RENEWABLE ENERGY RESOURCES AND LOCAL POTENTIAL FOR A REAL "SUSTAINABLE" DEVELOPMENT: A MULTI-CRITERIA DECISION PROCESS. CASE STUDIES FROM TER.R.E. PROJECT

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Abstract
In the last decades, the discussion about Renewable Energy Sources (RES) has been involved and integrated in many fields of studies. However, the discussion and integration of RES has been considered without critics and context considerations, producing a wrong belief, namely that the implementation of RES project is positive by definition. In that way it is believed that the mere production of Renewable Energies automatically brings development, forgetting that "sustainable" development is based on environmental, social and economic factors, connected and calibrated on local territories and their potential in producing RES. Thus, considering the relationship between RES and local framework and potential must be a priority, before adopting and implementing some RES projects or policies. Despite, all this is recognized and supported by the scientific community and European Union, the awareness and capacity to adopt multiple integrated criteria is not fully understood by decision makers and stakeholders, who are in charge of translating the general concept of local sustainable development into praxis. This paper aims at discussing the multi-criteria decision model developed in TER.R.E. project (TERritory, eneRgy & Employment), built on the comparative analysis between 11 case study areas from 8 South East European Countries.
The model's indicators, selected by the decision makers involved in the process, are compared with those found in the literature and commonly used for sustainability assessment. Considering the decision makers' preferences, it emerges that the integrated and multiple vision on which sustainability is composed is not perceived by decision makers. On the contrary, their vision on sustainable development is anchored to pre-conceived pure economic perception on energy production.

1. Introduction

In the last decades, sustainable development has been incorporated in many discussions on society and his future. The most common definition about sustainable development provided by Brundtland Commission, "to ensure that it meets the needs of the present without compromising the ability of future generation to meet their own needs" (WCED, 1987), is a starting point for any other definition of the concept. Sustainability research, which aims at better understanding the complex dynamic interactions between environmental, social and economic issues, and sustainability assessment, which aims at evaluating the progress toward sustainability, are based on the identification of criteria (and related indicators) (UN, 2007). Thus, the analysis of sustainable development means to develop a sustainable assessment, and in this paper it is presented one of these cases.
Renewable Energy Sources (RES) are generally considered to have a large potential, especially for local territories, in terms of achieving sustainable development. In fact, RES can provide a wide variety of socio-economic benefits, including diversification of energy supply, enhanced regional and rural development opportunities, creation of a domestic industry and employment opportunities (Del Rio and Burguillo, 2009). The European Directive 2009/28/EU on Renewable Energy (RED, EC, 2009a) recognises "the need to promote renewable energy sources as a priority measure given that

their exploitation contributes to sustainable development, create local employment and have a positive impact on social cohesion".

However, energy policies can produce local development benefits (Del Rio and Burguillo, 2009) but not automatically sustainable local development (Pflüger et al., 2005), which entails a process supported by local stakeholders built on local resources activation. All this produced a wrong belief, namely that the implementation of RES projects is always positive by definition. In that way, it is believed that the mere production of renewable energies automatically brings development, forgetting that "sustainable" development is based on environmental, social and economic criteria, connected and calibrated on local territories and their potential in producing RES. The aim of this paper is to demonstrate and discuss that this wrong belief about RES is widespread among decision makers and stakeholders, and it can lead to the selection of projects, which are not appropriate (i.e. sustainable) with is local context. The demonstration will be conducted using the case study of the project TER.R.E. (TERritory, eneRgy & Employment), under the South East Europe Programme of Territorial Cooperation 2007-2013. The study is based on the elaboration of a multi-criteria decision model and the analysis of its criteria and indicators. These criteria and indicators, selected by the decision makers and stakeholders, are compared with those found in the literature and commonly used for sustainability assessment.

Accordingly, the paper is structured as follow. Section (2) describe the TER.R.E. project as case study, its research objectives and its model. In section (3) the theoretical framework applied in the empirical study is summarize. Section (4) includes the methodology of the study, the decision model, its criteria and indicators. A discussion on the study results is made according to the comparison between the 11 case study areas across South East Europe is provided in section (5). The paper closes with some concluding remarks and policy implications in section (6).

2. Case study: the TER.R.E project

TER.R.E (TERritory, eneRgy & Employment) is a transnational project, involved 13 Partners (Figure 1) in 9 European South-East Countries (Italy, Hungary, Austria, Romania, Slovenia, Bulgaria, Croatia, Bosnia-Herzegovina, Albania).

Figure 1. TER.R.E Partners

Eleven case study areas are identified as "marginal rural areas", as small towns and villages located in less urbanized areas (or at the margin of metropolitan areas). They have, from an energy point of view, a greater competitive hedge compared to cities, as larger space and natural resources are available. These territories are characterized by hilly and mountain and are mainly rural, and are affected, although at different level, by similar problems: less or lack of service and less employment opportunities compared to urban agglomerations and competitive growth areas. Such problems cause (or could cause) a gradual depopulation of the less inhabited areas, with serious consequences in terms of new territorial disparities, risk of depopulation of more peripheral zones, risk of underproductive crops as well as loss of ecological safeguard and control of the territories.
TER.R.E. objective is to experiment and demonstrate that a wide and integrated exploitation of endogenous resources to produce renewable energy is an effective engine for a self-generated and sustainable local development in marginal and less developed zones. In such zones Private-Public Partnerships (PPP), between public institutions, private operators and local communities, can produce revenues and employment opportunities, and thus to promote tailored paths of growth and development based on a proper use of local resources. The project aims at path the way for long lasting positive effects on the local energy policies, which, if properly set, can overcame obstacles to energy plants investments across the civil society and can support policy-makers in elaborating RES programs and investments by adopting decision support models, based on a multi-sectorial approach.

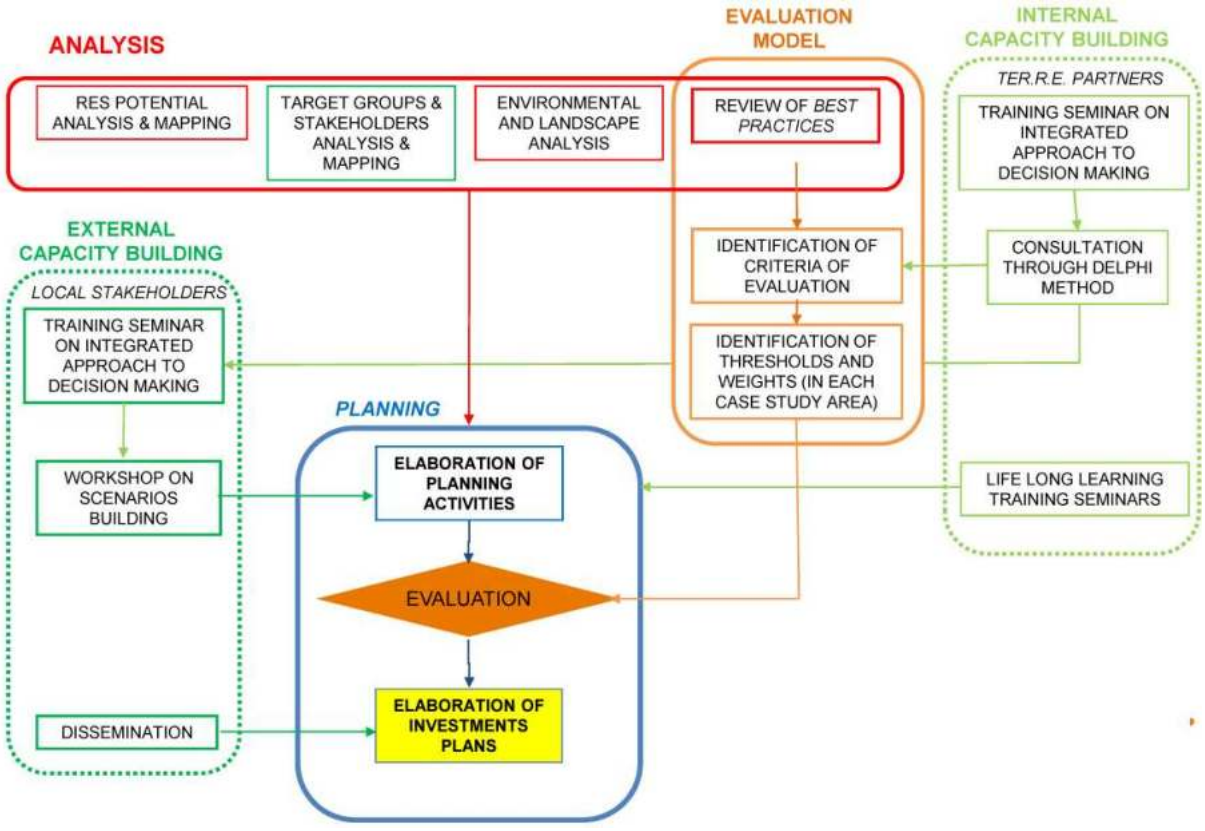

Figure 2. TER.R.E. rationale

The TER.R.E. approach (Gissi et al., 2014; Lucertini et al., 2014a; Lucertini et al., 2014b) was structured following different steps (Figure 2). The first step concerns the indications to support activities in mapping landscape capacity, and potential related to energy, and to build capacities for policy makers, stakeholders and target groups. In this way, in each case study area data are recollected

and stakeholders are informed about RES potential, as to make them part of the knowledge building process and to raise awareness about sustainability criteria (Analysis). The second step is related to the application of the Decision Support System (DSS) to elaborate investment plans. The evaluation model has been constructed through the involvement of all TER.R.E. Partners in an internal capacity building program. After the mapping phase, local actors are involved to discuss, in each area, about targets of local development and to elaborate strategies and actions, integrating human, natural and financial resources (external capacity building program). Planning alternatives are elaborated within a specific workshop in each case study area, and then evaluated according to the DSS. The third step concerns the capitalization of the results in relation to capacity building. Workshops for the promotion of investments (from different sources) are put in place, as well as specific actions towards target groups according to its interests, specificity and local contexts. In this way the outputs (investment plans) are supported in parallel by the construction of a networks of relevant actors (policy makers and stakeholders) and situated knowledge in all phases, two aspects that contribute to the implementation of the purposes and goals of the plans and public policies.

3. Theoretical framework

3.1. Multi-Criteria Decision Analysis

Multi-Criteria Decision Analysis (MCDA) is a research area within the field of Decision Analysis (DA), which deal with the process of making decisions in the presence of multiple objectives. It develops methods and tools to assist with decision-making (DSS), in terms of the choice, ranking or sorting of options (i.e., alternatives, solutions, courses of action, etc.), when there are conflicting criteria (Figueira et al., 2005). These methods, which can handle both quantitative and qualitative criteria, share the common characteristics of conflict among criteria, incommensurable units, and difficulties in design/selection of alternatives (San Cristobal, 2011). This is one of the most used methods in environmental/ecologic science (Huang et al., 2011; Fontana et al., 2013), since MCDA give the possibility to combine environmental, social and economic information, and thus address interdisciplinary and complex issues. Moreover, MCDA, if a discrete number of alternatives is given, is a useful tool to structure the decision-making process, and supporting with evidence the decision-makers choices (Bouyssou et al., 2000). Decision-makers objectives are usually conflicting and therefore, the solution is highly dependent on the preferences of the decision-maker and must be a compromise. In most of the cases, different groups of decision-makers are involved in the process. Each group brings along different criteria and points of view, which must be resolved within a framework of understanding and mutual compromise.
Until now, MCDA has been mainly applied in a case studies with specific focus, like forest management (Ananda and Herath, 2009), river alteration projects (Oikonomou et al., 2011), or bioenergy solutions (Buchholz et al., 2009). Most of those studies apply specific criteria, so that the solutions to the environmental problems addressed are hardly comparable or transferable to similar cases. However, different land-use options, or land-use changes in a sustainability perspective have rarely been the focus of MCDA studies. Usually, sustainability criteria are general and about omnipresent phenomena, but they are disconnected to specific land-use resources. Thus, in this work we try to strictly link local resources, land-use, decision makers and stakeholders' preferences and expectations with the criteria, sub-criteria and indicators selected, used into the MCDA model. They are selected by stakeholders through a Delphi method.

3.2. Delphi method

The Delphi Method is a systematic way to query and consult a panel of experts, through questionnaires in two or more rounds, that was developed by Norman Dalkey in a U.S. military project

of the RAND Corporation in the second half of XIX century (Dalkey and Olaf, 1963; Brown, 1968; Sackman, 1974; Linstone and Turoff, 1975, 2002; Skulmoski et al., 2007). Some authors (Thomas, 1972; Sackman, 1974; Rowe and Wright, 1999; Rowe and Wright, 2001; Green et al., 2007) define the Delphi Method an interactive and facilitated (assisted by a facilitator) process, used for the elicitation of opinions of experts and for the forecasting of the consequences of a specific issues. Delphi Method has been widely used in social, ecological and economic studies. For Rowe and Wright (1999), the principle features of the classical Delphi method were *i*) Anonymity of Delphi participants; *ii*) Iteration or information flows between participants through some rounds of discussion; *iii*) Interaction with controlled feedback through report of results, that inform the participants of the other participant's point of views; *iv*) Statistical aggregation of group response, for qualitative and quantitative results.
According to Linstone and Turoff (2002), the reasons to use this method are related to the undefined, unresolved and unclear issues that need to *i*) the subjective judgments on a collective basis; *ii*) the diverse backgrounds with respect to experience or expertise; *iii*) the preservation of the heterogeneity of the participants without domination of the positions; *iv*) an integration of efficiency, that a face-to-face meeting can't guarantee. Moreover, the Delphi Method reduces the time and cost of group meetings.

4. Methodology

The methodology proposed aims to identify a comprehensive list of criteria, sub-criteria and indicators, in order to construct a MCDA model able to assess the sustainability development produced by alternative options related to RES projects, considering that sustainable development "must aim to foster and preserve socio-ecological systems, from the family to the global levels, which are dynamic and adaptable, satisfying, resilient, and therefore durable" (Gibson, 2006a, p. 173). Thus, following the Gibson's (2006b, 2012) approach about sustainability assessment we identified the three main categories of sustainable development (environment, social and economic), plus one for the administrative and participation requirement, which have helped to underscore the mutual importance of the several sustainability aspects. In such perspective, we identify criteria and indicators through a process developed on four main steps (Figure 3).

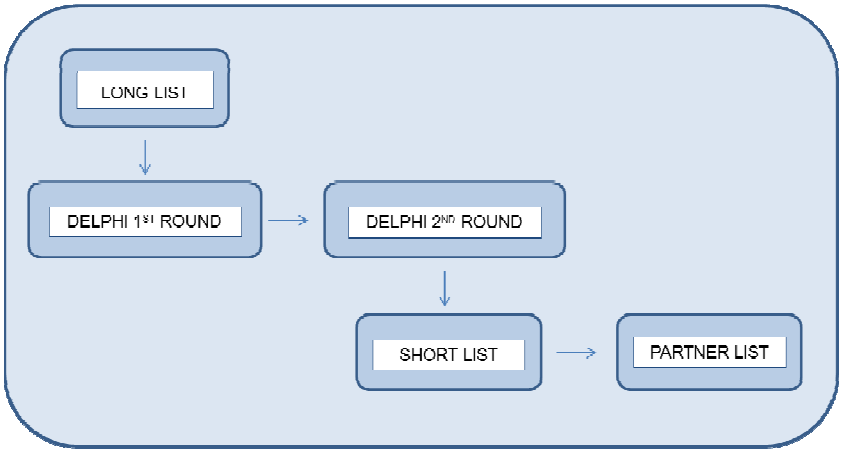

Figure 3. Delphi method, phases

A long list, of criteria, sub-critera and indicators, is completed by the involvement of experts from the Iuav research team, confirmed by European Union indicators and by the related scientific literature. The Delphi method is then applied starting from the long list. A facilitator coordinates a panel of informed and experienced actors through a series of questionnaires in a computer-assisted way. The

first questionnaire aims at acquiring preferences about each criterion, sub-criterion and indicator in their relevance in evaluating RES projects alternatives towards sustainable development. First round' results are elaborated through selection rules agreed with participants.
A second questionnaire is developed, in order to return at the Partners (PPs) the results of the 1st round, and to investigate on sub-criteria on which there is not perfect convergence of preferences. The indicators that will receive the absolute majority of preferences in 2nd round are included in the short list. Moreover, in this way, it is asked indirectly at the PPs to agree with the analysis, the selection rules and so with the short list emerging from the whole analysis process. The short list will be used to create the MCDA model.
In TER.R.E., 2 different groups of respondents were involved: an Experimental Group (EG) and a Control Group (CG). The EG was constituted from the panel of TER.R.E. project partners, 2 respondents for each partners, one decision maker and one professional (for the 12 partners of TERRE project, the panel consists of 24 respondents). The CG was composed of experts of the energy sector, technicians chosen by the Austrian partners (30 participants). In this case there was no anonymity, but the risk of mutual influence was very low and therefore negligible.

4.1 Criteria, sub-criteria and indicators

In the definition of sustainability criteria, sub-criteria and indicators related to the RES system, sustainability was represented according to the 6 principles of Afgan et al. (2000), who include *i*) relevancy to the sustainability, *ii*) indicators should be measurable, in quantitative or qualitative way; *iii*) significance in the time of sustainability assessment; *iv*) reliable information; *v*) enhancing a strategic reflection; *vi*) significance in the optimization of the criteria of evaluation.
Considering that, the long list of 4 criteria, 18 sub-criteria and 114 indicators was completed, including sets of criteria and indicators from European Union (HM Government, 2013; EC, 2013; EC, 2011) and by the related scientific literature (for example, Del Rio and Burguillo, 2009; Neves and Leal, 2010; Gibson, 2012; Hak et al., 2012; Piorr, 2003; Shen et al., 2011; Milman and Short, 2008; Moussiopoulos et al., 2010; Lebre La Rovere et al. 2010.).
The four criteria considered are: *i*) environmental aspects, *ii*) social aspects, *iii*) economic aspects, *iv*) legal, institutional and perceptional aspects. The criteria aim at characterizing all the possible changes or impacts due to the strategies/actions/projects /plants implementation which occurs, respectively, on the environmental components, on social groups, on economic aspects, and on institutional framework and on stakeholders perception.

5. Results and Discussion

According to Lancker and Nijkamp (2000), "a given indicator does not say anything about sustainability, unless a reference value such as thresholds is given to it". However, considering the indicator selected by the project partners and decision-makers we can understand how they consider sustainability and RES.
In the TER.R.E. project 24 participants took part to the Delphi. From the complete list of 114 indicators, grouped in 18 criteria and 4 operational objectives, the participants have selected 43 indicators (but the short list contains 58 subcriteria).
With respect to the Operational objective related to the environmental aspects, almost half of the indicators were discarded (23 out of 47). Most of the maintained indicators were the ones related to natural resources in general, as "water", "habitats and biodiversity", followed by "soil". Surprisingly, the "available energy potential" was considered less important with respect to the precedents, even if the evaluation of sustainability is related to RES projects. The sub-criterion related to "greenhouse gas emissions" is in a lower position in the preference ranking, even if it is explicitly mentioned in RED (EC, 2009a). Finally, some criteria deriving from EU Directives, as the Directive 92/43/EEC

"Habitats" (EC, 1992) and Directive 2009/147/EC "Birds" (EC, 2009b), are excluded from the list as "habitats amount", "Protected areas", and "Habitats conservation". The least represented criterion is the one of "Landscape", interpreted only as "crops change (loss)". Landscape is widely considered as a resource for multiple purposes, as for rural tourism. This aspect might entail several problems in the evaluation of sustainability of local development from RES projects, reducing the possibility to consider synergies with other possible strategies in local development.

Table 1. Objectives, criteria and subcriteria (in number) in the short list and in the long list

Operational objective	Criteria	Subcriteria of the Long List	Subcriteria of the Short List	Percentage of Subcriteria stability
A. Environmental aspects	A.1 Soil	7	4	57%
	A.2 Water	6	5	83%
	A.3 Air	6	3	50%
	A.4 Landscape	5	1	20%
	A.5 Habitat and Biodiversity	10	5	50%
	A.6 Energy	7	4	57%
	A.7 waste/residues	6	2	33%
B. Social aspects	B.1 Population	5	1	20%
	B.2 Services	7	4	57%
	B.3 Job	7	2	29%
	B.4 Poverty	5	3	60%
	B.5 Settlement and Infrastructure	8	3	38%
	B.6 Risks	5	3	60%
C. Economic aspects	C.1 Costs and benefit	7	4	57%
	C.2 Financing and Funds	6	4	67%
	C.3 Productive investments, Research and Development	7	3	43%
D. Legal, institutional and perceptional aspects	D.1 Legal and institutional	5	4	80%
	D.2 Partecipation and acceptability	5	3	60%
TOT.	18 Criteria	114	58	51%

With respect to the operational objective related to the social aspects, they represent the second represented criteria among the 4 ones. Only 16 out of 37 criteria are accepted by the respondents. The most preferred criteria are related to "Services" to education and health, "Poverty" and "Risks". In contradiction with European social policies, Jobs and Gender issues are the least represented, as for the policies related to the construction of Smart Energy strategies. Social Inclusion and innovation strategies might risk to weigh less in the evaluation model.

With respect to the operational objective related to the economic aspects, some indicators were constrained by the authors, as required by the setting of the TER.R.E. project, as the criterion "Financing and Funds". They are at the basis for the elaboration of the investments plans related to RES. With respect to the others, 9 out of 20 indicators were discarded, confirming that market-related issues (as cost and benefits) are more relevant than issues related to innovation and research. It might result that classical economic approaches might weigh more than innovative and diversified approaches towards RES.

With respect to Legal, institutional and perceptional aspects, 7 out of 10 were constrained by TER.R.E. project, and only those indicators were maintained.

6. Conclusions

Besides the general agreement on the importance of considering significant criteria to assess sustainable local development, our analysis put in light that sustainable development is not completely understood in its complexity by decision makers and professionals in charge to support it. Beside the wide variety of objectives, criteria and subcriteria emerging from literature, experts and EU documents, still economic issues are perceived in quantitative terms, considering with higher rank the costs-benefits characteristics instead on including innovative aspects connected to investing in research and development. Moreover, criteria connected to PPP were not acknowledged for their importance to support local development, as to indicate that innovative practices might be difficult to be implemented.

Legal and institutional objectives as well as social acceptability – and related criteria and subcriteria – play a marginal role in the set of criteria selected by TER.R.E. partners. This aspect reinforces the fact that lifelong learning programs are needed to support decision makers and professionals in updating their understanding of problems. It is not sufficient to provide innovative criteria in a top-down manner, as issuing new laws or regulations.

The analysis has been replicated in a case study area in Austria, were RES have been considered as a source of local development till 30 years. From the comparison of the results it is evident that more advanced Austrian context and marginal rural areas from South Est Europe diverge with respect to the issues related to research and innovation, as well as on public-private partnership. To overcome this divide, it is necessary to accompany the process of elaboration of planning proposals related to RES with specific trainings and processes of capacity building, to support learning and understanding of innovative approaches.

Another important aspect is that landscape issues were considered negligible when evaluating local sustainable development through RES investments from the respondents. Landscape entails integration between ecological and social aspects, as well as the perception and preferences of local communities, as declared in the European Landscape Convention (Council of Europe, 2000). Landscape is considered as an asset in sustainable local development (Termorshuizen and Opdam, 2009), as it provides multiple services as, for example, flood prevention and recreational values (De Groot, 2006), besides the capacity to provide renewable energy sources. It would be worth to evaluate how sustainable local development can derive from different types of investments plans, without considering RES as a panacea for development (Del Rio and Burguillo, 2009). The risk is to disregard other possible paths, as for example, rural tourism based on landscape cultural services, or to underestimate possible impacts deriving from the implementation of RES projects with respect to multiple ecosystem services delivered by landscapes.

The analysis of RES investments plans according to a Multi-Criteria Decision Analysis (MCDA) model is meant to anticipate possible trade-offs between different alternatives. Objectives, criteria and sub-criteria are at the core of the model to interpret and to evaluate the performances of alternatives to achieve sustainable local development, as the result of multiple and integrated perspective able to include social, environmental and economic issues at once. The challenge is related to the perception and understanding of decision makers and stakeholders with respect to the interpretation of sustainability within DSS, as put in light in this paper.

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