APPLICATION OF PREFERENCE RANKING ORGANIZATION METHOD FOR ENRICHMENT EVALUATION METHOD IN ENERGY PLANNING - REGIONAL LEVEL

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Abstract. Nowadays energy is one of the most essential needs of human being and it can be considered as the basic prerequisite of social and economic development. Hence, many of the correlations and legislations of a country are affected by it. Since Iran has huge source of gas and oil, it has turned to a fossil fuel oriented county. But as oil and gas sources are non-renewable ones and cannot be replaced, it is essential for every country to focus on Renewable Energy Sources (RES). So today is the time of studying and investing on RES to be able to exploit them in the time of oil and gas crisis. In the past, the choice among alternative sources was based on the cost minimization, but ranking the RES options is a complex task. The objective of this paper is determining the best renewable energy alternative for Sistan & Baluchestan province of Iran by using interval Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) method. In the application of the proposed methodology the most appropriate renewable energy alternative is determined fuel cell and biomass for the mentioned province.

1. Introduction

Energy is a vital input for social and economic development of any nation. By increasing agricultural and industrial activities in Iran, demand for energy is also increasing. Formulation of an energy model will help in the proper allocation of widely available renewable energy sources such as solar, wind, bioenergy and small hydropower in meeting the future energy demand in Iran [14]. In the past, the choice among alternative sources was based on cost minimization, but ranking the RES options is a complex task, considering different aspects such as technological, environmental, social and economic ones. Multi criteria decision making (MCDM) methods can help governments to evaluate energy sector plans and policies [15]. Renewable energy sources have been important for humans since the beginning of civilization. Clean, domestic and renewable energy is commonly accepted as the key for future life. This is primarily because renewable energy resources have some advantages when compared with fossil fuels. Renewable energy sources are also called alternative sources of energy. Renewable energy resources that use domestic resources have the potential to provide energy services with zero or almost zero

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emissions of both air pollutants and greenhouse gases. Main renewable energy resources are biomass energy, Fuel cells, geothermal energy, solar energy, and wind energy [3-6].

Since there are many criteria which usually are conflicting ones, conducting the survey based on e.g. cost minimization will not lead us to an acceptable output. So we need to rank the alternatives according to so many criteria which must be summarized to the most frequently used ones. In this paper, PROMETHEE which is an outranking technique is used to rank different kinds of renewable energy sources. PROMETHEE can be easily adapted for group decision aid, for example by including different weighting schemes [7-9]. Thus, in our study PROMETHEE is preferred to other outranking approaches, because it is perceived to be more transparent and easier to understand even for decision makers (DM) not familiar with Multi Attribute Decision Making (MADM)[8,10,11].

In this paper the use of PROMETHEE method in the ranking of renewable energy sources of Sistan & Baluchestan province of Iran is shown. The method is improved by using SMART Exploiting Ranks (SMARTER) method for assigning the weights of relative importance of attributes.

The paper is organized as follows: Section 2 reviews MADM methods which have been used in energy planning and also includes some of recent studies about renewable energy ranking by use of MADM methods. Section 3 gives a brief summary about the potential of renewable energy sources of Sistan & Baluchestan province. Section 4 introduces the used methodology in this paper. Section 5 is dedicated to the explanation of interval PROMETHEE. Section 6 presents the related criteria to evaluate the alternative renewable energy resources and includes application of the proposed methodology in the energy planning problem of this paper. Finally results and conclusion are discussed in section 7 and 8.

2. **Review on MADM Methods on Energy Planning**

MADM methods can help governments to evaluate energy sector plans and policies. Recently some studies of MADM have concentrated on energy planning. In this section the recently ones, after 2000, are summarized.

Kahraman et.al [15] presented the selection of criteria and options for the new and renewable energy alternative assessment. They also considered biomass, hydropower, geothermal, wind and solar energy as the most appropriate renewable energy alternative in Turkey. They used axiomatic design and Analytical Hierarchy Process (AHP) for renewable energy alternatives under fuzziness.

Kaya and Kahraman [17] aimed at determining the best renewable energy alternative for Istanbul by using an integrated VIKOR (Vlsekriterijumska Optimizacija I Kompromisno Resenje) -AHP methodology and then selecting among alternative energy sites in this city by using the same approach. Kahraman and Kaya [16] suggested a fuzzy multicriteria decision-making methodology for the selection among energy policies. The methodology is based on AHP under fuzziness. In this paper a fuzzy multi criteria decision-making procedure proposed by Zeng, An, and Smith [34] is reconstructed to select the best energy policy alternative. A modified AHP method is applied to work out the priority weights of energy policy alternatives.

Yung-Chi Shen et.al [27] attempts to reveal the suitable renewable energy sources for the purpose of meeting the 3E (Energy, the Environment, and the Economy) policy goals. They used fuzzy analytical hierarchy process (FAHP) to resolve the multi-goal problem for achieving the research purposes.
Eunnyeong Heo et.al [12], according to a paper with the title of analysis of the assessment factors for renewable energy dissemination program, established the criteria and factors about effective dissemination program alongside Research and Development (RD) on new and renewable energy technology using AHP method.
J. Terrados et als approach [29], combines advantages of PROMETHEE, Delphi and SWOT analysis. Validation and assessment of the strategies had been done by means of experts opinion. Applying Multiple Criteria Decision Analysis (MCDA), ranking of alternatives had been done and according to this stage, final strategies had been chosen and so the amounts of energy production from different renewable energy resources were suggested.
S. Ghafghazi et al [10] used PROMETHEE method to rank the energy options. The PROMETHEE II method was used to rank the alternatives against six criteria of cost, Green House Gas (GHG) emissions, particular matter (PM) emissions, maturity of technology, traffic load, and local source.
Beccali et al [3] conducted a survey to show an application of the multi criteria decision-making methodology used to assess an action plan for the diffusion of renewable energy technologies at regional scale. This methodological tool helps decision-maker in the selection of the most suitable innovative technologies in the energy sector, according to preliminary fixed objectives. In this paper, a case study is carried out for the island of Sardinia.
Haralambopoulos and Polatidis[23] describe an applicable group decision making framework for assisting multi-criteria analysis in renewable energy projects, utilizing PROMETHEE II outranking method. The proposed framework is tested in a case study concerning the exploitation of a geothermal resource, located in the island of Chios, Greece. Four scenarios were chosen instead. In this paper they developed an integrated, dynamic framework for achieving group consensus in renewable energy projects based on PROMETHEE II.
Georgopoulo et al [9] presented a paper in which they used Elimination et choice translating reality (ELECTRE) III to take into account several and often conflicting points of views about a significant potential of renewable energy sources, through the examination of a particular case study in a Greek Island.
Haris Doukas et al [8], in their paper with the title of Computing with words to assess the sustainability of renewable energy options show how energy policy objectives towards Sustainable development (SD) and RES options are related and assessed using linguistic variables. The linguistic variables take values from a set of linguistic terms and their semantics is represented by the corresponding fuzzy sets. The objective of the paper is to extend the numerical multi criteria method TOPSIS for processing linguistic data in the form of 2-tuples, so as to show how energy policy objectives towards SD and RES options are related and assessed using linguistic variables.
Julia Oberschmidt et al [21] tried to elaborate a multi-criteria methodology for the

performance assessment of energy supply technologies, which also takes into account the dynamics of technological change. Criteria need to be defined to measure to what degree the different energy technologies can contribute to achieving these goals. Seven criteria were applied to this case study. The approach chosen is based on the multi-criteria outranking methodology, PROMETHEE, which is linked to the concept of technologys life cycle by assigning criteria weights depending on the actual development phase of a certain technology.

Thomas Buchholz et al [7] aimed at evaluate the potential of Multi Criteria Analysis (MCA) to facilitate the design and implementation of sustainable bioenergy projects. Four MCA tools (Super Decisions, Decide IT, Decision Lab, and NAIADE) are reviewed for their suitability to assess sustainability of bioenergy systems with a special focus on multi stakeholder inclusion. The MCA tools are applied using data from a multi- stakeholder bioenergy case study in Uganda.

J.R. San Cristóbal [26] applied the VIKOR method in the selection of a Renewable Energy project corresponding to the renewable energy plan launched by the Spanish government. The method is combined with the AHP method for weighting the importance of the different criteria, which allows decision-makers to assign these values based on their preferences.

Theocharis Tsoutsos et al's [30] paper exploited the multi-criteria methodology for the sustainable energy planning on the island of Crete in Greece. A set of energy planning alternatives were determined upon the implementation of installations of renewable energy sources on the island and were assessed against economic, technical, social and environmental criteria identified by the actors involved in the energy planning arena. Amongst the existing alternatives assessment methods for multi-actor policy settings, MCDA method was chosen. The energy alternatives were assessed according to PROMETHEE method.

3. **Region Under Investigation**

Sistan & Baluchestan Province is one of the 31 provinces of Iran. It is in the southeast of the country, bordering Pakistan and Afghanistan and its capital is Zahedan. The 120-day winds are a distinguishing feature of this region. Bazman, also known as Kuh-e-Bazman is a stratovolcano in a remote desert region of Sistan & Baluchestan province in southeastern Iran. A 500-m-wide crater caps the summit of the dominantly andesitic volcano. Although no historic eruptions have been reported from Bazman, it does contain fumaroles. Its satellite cones have been the source of basaltic lava flows [36].

According to a survey conducted by Safaii et al [26] Sistan & Baluchestan is among 5 provinces of Iran which have a high potential for the exploitation of solar energy. Iran plans to boost power supplies to Afghanistan and Pakistan through its southeastern Sistan & Baluchestan province. State-run Power Supply and Distribution Company (TAVANIR) is expanding infrastructures in Sistan & Baluchestan province. Also, Iran has offered cheap electricity to Pakistan to supply the countrys acute energy shortages [38].

Wet biomass of seaweeds in the total area of Sistan & Baluchestan coasts was 10286340.3 kg of which 2645192.1 kg (25.7%) were green algae, 2955963.9 kg

(28.7%) were brown algae and 4685184.2 kg (45.5%) were red algae. The estimated monthly average was 264522.3, 295327.9 and 467089.7 Kg for green, brown and red algae respectively. The maximum biomass was 15.4 kg/m^2 seen in Chabahar and the minimum biomass was 4.9 kg/m^2 obtained in Pozm [11].

4. Methodology

Multi criteria decision techniques were developed profusely in the 1960s. Classic methods come from that decade, when Goal Programming and ELECTRE method were proposed. In 1970s new methods and refinements of existing ones were developed, and finally in 1980s support from computer sciences has allowed a fast growth in applications and results from multiple criteria decision making techniques [2].
When comparing different outranking methods, PROMETHEE stands out due to its fairly simple design, ease of computation, application and stability of results. Generalized preference functions allow hesitations in DMs' preferences and uncertainties in criteria performance values to be modeled [21]. Also, PROMETHEE to be easily adapted for group decision aid, for example by including different weighting schemes [1]. Thus, in this study, PROMETHEE is preferred to other outranking approaches, because it is perceived to be more transparent and easier to understand even for DMs not familiar with MADM. The following briefly describes the general PROMETHEE framework.
Let A be a set of alternative renewable energy sources to rank or choose from. Assuming K criteria have been considered, for each alternative $a \in A$, $f_j(a)$ is the value of criteria j for alternative a. A ranking is performed as the following steps:

Step1: Since the importance of each criterion is different from the other ones and this matter has a great effect on the final result, first of all we had to determine the weights of each criterion. We used a questionnaire of our criteria and asked the managers of renewable energy departments in Iran Renewable Energy Organization (SUNA) to fill them out. The weights were calculated through SMARTER method.

Step2: The normalized decision matrix must be calculated. The normalized value is calculated as [13]:

$$\bar{n}_{ij}^{L} = \frac{x_{ij}^{L}}{\sqrt{\sum_{j=1}^{m}((x_{ij}^{L})^2 + (x_{ij}^{U})^2)}} \quad \imath = 1, ..., n \quad \jmath = 1, ..., m \tag{1}$$

$$\bar{n}_{ij}^{U} = \frac{x_{ij}^{U}}{\sqrt{\sum_{j=1}^{m}((x_{ij}^{U})^2 + (x_{ij}^{U})^2)}} \quad \imath = 1, ..., n \quad \jmath = 1, ..., m \tag{2}$$

Step3: A pair-wise comparison between any two alternatives a and b is implemented:

$$d_j(a,b) = f_j(a) - f_j(b) \tag{3}$$

Step4: A preference function P_j is associated with each criterion j. $P_j(a,b)$ is calculated for each pair of actions. It varies from 0 to 1, starting at 0 if $f_j(a) = f_j(b)$ and increasing with $f_j(a) - f_j(b)$, to reach 1 when the difference is big enough. Various shapes can be used for P_j, depending on the situation modeled by criterion j [5].

The decision makers can also define their own preference function. A linear preference function [4] is selected in this paper:

$$P_k(d_k) = \begin{cases} 0 & \text{if} \quad d_k < 0 \\ \frac{d_k}{q_k} & \text{if} \quad 0 \le d_k \le q_k \\ 1 & \text{if} \quad d_k > q_k \end{cases} \tag{4}$$

Step 5: The outranking degree $\pi(a, b)$ of every alternative a over alternative b is calculated. The higher $\pi(a, b)$ is, the most preferred is alternative a. Let $a, b \in A$, and let:

$$\pi(a, b) = \sum_{j=1}^{k} W_j P_j(a, b) \quad , \quad \sum_{j=1}^{k} W_j = 1 \tag{5}$$

Step 6: $\pi(a, b)$ is the outranking degree of relative a to b. to get the 'absolute' outranking power of alternative a, the *leaving flow* is calculated as:

$$\phi^+(a) = \frac{1}{n-1} \sum_{b \in A} \pi(a, b) \quad , \quad b \neq a. \tag{6}$$

The outranked power of alternative a is called *entering flow* and calculated as follows:

$$\phi^-(a) = \frac{1}{n-1} \sum_{b \in A} \pi(b, a) \quad , \quad b \neq a.$$

Thus, a partial preorder between alternatives is obtained from the intersection of the two ranking induced by ϕ^+ and ϕ^- (PROMETHEE I ranking). A complete preorder is induced from the *net flow* of each alternative (PROMETHEE II), expressed as [28]:

$$\phi(a) = \phi^+ - \phi^- \tag{7}$$

5. Interval PROMETHEE

As we can see above, the original PROMETHEE method is designed for a single valued number. But since most of the data provided for this paper are interval ones, the interval PROEMTHEE method is then applied. The reason of using interval numbers is that the data provided for each alternative in this research covered a range of numbers. For example the capital cost of EPC considers the essential instruments produced from different countries and different companies. Also different kinds of technologies were considered for each alternative and caused a range of data for each criterion. So the data provided from SUNA was interval ones. The regular PROMETHEE algorithm will be generalized to the interval PROMETHEE.

An interval PROMETHEE is proposed in this section. Some basic notifications and operations of interval numbers are presented here, either. An interval number x has such a form: $x = [a, b]$, $a < b$, where a and b are all real numbers. The interval number set is recorded as $I(R)$. Obviously for $x = [a, b] \in I(R)$, if $a = b$, then $x = a = b$ is an ordinary real, so $R \subset I(R)$. The basic operations with interval numbers are summarized in table 1 [24].

Addition	$[a,b]+[c,d]=[a+c,b+d]$
Subtraction	$[a,b]-[c,d]=[a-d,b-c]$
Multiplication	$[a,b][c,d]=[min\{ac,bd,ad,bc\},max\{ac,bd,ad,bc\}]$
division	$[a,b]/[c,d]=[min\{a/c,b/d,a/d,b/c\},max\{a/c,b/d,a/d,b/c\}],0\notin[c,d]$

Table 1. The Basic Operations with Interval Numbers

When alternatives a_i and a_j have interval numbers for criterion k, then the $d_k = f_k(a_i) - fk(a_j)$ will be an interval number (u, v) and $P_k(d_k)$ between a_i and a_j will be calculated as:

$$P_k(d_k) = \begin{cases} 0 & \text{if} \quad u \leq 0 \\ \frac{(u,v)}{q_k} & \text{if} \quad u \geq 0, v \leq q_k \\ 1 & \text{if} \quad v > q_k \end{cases} \tag{8}$$

Where q_k could be expressed as interval, but for simplicity, we take single value numbers. Then the procedure of the PROMETHEE method described above is followed step by step by the interval number calculations.

6. **Application**

One of the characteristics of Iran energy system is its high dependence on natural gas and oil which are non-renewable sources and in the close future they wont be able to provide the electricity need of this country. Also, having great sources of renewable energy such as wind, solar, geothermal and biomass, Iran would be able to import more electricity to its neighbor countries such as Afghanistan, Pakistan, turkey, etc besides meeting the need of itself. Conducting surveys about the most appropriate places for exploiting renewable energy sources, plays a crucial role in SD of this country. Based on this matter, Sistan & Baluchestan has an impressive potential of renewable energy sources in Iran. Thus, the aim of this paper is choosing the best alternative of RES to be exploited in this province. As the previous explanations, among different MADM methods, Interval PROMETHEE has been chosen to rank the alternatives. The methodology has been conducted by MATLAB. There were so many criteria which could be taken into account, but according to a questionnaire answered by the managers of SUNA as the DMs of this survey, the most important ones were chosen which have been presented in Table 2.

Capital cost of EPC	$(€/kw)$	C_1
Annual operation and maintenance cost	$(€/kw)$	C_2
Efficiency	%	C_3
Capacity factor	%	C_4
Lifetime	Year	C_5
Internal consumption	%	C_6
Resource potential	(MW or MWh)	C_7

Table 2. The List of Evaluation Criteria

6.1. **Description of Criteria.** As it comes below the criteria that will be used to evaluate alternative renewable energies are explained briefly.
C1. Capital cost of Engineering, Procurement and Construction (EPC)
Economic magnitude expressing the cost of introducing the examined energy option. It comprises the required costs for all the implementation phases of the option's introduction. This criterion analyzes the total cost of the energy investment in order to be fully operational including engineering, procurement and construction cost.
C2. Annual operation and maintenance cost
This criterion refers to annual maintenance cost of the proposed alternatives power plant.
C4. Capacity factor
Capacity factor shows the power plant capacity to produce energy without any kind of defect or break down.
C6. Internal consumption
Alternatives of renewable energy sources which have been considered in this paper have been presented in Table 3. Capacity factor shows the power plant capacity to produce energy without any kind of defect or break down.
Each power plant needs a certain amount of electricity by itself to start working which is provided through the country electricity distribution network. This criterion shows the needed amount of electricity for each of the proposed alternatives.
Alternatives of renewable energy sources which have been considered in this paper have been presented in Table 3.

Wind	On shore		a_1
Solar	Photovoltaic	On grid	a_2
		Off grid	a_3
	Solar Thermal	Linear parabolic collector	a_4
		Central receivers (towers)	a_5
		Stirling dish (parabolic dishes)	a_6
Geothermal			a_7
Biomass		landfill gas	a_8
		Muncipal Solid Waste (MSW)—incinerator	a_9
		Muncipal Solid Waste (MSW)—digestion	a_{10}
		Sewage (biosolids)	a_{11}
		Animal Waste (manures)	a_{12}
		Forest residues	a_{13}
Fuel cell			a_{14}

Table 3. The List of Renewable Energy Alternatives

6.2. **Biomass Energy.** Biomass refers to living and recently dead biological material that can be used as fuel or for industrial production. Most commonly, biomass refers to plant matter grown for use as biofuel, but it also includes plant or animal matter used for production of fibers, chemicals or heat. Different types of biomass which has been considered in this paper are as follow: landfill gas, municipal Solid Waste (MSW)-incinerator, municipal Solid Waste (MSW)-digestion, sewage (biosolids), animal waste (manures), forest residues. [16]

6.3. **Geothermal Energy.** Geothermal power is the energy generated by heat stored beneath the Earth's surface or the collection of absorbed heat derived from underground in the atmosphere and oceans. [16]

6.4. **Solar Energy.** Solar energy can be used to generate electricity, provide hot water, and to heat, cool, and light buildings. Photovoltaic (solar cell) systems convert sunlight directly into electricity. A solar or PV cell consists of semi-conducting material that absorbs the sunlight. The solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. [16]

6.5. **Wind Energy.** Wind turbines capture the winds energy with two or three propeller- like blades, which are mounted on a rotor, to generate electricity. The turbines sit high atop towers, taking advantage of the stronger and less turbulent wind at 100 ft (30 m) or more aboveground. Wind turbines can be used as stand-alone applications, or they can be connected to a utility power grid or even combined with a photovoltaic (solar cell) system. Stand-alone turbines are typically used for water pumping or communications. [16]

6.6. **Fuel Cells.** A fuel cell is a device that converts the chemical energy from a fuel into electricity through a chemical reaction with oxygen or another oxidizing agent. Hydrogen is the most common fuel, but hydrocarbons such as natural gas and alcohols like methanol are sometimes used. Fuel cells are different from batteries in that they require a constant source of fuel and oxygen to run, but they can produce electricity continually for as long as these inputs are supplied. [37]

The structure of the energy planning decision-making problem formulated in this study is presented in Figure 1. But as it is seen in Table 3, each alternative of renewable energy sources are divided into different types. But to show a brief scheme of this paper's model, we just used the topics of each type of renewable energy sources.

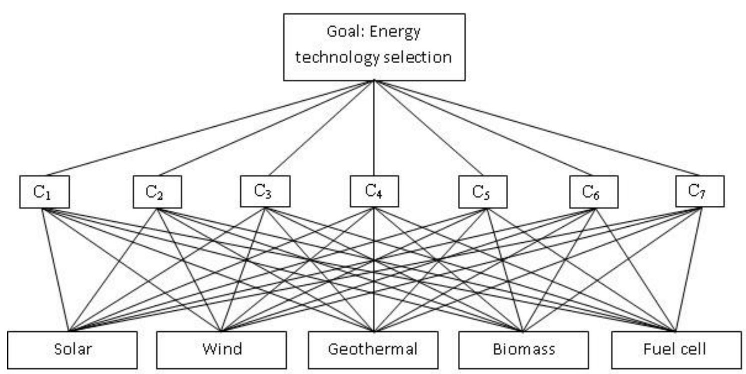

Figure 1. The Structure of the Energy Planning Decision-Making Problem

According to the data provided by SUNA for the year of 2011, the measures of each criterion has been calculated for each alternative. As it is presented in Table 4, criterion C_1 up to C_6 consist of interval numbers. But the data related to C_7

alternatives	Capital cost of EPC	Annual operation and maintenance cost	Efficiency	Capacity factor	Lifetime	Internal consumption	Resource potential
	C_1	C_2	C_3	C_4	C_5	C_6	C_7
a_1	(1100,1450)	(11,14.5)	(25,35)	(25,40)	(20,20)	(1,1)	15000
a_2	(3000,6000)	(30,60)	(11.4,11.4)	(15,25)	(20,25)	(5,5)	500000
a_3	(6000,8000)	(250,300)	(10.3,10.3)	(15,95)	(25,25)	(15,15)	500000
a_4	(6000,6000)	(37,46)	(13,17)	(46,46)	(30,30)	(15,15)	60000
a_5	(5000,6000)	(16,25)	(12,17)	(20,44)	(30,30)	(15,15)	60000
a_6	(8000,8000)	(184,200)	(22,30)	(50,50)	(30,30)	(15,15)	60000
a_7	(3000,3000)	(250,300)	(40,40)	(85,85)	(25,35)	(8,10)	300
a_8	(1500,2000)	(75,100)	(35,40)	(90,90)	(15,30)	(2,2)	500
a_9	(3500,6000)	(350,600)	(20,23)	(87,87)	(20,30)	(10,15)	500
a_{10}	(3000,3500)	(210,245)	(35,40)	(90,90)	(20,30)	(7,10)	75
a_{11}	(1500,1500)	(75,100)	(35,40)	(90,90)	(20,30)	(5,5)	50
a_{12}	(2000,2500)	(132,165)	(35,40)	(90,90)	(20,30)	(4,4)	200
a_{13}	(2000,2500)	(160,200)	(35,35)	(85,85)	(20,30)	(5,10)	1275
a_{14}	(1400,3200)	(0,1)	(85,85)	(90,90)	(0.5,4.5)	(0,0)	10

Table 4. Measures of Each Criterion for All the Alternatives

is crisp numbers. In this paper, we used equation (4) for the crisp numbers and equation (8) for interval ones.

The normalization of interval and fuzzy weights is often necessary in MCDM under uncertainty [33]. The point of normalization is to make variables comparable to each other. The reason of this matter is that measurements made using such scales of measurement as nominal, ordinal, interval and ratio are not unique. Normalization is the process of reducing measurements to a neutral or standard scale [35]. So in this paper equations (1) and (2) are used to normalize Table 1. As it is declared in step 3, we use equation (3) to calculate d_j by a pair-wise comparison between any two alternatives a and b.

At the next step we need to calculate p_j as it is formulated in equation (8), where q_k could be expressed as an interval number, but for simplicity we take single value numbers. Then the PROMETHEE method described in (4) and (5) are followed step by step by the interval number calculations. According to equation (5) in section 4, the outranking degree $\pi(a, b)$ of every alternative a over alternative b is calculated. The higher $\pi(a, b)$ is, the most preferred is alternative a. $\pi(a, b)$ is the outranking degree of a relative to b. To get the 'absolute' outranking power of alternative a the *leaving flow* is calculated. The outranked power of alternative a is called *entering flow* and calculated as equation (6). A complete preorder is induced

from the *net flow* of each alternative (PROMETHEE II), expressed as equation (7). The final results which are the *net flows* are presented below:
Since we came to interval numbers as the results, we use the following procedure

a_1	(0.005942,0.008265)
a_2	(-0.01144,-0.00488)
a_3	(-0.01673,-0.01215)
a_4	(-0.01791,-0.01558)
a_5	(-0.02181,-0.01321)
a_6	(-0.02763,-0.02335)
a_7	(0.006114,0.005855)
a_8	(0.013288,0.017218)
a_9	(-0.00413,-0.01659)
a_{10}	(0.005679,0.004779)
a_{11}	(0.01476,0.0177)
a_{12}	(0.01068,0.014121)
a_{13}	(0.008953,0.011808)
a_{14}	(0.019031,0.02128)

TABLE 5. Calculated Net Flows

to rank them.
To do so, we need to calculate $C\binom{14}{2} = 91$ comparisons between the interval numbers given in Table 5 as the following equations. To do the comparison between two interval numbers such as $A = (c, d)$ and $B = (e, f)$, first we need to subtract B from A to get to another interval number (a, b). Then we need to solve equations (9) and (10) on the gotten interval number and considering all the numbers even the negative ones as positive (Maghsood Amiri,2012):

$$P(a < b) = \frac{\textit{Lower Limit}}{\textit{The Interval}} \tag{9}$$

$$P(a \geq b) = \frac{\textit{Upper Limit}}{\textit{The Interval}} \tag{10}$$

According to the upper formula, the ranking of the proposed alternatives would be as bellow:

7. Results

The results show that fuel cell is the best source of renewable energy for Sistan & Baluchestan province of Iran. But since fuel cell is a type of renewable energy which has not a great relationship with the environmental potential and can operate and produce electricity where ever, it cannot be considered as an advantage of Sistan & Baluchestan province and this kind of technology is a very useful and profitable one with the same potential for elsewhere. And this profitability goes back to the high measures of efficiency, capacity factor, low cost of EPC and annual maintenance cost of this technology. But if we consider the rest of the results we will find that different kinds of biomass cover the second to the fifth rank. Biomass is abundant.

	Alternatives	Rank
a_{14}	Fuel cell	1^{th}
a_8	Landfill gas	2^{th}
a_{11}	Sewage(biosolids)	3^{th}
a_{12}	Animal waste(manures)	4^{th}
a_{13}	Forest residues	5^{th}
a_1	Wind	6^{th}
a_{10}	Municipal Solid Waste (MSW)-digestion	7^{th}
a_7	Geothermal	8^{th}
a_2	Photovoltaic (on grid)	9^{th}
a_9	Municipal Solid Waste (MSW)-incinerator	10^{th}
a_3	Photovoltaic (off grid)	11^{th}
a_4	Linear parabolic collector	12^{th}
a_5	Central receivers(towers)	13^{th}
a_6	Stirling dish (parabolic dishes)	14^{th}

Table 6. Final Ranking of 14 Proposed Alternatives

It can be found on every square meter of the earth as seaweed, trees or dung especially in Sistan & Baluchestan. It is cheap in contrast with the other energy sources. Biomass production can often mean the restoration of waste land (e.g. deforested areas). It may also use areas of unused agricultural land and provide jobs in rural communities. If it is produced on a renewable basis using biomass energy does not result in a net carbon dioxide increase as plants absorb it when they grow. It is very low in sulphur reducing the production of acid rain. [39]
San Cristóbal (2011) chose biomass plant alternative as the best option for Spain. As we came to the second priority for biomass in this paper, we can conclude that this alternative is a great choice for our survey, either.

8. **Conclusion**

Selecting the best among various renewable energy alternatives requires different groups of decision makers involved in the process. A decision which needs to take social, economic, technological and environmental factors into account is so complex. Assessing RES options to select the appropriate ones, is a complex process. In this paper, PROMETHEE method was used since this method is well adapted to problems where finite number of alternative actions is to be ranked considering several, sometimes conflicting, criteria. Moreover, of the methods for Sistan & Baluchestan province energy system are realistic. Fuel cells′ efficiency can be up to 85%. The low cost of EPC is another advantage. Overall, the advantages of Fuel cells are high efficiency, low chemical, thermal and noise pollutants, high reliability, very low maintenance cost, etc. They can be used in different electric power plant sectors such as hotels, schools, hospitals, commercial buildings, shopping centers and also can be a supportive source of energy for exploitation of other renewable energy sources. Since Iran is a country with high rate of annual electricity consumption and has a great problem with emissions and air pollution, fuel cells can

be the best choice in the path of sustainable development for this country.
It also should be noted that the methods applied is country specific, since the criteria and the performances depend on the countrys specific energy characteristics, as well as its different circumstances, development needs and perspectives. Finally, the methods concept can provide a sufficient framework for supporting other decision making problems, such as evaluating scenarios and environmental impact's assessment. [8]
As a recommendation for further researches, we propose using $HIPRE^{3+}$ and in case of local answers, using heuristic algorithms to choose the best measures of each criterion for all the proposed alternatives of the survey.

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