A novel AHP framework for Decision Making in Power Systems sustainable development

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ABSTRACT

Energy planners are supported by MCDA (Multi-Criteria Decision Analysis) often called MCDM (Multi-Criteria Decision Making) in order to achieve coherent and more appropriate choices oriented to a certain areas' energy sustainable development. AHP (Analytic Hierarchy Process) is one of the most widely used multi-criteria decision-making methods in the field of energy planning. AHP enables Decision Makers (DM) to structure a complex decision in form of a hierarchical process and to make assessments through the fundamental scale of Saaty (containing 9 levels of evaluation). The paper develops an innovative framework to be used for an AHP to assist the decision making in sustainable electrical power systems planning. The methodology has been tested on a real and complex case concerning the planning of a electrical power system to supply end users of an island in the Indian Ocean (Mafia island in Tanzania). Interesting results emerge from the study, while it should be beared in mind that they have explorative nature and indeed they should be not interpreted as unique and absolute response to the initial problem.

1. INTRODUCTION

A territorial energy planning in a sustainable development's perspective is a complex decision problem since it involves several stakeholders and DMs (Decision Makers) with their own several heterogeneous and conflicting aspects. The need to consider environmental and social issues leads to abandon mono-criterial approaches (based on cost-benefit analysis or macro-economic indicators) which only able to select the least-cost planning strategy. Multi-dimensional (multi-objective) and multi-DM features of the problem make it quite suitable to be solved by MCDA (Multi-Criteria Decision Analysis/Aid). "Tsoutsos et al in [1]" summarize the suitability of the MCDA to energy planning problems through some reasons. MCDA, often called MCDM (Multi-Criteria Decision Making) is a valuable decision support tool able to guide the planners towards acceptable and equitable alternatives. It provides wide ranges of methods classified as MODM (Multi Objective Decision Making) e MADM (Multi Attribute Decision Making). Commonly MCDM methods applied in energy planning field are: PROMETHEE, MAUT, AHP, ELECTRE, fuzzy methods and so on. AHP (Analytic Hierarchy Process) is one of the most widely used multi-criteria decision-making methods in energy planning field. The paper contribution aims to develop an innovative framework to be proceed under AHP in order to improve decision-making regarding sustainable electrical power systems development. It will be able to improve the solution of complex cases in presence of heterogeneous and conflicting aspects. It will be tested on a real geographical context and complex case concerning the planning of a electrical power system to supply an island in the Indian Ocean (Mafia Island in Tanzania). To this purpose the case study will compare three different alternatives.

2. Methodology

The AHP (Analytic Hierarchy Process) developed by T. L. Saaty [2-4] is a comprehensive structured methodology to solve complex decision problems. The main future of the methodology is to discompose a complex decision problem into elemental issues organized in a hierarchical structure. The hierarchy begins at the top most level with an overall goal to be attained usually the selection of the best alternative; the next level under the objective is the set of criteria that must be met in order to meet the objective; and finally the lowest level consists of the various alternatives to meet the objective. One of the strengths of the methodology at this stage is to address the decision problem with the desired degree of detail: a more detailed analysis is possible simply adding intermediate level (s) between those above mentioned, containing specific sub-objectives or subcriteria. Once the hierarchy is built, the DM (s) systematically have to compare each cluster in the same level in a pairwise fashion based on his (their) own experience and knowledge. In making the comparisons the AHP requires to answer to a sequence of numerical or verbal questions that compare two elements of the same hierarchical level. Judgmental opinions of the DM are hence elicited using a typical question as this one: 'Of the two elements (i.e. criterion, sub-criterion or alternative) C_i and C_j , which is more important and how much more?'.

Intensity	Definition	Explanations
1	Equal importance	Two activities contribute equally to the objective
3	Moderate Importance	Experience and judgment slightly favor one over another
5	Strong Importance	Experience and judgment strongly favor one over another
7	Very Strong Importance	An activity is strongly favored and its dominance is demonstrated in practice
9	Absolute importance	The importance of one over another affirmed on the highest possible order
2,4,6,8	Intermediate values	Used to present compromise between the priorities listed above

Table 1 - Saaty's 1-9 scale for pairwise comparison

The answers are given (numerical questions) or converted (verbal questions) by fundamental 1-9 Scale of Saaty, the most adequate scale able to encapsulate quantitative and qualitative aspects of the decision problem in pairwise comparison mode.When answering a pairwise comparison question, the DM estimates the ratio (weight) between the relative importance of C_i and C_j. Let suppose that it's equal to 5. In the case of a comparison of qualitative factors, it means that the relative importance of C_i is stronger than that of C_j. In the case of a comparison of quantitative factors, it means that the relative importance of C_i is five times than the relative importance of C_j. The results of these comparisons are presented in compact way in a *nxn* reciprocal judgment matrices [A], where *n* is the number of elements to be compared with each other. For each judgment matrix the eigenvector *w* (local priority vector) corresponding to the largest positive real eigen value (λ_{max}) establishes a ranking among the elements of the same hierarchical level. Of course the aim of the methodology is to establish a ranking of priorities of the alternatives with respect to the main objective. To do so, it's necessary to synthesize the local priorities to yield a set of global priorities which express the relative weight of the alternatives respect to goal. Global priorities are obtained through hierarchical composition principle: the local priorities are multiplied by those of the corresponding higher-level elements and the products thus obtained are added up. The power of the AHP is that the resultant weights are ratio scale numbers (all positive and normalized to one) and not ordinal or interval numbers: it allows to claim that an alternative is preferred to another as many times as the ratio of their weights (the ratio of two interval scale numbers have no meaning). In making all pairwise comparisons may occur, especially for decision problems that have more than 5 criteria and/or alternatives, that the judgments are inconsistent. The inconsistency of the pairwise comparison matrix [A] may depend on various causes, the most frequent are the violation of intransitive relationship and of proportionality relationship (even if the transitivity relationship is respected in this last case) among pairwise comparison judgments. Whereas the perfect consistency is neither required nor desired, it's therefore necessary to set a tolerable inconsistency level so that the solution identified by the evaluation process is acceptable. In order to assume acceptable a solution Saaty proposed the calculation of two indexes, *consistency index CI* and *consistency ratio CR [2-4]*:

$$CI = \frac{\lambda_{\max} - n}{n-1} \qquad CR = \frac{CI}{RI}$$

where λ_{max} has been defined above, *n* is the order of pairwise comparison matrix [A] and *RI* is *random consistency index*. RI is the average consistency index of a large number of square random matrixes (reciprocal and positive) which varies by matrix size and is 0.52 for a 3x3 matrix to 1.58 for a 15x15 matrix [2-4]. So, dividing consistency index by the random consistency index gives the *consistency ratio CR* of comparison matrix. CR can go from zero (when CI is zero, perfect consistency) to a very large positive number. If CR is 0.10 or less should be accepted, while for any larger number DM must strive to increase the coherence of his own judgments, and if that's not enough, it's necessary to go back and revisit those elements in hierarchical articulation that create misunderstanding and inconsistencies.

Potentialities and critical in AHP

Like every other method, AHP has its own strengths and weaknesses. It allows to analyze a decision problem with the desired details levels and makes possible to analyze highly heterogeneous and conflicting aspects. At the same time it offers the possibility to verify the correctness of procedure (by calculating Consistency Index (CI) and Consistency Ratio (CR)) and allows to manage uncertainty and the partial unavailability of data [2-4]. On the other side, however, it is important to underline that the results depending on the type of designed hierarchy; in some applications it is necessary to consider that one element of the hierarchy could influence some elements of the upper hierarchical level or of the same level. Do not forget the rank reversal of the alternatives which could occur when, once defined the initial problem, during the assessment process it should consider another alternative. But the most critical aspect of the evaluation method is the judgments assignment, in pairwise comparison step, both quantitative and qualitative elements. Regarding qualitative elements, the most important weakness is the subjectivity of the weights: the translation of qualitative information into weights associated with specific criteria encompasses a degree of responsibility and subjectivity from the analyst. Regarding quantitative elements the use of the fundamental 1-9 Scale of Saaty does not allow the comparison of elements whose difference exceeds the width Saaty' s fundamental scale (because the largest elements in any comparison set should be no more than 9 times the smallest elements).

3. Case study

The hypothetical case study considered justifies the adoption of the methodology proposed. The analyzed territory is an island that covers an area of 1050 km^2 ,70 km long and 15 km wide, in Indian Ocean and it has 41.000 inhabitants. It's still a paradise untouched by global tourism and preserves spectacular wildlife reserves, biodiversity, forestry resources, coral reefs and so on. The bays and the surrounding forests of palm trees are actually protected by Island Marine Park, which is assisted by the World Wide Fund for Nature. Island's economy is based on non-intensive agricultural activities of cash crop but mainly on farming prawns carried out in small fish factories. Not to be overlooked is the tourist flow, attracted by a pristine nature which is not altered by human action. This already shows a strong discrepancy that exists between local population, living with the lowest in the world (100 kwh/year per capita), energy consumption standards and tourists accommodated in the few existing and comfortable resorts. The island is presently supplied by a Diesel Power Plant unable to ensure continuity of supply. Local Utility is a 100% government owned company responsible in the rest of the nation (Tanzania) for generation, transmission and distribution of electricity for 98%. Less notable, however, is

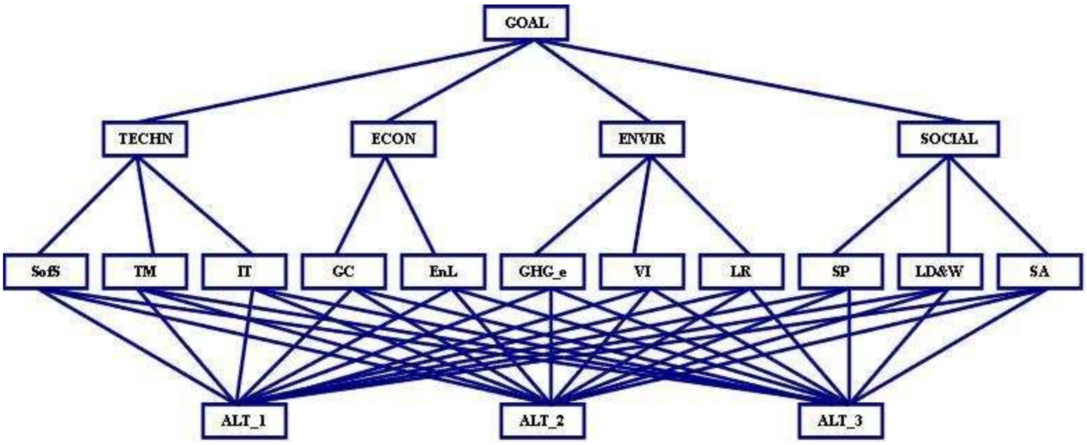

Fig.1-Hierarchy

a local private initiative to use biomass (fuel-wood and charcoal both natural forest and plantations) for electricity generation on the island to supply lodges and the fish factory and to connect the villages in the north [5].
Technical studies on site shows a good availability of wind and solar resource, identified them as the best suited energy options for national energy development in a environmental assessment view [5]. The island has good and more constant wind speeds than the coastline of the mainland due to the action of southern (May to September) and northern (November to March) monsoons. The induces significant wind speed variations more higher during daytime hours than at night. The average monthly wind speeds recorded vary in the range 4.7 – 6.2 m/s [5]. The investigations have revealed a considerable good and stable solar potential in the island with only limited variation over the year: minimum monthly average insolation between 4.5 and 5.3 kWh/day [5]. On the demand side instead, considering the local end users, the existing resorts and those planned to accommodate a seasonal peak of tourist amounted i.e to 10.000 people and the shellfish farming activities, it was possible to estimate a nominal power of 34 MW. Table 2 shows the supposed peak value of power planned into its main rates explained above. In reference to the methodology presented in Section 2, three different electrical supply systems of the island have been considered, evaluated against 4 main criteria and 11 sub-criteria suitability arranged in a dominance hierarchy. Three basic alternatives will be compared: the first one consists in a conventional electrical grid powered from the mainland, via HVDC monopolar system, with submarine cable; the second one is a stand alone electrical power system consisting in a conventional electrical grid supplied by a fossil fuel power plant; finally, the last alternative is a stand alone system consisting of a Smart Grid with local electrical generation from RES (Renewable Energy Sources) coupled with a back-up system. In the last hypothetical alternative the electrical power planned is generated by 8 wind generators (3 MW each one) installed on the North coastline of the island and by 10MWp polycrystalline photovoltaic plant installed in the hinterland. The basis technology of the back-up system is composed by electrolyzers which produce hydrogen and fuel cells that use it.

Power consumption for main activities on island	Nominal power for each specific activity [MW]
Local activities	20
Touristic activities	10
Shellfish Farming activities	4

Table 2 Energy requirements for main activities on island

3.1 Hierarchy

Hierarchy tree model of the decision problem highlights its aspects (general and particular) in a stratified structure that increases its own understanding. The hierarchical approach allows to capture the detailed knowledge of complex reality by structuring it into its constituent parts, and these into their constituent parts, proceeding down hierarchy. The goal is the selection of an alternative to supply end users of the island in a sustainable development perspective. The term *sustainable development perspective* requires to the planner to consider as main constituents of the goal also the dimensions economic, environmental and social of the problem. The identification of the criteria and relative subcriteria is a crucial step in the problem formulation. It is strongly linked to the availability of the data and it depends on the degree of understanding and sensibility of the planner to the problem. Each criterion has been split into two or three subcriteria. Hierarchy (Fig. 1), hence, includes several subcriteria that can be assessed either objectively or subjectively. At the bottom of dominance hierarchy are placed the *alternatives* candidate to meet the overall goal. The cluster of alternatives, resulting out of an initial screening, consists of three reasonable candidates well-described above.

3.2 Criteria and subcriteria weights

Given that the main objective is to provide an advanced framework for solving complex cases, like the analysed case, the authors make reference for the experimental purely numerical application to their sensibility regarding the evaluation of local aspects, which is indeed based on deductible items in line with similar cases and therefore should be investigated in local key. The criterion weight measures the relative importance of each criterion respect its parent, the overall goal. This is a crucial step in the evaluation process because it is based on subjective assessments which should typically reflect the sensibility, education and culture of the local political class. The comparative judgments are awarded as circumstances by the authors who are facing an electrification problem for a country considered in developing: only one set of criteria weights is considered in this paper (it will be made a sensitivity analysis later). They should be compared with those of local political class and all potential stakeholders involved in the decision making. Thanks to sensitivity analysis, the behaviour of other stakeholders can be taken into account, analyzing if variations of criteria weights are able to subvert the rankings (partial and overall) previously came out. In particular proceeding along hierarchical tree from top to bottom, criteria and subcriteria weights are subjectively deduced by pairwise comparisons of cluster elements in the second and third level. Alternative's weighting against each subcriteria, instead, is made on objective basis where the parent is a quantitative sub-criterion (when reliable data input exist) while is made on subjective basis where the parent is a qualitative sub-criterion (or when no data input exist).

Technological-Economic -Environmental-Social aspects

The four main criteria on which has been decomposed the initial problem are based on Technological, Economic, Environmental and Social aspects. As mentioned above, it is crucial to express in their comparative weighting, made on subjective basis, judgments that reflect the sensibility and the experience of local politicians (which is expected to make the interests of local community).

Criteria	Techn	Econom	Envir	Social
Techn	1	1	1/5	1/3
Econom	1	1	1/5	1/3
Envir	5	5	1	3
Social	3	3	1/3	1

Table 3 - Criteria's pairwise comparison matrix

The values assigned in Table 3 explain the relative importance of the evaluation criteria.

Security of supply-Technological maturity-Installation time

Security of supply, Technological maturity and Installation time belong to the same cluster of sub-criteria whose relative importance must be assessed with respect to their parent, Technological aspects. The values assigned in Table 4 explain the relative importance of the technological sub criteria.

Techn subcriteria	SofS	TM	IT
SofS	1	3	3
TM	1/3	1	1
IT	1/3	1	1/3

Table 4 Technological subcriteria's pairwise comparison matrix

Energy losses - Global costs

Energy losses and Global costs belong to the same cluster of sub-criteria whose relative importance must be assessed with respect to their parent, Economic aspects. Table 5 shows that Global costs (€) is considered far more important than Energy losses (kWh), an evaluation that seems quite reasonable and broadly shared. Global costs sub-criterion which includes investments, operating and maintenance costs of the solution will have to meet the initial goal while Energy losses sub-criterion simply takes into account the energy not supplied to the users due to joule effect.

Econ subcriteria	EnL	GC
EnL	1	1/5
GC	5	1

Table 5 Economic subcriteria's pairwise comparison matrix

GHG emissions - Visual impact - Landscape Risk

GHG emissions, Visual impact and Landscape Risk belong to the same cluster of subcriteria whose relative importance must be assessed with respect to their parent, Environmental aspects. GHG emissions sub-criterion measures the total amount of equivalent carbon dioxide CO_2 released into environment as result of required energy production to meet the total consumption over a defined time interval (tCO_{2eq}/year). Visual impact sub-criterion refers to the potential visual effects, related to the change in the views experienced by people observing landscape, arising from the choice of a determined power supply solution. Landscape risk sub-criterion, instead, measures the fraction of the intervention area occupied by area with very high landscape value. The values assigned in Table 6 explain the relative importance of the environmental sub criteria.

Envir subcriteria	GHG_e	VI	LR
GHG_e	1	5	1
VI	1/5	1	1/5
LR	1	5	1/3

Table 6 - Environmental subcriteria's pairwise comparison matrix

System Pressure - Local development - welfare - Social acceptance

System pressure, Local development and welfare, Social acceptance belong to the same cluster of subcriteria whose relative importance must be assessed with respect to their parent, Social aspects. System pressure sub-criterion estimate the density of electric grid according to the power supply solution, calculated with reference to island's population (km/1000*$n_{inhabitants}$). Local development and welfare subcriteria refers at the establishment of new commercial, repair and service shops, new food processing units, new metal construction shops and new furniture maker shops, creation of new workplaces. Social acceptance sub-criterion expresses the position of local community concerning the adoption of a certain power supply solution.

The values assigned in Table 7 explain the relative importance of the social sub criteria.

Social subcriteria	SP	LD&W	SA
SP	1	1/3	1/3
LD&W	3	1	1
SA	3	1	1/3

Table 7 - Social subcriteria's pairwise comparison matrix

3.3 Alternative's scoring against each subcriteria

Alternative's scoring against each subcriteria, is made on objective basis where the parent is a quantitative sub-criterion while is made on subjective basis where the parent is a qualitative sub-criterion. Security of supply and Technological maturity, for example, are qualitative subcriteria against which the alternatives can be evaluated through the use of two different scales defined by Theocharis Tsoutsos et al in [1]. Installation time is a quantitative sub-criterion against which the alternatives can be evaluated on objective basis considering the necessary time for the implementation of each system. Energy Losses is a quantitative sub-criterion against which the alternatives can be evaluated on objective basis considering the energy dissipated by their Joule effect. Global costs is a quantitative sub-criterion against which the alternatives can be evaluated on objective basis considering the necessary total costs for the implementation of each system. GHG emissions is a quantitative sub-criterion against which the alternatives can be evaluated on objective basis considering the total amount of CO_{2eq} released in the environment by each of them. The environmental impact analysis has been conducted exclusively for the useful life for supply alternatives. Visual impact is a qualitative sub-criterion against which the alternatives can be evaluated considering the change in the views experienced by people observing landscape. At this regard it has been made a specific evaluation scale shown in Tab.9.

Visual Impact evaluation scale - hypothesis	Value
The majority of the residents looking at the landscape does not notice a significant change (none)	1
The majority of the residents looking at the landscape notes some significant changes only in sporadic points (weak)	2
The landscape has been altered slightly, the majority of the residents is able to recognize the several distinctive elements of the previous structure (moderate)	3
The landscape has been altered, currently there are in it few items that can be traced back to the previous structure (high)	4
The landscape has been radically altered following the implementation of intervention, it has lost each trace of the previous structure (very high)	5

Table 9 - Visual Impact evaluation scale

Landscape risk is expressed through a quantitative sub-criterion which measures the fraction of intervention area $A_{INTERVENTION}$ occupied by area with very high landscape value A_{VHLV} [6]. System pressure is also a quantitative sub-criterion against which the electrical power systems can be evaluated on objective basis considering, the ratio SP [6]:

$$SP = \frac{A_{INTERVENTION}}{1000 n_{INHABITANTS}} \qquad LR = \frac{A_{HLV}}{A_{INTERVENTION}} * 100$$

Local development and welfare and Social Acceptance are qualitative subcriteria against which alternatives can be evaluated through the use of two different scales defined by Theocharis Tsoutsos et al in [1].

	IT [years]	EnL [%]	GHG_e [tCO_2eq]	SP [km/1000 inh]	LR [%]	GC [Mln€]
A1	2	3	neglect.	2.3	50.6	102
A2	4	8.5	29.1	4.3	8.3	196
A3	1	6	28.5	3.1	10.9	44

Table 8 Alternative performance under quantitative subcriteria

4. Critical Analysis of the results

It is assumed once again that the main objective is to provide an advanced methodology for solving complex cases and able to encapsulate heterogeneous and conflicting aspects which characterized the choice of an alternative power supply. The results come out from purely numerical application of the methodology should not be interpreted as absolute answer to the initial problem but as authors' solution that should be compared with the real one of local politicians. The goal of the AHP method is to synthesize alternative's overall priorities in order to establish a preferability ranking among them. Smart grid powered by RES seems to be the best alternative for electrification of the island (overall priority of 35.8%), followed by the installation of a conventional power plant directly on the island with relative traditional network (overall priority of 33.1%). The last position of the ranking is occupied by the alternative of connection to the continental network via HVDC system by undersea cable (overall priority of 31.1%).

<u>*Analysis by subcriteria*</u>

It has been denoted for simplicity, the alternative Smart Grid powered by RES as A1, the alternative HDVC system with conventional grid as A2 and at last the alternative Power plant with conventional grid as A3. Table 10 shows the percentage contribution of all subcriteria to the overall performance of all types of power system. In the overall ranking, it does not identify significant differences because the subcriteria, in which the initial problem has been decomposed, lay in highlighting the conflicting characteristics of each alternative.

5. Sensitivity Analysis

Thanks to sensitivity analysis, it is possible to overcome the weakness of a subjective evaluation of criteria, (taking into account, moreover, the behaviour of other potential stakeholders) by analyzing if variations of criteria weights are able to subvert the previous ranking. Strictly speaking, a sensitivity analysis requires a considerable effort and it

Type of electrical power system	Default case TA=0,095 EcoA=0,095 EnvA=0,56 SA=0,25		Case 1 TA=0,25 EcoA= 0,25 EnvA=0,25 SA=0,25		Case 2 TA=0,20 EcoA= 0,40 EnvA=0,20 SA=0,20		Case 3 TA=0,20 EcoA= 0,20 EnvA=0,20 SA=0,40		Case 4 TA=0,20 EcoA= 0,20 EnvA=0,20 SA=0,40	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
A1	35,8%	1	29,7%	3	13,0%	3	30,1%	3	26,3%	3
A2	31,1%	3	30,1%	2	39,2%	2	31,7%	2	31,9%	2
A3	33,1 %	2	40,2%	1	47,8%	1	38,3%	1	41,7%	1

Table 11 Overall priorities and ranking from sensitivity analysis

GHG Emissions 25,48%	**%**	**Visual Impact 5,10%**	**%**
A1	20,84	A1	0,64
A2	2,32	A2	2,34
A3	2,32	A3	2,12
Landscape Risk 25,48%		**System Pressure 3,56%**	
A1	2,14	A1	1,47
A2	12,03	A2	0,93
A3	11,31	A3	1,16
LocalDev&Welf10,68%		**Tech.Maturity 1,90%**	
A1	4,27	A1	0,17
A2	2,14	A2	0,86
A3	4,27	A3	0,86
SocialAcceptance10,68%		**InstallationTime1,90%**	0,27
A1	2,14	A1	1,09
A2	6,40	A2	0,54
A3	2,14	A3	
Global Costs 7,91%		**Energy Losses 1,59%**	
A1	2,18	A1	0,86
A2	1,01	A2	0,26
A3	4,71	A3	0,47
Security of Supply 5,70%			
A1	0,52		
A2	2,59		
A3	2,59		

Table 10 Percentage contribution of each sub-criterion to the overall performance of the hypothetic alternatives analyzed.

deserves a specific and more detailed study as 'Athanasios et al' did in their work: new global priority vectors were determined by varying only the local priority vector of pairwise comparison matrix of criteria. Apart from the case just analyzed (Default Case) where Technological and Economic aspects assumed 9,5%, Environmental aspects assumed 56,0% and Social aspects 25,0%, three other cases are examined. The results, in terms of overall ranking and global priorities of alternatives, for each set of local priorities are presented in Table 11. The most important consideration which can be made is that, in all new scenarios defined, the overall ranking is the same: the alternative Power plant on the island with conventional grid becomes the most preferable followed by an HVDC system with conventional grid on the island and at last a Smart Grid powered by RES.

6. Final considerations

The paper develops an innovative framework to be used for an AHP to assist the decision making in sustainable electrical power systems planning. The methodology has been tested on a real complex case concerning the planning of an electrical power system to supply end users of an island in the Indian Ocean (Mafia island in Tanzania). At this stage, the conflicting aspects that characterize each alternative planning, highly heterogeneous and sometimes intimately linked together, are emphasized. AHP developed is able to take into account each of these aspects synthesizing them in a single index of overall priority. In this study, three hypothesis different electrical power system configurations to feed the island are evaluated against 4 main criteria and 11 subcriteria both qualitative and quantitative. Criteria and subcriteria weights are subjectively deduced by pairwise comparisons of cluster elements in the second and third level of hierarchy. Alternative's weighting against each subcriteria, instead, is made on objective basis where the parent is a quantitative sub-criterion while is made on subjective basis where the parent is a qualitative sub-criterion. An initial set of criteria/subcriteria weights was assigned which reflects the authors' awareness towards an electrification problem of a developing country. Obviously they should be compared with those of local political class and all potential stakeholders involved in the decision making. Sensitivity analysis allowed to consider other potential viewpoints of the same problem. In conclusion this study has an explorative nature: there is not a truth to search but a truth to build, and the application of a multi criteria decision-making methodology has the merit of making transparent, integrated and participated the construction process of this truth. The value of the achieved result must be considered as a path of systematic alternatives analysis of able to guide and assist the decision maker (DM) in the choice.

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