers, owners or others) at an early stage of the CBA study may be very helpful and is highly recommended.

Moreover, discussion and agreement with stakeholders on the selection of methods for impact quantification and monetising during the CNC national implementation process may also be very helpful and is highly recommended.

Alternative scenario assessment

Identification and quantification of assets affected by the requested derogation and/or retrospective application

Usually, the facility or equipment owner will have all the information needed to identify the assets affected by the requested derogation and/or retrospective application.

Assuming that a confidential data management procedure may be followed between the involved asset owner(s) and the relevant SO, this task might not present particular difficulties in both retrospective application and class derogation cases.

Cost assessment

As stipulated in Article 39 of RfG, Article 49 of DCC and article 66 of HVDC Connection Network Codes, at least the following costs related to the requested retrospective application or derogation should be assessed:

- The direct costs incurred in implementing a requirement;
- The costs associated with any attributable loss of opportunity where this is definable (for example in being unable to provide a specific service);
- The costs associated with resulting changes in maintenance and operation.

Granting a derogation to the CNC provisions may normally reduce direct, O&M and other costs of affected assets, so, compared to the reference scenario (with no derogation granted), the asset cost variation may be negative.

Regarding the data needed, in the case of a class or individual derogation to the CNC provisions, the use of individual asset's data may raise the following issues:

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- Sharing confidential data between different asset owners involved in the derogation process may be problematic, considering potential direct competition between them;
- Collecting and harmonizing individual data from an important number of asset owners may represent a substantial and time-consuming task.

Therefore, in some specific cases of derogation requests the use of generic data may be helpful, subject to a consensus on the matter between involved parties.

From a practical perspective, identifying the data needed for cost quantification, as well as the parties that can provide it (from grid users, grid or system operators, equipment manufacturers, or others) at an early stage of the CBA study may be very helpful and is highly recommended.

Alternative scenario global economic performance assessment

As stipulated in Article 39 of RfG, Article 49 of DCC and article 66 of HVDC Connection Network Codes, a cost-benefit analysis shall be based on one or more of the following calculating principles:

- The net present value;
- The return on investment;
- The rate of return;
- The time needed to break even;

Due to a potentially large number of impacts to evaluate, the CBA is often based on a deterministic vision of the future based on a limited number of scenarios. Therefore, sensitivity analyses could help involved actors to significantly increase the reliability or informational value of a CBA's output.

In the power system domain, the most common parameters for CBA sensitivity are:

- The discount rate;
- The involved asset's key performances;
- The involved asset's costs
- Renewable energy penetration rate

However, the final choice of sensitivity parameters will mostly depend on the local study conditions.

Data and information to be exchanged	The conduct of CBAs requires all necessary data for the full assessment of the costs and benefits. All data and information to be exchanged in the frame of a CBA needs to be validated based on a quality control process accepted by all parties. Such a process, depending on the specific requirements, may prove relatively onerous. The CNCs place obligations upon grid users (power generating facility owners under the RfG, demand facility owners under the DCC, HVDC system owners and DC-connected power park module owners under the HVDC and DSOs, including CDSOs, under all CNCs) to assist and contribute to the CBA. They have the clear obligation to provide the

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	necessary data requested by the relevant system operator performing the cost-benefit analysis, within three months of the request, unless agreed otherwise by the relevant system operator [bearing in mind potentially any studies that would need to be carried out and/or the availability of data relating to historic equipment] To make sure (and notwithstanding any national considerations) the data and information is reliable, the following elements (non-exhaustive list) could be taken into account where available: • Provision of data that can be validated and is from accessible sources (this will however not always be possible, if information relates to a specific grid user or operator and/or is confidential as noted in the following section of this IGD); • Current knowledge and experience (and where agreed, value ranges, set-points, etc); • Where available, subject to comparison with similar cases; • Validation through independent assessment where agreed; • Benchmarking. The provider of the data and information must be accountable for the accuracy of its transmission, but it is not appropriate for them to bear responsibility for the original quality of the data where this is supplied to them by a third party. In case of such provision, the source shall be communicated to allow reliability to be checked and the owner (source) of the data will remain responsible for its validity. In case of disagreement, the regulator shall hold the final decision. In order to reflect the obligations [and in the application of art 39.1 of RfG, art 49.1 of DCC and 66.1 of HVDC] on all parties involved in the CBA process, it is recommended that during the national implementation of the CNCs the process around these requirements is addressed in more detail.
Support for CBAs nationally	Consideration should be given nationally to the creation of an ad-hoc CBA expert group including all stakeholders which could assist the NRA in supporting applications for derogation /retrospective application and which could help to provide and validate data in a timely fashion.
Data Provision and Confidentiality obligations	Data should be provided even if confidential. The CNCs (Art 12 of RfG, Art 11 of DCC and Art 10 of HVDC) provide that any confidential information exchanged or transmitted pursuant to the CNCs is subject to professional secrecy (without prejudice to cases covered by national law or EU law) such that: • Confidential information received by system operators or TSOs for the conduct of CBA may not be divulged to any other person or authority, excepting of course the NRA where necessary in their decision making process; • Confidential information may only be used for the purpose of carrying out duties under the CNCs. The impact of commercial confidentiality considerations may be mitigated by using normalized data where possible (may be difficult for individual derogations) or through

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	appropriate provisions regarding non-disclosure of portions of the analysis or underlying data. The provider is responsible for indicating which part of the data is confidential and which part is not and for justifying this accordingly[10]. Specific confidentiality agreements can be used and should usually be agreed before data is transmitted. Again, the regulator shall hold the final decision. Data provided in support of an individual derogation request is likely to be particularly subject to confidentiality requirements. In any case and in order to allow the TSO to carry out a proper CBA, and subject where applicable to public consultation, TSOs/relevant system operators should endeavour to publish at least the aggregated data and the outcome of the analysis made on the requested data. In the application of art 39.1 of RfG, art 49.1 of DCC and art 66.1 of HVDC, Grid Users not providing the necessary data to the TSO will be in breach of their obligations under the CNCs. By the same logic, system operators not providing the necessary data to Grid Users in support of an individual derogation request will also be in breach of their obligations. A system operator or TSO duly requesting data from grid users but still not receiving it within the 3 months deadline set in the CNCs should not be expected to perform a full CBA; it would perform its CBA on the basis of only the available data, and where applicable assumptions of costs based on the best available knowledge. The system operator or TSO is invited to clearly mention in its CBA any data requests that remain unanswered. Additionally, the system operator or TSO could bring the lack of data provision to the attention of its national regulatory authority (NRA), who is competent to ensure compliance of system users with their obligations. In order to reflect the obligations [and in the application of art 39.1 of RfG, art 49.1 of DCC and 66.1 of HVDC] on all parties involved in the CBA process, it is recommended that during the national implementation of the CNCs the process around these requirements is addressed in more detail.
Further information (examples and references)	**Caveat – no example will be complete or perfect and an individual example should not be taken as a gold standard as there will always be certain provisions specific to the circumstances.** Provided by EC: • Electricity Network Codes Roadmap accompanying the network codes. • KEMA report on ENTSOE NC-RfG; contains CBA outputs from European associations of stakeholders that could be considered in order to assess the costs of implementing requirements in power generating modules Provided by National Grid: (GB TSO)

[10] Information that can be linked to one individual party shall not be publicly divulged.

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- GC0063 'Power Available' GB Grid Code modification.

Provided by Eirgrid: (in the attachments)

- All island grid study. Work stream 4. Analysis of impacts and benefits.
- DS3: System Services Review. TSO Recommendations.
- An Estimate of the Value of Lost Load for Ireland

ENTSO-E:
ENTSO-E Guideline for Cost Benefit Analysis of Grid Development Projects (February 5, 2016). Includes Benefit Categories for grid development projects (on page 26) that can be directly applied to the CNCs.

EPRI (in the attachments)

- CBA of power system reliability. Determination of interruption costs
- Cost of providing ancillary services from power plants
- Measurement of ancillary services from power plants

Note that national examples are provided for illustration purposes only.

INTERDEPENDENCIES	
Within CNCs	This file covers the current 3 CNCs.
In other NCs	No
System characteristics	N/A
Technology characteristics	N/A

COORDINATION

TSO – MS-NRA	Final approval required by Member State or NRA as applicable to every case as proposed. For retrospective application of requirements to existing generators, the TSO also needs NRA approval of the qualitative analysis to be allowed to progress to consultation and more detailed quantitative analysis.
TSO – generator owner – DSO-CDSO	As stated above under 'Data Provision', all parties are required to cooperate and to provide information as requested in the preparation of CBAs. Article 5.4 of RfG states that in setting the banding thresholds power generating facility owners are to assist in the process and provide data as requested by the relevant TSO. Article 39 of RfG on Principles of cost-benefit analysis (DCC and HVDC similar – articles 49 & 66 respectively) also sets out the requirement for assistance as follows:

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1. Power generating facility owners and DSOs including CDSOs shall assist and contribute to the cost-benefit analysis undertaken according to Articles 38 and 63 and provide the necessary data as requested by the relevant system operator or relevant TSO within three months of receiving a request, unless agreed otherwise by the relevant TSO. For the preparation of a cost-benefit-analysis by a power generating facility owner, or prospective owner, assessing a potential derogation pursuant to Article 62, the relevant TSO and DSO, including CDSO, shall assist and contribute to the cost-benefit analysis and provide the necessary data as requested by the power generating facility owner, or the prospective owner, within three months of receiving a request, unless agreed otherwise by the power generating facility owner or the prospective owner.

Noting these principles and that where information is not available or forthcoming it is therefore likely that a CBA will be incomplete or based on assumptions, it is expected that this will be taken into account in the decisions made by NRAs or member states on the basis of such analysis but also that parties not providing data may be held to account.

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