The role of the Expert Knowledge Broker in Rural Development: renewable energy funding decisions in Greece

Abstract

Within debates on rural development, Neo-Endogenous Development has emerged as the consensus 'best-practice' approach. Central to this approach is the role of the Expert Knowledge Broker – the conduit that brings local and 'extra-local' together. This paper contests that, despite a wealth of research on this paradigm and the knowledge flows that operate within, little research has been conducted regarding the decision-making process of the Expert Knowledge Broker. However, this is arguably decisive in which type of rural development is enacted. Using the allocation of funding for Renewable Energy projects in Greece as a critical context, this paper explores the decision-making approach of experts using Analytic Hierarchical Process analysis. We find that the type of rural development enacted is contingent upon the funding decision and the balance between local and extra-local funding decisions vary depending upon heterogeneous criteria. The paper contributes to knowledge through a nuanced explanation of the role of the Expert Knowledge Broker and suggests how EU Renewable Energy policy funding decisions can become more effective.

Keywords: renewable energy, rural development, EU Structural Funds, rural communities, AHP

1. Introduction

Renewable Energy is a major pillar of the European 2020 Strategic Plan, which aims to boost renewable energy production across the EU. Key to this approach is the ongoing debate on whether nationally or locally based projects constitute the 'best-bet' for the socio-economic development of rural areas (Walker and Devine-Wright, 2008; Rogers et al., 2012; van der Schoor and Scholtens, 2015; Seyfang et al., 2013; Morrison and Ramsey, 2018). Placing this debate within a rural development frame, there are important arguments about how exogenous, endogenous and mixed development paradigms bring different rural benefits. Neo-endogenous Development (NED) is presented as offering the best of both worlds, with a focus on the local with a recognition of the importance of mechanisms that bring in 'extra-local' knowledge. Critical to this argument is the role of the Expert Knowledge Broker. Whilst much research has been conducted regarding empirical cases of NED, and in particular the role of networks in supporting knowledge flows (Bennett, 1999; Newbery et al. 2013; Newbery and Bosworth, 2014), little evidence has been gathered where the Expert Knowledge Broker role is taken by an individual decision maker. This expert role as a facilitator and translator of knowledge between horizontal and vertical networks (Murdoch, 2006) is central to the brokerage model that NED is built upon. Within the renewable energy sector, successive support packages have been introduced by the European Commission, with an aim to develop a functioning integrated internal market for energy (Howarth, 2009). This is particularly important in Greece, where a lagging economy aims to leverage rich wind and solar energy potential for economic development. As such, various policy tools and mechanisms have been used in the expansion of renewable energy (Fouquet, 2013), leading to a mixture of natural and local, community-led, projects.

Focusing on the decision-making process of appropriate experts regarding the allocation of funding for EU structural funding in provincial Greece, this paper explores whether experts recognise the importance of endogenous / exogenous debates and how they broker funding allocation decisions. This allows an exploration of NED theory and provides policy insights into the allocation of EU Structural Funding.

The paper next describes rural development paradigms and how debates are mirrored within contemporary renewable energy policy and literature, exploring why Expert Knowledge Brokerage is a critical part of the puzzle. The Greek renewable energy context is then explored, before applying Analytic Hierarchical Process as an appropriate analytic technique of expert decision making. We then discuss and conclude on the importance of these experts in defining the relative importance of rural development decisions, based on a heterogeneous criterion.

2. Rural development paradigms and Renewable Energy initiatives

2.1 Rural Development Paradigms

Dissatisfaction with a binary approach to rural development (Saracen, 2013) where interventions fail to reflect complex reality (Copus, de Lima, 2014) have led to a changing landscape in policy. Here approaches have iterated between the extremes of top-down, national-level dictat and bottom-up local-level action. In turn this has led to hybrid network approaches that combine aspects of productivist and participatory paradigms (Meader, 2019). Underpinning these rural development paradigms are debates around governance and knowledge.

Post WWII, rural areas were regarded as spaces of production, where national plans required specific outputs and a homogenous national level policy. Focused on economies of scale and sector-based industrialisation strategy (Atterton et al. 2011), national government regarded as both the system of governance and the most efficient producer of scientific knowledge. Recognition by academics and policy-makers that a national governance ignored the needs of heterogeneous and differentiated rural communities and had a corrosive effect on the environmental quality and cultural uniqueness of rural areas (Lowe et al 1995) led to a renewed focus on endogenous approaches (Lowe et al 1998; Was? Et al 2005). These placed the emphasis on bottom-up and participatory approaches that leveraged local territorial resources to create locally relevant development (Lowe et al 1998). In this approach governance for development is driven by local networks (Snowdon 2003) and expertise of actors is contingent on local, vernacular, expertise (Lowe et al. 2017).

The disadvantage of endogenous development is that is ignores the importance of external influences, actors and resources on development and may suffer from 'over-embeddedness'. Where local knowledge is limited, without access to external knowledge the local networks become stagnant and may be bound by social obligation (Atterton, 2007; Newbery et al. 2015). Neo-Endogenous Development approaches (Ray, 2001; Shucksmith, 2010) were subsequently promoted as a 'new rural paradigm' (OECD, 2006), where the importance of locally driven development remained the focal point, but recognition was given to the role of 'extra-local' factors to promote development (Ray, 2001:4). This relies on local or extra-local actors to act as the conduits of knowledge (Bosworth, 2010).

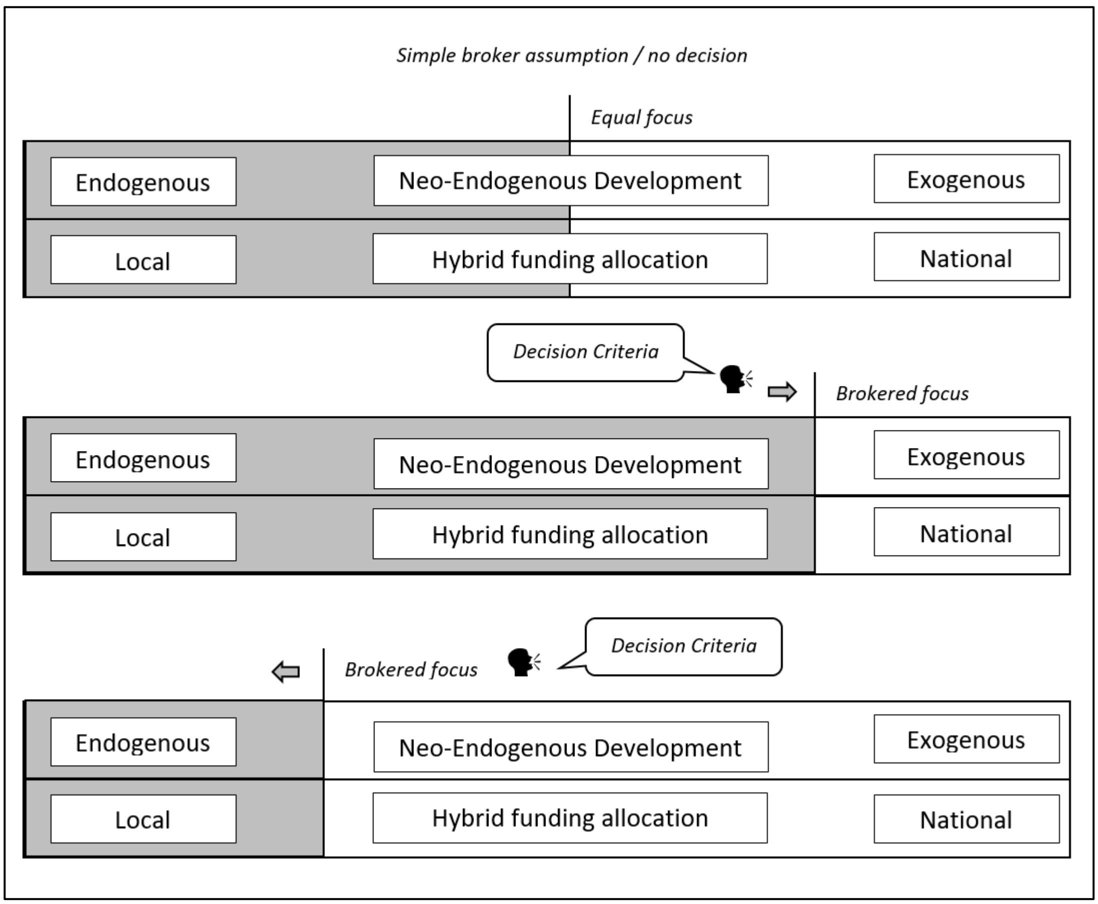
2.2 The role of the expert

Within this framing of NED and endogenous / exogenous development, the role of the expert is central. Exogenous development leads with the primacy of the external expert providing scientific knowledge, whilst endogenous development valorises the vernacular expert and local, contextual and socially embedded knowledge (Lowe et al., 2017). With NED, the top-down and bottom-up paradigms are brought tougher through knowledge brokerage (Newbery et al. 2015). The broker acts as a conduit that facilitates and translates knowledge flows between the locally unique vernacular knowledge and the 'extra-local' scientific knowledge. Little has been written on this key aspect of NED, but the brokerage conduit may be performed by a network (Atterton et al. 2011; Newbery et al. 2013) or by individual experts (Bosworth, 2010). This links to Burt's (2000) conceptualisation of the network entrepreneur – an individual that facilitates the flows of knowledge and resources between two or more otherwise separate networks.

Networks have been explored as knowledge conduits, bringing benefits to both the members and the local community (Newbery and Bosworth, 2014), with numerous examples evidencing this from the Leader and Leader + initiatives in the EU (Böcher, 2008; Fałkowski, 2013; Nardone et al. 2010). At the level of individual experts, Bosworth (2010) discusses the role of commercial in-migrants in bridging local and extra-local knowledge networks and thus acting as unintentional knowledge brokers. Given the importance of the knowledge brokerage role, it is surprising that the significance of these experts have not been more thoroughly explored regarding their perceptions of the most effective forms of development in particular. Without this, the concept of NED relies on a simple broker assumption, with an assumption that the development mix lies somewhere between endogenous and exogenous, but without a decision making agent. This is illustrated as a conceptual model in Figure 1, where the simple broker impact on development is contrasted with

Expert Knowledge Brokers that rely on various criteria. This is particularly relevant when we explore Renewable Energy initiatives, where these Expert Knowledge Brokers make important decisions regarding ongoing debates as to whether national or local level funding is most effective in the development of an integrated internal market.

Figure 1 Conceptual Model



2.3 Parallel debates in Renewable Energy initiatives

European Union members use a wide range of instruments to implement their renewable energy policies (Chalvatzis, 2009; Kitzing et al., 2012). These include financial support schemes targeting and de-risking various parts of renewable energy development (EU Commission, 2018a). The recent rapid price collapse of renewable energy refocuses interventions towards supporting infrastructure that will enable capacity for further renewable energy development - especially in rural areas. Within this context the role of EU Structural Funds is debated, particularly with regards to whether EU members should adopt a national or local approach to maximise gains from renewable energy production. Paralleling debates in rural development, the recent study of Schafft et al. (2018) suggests that there is a dearth of literature regarding the interaction between renewable energy and Structural Funds through the lens of national or local based funding allocations.

However, within renewable energy the discussion between nationally centralised and locally decentralised approaches offers a fragmented view, with research highlighting the benefits of both approaches. Indeed, Battaglini et al. (2009) suggest that policy-makers are attempting to find an equilibrium point between smart energy production focusing on Smart Grids following a decentralised approach and Super Grids following a centralised approach, concluding that the option of hybrid SuperSmart Grids presents the ideal option.

Reiche and Bechberger (2004) explore the different policies that EU countries implement in meeting renewable energy targets. They highlight issues with social acceptance and argue that renewable energy strategies need to follow a local approach. However, the success in decentralised energy markets demands the development of new organisational structures (Eid et al., 2016). Here Dahlmann et al. (2017) stress the importance of local factor in EU energy policies *"we find that the energy geography concepts of location, territoriality, landscape and spatial embeddedness are valuable tools…"*(p.399). Community sustainable energy has been growing (Seyfang et al., 2013) alongside ICT use that contributes to personalisation of energy experiences (Pothitou, 2017). Despite the benefits of local community buy in, the EU Energy Road Map 2050 attributes more weight to large, national projects than to an equal number of small, local ones.

A centralised national approach can arguably overcome the barriers often posed by local governance (Smith, 2007), where the diverse nature of communities creates constraints in the transformation to a new sector of community energy production. There are different levels of social acceptance depending on the geographical level (Bertsch et al., 2016) and community networks in renewable energy matter (Morrison and Ramsey, 2018). Despite contrasting in approaches in the allocation of structural funds (Bachtler and Turok, 2013), a recent study exploring their impact between 1990-2010 shows a positive impact in the renewable energy sector (Maynou et al., 2014), with an improving energy mix (Streimikiene and Šivickas, 2008; Streimikiene at al., 2007).

2.4. Decision-making factors for Expert Knowledge Brokers in Renewable Energy

As Weller (2018) stress, energy policy frameworks can generate a lack of fairness in the distribution of funding. From the renewable energy and rural development literature we can identify six criteria as particularly relevant to the decision maker for allocating funding for renewable energy projects within the alternatives of national or locally based investment: type of production; social acceptance; fund type; fund size; firm type; and firm size.

The *type of renewable energy production* often raises concerns at local level (Bertsch et al, 2016; Schumann, 2015). Indeed, the type of renewable energy production plays a role in landscape modification, which is an important factor influencing public opinion (Bertsch et al, 2016). In addition, large scale projects are more probable to be affected by local level protest and some regions or local areas might prefer different types of renewable energy production (Devin-Wright, 2011). It can be argued that the technology used in energy systems should take account of local and national views as the technological swift and transition in renewable energy should balance technological progress with governmental regulatory framework. (Hvelplund and Djørup, 2017).

S*ocial acceptance* can be a crucial factor in implementing renewable energy projects (Cowell, 2016; Ribeiro et al, 2014; Batel, 2013; Wolsink, 2007) where in rural areas social resistance can act as limiting factor for renewable energy investments (Rogers, 2012; Van Der Schoor and Scholtens, 2015). Indeed, initiatives in community level are influenced by "shared vision" and "type of activities" (Van Der Schoor and Scholtens, 2015) and the outcome towards decentralisation might not be the expected one. With that said, public acceptance creates constraints in renewable energy expansion highlighting the role of public acceptance (Devin-Wright, 2005) and social multi-criteria evaluations show that public opinion influences the installation of renewable energy production in rural areas (Munda and Russi, 2008). Such social acceptance may be polarised, for instance environmental groups may be influential in supporting a renewable energy project, whilst other community groups might be in opposition (REF) (Tosun and Schulze, 2015).

The *Fund type* and *Fund size* have been identified as criteria affecting renewable energy investments (Bürer and Wüstenhagen 2009), especially when it comes to the use of EU Structural Funds. These criteria may help overcome market failures and externalities (Streimikiene et al.,

2007) as the type and size of the fund can support overcoming negative environmental consequences (externalities) or minimize landscape modification. The fund can affect the distribution of the benefits to the local society (Hicks and Ison, 2018) especially if the complexity of different schemes promoting local renewable energy production is considered (Rudolph et al, 2017). However, despite the fact that the funding availability might create opportunities for large scale projects, the communities are usually resisting to large scale projects (Devin-Wright, 2011).

The *Firm type* and *Firm size* have been also identified as important parameters. The scale of the investment can define the fragility of the projects with small scales projects to demonstrate higher fragility when at the same time are important as response to economic problems of communities (Bere et al, 2016). Firm size is important as whilst at national level renewable energy initiatives may be led by large business, at local level, small private companies, including farms, may be involved in these projects (Magnani et al., 2017). The firm type plays an important role in getting access to funding as in some countries like in case of Greece, private business can access to grants, whereas social entrepreneurs and charities are currently excluded from direct funding (Apostolopoulos et al, 2018). Indeed, the type of firm may affect the access to grants and investment available (Homsy, 2015). Renewable energy projects and the schemes forged through collective actions (Hoffman and High-Pippert, 2010) affect the firm type as different actors from the local communities are involved.

Having developed a conceptual framework that identifies parallels between the rural development and renewable energy debates, the paper next explores whether expert knowledge brokers operating in the sector in Greece recognise the importance of endogenous / exogenous debates and how various critical factors influence their funding allocation decisions. The next section explores the methodological approach, looking at the Greek Renewable Energy context and the AHP technique.

4. Methodology

4.1. Context and the decision-space

The current programme of the European Regional Development Fund (ERDF) (2014-2020) set out its most important investment priorities on energy as: the improvement of energy efficiency of buildings and enterprises through subsidies; loans, guarantees and support for energy infrastructure; and natural gas. Investment priorities additionally aimed to address the installation of intelligent energy measurement systems as well as the promotion of Renewable Energy and high-efficiency cogeneration especially in rural areas (Ministry of Productive Reconstruction of Environment and Energy, 2015; Ministry of Environment, Energy and Climate Change, 2012; European Union, 2011).

In addition to the current programme of structural funds EU members can draw policy and technical support and financing from the European Fund for Strategic Investments, the so-called Juncker Fund which dedicates a large portion of funds for new energy infrastructure under the Connecting Europe Facility (INEA, 2018). Furthermore, a suite of new energy regulations also known as the Clean Energy Package has been proposed in the end of 2016 and is being discussed for approval by 2019 (European Commission, EC, 2018b). One of the core elements of these proposals is their focus on a consumer-centric approach, encouraging in this way the development of active consumers, also known as prosumers i.e. consumers who also produce energy and provide energy services (Kubli et al., 2018). This approach is facilitated by, and in turn facilitates renewable energy acceptability leading to a virtuous cycle.

Aiming to address the long-term air pollution problem of Greece (Kaldellis et al., 2004; Spyropoulos et al., 2005) and its dependence on indigenous diminishing lignite reserves that threaten energy security (Chalvatzis and Ioannidis, 2017) the National Plan for Renewable Energy Sources 2010-2020 has set as a priority target to increase their contribution to total power production from 13% in 2010 to 28% in 2020, which means that the installed capacity will increase significantly from 4.11GW to 9.33GW. As far as solar energy is concerned, this will grow from 0.18GW in 2010 to 0.7GW in 2020. Rural areas will be largely benefited by this resource availability enhancing rural development. The available resources of the 5th CSF per intervention sector are reflected in the following table:

Table 1: Available resources per intervention sector

INTERVENTION SECTOR	**TOTAL INTERVENTION FUND (euros)**
Electricity (infrastructure for transmission and distribution networks)	164,999,999
Natural gas (infrastructure for transmission and distribution networks)	120,135,696
Renewable Energy (Biomass)	47,399,998
Other Renewable Energy forms (hydroelectric, geothermal, sea)	46,136,500
Renovation of public infrastructure aiming at energy efficiency, demonstration projects and support measures	194,875,828
Renovation of houses aiming at energy efficiency, demonstration projects and support measures	227,437,460
Smart power distribution systems of medium and low voltage	46,310,456
High efficiency cogeneration and district heating	30,888,145
Energy efficiency and demonstration projects to SMEs and support measures	39,449,234
TOTAL	917,633,317

Source: Ministry of Productive Reconstruction of Environment and Energy, 2015; Ministry of Development and Competitiveness, 2014.

With this research we focus on the role of the Expert Knowledge Broker as the agent that determines the funding mix at a local and national level. This is based on their subjective expert judgement of the 'best' funding allocation to grow renewable energy investment. Here they are the decisive factor in which development trajectory to follow: endogenous, exogenous or neo-endogenous.

4.2 Analytical Hierachy Process

To explore the decision-making process of the Expert Knowledge Broker in the Greek renewable energy funding allocation, we use the Analytic Hierachy Process (AHP) (Saaty,1996). AHP is a theory of measurement that uses pairwise comparisons and expert judgments to measure of qualitative or subjective criteria. AHP is based on four axioms: (1) reciprocal judgments; (2) homogeneous elements; (3) hierarchic dependent structure; and (4) rank order expectations (Wiecek et al., 2008). Decision support techniques have recently been applied in the energy domain including multi-criteria approaches (Malekpoor et al, 2017; 2018), AHP (Yagmur, 2016; Punia and Sindhu et al., 2016; Apostolopoulos and Liargovas, 2016; Büyüközkan and Karabulut, 2017; Ishizaka et al., 2016) and in handling of complex energy data (Chalvatzis et al, 2018). Furthermore, the decentralised sustainability in bioenergy was analysed with the use of AHP, capturing the preferences of energy experts (Kurka, 2013).

It is a multi-criteria decision-making method where a graph structure is created using the problem components and a number of decision makers are asked to compare the components, in order to determine their priorities. Experts are selected based on their knowledge of the criteria. The method is based on relative measurements used to derive composite priority ratio scales from individual ratio scales that represent relative measurements of the influence of elements that interact with respect to control criteria (Saaty, 1996). Paired comparisons are made with judgments using numerical values taken from an AHP absolute scale of 1-9 (see Table 2) to capture the outcome of dependence and feedback within and between clusters of elements (Saaty, 1996).

Table 2: AHP Rating Scale (Saaty 1996)

The Saaty Rating Scale		
Intensity of importance	Definition	Explanation
1	Equal importance	Two factors contribute equally to the objective
3	Somewhat more important	Experience and judgment slightly favour one over the other
5	Much more important	Experience and judgment strongly favour one over the other
7	Very much more important	Experience and judgment very strongly favour one over the other. Its importance is demonstrated in practice.
9	Absolutely more important.	The evidence favouring one over the other is of the highest possible validity.
2,4,6,8	Intermediate values	When compromise is needed

The key purpose of using AHP is to analyse the problem space and determine which critical factors influence a stated decision, along with the most viable alternative solutions. These factors, called criteria in AHP, are grouped on a common property into clusters. The model should incorporate a cluster containing all the alternative solutions of the problem and one or more clusters containing the elements/decision criteria. Following this the relationships among all the model objects, both clusters and elements, should be defined. Here criteria structuring is hierarchical, with the goal at the top level, followed by the criteria connected to the goal and each of them connected to the alternative solutions. The decision maker is asked to compare dyads of elements with respect to a property or criterion they share. Once specified, the model is analysed using available tools (Saaty and Sagir, 2009; Rokou and Kirytopoulos, 2012).

4.3 Sample selection

A purposive sampling technique was used to capture Expert Knowledge Brokers responsible for EU finding allocation decisions for Greek renewable energy projects. Purposive sampling aims to provide an explanation to a phenomenon and is often used to select expert samples (Cresswell and Clark, 2011; Patton, 2002). The size of the sample varies as it is a non-probability sample that prioritises expertise in the phenomenon (Palinkas et al, 2015). Here, AHP is not aiming to generalise findings to a population based on a probalistic sample, rather to gain expert insights into their particular decision-making process. Experts were selected based on their extensive knowledge on the subject and on the basis that policy makers should be aware of the local energy complex mosaic (Guy and Marvin, 1996). The sample of experts was selected to provide depth of knowledge, where we required at least 10 years of expertise in renewable energy and relevance. As such the sample of 6 experts comprised of: two experts who have worked in both national and local level EU structural funded energy projects; two experts from the public energy grid responsible for large-scale and small-scale renewable energy installations; and two experts in rural development from the public sector with extensive experience in renewable energy, with expertise in shaping priorities aligned with the EU priorities and framework. The resulting hierarchy is shown in Figure 1. The sample size itself is comparable with similar studies undertaken in AHP (see Saaty,1986; Hamalainen, 1990; Lai et al., 2002; Srdevic and Srdevic, 2013; Kurka, 2013).

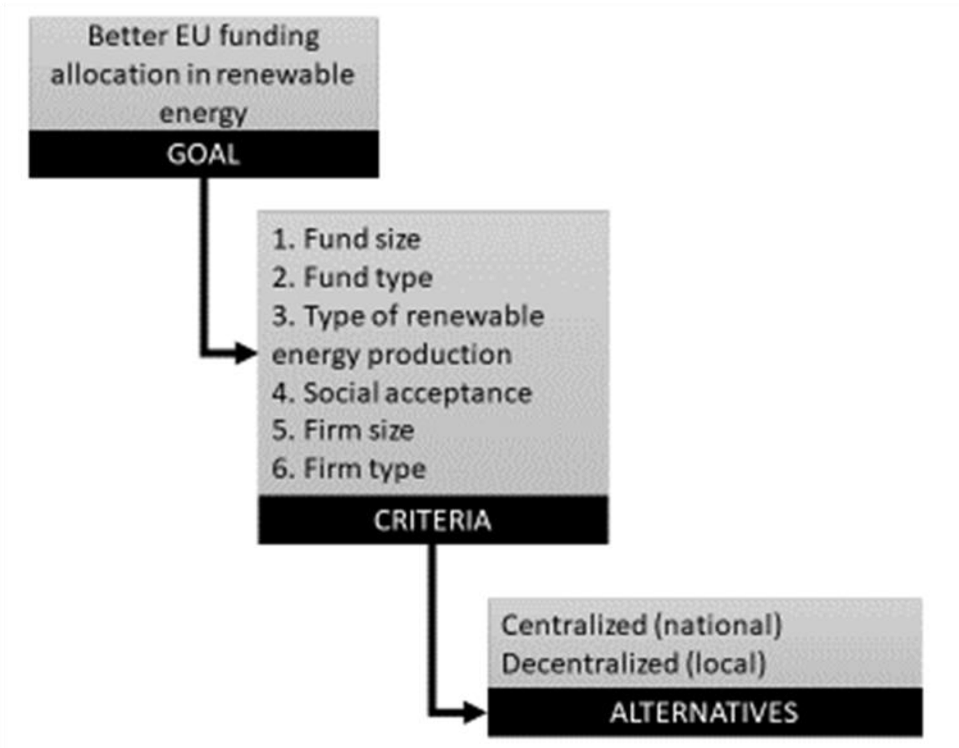


Figure 1: Allocation of funds AHP

4.4 Pairwise Comparisons

Having structured the problem as a hierarchy where we defined: a) the goal to find the best funding allocation (national or local) and identified the main factors; b) the criteria (Fund size, Fund type, Type of renewable energy production, Social acceptance, Firm size and Firm type). We next connected the criteria to the two alternative solutions that we are investigating, allocation in national or local level.

After structuring the problem, we need to determine the priorities. In AHP the priorities are calculated by level and then synthesized to get the overall results. In a three-level hierarchy, the importance of each criterion is assessed with respect to the goal and then the importance of each alternative is assessed with respect to each of the criteria. Each time we request the decision makers to compare the paired elements of the same group with respect to the parent element. The judgments are given using Saaty's 1-9 scale. We compare *n* elements and that involves making a total of $n\ (n\text{-}1)\ /\ 2$ comparisons to obtain an ordering according to estimated relative magnitudes among them. This approach relies on relative judgment about the degree or intensity of dominance of one element of a pair over the other with respect to a given property, the parent node, present to the decision maker. Such comparison is made by first identifying the smaller or lesser element as the unit and then estimating how many times the greater element is a multiple of that unit. When all the comparisons are made, a scale of priorities is derived from them that represents the relative dominance of the element. The role of the decision maker is to provide judgments on the relative intensity of these elements and ensure that the judgments are quantified to an extent that also permits quantitative interpretation of the judgments among all the elements.

4.5 Judgment matrices

In AHP the pairwise comparisons are used to form matrices of judgments. Let $A_1, A_2, \ldots, A_n$, be the set of elements. The judgments on pairs of element A_i, A_j, are represented by an *n-by-n matrix* $A = (a_{ij}),\ ij = 1, 2, \ldots,\ n$. The entries a_{ij} are defined by the following rules:

- If $a_{ij} = a$, then $a_{ji} = 1/a,\ a \neq 0$.
- If A_i is judged to be of equal relative intensity to A_j then $a_{ij}= 1$, $a_{ji}= 1$; in particular, $a_{ii} = 1$ for all $i=j$.

Thus, the matrix A has the form:

$$A = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{bmatrix} \qquad (1)$$

Table 3 presents the judgment matrix for our group of experts. This matrix presents the judgments for all the criteria of our model with respect to the parent node, which is the goal node.

Table 3: Judgment matrix for the criteria

	1. Fund size	2. Fund type	3. Type of ren. en. prod.	4. Social acceptance	5. Firm size	6. Firm type
1. Fund size	1.000	1.188	0.607	0.626	1.813	1.940
2. Fund type	0.842	1.000	0.630	0.780	1.590	1.388
3. Type of ren. en. prod.	1.647	1.587	1.000	1.587	2.839	2.475
4. Social acceptance	1.597	1.282	0.630	1.000	1.587	1.772
5. Firm size	0.552	0.629	0.352	0.630	1.000	0.693
6. Firm type	0.515	0.720	0.404	0.564	1.443	1.000

When we have a group of decision makers the aggregation of the judgments can be done either at the judgment level, before the calculation of the priority vectors or afterwards, in which case we would aggregate the priority vectors before the calculation of the final results. We applied the former method and aggregated the judgments using the geometric mean. This is the reason that in Table 3 we see decimal values instead of the 1-9 scale and their reciprocals. Judgments are requested only for the white section of the table, the diagonal is filled in with "1" by default, and the rest of the greyed-out area is calculated as reciprocals of the given judgments. For instance, in Table 3 we have the value 0.607 for the pairwise comparison of "Which factor is more important, *Fund size* or *Type of renewable energy production* with respect to the goal of this decision and by how much?" (we read first the row title and then the column title). This value is calculated using the geometric mean of the corresponding judgments of the decision makers in this case: 1/3, 3, 1/3, 1/5, 3, ¼ as seen in Table 4.

Table 4: The first line of the criteria judgment matrix for all the decision makers

	1. Fund size	2. Fund type	3. Type of renewable energy production	4. Social acceptance	5. Firm size	6. Firm type	
1. Fund size	1	0.5	0.333333333	0.2	0.333333	0.33333333	DM1
1. Fund size	1	3	3	3	4	4	DM2
1. Fund size	1	0.5	0.333333333	0.3333333	0.333333	0.5	DM3
1. Fund size	1	0.25	0.2	0.2	4	4	DM4
1. Fund size	1	3	3	6	5	5	DM5
1. Fund size	1	5	0.25	0.25	4	4	DM6

In order to have meaningful results the decision makers need to be consistent, meaning that the occurrences must be transitive. For example, if A is preferred to B and B preferred to C then A must be preferred to C. This is frequently contradicted in our preferences thus, instead of requiring or assuming full consistence we leave room for a modicum of inconsistency. We use the consistency index to measure how consistent are the judgments and we require that the inconsistency in each judgment matrix is up to 10%. In more detail, having a judgment matrix, that is positive due to the scale used to represent decision makers judgments and is reciprocal due to the way it was created, we need to determine if the contained judgments are consistent or in the opposite case, if the inconsistency is within acceptable levels. As measure of deviation from consistency, we use the introduced by Saaty (Saaty, 1996) consistency index (*CI*):

$CI = (\lambda_{max} - n) /(n-1)$

where λmax is the Perron eigenvalue of the positive reciprocal matrix being examined. The consistency ratio (*CR*), of the pairwise comparison matrix is the ratio of its inconsistency index *CI* to the corresponding random index value, $CR = CI$ /RI.

Random index (*RI*) values are computed using multiple simulations of randomly created comparison matrices and calculating the average of the consistency index for each of them. If the *C.R*. of a pairwise comparison matrix is larger than 10% then it is necessary to find which are the most inconsistent judgments in that matrix and ask the decision maker to consider changing their judgment to a value that will lead to an acceptable *CR* value. The most inconsistent judgment can be computed using the formula: $Max(aij * wj \ \forall i, j \in 0,1,..,n)$. In our case the consistency index of the judgment matrices of each decision maker never rose above 10% so no adjustments were needed (calculations of the consistency index were done using the SuperDecisions software). For instance, the matrix illustrated in Table 3, has CR value of 0.0083.

4.6 Priorities Derivation

The calculation process in AHP starts with calculating the priority vectors from each judgment matrix, for instance for Table 3 the resulting priority vector is shown in Table 5. Note that Table 5 normalised values can be found in column "Goal" of Table 6. The unweighted super matrix is a column stochastic matrix, meaning that each column's values sum is 1. The overall results are given by the weighted sum of the partial results in a process called synthesis. The local priorities are synthesized over the levels of the hierarchy until the top level; then the overall priority of each alternative is calculated. In our simple hierarchy the final results are calculated by multiplying the weights of the criteria to the corresponding local priorities of the alternatives and sum over the alternative (Table 5). For the alternative "Allocation in national level" we have

0.758*0.170+0.344*0.153+0.224*0.273+0.195*0.195+0.75526*0.096+0.4952*0.110=0.409

Normalizing the results gives the overall priorities of the alternatives (Table 5).

Table 5: Priorities vector

Criteria	Normalised alternative priorities	Weight of criteria in respect with centralised (national) approach	Weight of criteria in respect with decentralised (local) approach
1. Fund size	0.17023	0.75886	0.24114
2. Fund type	0.15384	0.34426	0.65574

3. Type of renewable energy production	0.27363	0.2242	0.7758
4. Social acceptance	0.19563	0.1955	0.80451
5. Firm size	0.09623	0.75526	0.24474
6. Firm type	0.11043	0.4952	0.5048
Centralised (National) approach Score	0.409 (40.9%)		
Desectralised (Local) Score	0.591 (59.1%)		

The centralised (national) approach (40.9%) is less preferable than the decentralised (local) approach (59.1%).

4.7 Interviews

After applying the AHP and the pairwise comparisons, interviews were undertaken with the experts to provide further insights into the consequences of their decision-making and the influence of the development debates. This supported the research strategy by collecting qualitative data towards better understanding their attributed prioritisation.

5.0 Results

As presented in Table 5 the funding allocation at the local level obtains 59.1% priority compared to the allocation at the national level where the priority is 40.9%. These results reveal that funding at the local level is regarded as more effective in the renewable energy sector. The interviews highlight that the experts are cautious in simply 'pushing through' national policies on renewable energy:

> *Social acceptance and deliberations with local communities matter in the implementation of EU funded projects…it is not easy someone from upper level of governance to force communities to accept energy installations…they have to be part of it. (Expert 2)*

However, as the 59.1/40.9 split shows, this is by no means a simple decision and

> *we cannot ignore the big image but we should take into account community distinctiveness…however, projects should not always [be] blocked due to resistance of small communities…the country needs investments. (Expert 1)*

In turn, this leads to expert recognition that mixed development approaches are necessary:

> *National and Regional authorities have the knowledge to run projects in multiple sites…it is not always easy to leave the energy planning to local communities…of course, local rural communities can manage their resources but they cannot easily do this by themselves. (Expert 6)*

As shown in Figure 2, the type of renewable energy production is the most important in the group decision making being weighted with 27%. The second most influential criterion in funding allocation is social acceptance with 20% weight. Communities can effectively block Renewable Energy projects and therefore

> *[t]he social acceptance and type of installation can be the two crucial factors of a successfully funded initiative. I have in my office cases of projects in biogas or wind energy that didn't take account the externalities caused by these kind of technologies and local communities blocked the project or we have completed installation which do not operate due to protests…they are even cases of sabotaging the installation by causing damages to the equipment. (Expert 5)*

The third criterion which affects the funding allocation is fund size with 17%. The last two criteria are firm size and firm type, weighted with 10% and 11%, respectively. Here, for sustainable large-scale investments, private firms are regarded as necessary:

> *The involvement of private companies in these projects matters in order to be ensured that the projects will create benefits long-term benefits to the society…the schemes providing incentives to farmers don't work properly as they don't have the capital to move forward… maybe, cooperatives schemes can work better in community level. but in national level large scale investments can be attracted with an indirect impact to the communities impacted by the installations. (Expert 3)*

However, it is important here to ensure that local communities also benefit directly:

> *Projects in community level with companies as investors and managing for example big wind parks with a turnover attributed to the community can work and the funded priorities should be directed towards this direction. (Expert 4)*

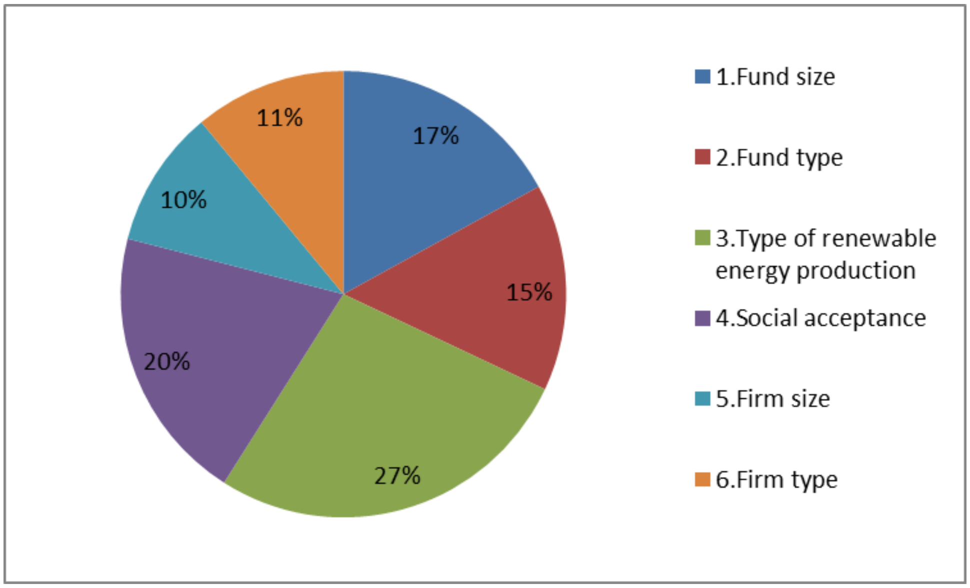


Figure 2: Priorities/importance of the decision factors

In Figure 3 we see how each alternative scores per criterion and note that the allocation at local level prevails in the social acceptance, type of renewable energy production and fund size while the other three factors give the lead to the allocation at national level.

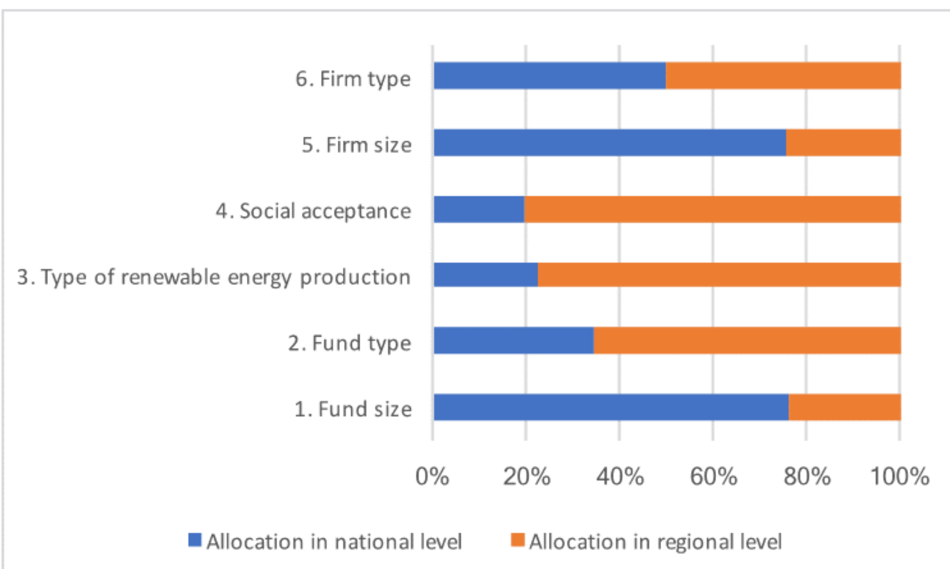
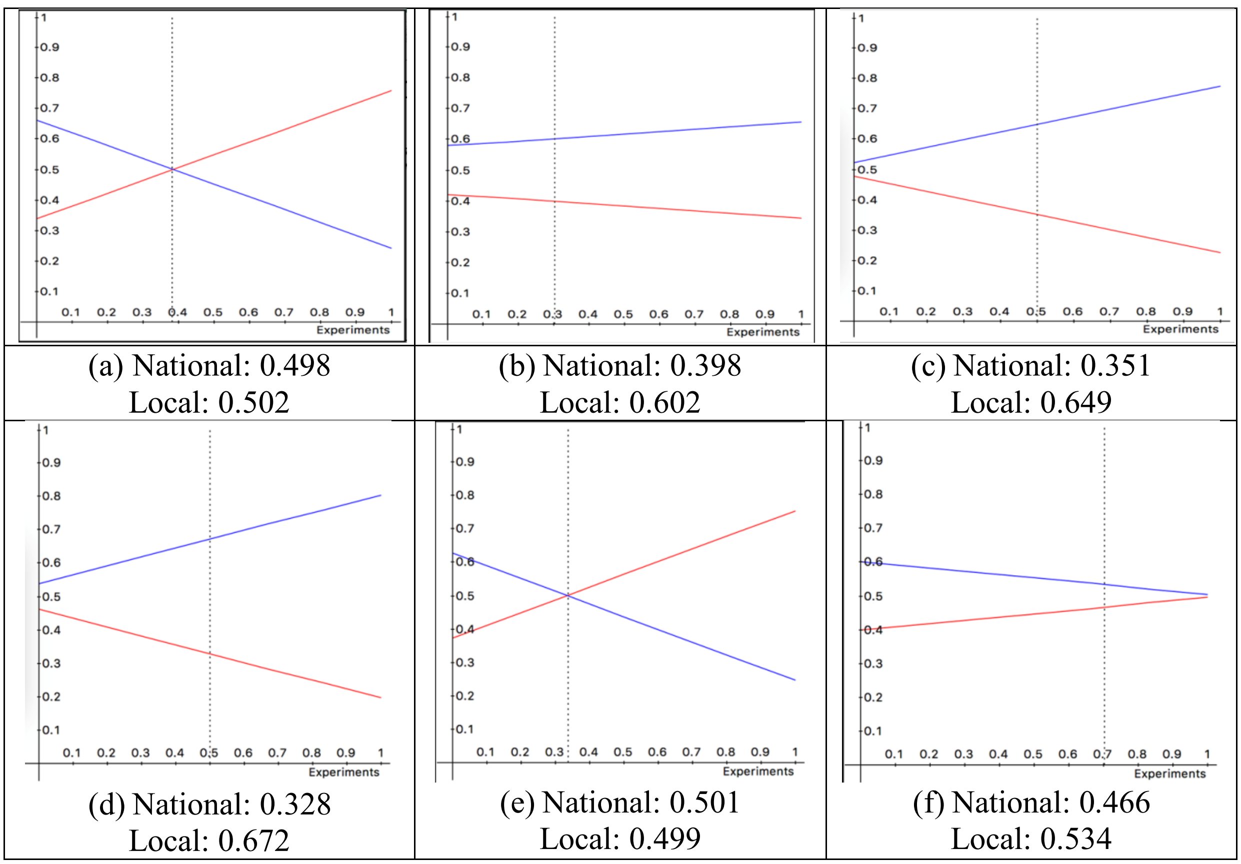


Figure 3: Performance of alternatives per decision factor

5.5 Sensitivity analysis

The aim of the sensitivity analysis of an AHP model is to examine the robustness of the decision and identify those criteria whose weight can lead to fluctuations of the results and changes in the final decision (Figure 4). In typical AHP sensitivity, we take the local weights for the collection of criteria under a common parent, and drag up or down a particular criterion's weight. Since we are dealing with a hierarchy, a criterion's local weight and global weight are essentially the same (a simple rescaling is the only change that happens from local to global). By changing said local weight (or weights) we get new local priorities for the criteria in question, and resynthesize to get new scores for our alternatives.



(a) National: 0.498
Local: 0.502

(b) National: 0.398
Local: 0.602

(c) National: 0.351
Local: 0.649

(d) National: 0.328
Local: 0.672

(e) National: 0.501
Local: 0.499

(f) National: 0.466
Local: 0.534

Figure 4: Sensitivity analysis of the model with respect to: (a) fund size, (b) fund type, (c) type of renewable energy production, (d) social acceptance, (e) firm size and (f) firm type. (Centralised (National) approach: red line and Decentralised (local) approach: blue line)

By dragging a single criterion's priority towards one or zero, we get an idea of the influence that criterion has on our alternatives. In the process of doing AHP sensitivity we need only choose the criteria we wish to analyse, and we are then able to see the impact of those criteria on the alternatives.

The sensitivity analysis reveals that even when the weights of different criteria are changed, in most cases the alternatives ranking remains the same. The results are only sensitive to changes to the weight of the fund size and firm size criteria. Specifically, by increasing the importance of fund size and/or firm size, the allocation of funds in national level becomes preferable.

6. Discussion

The research reveals that Expert Knowledge Brokers recognise the costs and benefits of endogenous and exogenous approaches to renewable energy and are enacting hybrid decision making that valorises locally based renewable energy funding allocations. This supports an endogenous view, where local, social and contextual factors are important in supporting and tailoring the initiative to their needs. Here the degree of decentralisation is important, where it may be argued that the greater the decentralisation, the greater the impact (Bahr, 2008; Stegarescu, 2004). These local factors are critical in supporting a renewable energy transition and addressing energy inequalities in the EU (Dahlmann et al., 2017; Bouzarovski and Herrero, 2017).

Previous research (Rogers et al., 2008) stresses that local communities do not always want to get involved in renewable projects. In this case, experts recognise that a national-based approach is at times preferred, granting higher public acceptance than at a local level.

The preference for a local based approach in our findings is consistent with recent rural studies as the spatial dimension of energy can be enhanced delivering benefits to the socio-economic development of communities (Schafft et al., 2018). Moreover, the benefits in rural development from the Community Renewable Energies as presented by Magnani at al. (2017) can be maximised while at the same time more power to people living in rural areas can be delivered (van der Schoor and Scholtens, 2015; Morrison and Ramsey, 2018). The fact that the type of renewable energy plays an important role as it is revealed in this study, it is also supported by other studies (Fast, 2013) which highlight the heterogeneity of approaches between policy-makers and local communities. The findings are in conflict with Helm (2014), who identified that a local approach to funding has poor outcomes. However, our research shows that, regardless of the final outcomes, the experts making the funding decisions regard a hybrid energy mix that prioritises local funding as the most acceptable approach.

7. Conclusion and Policy Implications

This paper contributes to knowledge through a nuanced explanation of the role of the Expert Knowledge Broker, suggesting how EU renewable energy policy funding decisions can become more effective. Arguing that little research had been conducted regarding the decision-making process of the Expert Knowledge Broker, this paper explored the process using Analytic Hierarchical Process analysis in the context of the renewable energy sector in Greece. We found that the types of rural development enacted are variable hybrids of endogenous / exogenous approaches. The Expert Knowledge Broker role is critical to the balance and enactment of rural development and, regardless of research demonstrating better outcomes of different approaches, we argue that it is the preferences of these critical decision-makers that determine the form of development realised.

Focusing on the renewable energy context, we recommend that Greece should exploit the Structural Funds resources to modernise renewable energy infrastructure and production while encouraging rural development through a hybrid allocation of funding that prioritises local approaches. The careful use of European funding opportunities offered by these Structural Funds is an opportunity to use renewable energy as a lever for growth in the current difficult post-crisis context. Here, according to Creutzig et al. (2014), renewable energy could contribute positively to the GDP by up to 0.5%. The favourable environmental conditions in Greece for energy, have caught the interest of investors (Ernst and Young, 2012) and to leverage this, our results suggest that policy-makers focus on hybrid approaches to the energy mix.

In terms of limitations, the criteria chosen for our analysis are contextual to Greece in the renewable energy context and cannot comprehensively cover the complexity of fund allocation. In future research, more parameters could be included such as the level of energy infrastructure currently available at national and local levels. The research can be applied to other geographies and contexts to understand the funding preferences of expert knowledge brokers.

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