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An application of Soft Systems Methodology in the evaluation of policies and incentive actions to promote technological innovations in the electricity sector

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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, integration of larger shares of distributed (micro)generation, and the introduction of storage systems. In addition, these technological developments represent new business opportunities for several players, 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 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 work 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 under different perspectives suggest a large number of issues to be taken into account that were organized as a hierarchy of objectives. These objectives correspond to the criteria of a multicriteria decision analysis model to assess policies promoting technological innovations. This methodology provides decision support to decision makers to shape policies aimed at fostering more reliable and sustainable electricity systems.

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Keywords: Electricity sector; technological innovations; problem structuring; Soft Systems Methodology; multicriteria decision analysis; innovation policies.

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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, multicriteria 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 [1-6], the problem structuring phase should constitute the first step, and one of the most important ones, in decision support processes. Real-world applications emphasize the critical nature of problem structuring in order to gather in a systematized 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