Available online at http://ijdea.srbiau.ac.ir

Int. J. Data Envelopment Analysis (ISSN 2345-458X)

Vol.2, No.2, Year 2014 Article ID IJDEA-00224, 7 pages

Research Article

International Journal of Data Envelopment Analysis

Science and Research Branch (IAU)

Hierarchical Analysis Method Application in Prioritization of Power Plant with Renewable Energy in Iran-case study

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Received 05 February 2014, Revised 10 June 2014, Accepted 28 June 2014

Abstract

With regard to the importance of scientific decision-making in power plants prioritization to produce electrical energy (power) from renewable energies (purified), in this paper, research with specialists opinions with respond to questionnaires provided upon three efficient operational criterion in position of three presented power plant in country which used wind, solar water energies for producing energy, and using group hierarchical analysis multi-criteria decision-making method (AHP), options prioritization performed Achieved results indicates this fact that among three presented criteria, environmental issues are the most important criteria and standards of maintenance costs and also initial investment cost per Kw/h produced electricity (power), in order of importance, are in second place and one the other hand, among three presented power plant in Iran which used renewable energies (new) for producing power, wind power plant placed in first priority and then solar and electrical power plants-water are in the second placed.

Keywords: Decision Making, Hierarchical Analysis, Renewable, Power.

1. Introduction

Energy called life essence, so that it is one of the crucial factors in economic and social development of each country. One of the energies which plays very important role in societies, is electrical energy,

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which regards to existing renewable and none renewable resources produced in nature. This energy produced by power plants and injected in country's power network.

On the one hand, oil crisis outbreak in 1973 and available limited human resources, required experts to create new methods indifferent decision making such as energy and on the other hand, negative effects resulted from power plants functions on environment, has led experts to believe that in new energy producing models, pay attention to environmental observations simultaneously with economical and technical observations. Awareness and worry growth in environment case in 80 century also gradually modified decision-making frameworks and needs to integrate environmental observation with economical and technical issues made a comprehensive use of multi-criteria decision- making in energy issues.

Multi-criteria decision-making, is general terms for all of the methods which help to decision-makers in issues with more than one criteria, based on tendencies and priorities (Luken, 2007), today, these methods are considered by many researchers Pohker and are Ramachandran [9] review more than 90 Articles, Zhou and colleagues [12] studied 252 Articles and Behzadian [5] and his colleagues also review 217 articles. The subject of these articles were multi-criteria decision-making in energy field. Kowalski [7] and others design scenarios and criterion in national and regional level and assess scenario with multi-criteria methods for Austria renewable resources. In Canada, performed one multi-criteria study on renewable sources and proposed five renewable resource and six criteria for choosing the best resource among options.

In California, four scenario designed and analyzed for energy planning until 2035.

In china with the purpose of better comprehension of possible path ways for power development used this method based on fuel sources and greenhouse gas diffusion rate.

For future power demand supply in Indonesia, used planning based on scenario across study.

With regard to above issues, this article introduce systematic framework in order to decision making about prioritizing three presented power plant in Iran. Which using renewable energies (new) produced for this purpose.

Mechanical engineering and authorities in energy field, employed in power industry and studied review about criteria that can have vital role in decision-making to prioritizing this kind of power plants for producing power in Iran and with exploiting from group hierarchical multi-criteria decision making performed periodization.

So, first, the concept of multi-criteria decision making and hierarchical analysis method and decision making elements introduced, and familiar with renewable energies concept and then a summary of article presented.

2. Multi- criteria decision-making

Decision-making, is a study for recognize and selecting options for finding the best solution based on different factors with concerning person's expectations and tendencies involved in decisions.

Multi decision-making MCDM, are useful decision-making methods that in them, decision-making performed upon compromise and agreement between criterion which, may sometimes be at conflicts with each other. These kind of methods allow decision-makers assess options based on multi-criteria and choose or rank them.

Multi-criteria decision-making model includes five key elements which they are: options, criterion, the points of each option in each criteria and response selecting system. Criteria in decision-making may be presented in two forms Attribute and/or objective. Based on multi-criteria issues divided in two multi-attribute and multi-objective categories. In multi-Attribute case we deal with issues that decision-maker to choose one options among several options with regards to multi-factors or rank options and multi-objective case used for issues that decision-maker want to determine the rate of activity with which is power plant options assessment and prioritization and selecting excellent option, multi-criteria decision making used in this article is as kind of multi-attribute decision-making.

Multi-criteria decision- making model involved five key elements that they are: options, criterion, criteria weight, the scores of each option in each criteria and response selection system, and based on, in the next parts, above five components (elements) to making decision for future electrical energy production studied in power industry.

2.1. Response selection system with group hierarchical analysis method

For evaluating options in this article, used group hierarchical analysis (AHP) which is one of the most useful techniques of multi-criteria decision-making. AHP; in addition to, qualitative criteria used quality criteria and allowed person to put specialized-non-objective inputs, individual experience and it's specialized intuitive in issue.

In this strategic method, decision portray in one tree. The above level of tree indicate purpose, intermediate level indicate criterion and the last level show options. Then a set of comparison by specialized individual or group performed based on technical knowledge, the intuitive potential, previous experiences and specialist existing position, for this purpose, the components of each level compared as two by two with regards to alone elements of higher level with each other and their relative rate don't have an any scores. Privilege consequents in different levels, determine the scores of each option as a whole.

In this article, the purpose (aim) is to prioritize wind, solar and power-water plant powers and criteria, environmental issues, maintained cost and also initial investment cost per Kw/h produced power-water plant power's option.

2.2 Scoring the options and criterion

For evaluating considered power plant's options in research to produce (generate) clean (purified) power, in this research based on selected criterion with group AHP method, first, this surface hierarchical tree is plotted acceding to Figure 1. Then options evaluation performed by groups of specialist of electrical engineering course (degree). Mechanical engineering and experts in the field of energy, employed in power industry. For collecting specialist's options, the questionnaire regulated upon hierarchical structure. In this questionnaire to choose best choose option in each question with comparing raised (presented) options and belonged option fits to desirable rate of option. Privileges (scores) calculated in four matrix of paired comparisons and with determine the total score for each criteria and options, ranking options was performed. By doing this, four paired comparison matrix, achieved according to table 1. In this table, the weight of each criteria and also score of each options are observed in each criteria.

3. Renewable energies (New)

The renewable energies are the kind of energy which, unlike the non-renewable energies, have the ability to return to nature and include wind energy, solar and water energy and geothermal energy.

4. Results

Based on achieved results, wind power plants with achieving %41 score placed in first rank and solar and power-water power plants with %35 and %24 in next rank, respectively- Among these three presented criteria, environmental criteria issue with achieving %59 score is the most important criteria and maintained cost and initial investment cost per Kw/h producing power with %31 and %20 placed in next position.

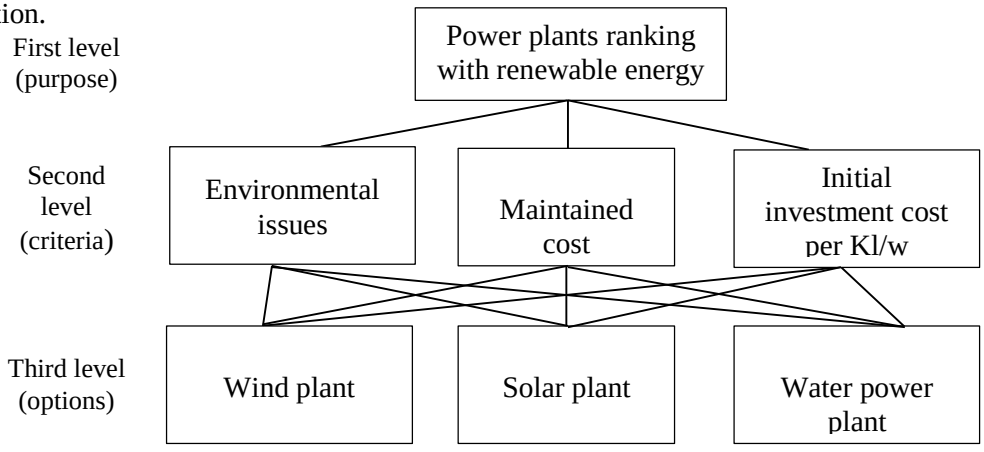

Figure1.Three surface hierarchical tree and the procedure of doing paired comparisons

Table1. Hierarchical tree elements in different levels and each component's score with regards to higher level elements

First level (Purpose)	**Second level (Criteria)**	**Third level (Options)**
Prioritizing power plants with renewable energy with group AHP	1. environmental issues (%59)	1. wind power plants (%22)
		2. solar power plants (%22)
		3.water power plants (0.16)
	2. maintained cost (0.21)	1. wind power plants (0.08)
		2. solar power plants (0.09)
		3.water power plants (0.05)
	3. initial investment cost per Kw/h produced power (0.20)	1. wind power plants (0.12)
		2. solar power plants (0.04)
		3.water power plants (0.03)

Table2. Obtained score for presented power plants in research and ranking them

Row	**Power plant kind**	**Obtained score**	**Rank**
1	Wind	0.41	1
2	Solar	0.35	2
3	Water power	0.24	3

Hierarchical methods could (enable) to illustrate comparison's compatibility rate with compatibility index calculation. If these index is below %1 comparisons are compatible with each other. Coefficients in this study obtained below %1 which indicate acceptable harmony and compatible in specialist opinions.

5. Conclusion

In this article, the prioritization of plant powers which generate power energy with using renewable energies, performed with group AHP method. Considering individual experience and decision-makers intuitive comprehension (understanding), using qualities and quantities criterion in one framework, are the benefits of this method. When using this this method, it should be noted that the results of this method always subject to the supervision of specialists team and also depend on the choice of criterion. So that in this study, specialists society which referred to them have desirable (suitable) diversity whether expertise area or activity field.

This has caused them to consider issue from different angles and perspectives using performance measure can and also this method's dependency resolve criterion choice. Achieved compatibility coefficient below %1 indicates performed paired comparison validity (value).

With regards to that in this research, we used group decision-making and "group decision-making quality is higher that individual decision-making". ATaee [3] and on ther hand, indicative of wind power plant's choice. As it noted previously, the environment pollution rate criteria determined as the most important decision-making criteria as view of experts and also choosing wind plant powers (completely) fully overlapped each other with these criteria, because in this wind power plants for generating electrical energy (power), Used wind energy which is part of renewable energy (New or purified)c Which doesn't have any pollution for environment. During several years ago, with developing environmental attitude and economical strategies in exploiting of renewable energies resources, using wind energy in comparison with other presented energy resources in many world's country are increased. Using wind turbine technology can be a suitable choice in comparison with renewable energy source as a following reason:

1. No need for water, 2. Lack of environmental pollution, 3. No need of wind turbine to fuel, 4. Creating permanent energy system and 5. The low cost of wind turbines in comparison with others form of energy. So that, the specialists, in designs related to generating electrical, in designs related to generating electrical energy (power) must considered environmental issues with economic issues, simultaneously and use renewable material in energy cycle.

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