Evaluation of policies and incentive actions to foster technological innovations in the electricity sector - structuring criteria

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ABSTRACT

The promotion of a reliable and sustainable power system has as key drivers the development of smart grids associated with demand-side management schemes, diffusion of electric mobility, accommodation of larger shares of distributed generation, in particular microgeneration and the introduction of storage systems. In addition, these technological development vectors represent new business opportunities for several players (utilities, retailers, ESCOs, aggregator entities, etc.), which should be considered by regulatory guidelines accounting for technical efficiency, economic feasibility and tariff affordability.

The technical and economic characteristics of the electricity sector (capital intensive, undifferentiated product, regulated tariffs, almost inelastic demand, need of instantaneous balance between supply and demand, etc.) do not induce that the process of technological innovation happens in an endogenous manner within the sector dynamics. Therefore, public policies have a role to play in this process.

This communication presents an approach using Problem Structuring Methods to frame the problem of analyzing and evaluating technological innovations and associate incentive policies in the electricity sector. The results of this structuring phase using Soft Systems Methodology suggest a large number of issues that were organized as a hierarchy of objectives. These objectives will correspond to the criteria of a Multicriteria Decision Analysis methodology devoted to assessing the potential courses of action promoting technological innovation. This methodology should provide decision support to policy and decision makers to shape policies aimed at fostering more reliable and sustainable electricity systems.

KEYWORDS: Electricity sector, technological innovations, problem structuring, multicriteria decision analysis, innovation policies

1 INTRODUCTION

Investments associated with technological innovations to guarantee the reinforcement, expansion and modernization of electrical network infrastructures to satisfy a growing demand with security, quality and less environmental impacts should be analyzed taking into account distinct perspectives of evaluation. The offer of a sustainable and reliable electricity system has as an important driver the evolution towards smart grids, associated with demand side management schemes, increase of distributed generation, in particular micro-generation, diffusion of electric mobility and introduction of storage systems. Additionally the technological development vectors represent new business opportunities, which should be considered by regulation guidelines to make viable the smart grids evolution process in the pursuit of technical efficiency, economic viability and tariff moderation.

The diffusion of smart grids is not just a technological innovation, but a technological transition is at stake. In this context, the analysis of the technological variables arising in this process is necessary, and the interests of the different stakeholders involved in the process should be considered. The techno-economic characteristics of the electricity sector (capital intensive, undifferentiated product, regulated tariffs, almost inelastic demand, need of an instantaneous balance between supply and demand, etc.) do not induce that the innovation process occurs endogenously to the sector dynamics. Therefore, public policies are required to foster this process.

The complexity of the study of innovation technologies and incentive policies associated stems mainly from the need to take into account aspects of distinct nature (technological, economic, financial, social, regulatory), several of them of intangible nature, in the evaluation models. Therefore, the structuring of the problem characteristics is an essential step to develop such models. Since decision making in the energy sector should take into account variables of heterogeneous nature and stakeholders of different spheres, traditional evaluation methods such as cost-benefit analysis, do not enable the explicit consideration of all elements involved on a consensual and realistic basis. This limitation is essentially due to the difficulties of monetizing several aspects of the problem, as well as making transparent the trade-offs to be established between the multiple perspectives the evaluation should encompass.

In this context, multi-criteria decision aid (MCDA) methodologies are particularly adequate to deal with a vast range of problems, in which potential alternatives (courses of action) should be judged according to different evaluation axes that are explicitly considered in the model. MCDA models enable to include evaluation criteria of different nature, which are generally conflicting and incommensurate, taking into account the points of view of different stakeholders, each one displaying in the decision process his/her own values, preferences and criteria.

This paper deals with the importance of problem structuring as an essential step of the analysis, enabling to unveil a deeper understanding of the problem, as well as the essential elements that should be included in the MCDA model through the interaction with the stakeholders, in order to provide decision support in the appraisal of policies and actions of incentive to technological innovations in the electricity sector.

2 PROBLEM STRUCTURING METHODS – SOFT SYSTEMS METHODOLOGY

As it is recognized by several authors (Bana e Costa and Beinat, 2011; Belton et al. 1997; Checkland and Scholes, 1990; Diakoulaki et al., 2006; Keeney, 1992; von Winterfeldt e Fasolo, 2009), the problem structuring phase should constitute the first step, and one of the most important ones, in decision support processes. The real-world applications emphasize the critical nature of problem structuring in order to gather in an organized manner all the relevant information, improve the understanding of the overall decision situation and clearly define the problem to be tackled.

In general, real-world problems arise in complex and ill-defined contexts. Therefore, it is necessary to identify the essential characteristics of the decision situation, establish the scope and the boundaries of the analysis, recognize the stakeholders involved, as well as their main motivations and objectives, and understand which actions can be carried out (Bana e Costa and Beinat, 2011). This analysis enables to offer all participants into the process of a common view and an operational basis from which the identification of the fundamental points of view, the operational criteria, and the potential actions to be evaluated will emerge.

Several Problem Structuring Methods (PSM) have been proposed for structuring complex decision situations (Rosenhead, 1996). According to Rosenhead (1996), these situations for which PSM are particularly useful area characterized by multiple actors and multiple perspectives, non-consensual or even antagonistic interests, different measurement units of the impacts, evaluation aspects of intangible nature, and uncertainty over several elements of the decision situation. PSM present two essential characteristics: facilitation and structuring. Facilitation aims to offer an environment in which the debate between the participants is duly oriented according to the components of each specific PSM, enabling to clarify the understanding of the decision situation. Structuring refers more generally to the process of organization of the elements unveiled during debate, in order to enable advancing on a common basis of knowledge about the problem, thus contributing to improve the quality of the decision making process.

Each PSM proposes a particular representation of the decision situation to: enable the analysis of different perspectives, be cognitively accessible even for actors less familiarized with the topic, work in an interactive manner reflecting the evolution of debate and learning of the actors, enable identifying and compromise of partial improvements rather than requiring a global solution. These requirements do not entail mathematical models or methods (Mingers and Rosenhead, 2004). PSM foster a better understanding of the role of each actor, his/her degree of intervention and power to influence decisions, the relationships between the different actors and the identification of their values, objectives e concerns. The application of PSM to decision situations in the energy sector has had some recent developments, with emphasis on Soft Systems Methodology (SSM). SSM is a general system analysis method developed from systems engineering concepts (Checkland and Scholes, 1990; Checkland and Poulter, 2006). Neves et al. (2004) used SSM to structure a problem of evaluation of initiatives for the promotion of energy efficiency. Ngai et al. (2012) used SSM to identify opportunities in management support of rational use of energy in textile manufacturing processes. Coelho et al. (2010) also used SSM to study problems in urban energy planning.

The main reasons for the selection of SSM to carry out this study are rooted on our experience in problem structuring of problems in the energy sector (Neves et al., 2004; Coelho et al., 2010), its flexibility in the description of the decision situation, including the definition of the role of each participant, his/her degree of involvement and intervention capacity, and the relationships between the participants. The SSM approach offers a systemic framework to carry out process analysis in which technological issues and the intervention of decision makers are interdependent. SSM was developed to use systems engineering concepts to complex and ill-defined problems in which the multiple inter-related issues are not clearly defined (Checkland and Scholes, 1990; Checkland and Poulter, 2006), with multiple world views and then multiple conflicting objectives pertaining to the stakeholders.

The SSM approach enables the linkage between the structuring and alternative evaluation steps, contributing to shed light on the main issues of distinct nature that should be incorporated in MCDA models. The approach to problems using SSM is carried out, in general, using a search process consisting of seven stages as illustrated in Fig. 1. In this diagram a clear distinction is made between the real world and the (conceptual) systems world. The line separating stages 1, 2, 5, 6 and 7 from stages 3 and 4 indicates that the SSM analysis addresses two main concerns: one associated with the real world and another one focused on the systems world in a systemic perspective.

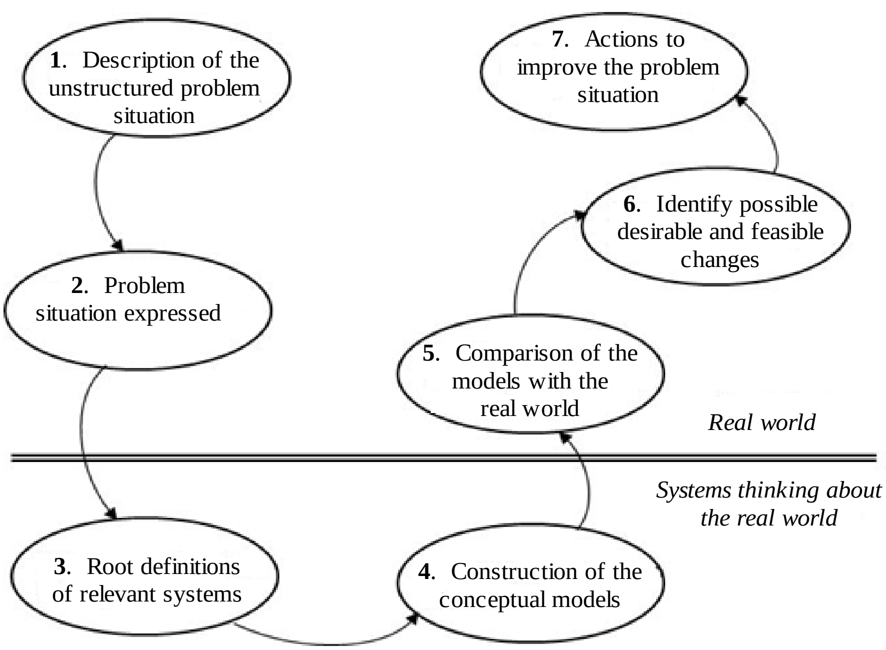

Figure 1 – The steps of SSM

The SSM approach begins with the identification of a real world situation that is considered problematical by some stakeholder. The description of the situation aims at making a diagnosis of the existing situation, identifying the participants and the problem nature. The most common strategy is the graphical representation of the problem under study. This graphical representation, called "rich picture", includes all stakeholders and their relationships in order to offer a broad vision of the problem. In stages 3 and 4 the SSM approach builds the conceptual models. This implies having a clear and objective definition of the system to be modeled, which is known as root definition, whose construction should be guided to contain the following components (CATWOE): Customers, Actors, Transformation process, Weltanschauung (world view), Owner, and Environmental constraints (Table 1).

From the root definition the conceptual model is developed as simple as possible to accomplish the transformation described in stage 3. This model is constituted by a set of activities conceived as a transformation process and connected by logical dependencies (Checkland and Tsouvalis, 1997). The conceptual models should then be validated by comparing them with a formal system. A formal system should possess the following elements: Purpose/mission; Performance measure; Decision making process; Sub-systems; Interaction with the environment; Physical and human resources; Continuity. This model should also include the monitoring and control activities to assess the system efficacy, efficiency and effectiveness (Checkland and Poulter, 2006).

Once the model is developed and returning to the real world problem situation, in stage 5 the SSM approach makes a comparison between the model and the real world. In this comparison stage, the participation of the stakeholders is of utmost importance in order to generate debate on possible changes that desirably may occur to improve the situation. Based on the comparisons, in stage 6 it is possible to identify change proposals that will be necessary to introduce in the real system processes and structures, which will be implemented in stage 7. The success of the implementation requires that change proposals are desirable and feasible.

Table 1 – Root definition - CATWOE

C	*Client* – the immediate beneficiaries or victims of the system results.
A	*Actors* – the participants in the transformation, i.e. those who carry out activities within the system.
T	*Transformation* – the core of the human activity system, in which some inputs are converted in outputs and given to the clients. Actors play a role in this transformation process.
W	*Weltanschauung* (world view) – the perspective or point of view that makes sense of the root definition being developed.
O	*Owner* – the individual or group responsible for the proposed system. He/she has the power to modify or even stop the system, overlapping other system actors.
E	*Environmental constraints* – the human activity systems work under some constraints imposed by the external environment, as legal, physical or ethical constraints.

3 MULTI-CRITERIA DECISION AIDING

Rather than trying to convert all aspects important for a decision into a single "currency", which is often difficult and subject to controversy, the paradigm of MCDA considers explicitly several evaluation criteria (Dias el al. 2015). According to Bouyssou (1993) there are three main advantages of adopting this paradigm: it allows a solid base for dialogue by acknowledging the concerns of all stakeholders, encouraging joint ownership of the evaluation models, it breaks down the problem thus facilitating the definition of assessment instruments and uncertainty modelling, and it invites decision makers to consider any choice as a compromise between conflicting objectives, since there is rarely an option better than all the rest on every evaluation criterion. The areas of energy and environment have been a fertile ground for the application of MCDA approaches, as can be witnessed in several books and reviews (Diakoulaki et al., 2016; Ehrgott and Stewart, 2010; Huang et al., 2011; Linkov and Moberg, 2012; Wang et al., 2009).

There are three main stages of a decision process under an MCDA paradigm: problem structuring, construction of the evaluation model, and exploitation of the model.

The stage of structuring the problem is the basis for all analyses that ensue. Structuring entails defining what the problem is, what the alternatives and their consequences are, and what criteria should be used to evaluate alternatives. Keeney (1992) sustains that decision makers should focus on objectives first and then alternatives, mainly because this can foster creativity in designing new alternatives and ensures the evaluation criteria are aligned with an individual's or an organization's objectives. The use of PSM such as SSMs can be quite helpful to the process of identifying relevant actors and objectives (Neves et al., 2009).

The stage of constructing the evaluation model entails, first, evaluating the performance of each alternative according to each one of the different evaluation criteria. These performances can be measured on quantitative or qualitative scales. Criteria such as costs or pollutant emissions can be measured quantitatively. If a direct indicator is not available for the assessment in question, it is possible to use an indirect indicator. For instance, acres of forest destroyed can be an indirect indicator for loss of biodiversity. On the other hand, criteria such as degree of opposition of the population, or aesthetic perception of the landscape, will usually be assessed on a qualitative scale using levels such as negligible, significant, etc., through a precise description (a descriptor table) for the meaning of each level, to avoid different interpretations of the same words (Keeney and Sicherman, 1983).

Once a performance table is built summarizing the assessment of each alternative on each criterion, the following step in an MCDA study consists in deriving a recommendation using an appropriate aggregation method. There are three main pathways to perform an aggregation of single-criterion performances (Roy, 1985): obtaining an overall synthesis value (allowing to rank all the alternatives), obtaining a binary relation (not necessarily complete) comparing alternatives in a pairwise way, or obtaining answers to simple questions from the decision maker in the course of an interactive questioning protocol able to identify the most interesting alternatives at its end.

4 PROCESS FOLLOWED TO STRUCTURE OBJECTIVES

Recognizing and structuring decision objectives is essential to reach adequate recommendations, but often decision makers fail in this crucial step (Bond et al. 2010). Bana e Costa and Beinat (2011) and Keeney (1992) presented methodologies to elicit and structure objectives (or points of view) for an MCDA process. Such methodologies allow identifying the so-called fundamental objectives set. Each fundamental objective should be controllable, essential, concise, specific and understandable. Fundamental objectives often comprehend different sub-objectives, but it should be possible to assess alternatives on each fundamental objective, one at a time, independently of the other fundamental objectives. As a set the fundamental objectives should be complete but not redundant.

Fundamental objectives are not means to a higher-level concern. They represent an end in themselves. For instance, let us consider an objective of reducing the consumption of electrical energy. Asking the decision maker why is this objective important the answer might reveal the objective of reducing costs to consumers, or the objective of reducing greenhouse gas emissions, or both. This distinction between means-objectives and end-objectives is important. For instance, if the fundamental objective is to reduce greenhouse gas emissions then not only the consumption of electricity matters, but also the carbon intensity of the country's mix.

The construction of a hierarchy of objectives can be carried out using a top-down or a bottom-up approach (Keeney, 1992; Parnell et al. 2013). The top-down approach starts by identifying the fundamental objectives, which are then decomposed into lower level sub-objectives, down to the relevant attributes of the alternatives. Its main advantage is that it focuses on the main concerns behind the evaluation process, but it risks omitting a few relevant sub-objectives. A bottom-up approach starts by considering a set of many attributes of the alternatives that are considered to be relevant for the decision process, and then these attributes are successively coalesced into higher-level objectives. Its main advantage is to allow discussing objectives at a more concrete and understandable level, but it risks missing a broader perspective.

The strategy followed in the current work sought to combine the advantages of bottom-up and top-down approaches. First, a bottom-up approach was followed to inform the definition of a set of fundamental objectives. Then, a top-down approach ensured no relevant aspects were missing.

Fig. 2 presents the rich picture for the problem of evaluation of policies and incentive actions to foster technological innovations in the electricity sector with a focus on the development of smart grids. This diagram results from information gathered in the scientific literature, namely a thorough revision of the practices in eighteen countries, technical visits to several entities in Portugal, France, Italy and Germany, as well as discussions held at the International Seminar on "Challenges of Regulation in the Electricity Sector" (Coimbra, 12-13 February 2015). This information has been discussed among experts at the R&D Institute INESC Coimbra and then discussed at GESEL-UFRJ, EDP Brazil, ONS (Transmission Network System Operator, Brazil) and ANEEL (Brazilian regulator of the electricity sector) in November 2015.

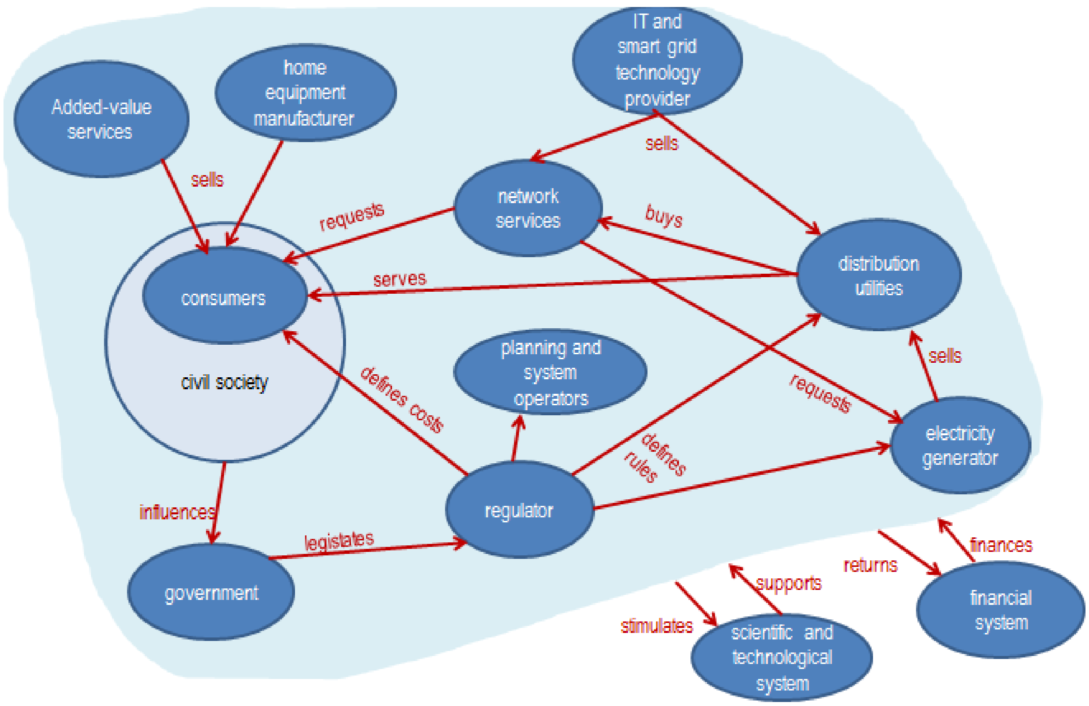

Fig. 2. Rich Picture

The following actors have been identified:

- **Consumers** are the final clients of the electricity distribution service; they may be individuals or companies.

- Consumers are a relevant part of the **Civil Society**, which also includes organizations representing them such as consumer associations, industry associations, or even the media, all influencing government policies.

- The **Government**, at different territorial levels, determines the energy policies at large.

- The **Regulator** has a mediation role between all the stakeholders in the electricity sector. This actor defines the rules that apply to generators, distributors and retailers of electric energy, also with the power to define the costs (or part of the costs) seen by the consumers in the tariffs.

- **Generators** of electric energy invest in generation capacity and sell energy in the market.

- **Distributor** / Retailers (in some countries these can be the same of different entities) supplies energy to consumers, charging the availability of service (power tariff wherever it exists) and the energy sold. It can buy network services to other entities to better achieve its aims, ensuring the best way to manage and satisfy demand.

- **Planning and operation entities** include those that have the mission of the long-term planning of the electricity system, the transmission network operator, to ensure the overall operation of the system according to quality of service standards.

- The **network service companies** may assume a more relevant role in the smart grid. These may include aggregators that use the demand flexibility of end-users for demand-side actions such as peak shaving and offering of ancillary services.

- Smart grids can foster new business for **equipment and technology suppliers**, who sell their services to the actors intervening in electricity distribution, as well as manufacturers of equipment and appliances for end-users. New business opportunities also arise for **added-value service suppliers** (energy service companies) to consumers.

- The whole system interacts with the **financial system**, which finances investments in smart grids.

- Also this system interacts with the **scientific and technological system**, which supplies knowledge and qualified human resources for the operation of all actors, for innovation and decision support.

In the CATWOE analysis four perspectives have been identified and explored. These perspectives under which it is relevant to promote smart grids and the associate technological developments are:

a) The smart grids as an instrument to optimize resources - smart grids will provide an intelligent manner to optimize resources, namely generation and distribution capacity but also the potential “hidden” resource which is the more efficient use of electricity by consumers.

b) The smart grids as opportunity of development and business - smart grids constitute an opportunity for economic development, fostering the creation of new businesses thus promoting technological innovation.

c) The smart grids to foster environmentally friendly technologies - smart grids constitute an opportunity to promote environmentally friendly technologies and energy efficiency, namely concerning the higher integration of renewable sources in the energy mix.

d) The smart grids to empower consumers / micro-generators - smart grids constitute an opportunity to increase the power of consumers and micro-generators, promoting their intervention capacity.

For each one of these perspectives the CATWOE analysis enables to identify a set of elements to be taken into account for the definition of evaluation criteria in MCDA, as suggested by Neves et al. (2009). To illustrate this process, Table 2 presents the analysis carried out for the first perspective.

Table 2. CATWOE analysis for the perspective “The smart grids as an instrument to optimize resources”

Clients	**What are the benefits and the disadvantages and why are they important?**
System operator, Distributor	(+) Lower costs, better quality of service, better information/monitoring, management flexibility, lower technical risks (-) Cyber risks
Society	(+) Lower costs and losses, better quality of service (-) Lower privacy, lower equity
Actors	**What is a good/bad performance?**
System operator, Generator, Distributor	(+) Lower costs, higher resiliency and reliability (-) Collapse/network dysfunction, loss of sensitive information, loss of commitment
Consumer	(-) Fraud/crime, loss of commitment, lack of collaboration
Weltanschauung	**Objectives unveiled**
Smart grids contribute to avoid/mitigate inefficiencies	Efficient utilization of installed capacity More efficient market
Owner	**Why stop or change the activity?**
Government, Regulator	Social acceptance, lack of funding, unverified economic benefits
Environmental constraints	**Objectives unveiled**
Financial resources	Modernize the network
Present technological basis	Form qualified staff e develop R&D
Existing know-how	Technological diffusion
Existing potential	Security of supply

The SSM described above, together with literature reviews, led to the identification of a “cloud” comprising about a hundred items, each one reflecting an attribute or a concern that could be evaluated when assessing policies to foster technological innovations in the electricity sector. The semantic analysis of this “cloud” of items (“social acceptance”, “tax benefits”, “costs of metering”, “to modernize the grid”, etc.) took into account the context in which each one emerged. This analysis allowed forming clusters of interrelated concerns pertaining to the same high-level objective. This formation of clusters is an important support to identify objectives, as demonstrated by research in psychology about memory (Bond et al. 2010). By defining categories one enhances the ability to enrich the list of objectives by means of cue-dependent retrieval: categories act as stimuli to remember targets in memory associated with them.

The categories that were formed are associated with fundamental purposes for technological innovation in the electricity sector. They can be seen as the top of a functional value hierarchy (Parnell et al. 2013, Ch. 7), which are combinations of the functional hierarchies from systems engineering with value hierarchies of decision analysis. Following (Parnell et al. 2013, Ch. 7), the top-level, fundamental objectives are end-objectives (rather than means-objectives). They are stated using expressions that are familiar to the stakeholders (in this work, actors involved in the electricity system), and are expressions that combine a verb plus an object for a clearer reading.

5 RESULTS

The resulting hierarchy of objectives is not tailored to any specific stakeholder. When using such a hierarchy to evaluate alternatives, all stakeholders can recognize the relevance of the objectives without having to agree on which are the most relevant or important ones. The resulting list of fundamental objectives is described in the following paragraphs, using an arbitrary presentation order.

Objective 1 - To benefit the environment and human health. One of the most frequently cited issues when discussing technological innovation in the energy sector is to reduce dependence on fossil fuels and the progressive replacement of these fuels by renewable energy. This is, however, a means-objective, i.e. using less fossil fuels is not a value in itself. The replacement of fossil fuels with renewable primarily seeks a fundamental goal that is the mitigation of greenhouse gas emissions or, more broadly, it aims at not harming the environment. Since there was also mention of other impacts on wildlife and human health, it was decided to define this objective in a more comprehensive way. This objective brings together, among many others, elements such as the avoided emissions through energy efficiency and the incorporation of renewables in the generation mix, the development of electric mobility, the impact on health and human mortality and other species, the use of soil and the use of water.

Objective 2 - To increase the flexibility and capabilities of the electricity system’s technological infrastructure. Technological innovation in the energy sector, in particular with the development of smart grids, is seen as an opportunity to modernize an electricity system in need of renovation, as well as to provide the electricity system with technical capacity to improve and to make its operation more flexible (in terms of grid and load management). One can debate whether this is a means-objective or an ends-objective. Having an electricity system with a more modern and more capable infrastructure contributes to multiple purposes (lower costs, better quality of service, better environment, etc.). But the development of this capital can also be seen as a political objective in itself, given the set of elements associated with it and the impossibility of reflecting directly the impact of this objective on the multiple purposes that it can promote for the different stakeholders. This objective brings together, among many others, elements such as peak shaving, ability to adapt and react, network monitoring, management flexibility, permitting an increasing share of distributed generation based on intermittent sources, and reducing losses.

Objective 3 - To ensure security of supply. Another desideratum sought when modernizing the electrical system is to ensure that demand is satisfied with low risk of disruption, considering technical risks (reliability), and political risks (foreign dependency). Note that the objectives 2 and 3 could be joined together in a more comprehensive formulation. However, the different nature of the concern regarding the risk advises for making this aspect explicit, as is often done in multicriteria benefits-costs-risks assessment. This objective brings together elements such as energy self-sufficiency, cyber risk, and quality of service.

Objective 4 - To ensure openness, fairness, transparency and efficiency of the electricity markets. Technological innovation is also seen as an opportunity to transform the electricity markets, corresponding to the aims of the regulator, the most competitive companies and the consumers. This reflects the aim to achieve a more open, efficient and transparent market, which can benefit from healthy competition between energy and services suppliers, and at the same time ensuring equity between the different agents. This objective brings together, among others, elements such as access to energy services, access to networks, increased competition, and efficient use of installed capacity.

Objective 5 - To provide financial benefit to the agents involved. Financial benefit is a ubiquitous aspect to stimulate the involvement of economic agents. The purpose of providing financial benefit translates the need to make investment in technological innovation interesting for those involved, because without this interest they will hardly accept these innovations. The financial benefit to the agents comprises revenues (including gains from reducing fraud), costs (investment, operational, etc.), subsidies and taxes, and concerns about low bills to consumers (considering tariffs and energy efficiency).

Objective 6 - To provide economic and social benefit to the country. This objective is of concern mainly to political decision makers, but it may indirectly benefit all the agents. It reflects the perspective that technological development can contribute to benefit the country that promotes it. This objective brings together issues such as the contribution to the national economy and employment, the encouragement of new businesses based on added-value services, the training of human resources and technological leadership.

Objective 7 – To ensure feasibility and to encourage adoption of technological innovations. Even if technological innovation can potentially bring many benefits, they will be of no avail if innovation is not adopted by the target stakeholders. Natural, financial and technical barriers may exist that hinder or prevent the success of innovation projects. This objective includes all the social and operational factors which could constitute a barrier to innovation projects, including legislative barriers, initial investment requirements, privacy concerns, availability of qualified human resources, telecommunications quality and other support services, etc.

One may note that some of the elements contribute to different objectives, although under different perspectives. For example, end-use energy efficiency contributes to avoid emissions (considered in Objective 1) and lower costs to the consumer (Objective 5). Another option could have been to consider this concern as a new high-level objective, in order to emphasize the importance of this objective for national policy. Such an option, however, would require particular attention in order to avoid double counting of benefits on objectives 1 and 5.

The objectives listed above were then further developed by listing the most relevant sub-objectives for the stakeholders in the electricity sector. Fig. 3 presents this decomposition, identifying the stakeholders most interested in each sub-objective. Finally, the initial “cloud” of items was revisited to ensure no important aspect had been missed.

6 CONCLUDING REMARKS

In the context of the project "Policies and incentive actions for technological innovation in the electricity sector: analysis of international experience and proposals for Brazil", this work aimed to develop and structure a set of fundamental objectives to promote innovation. Literature reviews, technical visits, and the use of SSM generated a dispersed cloud of aspects initially listed as potential concerns and criteria for the evaluation, which was necessary to structure. The categorization of these issues allowed us to propose a list of seven key objectives in line with priorities for technological innovation in the energy sector. This bottom-up approach was followed by a top-down approach aimed at breaking down each objective into sub-objectives clarifying the issues at stake under each perspective.

The work performed so far is an essential basis for the construction stage of the evaluation model, which will consist of the implementation of performance indicators for each objective and the definition of aggregation mechanisms to derive synthetic recommendations.

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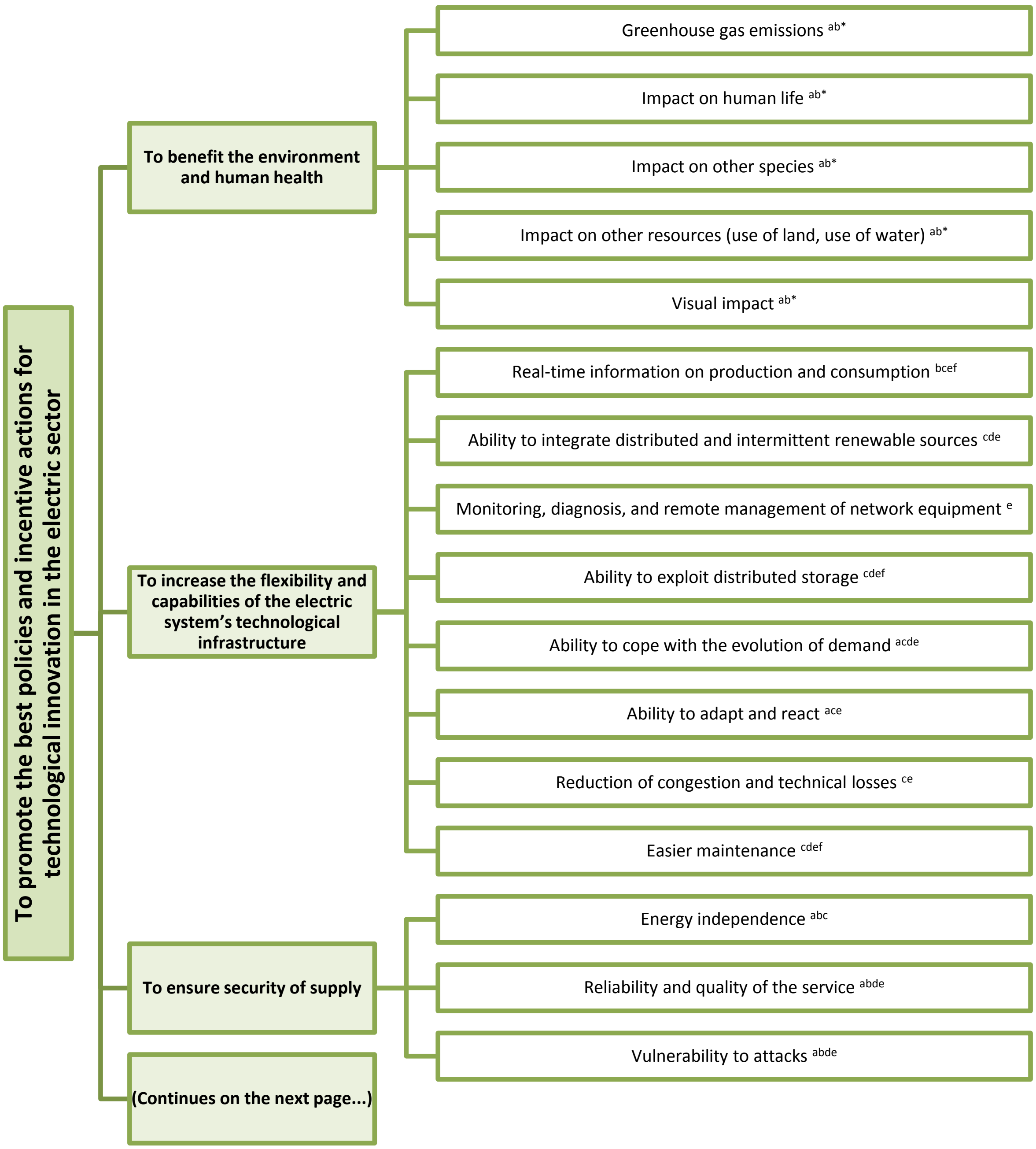

Figure 3. Objectives hierarchy identifying the interested stakeholder groups: a) Government and regulator, b) Consumers and civil society , c) Distributor / energy supplier, d) Power producer, e) system operator, f) Equipment and/or services suppliers, g) scientific and technological system, h) financial system *) also relevant to other stakeholders.

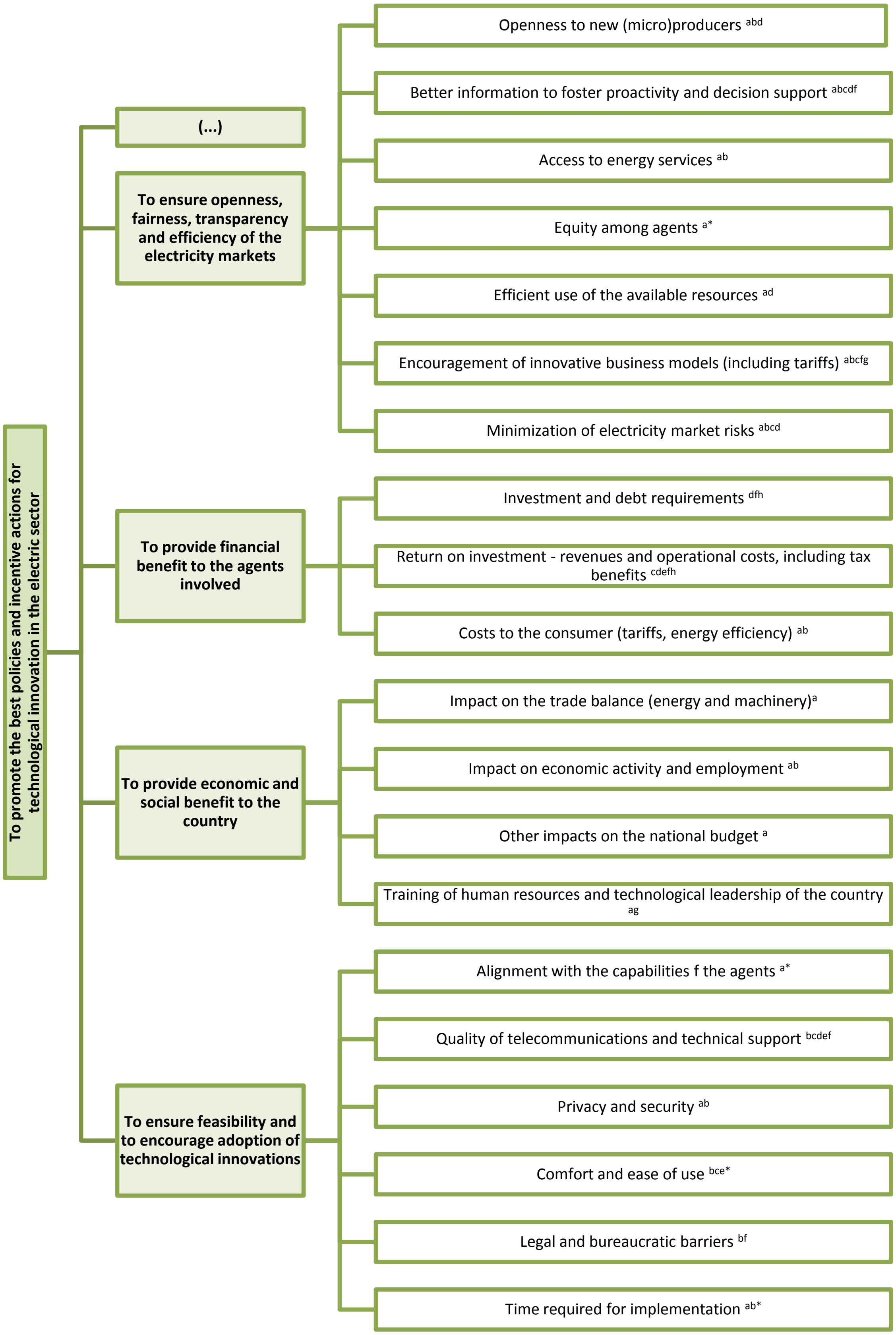

Figure 3 (cont.). Objectives hierarchy identifying the interested stakeholder groups.