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ESTUDIOS

A methodological framework to assist in the renewable energy policies of the Central American countries based on the Analytical Network Process (ANP)[1]

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Abstract: Renewable energies play an essential role in the Central American Countries, providing responses to face the economic crisis and improving the living conditions of the people, which are being undermined by the effects of the Covid–19. Although the states´ involvement in these processes is reflected through diverse endeavors to enhance renewable energies, their policies need to be readjusted to ensure their effectiveness regarding the current needs. For these reasons, is proposed a methodological framework to assist policymakers, the fundamentals of this tool are based on a Multicriteria Decision Analysis technique, called Analytical Network Process. The innovation of this methodology is that it reveals the best course of action, comparing the countries' economic, political, social, and environmental elements. The present study evidences its applicability through the cases of Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua. This novel methodology even addresses their main contextual constraints to guarantee the most realistic diagnoses.

Keywords: *Renewable energy, Analytical Network Process, Development.*

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Un marco metodológico de ayuda a las políticas de energías renovables de los países centroamericanos basado en el Proceso de Redes Analíticas (PNA)

Resumen: Las energías renovables juegan un papel esencial en los países centroamericanos, aportando respuestas para enfrentar la crisis económica y mejorar las condiciones de vida de la población, que se ven mermadas por los efectos de la Covid–19. Si bien el compromiso de los Estados en estos procesos se refleja a través de diversos esfuerzos por potenciar las energías renovables, es necesario reajustar sus políticas para asegurar su efectividad frente a las necesidades actuales. Por estas razones, se propone un marco metodológico para ayudar a los responsables políticos, los fundamentos de esta herramienta se basan en una técnica de Análisis de Decisiones Multicriterio, denominada Proceso de Redes Analíticas. La innovación de esta metodología es que revela el mejor curso de acción, comparando los elementos económicos, políticos, sociales y medioambientales de los países. El presente estudio evidencia su aplicabilidad a través de los casos de Costa Rica, El Salvador, Guatemala, Honduras y Nicaragua. Esta novedosa metodología aborda incluso sus principales condicionantes contextuales para garantizar los diagnósticos más realistas.

Palabras clave: *Energía renovable, Proceso Analítico de Redes, Desarrollo.*

Un cadre méthodologique pour soutenir les politiques d'énergie renouvelable dans les pays d'Amérique centrale, basé sur le Processus de Réseau Analytique (PNA)

Résumé: Les énergies renouvelables jouent un rôle essentiel dans les pays d'Amérique centrale, apportant des réponses pour faire face à la crise économique et améliorer les conditions de vie de la population, diminuées par les effets du Covid–19. Bien que l'engagement des États dans ces processus se traduise par divers efforts pour promouvoir les énergies renouvelables, il est nécessaire de réajuster leurs politiques pour assurer leur efficacité face aux besoins actuels. Pour ces raisons, un cadre méthodologique est proposé pour aider les décideurs politiques. Les fondements de cet outil sont basés sur une technique d'analyse décisionnelle multi–critères, appelée le processus de réseau analytique. L'innovation de cette méthodologie est qu'elle révèle la meilleure ligne d'action en comparant les éléments économiques, politiques, sociaux et environnementaux des pays. Cette étude démontre son applicabilité à travers les cas du Costa Rica, El Salvador, Guatemala, Honduras et Nicaragua. Cette nouvelle méthodologie prend même en compte leurs principales contraintes contextuelles afin de garantir les diagnostics les plus réalistes.

Mots clé: *Énergie renouvelable, Processus analytique de réseau, Développement.*

1. Introduction

Renewable energies have become part of the global agenda toward 2030 with the Sustainable Development Goals (SDGs). This promising designation arises from their counterbalances mitigating global warming, the economic crisis, and the progressive fossil fuel consumption (H. Meadows et al., 1972; Mauerhofer et al., 2016). That is to say, issues daunting for the development of the nations (Schwab, 2019), as the undermining effects of Covid-19, which are slowing down sustainable initiatives (Turk & Kamiya, 2020). In emerging economies, this is the latent reality and intrinsically indicates that renewable energies must be addressed imperatively, but with a shared and differentiated nuance, as established in emblematic milestones as the Brundtland Report (1987), the Agenda 21 (Calabuig, 2008), and the Kyoto Protocol (1998).

Albeit Central America has evident advances, such as the Central American Electricity Market Framework Treaty, promoted under the auspices of the Central American Bank for Economic Integration (Reinstein et al., 2011), in this type of initiative, the political, economic, and social aspects of the countries create certain conditionings (Iskin et al., 2012), as well as their main contextual barriers (Schwab, 2019). Despite this, they also reveal the historical contrast within a region of lower-middle-income countries, with enormous potential, owing to their natural resources that at all the lights could improve people's lives (UNDP, 2019). Evidently, using an appropriate management.

For this reason, a diagnosis of the elements that make up the renewable energies is almost mandatory for this region, considering that an update can assist and guide policy-makers to enhance the current dynamics, creating reforms for their public policies. Although several frameworks and tools address these complex topics, the diagnosis presented in this research is promising as it systematically embraces interactive updates and reveals the most accurate readjustments for each country.

2. Theoretical framework

For the accomplishment of this project was reviewed literature about renewable energies, about local and regional policies (Moner-Girona, 2009; Mauerhofer et al., 2016), even studies embracing benefits, opportunities, costs, and risks in developing nations and for corporations (Norton Rose Fulbright, 2016; Ram et al., 2018). Possibly, the most elucidating reference was a study carried out by Ibrahim Iskin, Tugrul Daim, Gulgun Kayakutlu, and Mehmet Altuntas (2012), comparing renewable energy pricing of a developed and a developing country with ANP.

However, the contribution of the proposed methodology is a construction process involving the aspects above in the context of Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua. Among the economic elements were contemplated operational costs to embrace aspects as salaries, supplies, equipment, and maintenance (Sokhansanj et al., 2006; Cannemi et al., 2014). Distribution costs as an indispensable basis to address factors related to timeliness and distance for the execution of projects; the reference is the study of Rudiger Barth, Christoph Weber, and Derk J. Swider (2008), which focuses on distribution costs and renewable energy.

For economic performance, was included return on investment to determine the importance that implies the financial rentability for corporations and states (El Kafazi et al., 2017). Likewise, investment costs concerning the minimum capital to the startup of operations, the leverage to disseminate the affordability within each country (Cannemi et al., 2014). The tax incentive as those described in the research of Paul Ekins (Ekins, 2004), and inflation to ensure both the feasibility and profitability of the projects (Maria, et al., 2017). The introduction of these elements is due to their sensitive influence over the renewable energy markets.

Regarding the political sphere, the regional achievements are possibly the most outstanding for the Central American countries. Nevertheless, their effectiveness differs both in its governance models and in the level of compliance with its internal and external policies (Mauerhofer et al., 2016). For this reason, this study encompasses their international and national regulations and, likewise, their political stability based on the Democracy Index (The Economist Intelligence Unit, 2020). The relevance of these systemic aspects is that they can affect, alleviate, and consolidate megaprojects.

On the other hand, given each country´s structural asymmetry, the social aspects have been disaggregated in social awareness to prevent the collective rejections sharpened historically owing to the neo-extractivist practices (Cannemi et al., 2014; Mauerhofer et al., 2016). Likewise, innovation & technology as the development catalyzers that are pumped through the projects (Schwab, 2019). The potential job opportunities, to reveal the importance that the incomes represent to the inhabitants, and the local development, aiming to expose the need to improve the living conditions of the people; the reference is the Human Development Index (HDI), taking into account that provides a panoramic vision of the social realities.

Other essential elements that cannot pass unnoticed in this study are those related to the environmental field, such as carbon dioxide reduction; its relevance lies in making the need to control greenhouse gas emissions visible. Besides this, air pollution reduction, renewable freshwater, and renewable energy share also were included. This last element is focused on diversifying a shared usage of all energies (Iskin et al., 2012). The general premise of these typologies is that they can reduce fossil fuel consumption, and therefore, are vital to minimize inequality gaps within the communities.

Nevertheless, as narrated in the introductory part, renewable energy projects have constraints and barriers. For this reason, was contemplated fossil fuel consumption, as an aspect rooted in every society. In addition to this aspect, the geography and the infrastructure of the countries as the main contextual issues that can undermine the renewable energy processes (Iskin et al., 2012; Schwab, 2019). Although the heterogeneity of the elements can be complex, the section below explains the process to obtain the diagnosis coherently.

3. Methodology

The methodology addresses the renewable energy aspects based on a Multicriteria Decision Analysis Technique, called Analytical Network Process (ANP). This model was designed by Thomas Saaty[3] (2001). The main attribute is that this model can be used to prioritize qualitative and quantitative data, represented in elements, then are grouped into clusters (also called components) and are established their internal and external dependencies or relations. Thus, the elements and components are modeled as a network, and with this structuration, they are compared.

Regularly, in processes with ANP, the decision–makers are groups of experts or specialists with broad experience in the thematic addressed (Saaty & Vargas, 2006). For this reason, the outcomes are so binding and assertive, given that they are based on different specialized knowledge and judgments. Nonetheless, to comply with the fundamentals of ANP and with this novel approach, a facilitator is recommended to provide accompaniment to those participants[4] or stakeholders that are not acquainted with ANP.

According to Thomas Saaty (2004)of one of two elements over the other in a pairwise comparison process on a third element in the system, with respect to an

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[3] He was a distinguished Professor of the University of Pittsburg who wrote more than 35 books and 150 articles about math, planning, and decision making. The main contributions of this author are the Analytic Network Process (ANP) and the Analytic Hierarchy Process (AHP).

[4] In this research, the aim is not to obtain generalized results with many participants, is to generate an analysis based on the integration of specialized experiences. For this, the involvement of key actors is needed to play the role of stakeholders.

underlying control criterion. Through its supermatrix, whose entries are themselves matrices of column priorities, the ANP synthesizes the outcome of dependence and feedback within and between clusters of elements. The Analytic Hierarchy Process (AHP, the steps of ANP are the following:

- Identifying the components and elements of the network and their relationships.
- Conducting pairwise comparisons on the elements.
- The resulting relative importance weights (eigenvectors) are placed in matrices within the supermatrix (unweighted matrix).
- Conducting pairwise comparisons on the clusters.
- Weighting the blocks of the unweighted matrix by the corresponding priorities of the clusters so that it can be a stochastic column (weighted matrix).
- Raising the weighted matrix into limiting powers until the weights converge and remain stable (limit matrix).

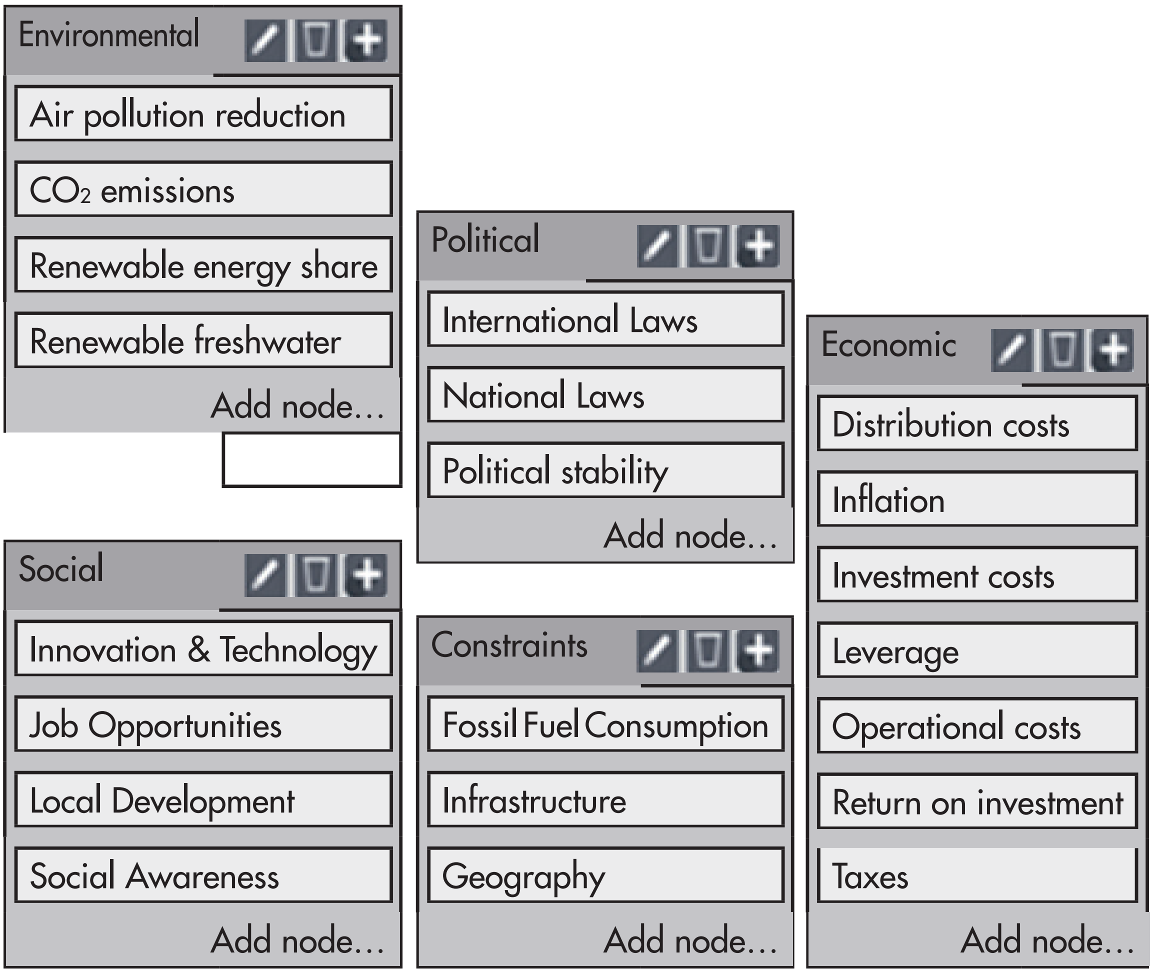
However, to facilitate the development of these steps, they have been synthesized in four basic phases:

- Model the decision problem as a network.
- Pairwise comparison.
- Priority calculation.
- Data analysis.

3.1. Model the decision problem as a network

During this initial phase, the participants must brainstorm over aspects related to renewable energies. Although multiple elements may arise due to the diverse experiences of the participants, the aim must be the selection of the most binding. The consensus is fundamental for determining their scope, in view that their ideas can be fuzzy about the elements that will be assessed. In the pilot study, the literature review allowed the identification of 21 elements, which were grouped into 5 clusters, as shown in Figure 1.

FIGURE 1. **Renewable Energy Network in the Software: Super Decisions**

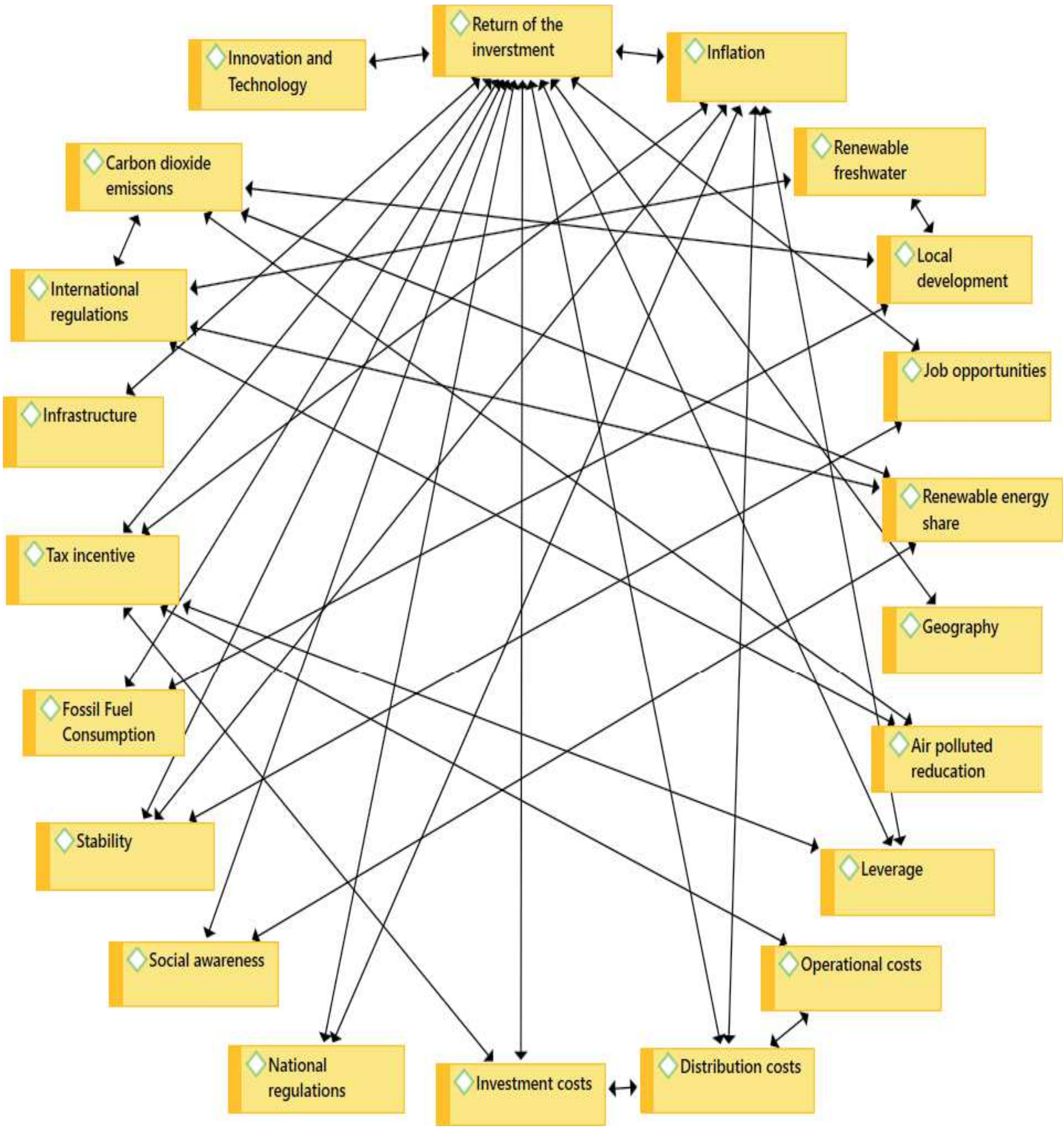


Source: own elaboration.

Even though the clusters may vary according to the number of elements, it must be established that this does not imply that they have greater or lesser importance. Besides structuring the network, the cluster´s function is that they facilitate defining the relations between elements, and these relations, which elements will be an object of comparison. Although can be overwhelming given the diversity of elements and relations, as shown in figure 2. The software: Super Decisions designed for ANP assists in processing the data. Nevertheless, the comparisons fulfillments that determine the priorities depend exclusively on the participants´ knowledge, experience, and judgment.

For the pilot application, in addition to the literature described in the theoretical framework, the reference for the comparisons fulfillments were indicators from the World Bank Open Data; from the Sustainable Development Goals Global Database; from the Organization for Economic Cooperation and Development; from the Global Competitiveness Index and from the International Labor Organization.

FIGURE 2. **Element's relations**



Source: own elaboration.

3.2. Pairwise comparison

In projects with ANP, these relations or dependencies are represented through an influence matrix, as shown in Table 1, in which 1 indicates their dependence and 0 its independence. These characters mean that those with 0 aren´t related and will

TABLE 1: **Influence matrix**

Countries		Economic							Environmental				Political				Social				Constraints	
Costa Rica El Salvador Guatemala Nicaragua Honduras		Distribution costs	Inflation	Investment costs	Leverage	Operational costs	Return of the Investment	Tax incentive	Air polluted reduction	CO2 emissions	Renewable energy share	Renewable freshwater	International laws	National laws	Stability	Job opportunities	Local development	Social awareness	Innovation& technology	Fossil FuelConsumption	Geography	Infrastructure
Economic	Distribution costs	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Inflation	1	0	0	1	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	Investment costs	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0
	Leverage	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Operational costs	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Return of the Investment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tax incentive	0	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Environmental	Air polluted reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	CO2 emissions reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Renewable energy share	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0
	Renewable freshwater	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Political	International laws	0	0	0	0	0	0	0	1	1	0	0	0	1	1	0	0	1	0	0	0	0
	National laws	0	0	1	0	0	0	1	1	1	0	0	0	0	1	1	0	1	0	0	0	0
	Stability	1	0	1	1	1	0	1	0	0	0	0	1	1	0	1	1	0	0	0	0	0
Social	Job opportunities	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
	Local development	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	0	0
	Social awareness	0	0	0	0	0	0	0	1	1	1	1	0	1	0	1	1	0	0	1	0	0
	Innovation & technology	0	0	1	0	1	0	0	1	1	1	1	0	0	0	1	1	1	0	1	0	0
Constraints	Fossil fuel consumption	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0
	Geography	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Infrastructure	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0

Source: own elaboration.

not be an object of comparison. The relevance of this restriction is that it prevents decision–makers from unnecessary assessments, usually held in mega–projects. Rather than that, it only allows comparisons between those with an explicit binding. The favorable attribute during this phase is the flexibility of ANP, considering that it doesn´t establish a rigid sequence for the comparisons. The participants decide this sequence according to their own convenience.

For example, centered on distribution costs must be compared inflation and investment costs due to their relations. The comparative logic used is to display the level of importance or priority over the element of the column. The characteristic of these comparisons is that they are made only between those of the same cluster (Saaty, 1999)of one of two elements over the other in a pairwise comparison process on a third element in the system, with respect to an underlying control criterion. Through its supermatrix, whose entries are themselves matrices of column priorities, the ANP synthesizes the outcome of dependence and feedback within and between clusters of elements. The Analytic Hierarchy Process (AHP. In these processes, the priorities are determined through a scale of levels (Saaty, 2006), which uses both cardinal (1, 3, 5, 7, 9) and ordinal values (equal, moderate, strong, very strong, extreme), when it uses ordinal values, its representation is very similar to the adjectives of the Likert Scale (Bisquerra & Pérez–Escoda, 2015). A format to exemplify the questions that can be used is the following:

TABLE 2. **Generic question with nominal scale of ANP**

According to your experience, which element is more important, and to what extent more influential in relation to E.1?								
E.3	Extreme	Strong	Moderate	Equal	Moderate	Strong	Extreme	E.5
E.3	Extreme	Strong	Moderate	Equal	Moderate	Strong	Extreme	E.7
E.5	Extreme	Strong	Moderate	Equal	Moderate	Strong	Extreme	E.7

Source: own elaboration.

The advantage of this format is that it provides homogeneity in the questions and answers. After the fulfillments with this type of format, the priorities are converted into weightings, and once added, they constitute a unit per cluster, as shown in the following vector:

TABLE 3. **Conversion of influences**

E.1.	E.3.	E.5.	E.7.	Weights	
E.3.		3	5	0.63699	63.699
E.5.	1/3		3	0.25828	25.828
E.7.	1/5	1/3		0.10473	10.471
				1.00000	100.000

Source: own elaboration.

3.3. Priority calculation

In the pilot study, there were 42 pairwise comparisons, and after completing them, was generated an unweighted matrix. This process was filled out on five occasions according to the context of each country. Then this comparative technique was applied among clusters and, thus, was obtained the weighted matrix. The difference from the unweighted matrix is in the input number in the vectors, considering that the weighted matrix doesn´t collect null vectors. After prioritizing the clusters, the weighted matrix is raised into limiting powers until the weights converge and remain stable. Thus, the final data is revealed using the network as a whole, as shown in Table 4.

3.4. Data analysis

In this last phase, after obtaining the prioritization, for the data analysis, the application allows the identification of key elements for each diagnosis. A steady parameter for this process is the aggregation weights that sum more than 75%, considering that this represents 3/4 on each cluster. In this way, the remaining percentages with lower priorities aren´t analyzed in–depth. But this must be carried out independently due to the differentiated necessities of the countries.

For example, based on these parameters in the economic cluster of Nicaragua, the most compelling readjustment would be for inflation (39.094) and investment (47.897), jointly representing (86.991). For the case of its environmental cluster, primarily renewable freshwater (58.477) and renewable energy share (15.129), representing (73.606), in view that any other minimum weight will provide a percentage over 75%. For the most part, this allows several microanalyses, however, an important observation is that there may be unexpected weights as 0 or its approximation, and this is due to their low importance or few connections.

TABLE 4. **Renewable Energy elements prioritized**

Elements	Costa Rica		El Salvador		Guatemala		Honduras		Nicaragua	
	Cluster	Limit	Cluster	Limit	Cluster	Limit	Cluster	Limit	Cluster	Limit
Distribution costs	—	—	—	—	—	—	—	—	—	—
Inflation	37.958	10.383	53.237	12.445	41.635	8.429	62.410	18.122	39.094	7.302
Investment costs	37.554	10.272	32.313	7.554	55.019	11.139	20.504	5.954	47.897	8.946
Leverage	6.286	1.712	1.027	0.240	—	—	1.739	0.505	7.125	1.331
Operational costs	6.147	1.681	1.970	0.460	2.260	0.458	0.981	0.285	0.777	0.145
Return of the Investment	—	—	—	—	—	—	—	—	—	—
Tax incentive	12.054	3.297	11.453	2.677	1.086	0.220	14.366	4.171	5.106	0.954
Air pollution reduction	9.914	0.309	21.640	0.519	40.898	1.228	5.747	1.163	13.197	0.565
CO2 emissions reduction	35.995	1.123	15.737	0.377	13.634	0.409	17.717	0.359	13.197	0.565
Renewable Energy share	31.522	0.983	25.833	0.619	31.834	0.956	10.079	0.204	15.129	0.648
Renewable freshwater	22.569	0.704	36.789	0.882	13.634	0.409	14.733	0.298	58.477	2.503
International law	25.502	10.072	27.039	11.518	14.616	6.020	11.362	4.968	18.604	6.894
National law	26.031	10.281	23.352	9.948	31.886	13.134	25.501	11.149	15.211	5.637
Political stability	48.467	19.142	49.609	21.133	53.498	22.036	63.137	27.603	66.185	24.525
Innovation & Technology	27.235	6.217	25.701	6.422	29.420	7.561	17.344	3.691	32.546	11.681
Job Opportunities	33.016	7.537	21.990	5.495	21.328	5.482	45.474	9.676	9.970	3.579
Local Development	30.851	7.043	36.152	9.034	40.643	10.446	31.064	6.610	52.174	18.727
Social Awareness	8.898	2.031	16.157	4.037	8.609	2.213	6.118	1.302	5.311	1.906
Fossil fuel consumption	62.024	4.468	74.759	4.964	55.093	5.433	69.586	2.743	66.891	2.740
Geography	18.746	1.350	19.973	1.326	10.334	1.019	20.679	0.815	3.033	0.124
Infrastructure	19.230	1.385	5.268	0.350	34.573	3.409	9.736	0.384	30.076	1.232

Source: own elaboration.

Besides the microanalyses, ANP also allows an analysis based on the limiting weights of the network. Although in these processes regularly there is only one limit matrix, the fundamentals of ANP establish that when there are several specialists and therefore several limit matrices, can be applied the geometric mean (Saaty, 2008). This aggregation represents a collective result in which their perspectives, experiences, and judgments converge.

4. Results

As previously mentioned, the research has aimed to assist in the readjustments of the renewable energy policies for the Central American countries, and correspondingly, have been displayed several macro–comparisons. However, contemplating their scope, this section is focused on the limiting results to provide the most illustrative findings.

Regarding the environmental elements, the weights have exposed different necessities, in Costa Rica mainly in the policies of CO2 emissions reduction and renewable energy share; in El Salvador in those of renewable freshwater and renewable energy share; in Guatemala, air pollution reduction and renewable energy share; in Honduras primarily on air pollution reduction and in Nicaraguan on renewable freshwater. The rest must be treated parallelly in this last case since they are within the same range.

In political terms, stability is the most relevant in all the networks. However, when the weights of international and national laws are analyzed sensitively, they evidence some contrasts. For example, in Costa Rica, the policy review requires the most similar treatment, followed by El Salvador, and in the cases of Guatemala and Honduras, particularly national laws. For the Nicaraguan case, international laws, under the premise that the compliance of their multilateral agreements could enhance the political conditions for the fostering of renewable energies.

With the social disaggregation, the Costa Rica results indicate that job opportunities and local development are the main priority; in El Salvador and Guatemala, local development; in Honduras, job opportunities and in Nicaragua, innovation & technology and local development. Regarding the constraints, fossil fuel consumption obtained the greatest weighting in all the networks. In the case of geography and infrastructure, which are those concerning contextual issues, they can be deemed in lower rankings.

5. Conclusions and recommendations

At this point, it has been revealed that the methodology yields promising results for the renewable energy policies of the Central American Countries, primarily due to the elements involved and for their influence on their contexts. However, this has been just a pilot application, for this reason, the conclusions are formulated to expose the benefits of this methodology and its scope for subsequent applications.

First, this methodology and its fundamentals clearly can be used as an efficient tool to assist in readjustments and updates of binding content for renewable energy policies. Nevertheless, as has been mentioned, the decisions depend exclusively on stakeholders. Given that premise, the participants involved must develop all the phases, from the brainstorming to the pairwise comparisons. Even during the data analysis as feedback, in this manner, there will be a certainty of their judgments. Otherwise, the process will be characterized by skepticism and could lead to a lack of consistency in the results.

Second, about the results, it can be asseverated that they are products of a process with high scientific rigor, so they can be used as critical information to improve their public policies. And accordingly, the phases carried out as the formula for the new public management for the renewable energy policies. However, this methodology should not be limited to one participant; it is encouraged to apply it with multidisciplinary groups of stakeholders or participants. Undoubtedly, the involvement of more actors will provide more binding results and, therefore, more effective readjustments, particularly in those contexts characterized by their complexity.

Third, conclusively, it must be emphasized that a replica can provide increasingly binding information. During the pilot application, the approach revealed a diagnosis for each country. However, replicating this methodology, the approach may vary and generate other findings. Indeed, it can be designed to analyze a regional policy adjustment. In this case, the individual results could be averaged, evidently, with logic and coherence. The advantage of this approach is that besides providing a panoramic view, it would be enhancing the shared and differentiated nuance longed for this region.

6. Bibliography

BARTH, R., WEBER, C., & SWIDER, D. J. (2008). "Distribution of costs induced by the integration of RES–E power", *Energy Policy*, *36*(8), 3107–3115.

BISQUERRA, R., & PÉREZ–ESCODA, N. (2015). "Can Likert scales increase in sensitivity?" ["¿Pueden las escalas Likert aumentar en sensibilidad?"]. *Revista de Innovación e Investigación en Educación*, *8*(2), 129–147.

CALABUIG, C. (2008). *Local Agenda 21 and democratic governance for sustainable human development: foundations for process–oriented management* [*Agenda 21 local y gobernanza democrática para el desarrollo humano sostenible: bases para una gestión orientada al proceso*] [Tesis doctoral, Universidad Politécnica de Valencia]. Repositorio Institucional UPV. https://doi.org/10.4995/Thesis/10251/2503

Cannemi, M., García–Melón, M., Aragonés–Beltrán, P., & Gómez–Navarro, T. (2014). "Modeling decision making as a support tool for policy making on renewable energy development". *Energy Policy*, *67*, 127–137.

Ekins, P. (2004). "Step changes for decarbonising the energy system: Research needs for renewables, energy efficiency and nuclear power". *Energy Policy*, *32*(17), 1891–1904.

El Kafazi, I., Bannari, R., Adiba, E. B. E. I., Nabil, H., & Dragicevic, T. (2017). "Renewable energies: Modeling and optimization of production cost". *Energy Procedia*, *136*, 380–387.

H. Meadows, D., L. Meadows, D., Randers, J., & Behrens III, W. W. (1972). *The Limits to Growth*. New York, Universe Books. http://doi.wiley.com/10.1111/j.1752-1688.1972.tb05230.x

Iskin, I., Daim, T., Kayakutlu, G., & Altuntas, M. (2012). "Exploring renewable energy pricing with analytic network process – Comparing a developed and a developing economy". *Energy Economics*, *34*, 882–891.

Maria, A., Acero, J. L., Aguilera, A. L. & Lozano, M. G. (2017). *Central America urbanization review, making cities work for Central America countries and regions*. World Bank Group. https://openknowledge.worldbank.org/bitstream/handle/10986/26271/9781464809859.pdf?sequence=2&isAllowed=y

Mauerhofer, V., Alogna, I., Kerschner, F., Wagner, E., Khalid, R., Jalil, F., Bin Mokhtar, M., Sancin, V., Kovič, M., Stonianoff, N., Prades, J., De la Varga, A., Argyrou, A., Lambooy, T. E., Jan Blomme, R., Kievit, H., Nieuwenhuijzen, G., Hora Siccama, D., Okubo, N., … Williams, J. (2016). *Legal Aspects of Sustainable Development: Horizontal and Sectorial Policy Issues*. Switzerland, Springer.

Moner–Girona, M. (2009). A new tailored scheme for the support of renewable energies in developing countries. *Energy Policy*, *37*(5), 2037–2041.

Norton Rose Fulbright (2016). *Renewable Energy in Latin America*. United Kingdom, Norton Rose Fulbright. http://www.nortonrosefulbright.com/files/renewable-energy-in-latin-america-134675.pdf

Ram, M., Child, M., Aghahosseini, A., Bogdanov, D., Lohrmann, A., & Breyer, C. (2018). "A comparative analysis of electricity generation costs from renewable, fossil fuel and nuclear sources in G20 countries for the period 2015–2030". *Journal of Cleaner Production, 199*, 687–704.

Reinstein, D., Mateos, A., Brugman, A., Berman, L., & Johnson, T. (2011). *Regional Power Integration: Structural and Regulatory Challenges.* The World Bank Energy Unit, Sustainable Development department. https://openknowledge.worldbank.org/bitstream/handle/10986/2766/589340ESW0P1100toryModule00English0.pdf?sequence=1&isAllowed=y

Saaty, T. L. (2001). *Decision making with dependence and feedback: The analytic network process.* Pittsburgh, RWS Publications.

— (2004). Fundamentals of the analytic network process — Dependence and feedback in decision–making with a single network. *Journal of Systems Science and Systems Engineering,* 13(2), 129–157. https://link.springer.com/content/pdf/10.1007/s11518-006-0158-y.pdf

— (2006). The Analytic Network Process. Archive of SID, 1–26. https://www.researchgate.net/publication/226556079_The_Analytic_Network_Process

Saaty, T. L., & Vargas, L. G. (2006). *Decision Making with The Analytical Network Process, Economic, Political, Social, and Technological Application with Benefits, Opportunities, Costs and Risks.* Pittsburgh. http://www.untag-smd.ac.id/files/Perpustakaan_Digital_1/DECISION%20MAKING%20Decision%20Making%20with%20the%20Analytic%20Network%20Process.pdf

Schwab, K. (2019). *The Global Competitiveness Report 2019.* The World Economic Forum. http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf

Sokhansanj, S., Kumar, A., & Turhollow, A. F. (2006). Development and implementation of integrated biomass supply analysis and logistics model (IBSAL). *Biomass and Bioenergy, 30*(10), 838–847.

The Economist Intelligence Unit (2020). *Democracy Index 2020 In sickness and in health?* New York, The Economist Group. https://pages.eiu.com/rs/753-RIQ-438/images/democracy-index-2020.pdf?mkt_tok=eyJpIjoiWTJWak9HUTFNVFJtTUdOaSIsInQiOiJzU0VkZTNxcCtiaWNxMWtrSm95VzN5R3hXSVlSRDBoWk1YSHFnaXVudG56Q3lJckhGb3JPYjJoaDBMQUZJWXY1XC9TbzczWndTbFhGWDJ2cHlGNE9QNURuMExjZm13SFwvck1KdnMweX

Turk, D., & Kamiya, G. (2020). The Covid–19 pandemic is having a major impact on energy systems around the world, curbing investments and threatening to slow the expansion of key clean energy technologies. *IEA*, (11/06/2020). https://www.iea.org/articles/the-impact-of-the-covid-19-crisis-on-clean-energy-progress

Kyoto Protocol (1988). *Kyoto Protocol to the United Nations framework convention on climate change*. https://unfccc.int/resource/docs/convkp/kpeng.pdf

UNDP, United Nations Development Program (2019). *Human Development Report 2019: beyond income, beyond averages, beyond today*. New York, in United Nations. http://hdr.undp.org/sites/default/files/hdr2019.pdf

World Commission on Environment and Development (1987). *Brundtland Report: Our Common Future*. United Nations. https://digitallibrary.un.org/record/139811