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Combining AHP Method with BOCR Merits to Analyze the Outcomes of Business Electricity Sustainability

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Additional information is available at the end of the chapter

Abstract

Over the last three decades, many researchers and decision makers have investigated separately the issues of economic growth, profitability, and quality of life when thinking about business electricity sustainability. The correlations between these paradigms still remain at the stage of discussions, debates, and forecasts as a reaction to the occurred conflicts and disasters. There is a lack of real encryption that demonstrates their interactions. It is useful to materialize the expectations of stakeholders by mathematical modeling and providing answers to specific wants of each society according to its financial resources, its concrete societal objectives, especially to which kind of energy legacy it wants to contribute to future generations. It is imperative that experts assist decision makers, through transparent methods that seek consensus. To this end, the analytic hierarchy process (AHP) method was proposed as it has proven its efficiency in many areas of human activities. The outcomes were analyzed using this method, and the findings were compared and recommendations were made using other multi-criteria decision-making (MCDM) methods. As for energy sustainability, it is imperative to move toward renewable energy resources while trying to hold together the benefits, opportunities, costs, and risks (BOCR). We have retained that status quo is not sustainable.

Keywords: electricity sustainability, AHP, BOCR, renewable energy resources, cost-benefit analysis

1. Introduction

Sustainable development revolves around the legacy we bequeath to future generations, but it must meet the aspirations of the current generation. Can we build the future by ignor-

ing the present? No. How about the electricity sustainability? The Electric Power Research Institute (EPRI) describes electricity as a solution, an essential foundation for a sustainable world. Modernization of the electric system will increase productivity, contribute to economic growth, and transition to cleaner technologies and environmental sustainability, and it can also increase the reliability and safety of food while reducing the risk of failure or dangerous electrical disturbances as stated by North American Electric Reliability Corporation [1] and Bauchot and Marcaux [2]. In this chapter, we have investigated the main indicators of electricity sustainability, the multi-criteria decision-making methods that allow highlighting decision makers' attitudes and customers' reactions, and finally the merits of some energy resources taking into account simultaneously profitability and quality of life. Nowadays, many companies face the option to expand their business and venture into new global market. For their long-run growth planning, they are required to consider sustainability as a performance index. Decision makers should combine several indicators such as economic, social, and environmental, which are the three main pillars of sustainability. Many opinions were raised on the importance of such an area. Based on the Brundtland report of the United Nations in 1987, some researchers consider equal importance for the three areas [3]. However, Doane and Mac Gillivray [4] have reported that most of the existing sustainability management tools and systems are mainly designed by environmentalists and social scientists. Some do refer to economic sustainability but are so sketchy that they would be inadequate for actually managing a real business. They have shown that maintaining high and stable levels of economic growth is one of the key objectives of sustainable development. Murphy [5] has stated that a relatively limited treatment has been afforded to the social pillar. The author showed the way to expand the parameters of the latter by connecting it empirically to the environmental imperatives. The tilting of the societies in the areas of new technologies and sustainable development is a matter of decision making, knowing that the tools are available with the duty of obtaining the desired results. Today, we should face the decision making on business electricity sustainability in a multi-criteria context, including various energy resources technologies with their positive and negative attributes. Over the past three decades, a considerable progress has been made in multi-criteria decision analysis (MCDA), and many examples of applications can be found in the literature in different areas, such as design and control of complex systems, energy management, environment protection, territory planning and development. To provide knowledge and to assist decision makers, several researchers in sustainability have suggested the use of multi-criteria decision-making methods (MCDM) [6–10]. A review of the literature on analytic hierarchy process (AHP) and BOCR combination has generated a great interest in such fields, and it will be generalized to both enterprise long growth and electricity sustainability. The rest of the chapter is organized as follows: The BOCR subnets development is discussed in Section 2. AHP development is provided in Section 3. It is followed by reviews of its combination with BOCR merits and a concept development in Section 4. Section 5 is devoted to the economic criteria and to cost-benefit analysis methods. The electricity sustainability development with an application to a case study is discussed in Section 6. Conclusion and future work are provided in Section 7.

2. BOCR sub-nets developments for business electricity sustainability

For an energy project leader in business electricity sustainability, we have performed about 40 parameters (with some repetitions), classified into 12 groups, and specific for both BOCR merits and sustainability's main pillars. These groups are as follows: positives, characteristics, factors, results (considered twice), choices, policies, financials, resources, constraints, outlays, and sensitivities. The project leader is also requested to conceal growth and profit seen as key measurements of success, with sustainability observed as an obvious key measurement of quality of life and being better. He is asked for prudent management of risks and opportunities, and for optimistic assessment of benefits and costs. In this way, many researchers have proposed various methods to evaluate environmental, economic, and technical benefits. The important one evolved is the cost-benefit analysis [11, 12]. The BOCR merits toward business electricity sustainability are shown in the flowchart of **Figure 1**. The latter outlines in detail the different interactions between the criteria, the expectations, and the scenarios linked to the nature of the used energy resource. The examination of the hierarchy shows an interesting link between internal and external stakeholders sub-criterion with the BOCR merits regarding the environment pillar of sustainability. When dealing with the benefits, it is a factor. It is a constraint for costs, a policy for opportunities, and sensitivity for risks. That is to say that for energy sustainability, the project holder should join with the partners, contrary to what is done actually, where the tendency is going with political decisions taken at the head of governments. The second lesson drawn comes from the growth and development, which appears as a benefit to get and an opportunity to use, and concerns both economic and environment pillars. The third point discussed concerns job creation and employment. They are highlighted by costs and opportunities for social aspects; they also remain as a former evaluation index of the governments' performance. Unfortunately, nowadays we can observe that statistics confirm a lack of creation due to the inertia in technological transfer regarding restructuration and decentralization on power systems. In their recent publications, many authors [11–16] have stated that for solving a problem by BOCR analysis, they consider both positive attributes (benefits and opportunities) and negative ones (costs and risks) to determine a preference of alternatives in relation to a specific goal. They have defined for costs the following constituents: the capital cost (investment), operation and maintenance cost, pretreatment cost, land use cost, and finally ecological damage cost.

Five formulas were suggested to calculate the overall priorities of the alternatives by synthesizing the priority (B_i, O_i, C_i, R_i) of each alternative under each merit with the corresponding priorities (b, o, c, r) such as

Multiplicative:
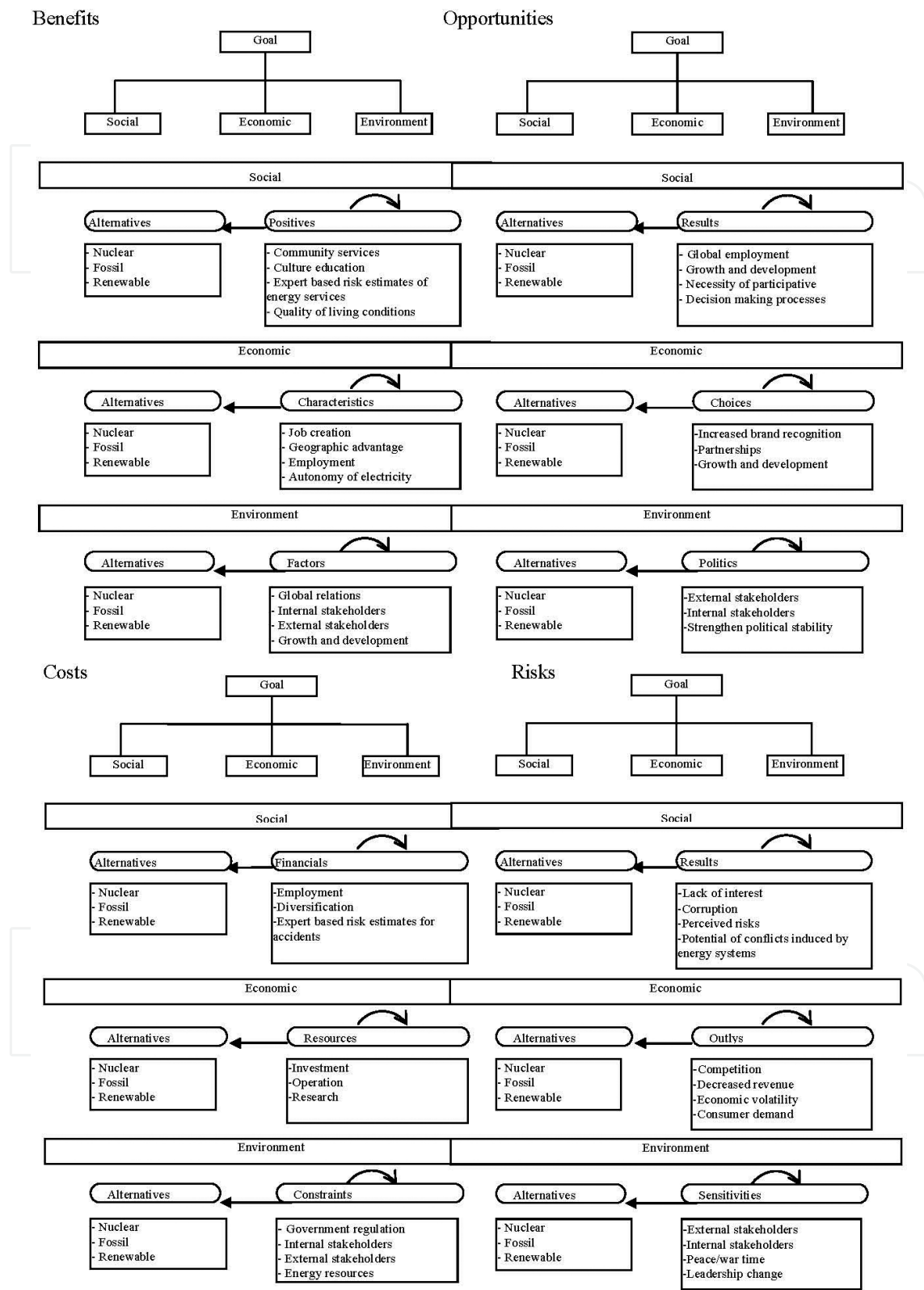
$$P_i = B_i.O_i / C_i.R_i \tag{1}$$

Additive:

Figure 1. BOCR (benefits, opportunities, costs, and risks) networks of electricity sustainability.

$$P_i = bB_i + oO_i + c(1/C_i)_{Normalized} + r(1/R_i)_{Normalized} \qquad (2)$$

Probabilistic additive:

$$P_i = bB_i + oO_i + c(1/C_i)_{Normalized} + r(1/R_i)_{Normalized} \qquad (3)$$

Subtractive:

$$P_i = bB_i + oO_i - cC_i - rR_i \qquad (4)$$

Multiplicative priority powers:

$$P_i = B_i^b . O_i^o . \left[(1/C_i)_{Normalized} \right]^c . \left[(1/R_i)_{Normalized} \right]^r \qquad (5)$$

3. Analytic hierarchy process (AHP) development

The analytic hierarchy process (AHP) is a method of the first performance aggregation-based approaches, and it was introduced by Saaty with the aim of evaluating tangible and intangible criteria in relative terms using an absolute scale. A literature review of around 150 applications was performed, and it stated that AHP use is increasing in the developing countries and augurs well with the economic development of emerging countries [17]. In a recent research dealing with renewable energy reviews, it was stated that the AHP method is popular looking to its simplicity, flexibility, and intuitive appeal [6]. The AHP method is judged as a transparent process and an appropriate tool to avoid conflict of interest when acting in a monopoly business environment and in a regulated market. This is the case of several societies today, where a lot of questions around the energy issues are posed. The approach defined by Rafikul and Saaty [18] involves the identification of the goal, the development of potential scenarios that can meet the desired objective, and the identification of the criteria and sub-criteria that influence the decision, it is summarized as follows:

i.   Having defined the objective of the decision to be reached and knowing a priori the basic scenarios and the criteria of each scenario, we model the problem as a hierarchy;

ii.   Beyond making judgments and using pair-wise comparisons between elements of the hierarchy, we come to establish their priorities;

iii.   After synthesizing the judgments to give a set of global priorities of the hierarchy, we verify their consistency and come to the final decision. Thanks to the sensitivity analysis, we can change a weight or delete a criterion if the consistency returns did not agree within the required tolerance.

Sensitivity measures are developed to determine the robustness of the consistency ratio and the principal right eigenvector to perturbation in the group judgments of the pair-wise comparison matrix, defined as A. The elements of this matrix are designated as a_{ij}, as a quantified judgment.

If A is a consistency matrix, the relations between weights W_i and judgments a_{ij} are simply given as $a_{ij} = \dfrac{W_j}{W_i}$ (for $i,j = 1,2,\ldots,n$). The largest eigenvalue $\lambda_{\max}$ is given as

$$\lambda_{\max} = \sum_{j=1}^{n} a_{ij} \times \frac{W_j}{W_i} \tag{6}$$

If A is a consistency matrix, the eigenvector X can be calculated as

$$(A - \lambda_{\max}I)X = 0 \tag{7}$$

The consistency index CI and the consistency ratio (CR) were proposed to verify the consistency of the comparison matrix. It is adopted that

$$CI = \frac{\lambda_{\max} - n}{n - 1} \tag{8}$$

$$CR = \frac{CI}{CRI} \tag{9}$$

where the values of CRI are varying with the consistency matrix size. In the AHP, the pair-wise comparisons in a judgment matrix are considered to be adequately consistent if the corresponding (CR) is less than 10%.

4. An overview on AHP-BOCR concept development

In a recent publication [13], authors have reviewed the MCDM methods of sustainability and have highlighted their great potential in the field of energy. AHP is the first popular method, and it was found that AHP and its associated family of methods account for 65% of the published papers. They have stated that to deal with the bipolarity of decision attributes more comprehensively, BOCR merits can be introduced into the AHP method to solve a problem. Saaty [19] asserts that the integration of BOCR into AHP allows for more comprehensive way to achieve meaningful preference scores, and it is well suited for the purpose of comparing and assessing energy technologies. It is also regarded as a suitable method to perform

sustainability evaluation owing to its flexibility and the possibility of facilitating the dialog between stakeholders, analysts, and scientists [20]. Recent advances in the literature dealing with the combination of AHP with BOCR have treated the issues, such as AHP-BOCR for energy planning including strategic analysis of wind projects in China [21], electricity supply chain analysis and multi-criteria, multi-actors high-tech selection problem in Turkey [15, 22], analysis of hybrids in renewable power energy generation in China [23] and on the evaluation of sustainable energy based on the view of different stakeholders for North Korea [24]. Other works dealing with AHP-BOCR combination were investigated to help select the suitable wind firm project [21] and the optimal hydrogen production method [25]. AHP-BOCR models have found their applications in economics, industry, and manufacturing, such as evaluation model of buyer-supplier relationships in high-tech industry [26], evaluation of the optimal recycling strategy in upstream of solar energy industry [27], and revitalization strategies in historic transport [28].

The objective of the present investigation is to select the appropriate technology of energy production (from three types of energy sources such as fossil, nuclear and renewable technologies), depending on the scenarios reflecting the behavior of decision makers. BOCR merits are often considered as control criteria as shown in **Figure 2**. For benefits are selected four main sub-criteria such as profitability, power customer satisfaction, life quality, and reduction of vulnerability of energy dependences. The first two criteria can be satisfied simultaneously. The enterprise can enhance performances and realize profits while satisfying the customer wants in terms of quality of service, reliability, and a minimal cost of the kWh delivered [17]. As for life quality, some researchers have measured it using life quality index (LQI) defined as a marginal function [29]. However, the reduction of vulnerability of energy dependences is an issue that concerns economists, politics, and managers. The entities doing forecasts to leave nuclear plants and jump to clean energies in the horizon 2020 or 2025 should take into account the operation feasibility as a function of financial resources needed to uninstall nuclear power plants. This allows us to introduce the costs side, where the cost-benefit analysis method is suggested associated with the economic criteria in uncertain future. It is dependent on the attitudes of decision makers summarized in four scenarios, such as optimistic, pessimistic, prudent, and gambler. Opportunities are also gathered in four clusters such as global employment, growth and development, external and internal stakeholders, and Enhance political stability. They are largely explicated in **Figure 2**, and their impacts are visible in medium- and long-term periods planning. The fourth merit describes the risks such as economic volatility, consumer demand, government regulation, and potential of conflicts. Profitability can be modeled as the gain that the enterprise has to procure; this is why we have introduced in the goal the term business. For costs, two groups are defined: external and internal costs with many constituents, namely capital cost (investment), operation and maintenance cost, pretreatment cost, land use cost, and ecological damage cost. We can define for each alternative a total cost as the sum of those of the constituents. It is to say that usually the cost can be defined as a sum of two costs: fixed cost and variable cost. This question is largely defined in reference [17] as well as for the attitudes of decision makers.
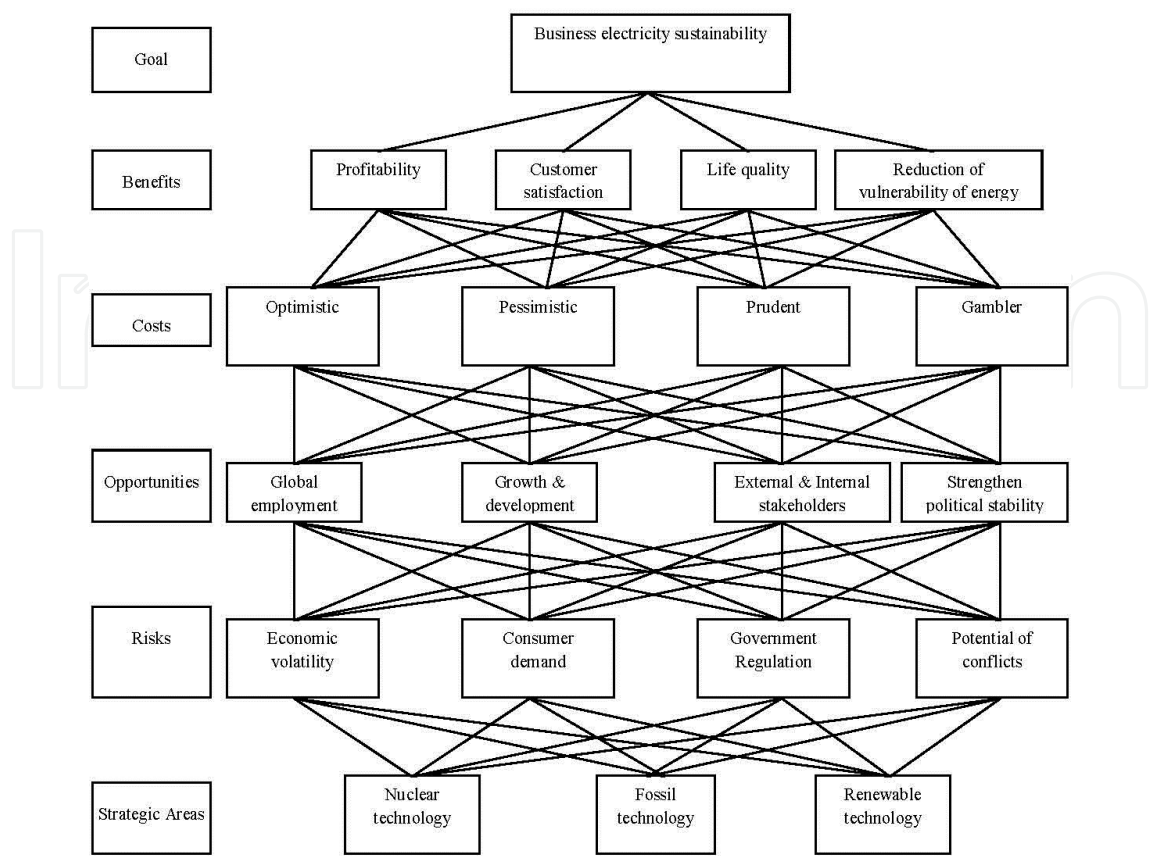
Figure 2. An explicit hierarchy to determination of business electricity sustainability.

5. Economic criteria and cost-benefit analysis

Research and development in the field of electrical energy is not oriented to the production part only, but it should be achieved through management of transmission and distribution networks. Due to the volatility of renewable resources, their integration poses major stability problems in overall networks. It is important to emphasize that technological advances have certain inertia and uncertainties in the outcome. Compared to these two characteristics, it is highly useful to introduce an adequate method of cost/benefit analysis and the decision applicability following economic criteria in uncertain future.

Cost-benefit analysis (CBA) incorporates many different aspects and interests of the involved parties in the decision of the investment strategy. In the traditional least cost planning method, the project with the lowest cost is selected. In that case, the overall cost involves operational, maintenance, and investment costs. However, this is only an economic criterion, and an energy production project might still not be able to provide satisfactory profit, as many parties are affected and during the project period the system configuration may change (e.g., increasing clean energy and decreasing fossil one, and vice versa). The proposed method will help select the project with a discounted benefit greater than its discounted cost, given as an indication

of its profitability. It should be combined with the multi-criteria analysis described earlier to provide satisfactory information for a confident solution. We propose a CBA that considers environmental, economic, and social benefits. The expression of these benefits turns around the rest of the difference between the revenues and the total costs. For economic criteria inspired from the game theory, there are a number of criteria for the analysis of game matrix and decision choice [17, 30].

In the Bayes-Laplace criterion, a probability or a weight is associated with each scenario i. If the cost associated with scenario i for a strategy j is V_{ij} and the probability of each scenario is Q_j, then the selection is made as follows:

$$Z_{BL} = \min_i \sum_j Q_j V_{ij} \tag{10}$$

In this economic criterion, each scenario is taken into account, and its importance is reflected through its probability of occurrence. The advantage of this criterion is that it leads to a risky decision.

In Laplace's criterion, the occurrence probabilities of scenarios are unknown, and the events are assumed equality probable. Laplace's criterion is processed as an optimal solution, minimizing the mathematical expectation of costs; its formulation is as follows:

$$Z_L = \min_i \frac{1}{n} \sum_j V_{ij} \tag{11}$$

The mini-max decision rule is to seek decision makers' action, which minimize the maximum potential loss. A decision maker who uses the mini-max criterion acts extremely conservative. He seeks the actions that achieve the best outcome under the worst scenario. The optimal solution is given as follows:

$$Z_{mM} = \min_i \ \max_j \ V_{ij} \tag{12}$$

The maxi-min criterion, known as Wald one, describes a prudent attitude of a decision maker. Its objective involves the identification of a scenario leading to worse outcomes. A decision maker adopting this criterion tries to cover himself by providing the least bad possible result. This technique provides information that the evolution of the competition (scenarios) is detrimental to the company.

$$Z_{Mm} = \max_i \ \min_j \ V_{ij} \tag{13}$$

Adopting the Hurwitz criterion consists of the assessment for each strategy a weighted average of the worst and the best of its potential outcomes and choose the one for which the solution is the largest. According to this criterion, the solution is given as follows:

$$Z_H = \min_i \left[\alpha.\max_j(V_{ij}) + (1 - \alpha).\min_j(V_{ij}) \right] \qquad (14)$$

where $0 \leq \alpha \prec 1$ is a parameter indicating planers' attitude toward risk. The value $\alpha = 1$ reduces Hurwitz' criterion to mini-max criterion as described above and corresponds to an extremely pessimistic decision maker. The value $\alpha = 0$ corresponds to an extreme optimism.

6. Electricity sustainability development

6.1. Criteria and indicators

This investigation was conducted to assist decision makers to understand the societal, economic, and environmental issues of the need for sustainable energy transition. The assumptions and models were summarized on the basis of existing data provided in the bibliographic references. They were submitted to experts to select those that meet the criteria of quality and relevance. The data used in this work are obtained from the statistical treatment and probabilistic modeling in the case where there are no archive data or a limited number available, with the help of expert judgments. Experts are energy service providers, politics oriented to research and development, specialists in the integration of renewable resources to networks, nuclear and nonrenewable energy scientists, researchers in risk analysis, and specialists in the management of energy-related conflicts. Each expert group dealing with the issue of sustainable development can provide a range of economic, environmental, and social indicators. As noticed in the literature, economic and environmental indicators seem to be obvious and common to the overall society, but it is not the case for social ones. Certainly, the sources of conflicts and accidents in the energy field are not frequent looking to electricity, but the impact of nuclear component highlights the main concerns. They reside in the utilities dysfunction causing blackouts due to their high capacities of production and risk of contamination in the case of accidents (random or premeditated (sabotage)). As for sustainable development, electricity sustainability (ES) is based on the three known pillars such as social aspects, economic and environment criteria, and indicators noted (Ci) and their associated subcriteria noted (Cij).

Environment (C1): Resources (C11; energy resources and mineral resources), Climate change (C12), Ecosystem damage (C13; impacts from normal operation and impacts from severe accidents), Waste (C14; chemical waste in underground depositories and radioactive waste in geological repositories).

- Economy (C2): impacts on customers (C21; price of electricity), impacts on the overall economy (C22; employment and autonomy of electricity generation), impacts on utility (C23; financial risks and plant operation characteristics).

- Social aspects (C3): The continuity of electricity supply (C31); stability of decisions centers (C32); the issue of energy systems and the stakeholders' contribution in decision making (C33); risks of accidents, perceived risks, and terrorist threat, the quality of living conditions (C34).

### 6.2 Case study application, simulation, and results

To the hierarchy given in **Figure 1**, were associated the criteria and their sub-criteria introduced in -Section 6.1 and using energy production resources as alternatives, we have determined a long-run growth of a company in the context of electricity sustainability.

To highlight the great interest of AHP application in sustainability, particularly in the field of energy, we have applied this process with the objective to compare the obtained results with those outlined by other MCDA methods summarized by Hirschberg [3], investigating the development of sustainability assessment at PSI. The different steps of AHP applications were followed, and the pair-wise comparison results between the indicators with respect to the goal are given in **Table 1**.

	Environment (C1)	Economy (C2)	Society (C3)	Priorities
Environment (C1)	1	1	1.1	0.343
Economy (C2)	1	1	1.1	0.343
Society (C3)	1/1.1	1/1.1	1	0.312
	$\lambda_{max} = 3.001$	$CI = -0.0001$	$CR = 0.00002$	

Table 1. Pair-wise comparison matrix of the criteria with respect to the goal.

It appears clearly that the criteria are equally prioritized and shown in **Figure 3(a)**. In **Figure 3(b)** are given the proportions (in %) of each sub-criterion against its main criterion (red color % represents the main criterion, black color % represents the sub-criterion against the main criterion, and blue color % represents the sub-criterion against the goal). Each value of a sub-criterion can be found using the following operation: (sub-criterion priority (in %) = the sub-criterion priority (in %) against the goal/the main criterion priority (in %) against the goal). In this case, the advantage of the AHP method is that it is possible to change weights to have an appropriate priority. However in the case of MCDA proposed in reference [3], the results are obtained from a survey work. The results in **Table 2** show the priorities of alternatives are based on all sub-criteria. The results have allowed us to do a synthesis in the case of equal priorities of main criteria, as given in **Table 3**. From decision makers' point of view, this consideration shows the prudent attitude. And the results show a high priority to renewable resources, followed by nuclear one, but the gap is not significant.

(a)

(b)
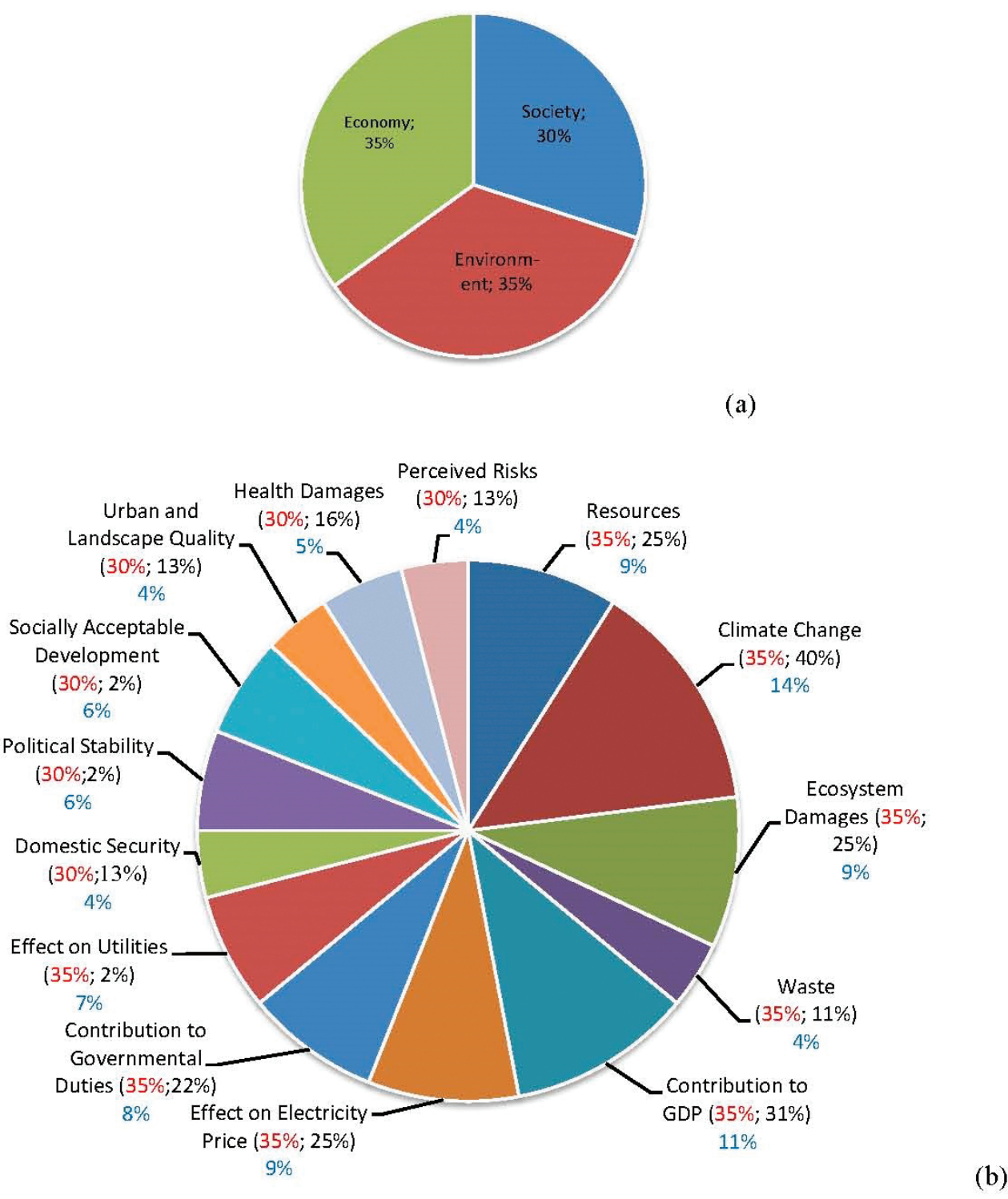
Figure 3. Syntheses of criteria and sub-criteria priorities (case of a prudent decision maker): Main criteria with relatively equal priorities (a) and sub-criteria weights (% in black) using AHP, to achieve the priorities (% in blue) compared to the goal (b).

C11	A1	A2	A3	Priorities	C12	A1	A2	A3	Priorities
A1	1	½	1/3	0.222	A1	1	3	1/3	0.249
A2	2	1	1/6	0.112	A2	1/3	1	1/6	0.097
A3	3	6	1	0.666	A3	3	6	1	0.654
	$\lambda_{max} = 3.000$	$CI = 0.00002$	$CR = 0.00003$			$\lambda_{max} = 3.018$	$CI = 0.0009$	$CR = 0.0158$	
C13	A1	A2	A3	Priorities	C14	A1	A2	A3	Priorities
A1	1	1/3	1/5	0.105	A1	1	½	1/4	0.135
A2	3	1	1/3	0.256	A2	2	1	1/3	0.235
A3	5	3	1	0.639	A3	4	3	1	0.630
	$\lambda_{max} = 3.038$	$CI = 0.0193$	$CR = 0.0332$			$\lambda_{max} = 3.0536$	$CI = 0.0268$	$CR = 0.0462$	
C21	A1	A2	A3	Priorities	C22	A1	A2	A3	Priorities
A1	1	3	5	0.637	A1	1	½	2	0.297
A2	1/3	1	3	0.258	A2	2	1	3	0.539
A3	1/5	1/3	1	0.104	A3	1/2	1/3	1	0.163
	$\lambda_{max} = 3.0385$	$CI = 0.0193$	$CR = 0.0332$			$\lambda_{max} = 3.0092$	$CI = 0.0046$	$CR = 0.0079$	
C23	A1	A2	A3	Priorities	C24	A1	A2	A3	Priorities
A1	1	2	3	0.527	A1	1	3	2	0.539
A2	1/2	1	3	0.332	A2	1/3	1	1/2	0.163
A3	1/3	1/3	1	0.139	A3	1/2	2	1	0.297
	$\lambda_{max} = 3.0536$	$CI = 0.0268$	$CR = 0.0462$			$\lambda_{max} = 3.0092$	$CI = 0.0046$	$CR = 0.0079$	
C31	A1	A2	A3	Priorities	C32	A1	A2	A3	Priorities
A1	1	2	5	0.581	A1	1	2	4	0.558
A2	1/2	1	3	0.309	A2	1/2	1	3	0.319
A3	1/5	1/3	1	0.109	A3	1/4	1/3	1	0.122
	$\lambda_{max} = 3.0037$	$CI = 0.0018$	$CR = 0.0032$			$\lambda_{max} = 3.0183$	$CI = 0.0091$	$CR = 0.0158$	
C33	A1	A2	A3	Priorities	C34	A1	A2	A3	Priorities
A1	1	1/2	3	0.332	A1	1	2	3	0.539
A2	2	1	3	0.527	A2	1/2	1	2	0.297
A3	1/3	1/3	1	0.139	A3	1/3	½	1	0.163
	$\lambda_{max} = 3.0536$	$CI = 0.0268$	$CR = 0.0462$			$\lambda_{max} = 3.0092$	$CI = 0.0046$	$CR = 0.0079$	
C35	A1	A2	A3	Priorities	C36	A1	A2	A3	Priorities
A1	1	2	1/4	0.218	A1	1	2	1/5	0.186
A2	1/2	1	1/3	0.151	A2	1/2	1	1/4	0.126
A3	4	3	1	0.630	A3	5	4	1	0.687
	$\lambda_{max} = 3.1078$	$CI = 0.0539$	$CR = 0.0930$			$\lambda_{max} = 3.0940$	$CI = 0.0470$	$CR = 0.0810$	

Table 2. Comparison matrices and local priorities.

	ENVIRONMENT (C1)				ECONOMY (C2)				SOCIETY (C3)						Priorities
Weights	0.343				0.343				0.314						
Sub-criteria	C11	C12	C13	C14	C21	C22	C23	C24	C31	C32	C33	C34	C35	C36	
Weights	0.254	0.346	0.242	0.157	0.321	0.252	0.226	0.200	0.139	0.207	0.205	0.149	0.153	0.145	
Nuclear resource	0.222	0.249	0.105	0.135	0.637	0.297	0.527	0.539	0.581	0.558	0.332	0.539	0.218	0.186	0.364
Fossil resource	0.112	0.097	0.256	0.235	0.258	0.539	0.332	0.163	0.309	0.319	0.527	0.297	0.151	0.126	0.266
Renewable resources	0.666	0.654	0.639	0.630	0.104	0.163	0.139	0.297	0.109	0.122	0.139	0.163	0.630	0.687	0.370

Table 3. Final results using synthesis (equal importance of main criteria).

In the case where the decision maker is optimistic toward environment effects, a high priority is given to the environmental aspects as highlighted in **Table 4** and confirmed in **Figure 4**; it shows that the renewable resources won the highest priority with an important gap compared to the other alternatives.
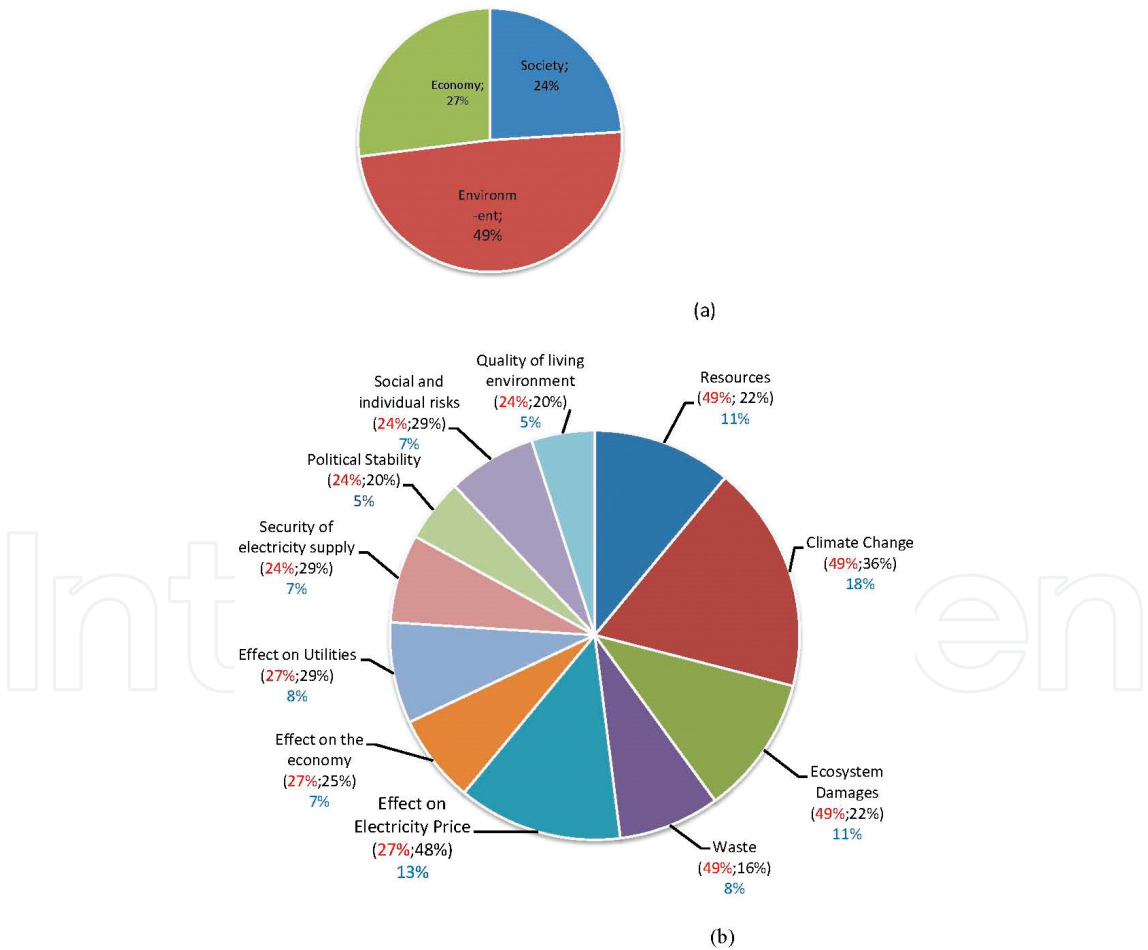
Figure 4. Syntheses of criteria and sub-criteria priorities (case of an optimistic decision maker toward environment): Main criteria with the main dominance of environment criterion (a) and sub-criteria weights (% in black) using AHP, to achieve the priorities (% in blue) compared to the goal (b).

Main criteria	Environment (C1)				Economy (C2)			Society (C3)				Priorities
Weights	0.490				0.270			0.240				
Sub-criteria	C11	C12	C13	C14	C21	C22	C23	C31	C32	C33	C34	
Weights	0.229	0.368	0.229	0.173	0.458	0.256	0.284	0.291	0.208	0.291	0.208	
Nuclear resource	0.222	0.249	0.105	0.644	0.297	0.547	0.539	0.218	0.558	0.218	0.333	0.283
Fossil resource	0.112	0.097	0.256	0.270	0.539	0.263	0.163	0.630	0.319	0.151	0.569	0.274
Renewable resources	0.666	0.654	0.639	0.085	0.163	0.189	0.297	0.151	0.122	0.630	0.097	0.443

Table 4. Final results using synthesis (with the dominance of environmental aspect).

Based on the investigation of Doane and Mac Gillivray [4], where they have stated that the economic criterion should be of high interest compared to the other criteria, we have considered that the decision maker is optimistic toward economy and relatively pessimistic toward social and environmental issues. The synthesis given in **Table 5** shows a high priority for nuclear resource with a nonsignificant gap compared to the other alternatives.

	Environment (C1)				Economy (C2)				Society (C3)						priorities
Weights	0.270				0.490				0.240						
Sub-criteria	C11	C12	C13	C14	C21	C22	C23	C24	C31	C32	C33	C34	C35	C36	
Weights	0.229	0.368	0.229	0.173	0.321	0.252	0.226	0.200	0.139	0.207	0.205	0.149	0.153	0.145	
Nuclear resource	0.222	0.249	0.105	0.644	0.637	0.297	0.527	0.539	0.581	0.558	0.332	0.539	0.218	0.186	0.395
Fossil resource	0.112	0.097	0.256	0.270	0.258	0.539	0.332	0.163	0.309	0.319	0.527	0.297	0.151	0.126	0.276
Renewable resources	0.666	0.654	0.639	0.085	0.104	0.163	0.139	0.297	0.109	0.122	0.139	0.163	0.630	0.687	0.329

Table 5. Final results using synthesis (with the dominance of economic aspects) with a completed number of sub-criteria.

Through this simulation, we retain the interest of the environmental aspect in sustainable development, and the development of renewable resources is imperative. From decision makers' point of view, the AHP method allowed us to simulate attitudes of managers without difficulty.

7. Conclusion and future work

Today, many countries set a policy goal commonly recognized in the long term, energy supply must be laid out more sustainably. The fossil energy source, which is still largely used to satisfy this demand, is the main cause of climate change. Energy demand cannot be satisfied with a sustainable and climate-friendly way that if energy supply and energy use are reworked in depth. Two lines of action are preferred: first, energy demand should be reduced substantially by its more efficient use and voluntary parsimony (sobriety); second, the energy supply in

the future must be based on renewable energy sources. The investments required for this reorganization of the energy system are enormous, and it will change in depth the energy sector and consumption patterns. This requires political framework conditions granted internationally. Compared to this point, we have used in this work evaluating method of cost/ benefit analysis and introduced the economic criteria in uncertain future for the assessment of costs.In the coming decades, nuclear power stations of the majority of countries will reach the end of their life in terms of the installations security. Approximately half of the current electricity supply will no longer be available. Meanwhile, despite the efficiency improvements, demand continues to increase, with the use of new technologies requiring electricity, population growth, increased consumption possibilities, and substitution of fossil fuels in the areas of heating (heat pump) and mobility (electric vehicles).The accident at the Japanese nuclear plant in Fukushima in March 2011 has raised a new urgency to the question of how the majority of developed countries rely on ensured electricity supply. Nuclear technology has at least for now lost acceptance; availability to start the "energy revolution" seems to have increased. To meet this energy revolution, we must, however, make decisions under uncertainty. Always incur certain risks, and it is unclear how to react dynamic system made by humans and their environment. Decisions must be taken, so that the electricity supply remains assured on one hand, and can be adapted to the changed framework conditions on the other.It must also respond to economic issues: how the investments are made in a liberalized electricity market, in which the generation, transmission, and distribution are separated? How will be the future of the business of electricity supply companies? so they must be compatible with a decentralized production of renewable electricity, more efficient use of electricity by consumers, and maintenance.The supply of future electricity of any country depends largely on technical and economic developments. The preferences of individual electricity consumers and the behavior of electricity producers and network operators in terms of investments likewise play a central role. Finally, political and legal decisions also influence the future of electricity supply. These decisions concern the efficient use of electricity, renewable electricity, the problem of adjustment and storage, network expansion, and liberalization of the electricity market. The decisions of the months and years ahead will influence the supply of electricity for decades. The question therefore arises of the bases on which lay the next milestones. And it is in this context that the AHP-method-based consensus was introduced with the details of the opportunities, benefits, costs, and risks of all proposed alternatives. The AHP method combined with BOCR merits becomes popular, looking to its simplicity, flexibility, and intuitive appeal. It was demonstrated that this combination allows the project holder to think objectively and to consider simultaneously profitability, customer satisfaction, and life quality on one hand and have the certitude that status quo is not sustainable on the other. The future work consists of the issue of combining AHP-BOCR paradigm with new information and communication technologies to solve the problem of unpaid bills of diminished customers by transforming state's aids on energy prepaid cards using the advantages of smart energy counters from one hand and the management of high pick of energy demand by shedding load for customers' owners of emergency resources instead of ordinary customers, using current power lines (CPL) from the other hand.

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