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A Data-Driven Analysis on Sustainable Energy Security:
Challenges and Opportunities in World Regions

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ABSTRACT

This study provides a data-driven analysis that illustrates a clear renewable energy depiction in sustainable energy security and unveils the regional issues. A hybrid method is proposed to validate those indicators and shows the trend of future studies. This study enriches the challenges and opportunities by contributing to understand the fundamental knowledge of renewable energy in sustainable energy security, conveyance directions for future study and investigation, and assessment on global renewable energy position and regional disparities. There are 19 valid indicators, in which energy demand, energy policy, renewable resources, smart grid, and uncertainty represent the future trends. World regional comparison includes 115 countries/territories categorized into five geographical regions. The results show that those indicators have addressed different issues in the world regional comparison.

KEYWORDS

Bibliometric Analyses, Data-Driven, Energy Security, Fuzzy DEMATEL, Renewable Energy, Sustainable Development

1. INTRODUCTION

The last decades, energy production is a tough topic that concerns governments and those interested in resources around the world (Abdel-Basset et al., 2021). The United Nations' Sustainable Development Goal 7, which is to "ensure access to affordable, reliable, sustainable and modern energy for all", accounts for the significance growing of renewable energy (RE) strategies and usages (UN, 2020). The RE refers to energies constantly derived from replenishing natural resources such as solar, wind, ocean (tidal and wave), hydropower, biomass, biofuels, geothermal, and electricity (Vakulchuk et al., 2020). Though utmost RE technologies are still developing, numerous governments have approved RE goals and implementations (Adelaja, 2020). Certainly, the ecological friendliness and the progressively engagement potentials make RE an important component of a sustainable future of energy security (ES). There is mass volume of RE literature on how to guide the opportunities and challenges and only few studies are utilized data driven analysis for the massive information and generate the indicators for sustainable ES.

In the literature, Valentine (2011) argued that RE advantages over fossil fuel as to distributing sustainable ES. Wang et al. (2014) claimed RE is not only occupied as a sustainable choice of clean

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energy scheme, but also approaches to address other social persistent requirements, including ES improvement, environmental effects reduction, and climate change mitigation. Wang et al. (2018) debated RE offers opportunities to ease energy deficiency, and provides up-to-date energy services assessment to substance sustainable progress. The RE are probable to transmit security-related characters close to fossil fuels throughout the provisional stage whereas ES is reinforced as large-scale of RE deployment in the long-term effects (Vakulchuk et al., 2020). However, the necessitous RE policy instruments and technical solutions is miserable, resulting in the RE deployment remains gaps and uninspiring (Adelaja, 2020; Cieplinski et al., 2021). Thus, ES is an imperative encounter to sustainable performance and RE may be a precious issue to be addressed.

ES is a polysemic concept comprehends diverse that evolves and depends consistent with the economic architype's experiential in energy markets (Chester, 2010). The literature discussed energy subjects in terms of RE and determined its role in ES (Bundschuh et al., 2021; Hasankhani et al., 2021). Wang et al. (2018) proposed RE deployment and ES by investigating the concept evolution and substantiating network symbiosis. Ahmad et al. (2020) argued the ES and reliability need to become dependent on the operational capability to provision expected and unexpected dispersal (generation and consumption) and alteration to continuity sustainability. However, the literature solely occupies ES concept in the view of descriptions, agendas and modeling, and operationalizations, or that pertains it to fossil fuels (Vakulchuk et al., 2020). In order to empathize how ES and RE is approached, an insightful examination how the concepts evolved from past viewpoints, which tend to have dominant regimens, is needed. There are various indicators might launch a linkage approach between the gigantic diffusion of RE and ES (Valentine, 2011; Hache, 2018). In sum, an inclusive unified valuation is crucial in extending the current literature, this study attempts to provide a data-driven analysis that illustrates a clear RE depiction in sustainable ES and discloses impeding augmentation ascribes for future examination.

One of the most important factors in the energy changeover is geography (Neffati et al., 2021). The desires of geographical region and regional players has shown their critical role in launching local strategies and distribution to innovative preparation (Lerman et al., 2021). Prior studies have abridged the tentative progresses of regional RE systems. O'Sullivan et al. (2017) argued that the regional control principle would be alike to those fossil fuel energy systems, and countries could pull their geographical spot if large-scale RE-established and cross-border occupation in energy generation are implied, and they could impend to disrupt energy supplies once there are conflicts. Ahmad et al. (2020) declared the geopolitics, which signify the geography influence between the local governments' and international organizations' power, would be more roughly with less determinism and more on their location. The importance of regional powers was found to be substantial. In fact, the divergence that drives RE already is noticeable in various countries, the regional balance thus is altered contributes to a discrete jeopardy growing in particular geographic partitions (Hache, 2018, Ahmad et al, 2020). Yet, only a few studies have approached the spatial or geography notions concerning RE and seldom forms analytical value (Vakulchuk et al., 2020). As a result, it remains unclear how specific geographic shapes the RE and energy relations stability. Thus, it is urgent to study the potential influences of regional RE development on sustainable ES if the RE intend to expand its assessment among different regions.

Therefore, examining the regional issues, apart from the overall global trends is essential. A systematic data-driven is required to address state-of-the-art RE effort in sustainable ES and identify challenges and potential opportunities for future studies. This study's objectives are as follows:

- To deliver a data-driven on RE trends in sustainable ES from existing literature
- To identify RE indicators for future study trends
- To determine the challenges and opportunities precise to geographical regions

This study enriches the literature by contributing to (1) empathy on the fundamental knowledge of RE to sustainable ES frontier; (2) conveyance on esteemed directions for future study and investigation by means of data-driven scrutiny from the existing literature; and (3) measurement on international RE position and regional disparities. This study conceals both qualitative and quantitative approaches. A hybrid method using content and bibliometric analyses, fuzzy Delphi method (FDM), fuzzy decision-making trial and evaluation laboratory (DEMATEL) is adopted due to the complex of RE system as well as the uncertainty of decision-making task. Content and bibliometric analyses are used to indicate the RE indicators adopting data from publications on Scopus database (Tsai et al., 2021). FDM is employed to detect valid indicators converted from the linguistic evaluation of expert (Bui et al., 2020). Fuzzy DEMATEL is applied to identify the important indicators for future study from qualitative verbal date (Bui et al., 2021).

The rest of this study is presented as follows. The proposed methodology is obtained in the next section. The third section reveals the analysis results. Formerly, the fourth section discusses the study trends, future challenges and opportunities, and regional disparities. Finally, the concluding remarks and recommendations for future work are specified in the last section.

2. METHODOLOGY

This section offers description of content and bibliometric analyses, FDM, and Fuzzy DEMATEL. The data collection process is provided

2.1. Data Collection to Data - Driven

Prior studies have formed a literature exploitation on RE by using the data from Proquest, Crossref, JSTOR Archival Journals, Dimensions, PLoS, Google Scholar, Web of Science (Bundschuh et al., 2021; Hasankhani et al., 2021). But these databases only integrate a small amount of literature. The Scopus is occupied due to a wider-ranging collection of publication with bigger scopes of peer-reviewed publication (Vakulchuk et al., 2020; Bui et al., 2021). The database including author, author affiliation, country identifications, title, abstract, keywords, publication time, and citation record, whose information outlines are more suitable for bibliometric analysis.

A feasible search term is ascertained for content analysis to drive the data from Scopus. The bibliographic analysis is obtained using VOSviewer software to indicate the RE keywords, nation coupling and regional classify. Content analysis is used to analysis documents and verbal contented objects via systematic texts or artifact reading or observation. The technique provides reproducible inspection on the literature distribution. The content analysis is to determine the full-text documents by compressing sizable words and texts into much smaller and pre-defined groups (Bui et al., 2021). By categorize information via text mining, it is an important phase to measure the big-data in a constructive and systematic assessment. The content analysis includes two types of wordings including deductive and inductive wordings. The deductive wording acquires the text-mining terms before the data-driven procedure and shape the investigative groups on the study focal point. The inductive wording settles the analytic groups by exploiting the data during the data-driven procedure. This study uses the deductive wording with pre-defined search terms to obtain RE literature from Scopus. Next, the inductive wording is utilized using bibliometric analysis to classify the regional information from literature.

The bibliometric analysis is a quantitative technique to form a graphic acquisitive literature by delivering scientific recording and additional replications. This study uses VOSviewer version 1.6.11 to accomplish a bibliometric analysis to classify literature and describe their relationships (Van Eck and Waltman, 2018). Tsai et al. (2021) used content analysis and bibliometrics to develop a literature data-driven analysis. Tseng et al. (2021) adopted the method to exemplify the co-occurrence of literature, with the world regional comparison. These studies exemplify the VOSviewer's usefulness and is sanctions its appropriateness in this study. The search terms used were "("sustain*") and

Table 1.

Linguistic terms (performance/importance)	Corresponding triangular fuzzy numbers (TFNs)
Extreme	(0.75, 1.0, 1.0)
Demonstrated	(0.5, 0.75, 1.0)
Strong	(0.25, 0.5, 0.75)
Moderate	(0, 0.25, 0.5)
Equal	(0, 0, 0.25)

("energy" or "energies") and ("green" or "renewable") and ("secur*")" spawning in titles, abstracts, or keywords. The examination constraint was established to March 26th, 2021 and restricted to articles and reviews in English-language.

2.2. Fuzzy Delphi Method

The Delphi method and fuzzy set theory is combined to filter the valid indicators by efficiently converting linguistic evaluations of experts into fuzzy numbers (Bui et al., 2020). Assuming that there are n indicators and m experts. importance level of indicator a is given by expert b the as $j = \left(x_{ab}; y_{ab}; z_{ab}\right)$, $a = 1,2,3,\ldots,n$; $b = 1,2,3,\ldots,m$, where the j_a denotes the weight of a as $j_a = \left(x_a; y_a; z_a\right)$ where $x_a = min\left(x_{ab}\right)$, $y_a = \left(\prod_{1}^{m} y_{ab}\right)^{1/m}$, and $z_a = max\left(z_{ab}\right)$. Formally, the experts' linguistic evaluation is interpreted to triangular fuzzy numbers (TFNs), as presented in Table 1.

Then, convex value V_a is indicated by:

$$V_a = \int\left(i_a, j_a\right) = \mu\left[i_a + \left(1-\mu\right) j_a\right] \quad (1)$$

Where the i_a, j_a are computed using a μ cut as:

$$i_a = z_a - \mu\left(z_a - y_a\right),$$

$$j_a = x_a - \mu\left(y_a - yx_a\right),\ a = 1,2,3,\ldots,n \quad (2)$$

This δ value may vary from 0 to 1 based on optimistic or pessimistic of experts' evaluations. The value is generally appointed in 0.5 to address the common situation.

The filter threshold for indicators is obtained as $p = \sum_{b=1}^{m}\left(V_a / m\right)$. If $V_a \geq p$, indicator a is valid. Otherwise, it is invalid and must be removed.

This study implies the FDM in 2 rounds. An interview with the committee of expert is possessed to filter the indicators from keywords. The round 1 intents to detach the unneeded indicators by compilating expert evaluations and round 2 lets the experts to reclarify their evaluation using the

Table 2.

Scale	Linguistic terms	Corresponding TFNs
1	No influence	(0.0, 0.1, 0.3)
2	Very low influence	(0.1, 0.3, 0.5)
3	Low influence	(0.3, 0.5, 0.7)
4	High influence	(0.5, 0.7, 0.9)
5	Very high influence	(0.7, 0.9, 1.0)

round 1 result. The procedure allows the experts to revising their choices by undertaking aggregation on confirming the proposed indicators (Bui et al., 2020).

2.3. Fuzzy DEMATEL

Fuzzy set theory is employed to interpret expert's linguistic orientations into quantitative data, while DEMATEL is adopted to diagram causal-correlations among indicators (Tseng et al., 2021). Tsai et al. (2021) utilized the method to discourse human perceptions and scrutinize the complexity of the indicators. Bui et al. (2021) employed the fuzzy DEMATEL to translate the qualitative data to crisp values for visual examination, then the critical indicators are appraised. This study manipulates fuzzy DEMATEL to inspect the indicators distribution by identifying the dependent and driving powers and visualizing the analysis result under uncertainty.

Fuzzy DEMATEL translates linguistic perceptions into TFNs and formerly generates them to crisp values using defuzzification technique. The fuzzy membership functions $\tilde{f}_{ab}^{k} = \left(\tilde{f}_{1ab}^{k}, \tilde{f}_{2ab}^{k}, \tilde{f}_{3ab}^{k}\right)$ are computed to the total weighted values. From minimum and maximum fuzzy numbers, the left and right values are computed. The crisp values are then interpreted to a total direct relation matrix and map an inter-correlation diagram to visualize the results. An indicator set is proposed as $E = \{e1, e2, e3, \cdots, en\}$, and precise pairwise comparison is employed to generate the mathematical relation.

Particularly, this study gathers crisp values using linguistic scales from VL (very low influence) to VHI (very high influence) (presented in Table 2). If there are t experts participating in the evaluation, $\tilde{f}_{ab}^{k}$ stipulates the a^{th} indicator's fuzzy weight forces on attribute b^{th} assessed by expert t^{th}.

The fuzzy numbers are computed as:

$$E = \left(e\tilde{f}_{1ab}^{t}, e\tilde{f}_{2ab}^{t}, e\tilde{f}_{3ab}^{t}\right) = \left[\frac{\left(f_{1ab}^{t} - \min f_{1ab}^{t}\right)}{\Delta}, \frac{\left(f_{2ab}^{t} - \min e_{2ab}^{t}\right)}{\Delta}, \frac{\left(f_{3ij}^{t} - \min f_{3ab}^{t}\right)}{\Delta}\right] \quad (8)$$

where $\Delta = maxf_{3ab}^{t} - minf$

The left (lv) and right (rv) normalized values are determined using:

$$\left(lv_{ab}^{n}, rv_{ab}^{n}\right) = \left[\frac{(ef_{2ab}^{t}}{\left(1 + ef_{2ab}^{t} - ef_{1ab}^{t}\right)}, \frac{ef_{3ab}^{t}}{\left(1 + ef_{3ab}^{t} - ef_{2ab}^{t}\right)}\right] \quad (9)$$

The total normalized crisp values $\left(cv\right)$ are obtained as:

$$cv_{ab}^{t} = \frac{[lv_{ab}^{t}\left(1 - lv_{ab}^{t}\right) + \left(rv_{ab}^{t})^{2}\right]}{\left(1 - lv_{ab}^{t} + rv_{ab}^{t}\right)} \quad (10)$$

The synthetic values' symbolization through gathering personal perception from k experts are attained as:

$$\tilde{f}_{ab}^{t} = \frac{\left(cv_{ab}^{1} + cv_{ab}^{2} + cv_{ab}^{3} + \cdots + cv_{ab}^{3}\right)}{t} \quad (11)$$

Pairwise comparison is utilized to obtain a direct relation $\left(DR\right)$ $n \times n$ initial matrix, where $\tilde{f}_{ab}^{t}$ is the influence level of indicator a on indicator b, qualified as $DR = \left[\tilde{f}_{ab}^{t}\right]_{n\times n}$.

The normalized direct relation matrix $\left(O\right)$ is molded as:

$$O = \vartheta \otimes DR$$
$$\vartheta = \frac{1}{\underset{1\le a\le k}{max}\sum_{b=1}^{t}\tilde{f}_{ab}^{t}} \quad (12)$$

The normalized direct relation matrix $\left(O\right)$ is determined to obtain the inter-correlation matrix $\left(IC\right)$ as:

$$IC = O\left(I - O\right)^{-1} \quad (13)$$

where IC is $\left[ic_{ab}\right]_{n\times n}$ $a, b = 1, 2, \cdots n$

The driving power $\left(g\right)$ and dependence power $\left(h\right)$ values are integrated from summary of the row and column values in the inter-correlation matrix as:

$$g = \left[\sum_{a-1}^{n} ic_{ab}\right]_{n\times n} = \left[ic_{a}\right]_{n\times 1} \quad (14)$$

$$h = \left[\sum_{b-1}^{n} ic_{ab} \right]_{n \times n} = \left[ic_b \right]_{1 \times n} \tag{15}$$

The indicators are positioned in an inter-correlation diagram initiated from $\left[(g+h), (g-h) \right]$, which firmly address horizontal and vertical axes. The indicators are accumulated in cause-and-affect factions based on the negative or positive $(g-h)$ values are. The ($g+h$) presents the indicators important value as the greater ($g+h$) value showing the more important an indicator has. This study employs the average value of ($g+h$) to categorize the important indicators, which impose auxiliary prominence (Bui et al., 2021).

The proposed analysis steps are as follows:

Data Collection

(1) A feasible search term is defined for content analysis to assemble the publication data from the Scopus.

(2) Bibliographic analysis is using VOSviewer software to determine the RE indicators to sustainable ES. The nations coupling and regional classify are criticized from the database.

Fuzzy Delphi method

(3) The committee perceptions on proposed indicators are obtained through questionnaire. The FDM is employed to filter the valid indicators.

Fuzzy DEMATEL

(4) The important indicators for regional and the overall global trends are indicated. The fuzzy DEMATEL is used to examine RE challenges and opportunities for future study, and the regional comparisons are specifying.

A committee of 30 experts was organized to assure the analytical processes reliability. The expert was approached among professionals and scholars around the world with a 10 years average of experience on studying and working in field of energy development, including 7 experts from government agencies and non-government organizations, 8 experts from the practice, and 15 experts from academia (show in Appendix A).

The analysis processes are presented in Figure 1.

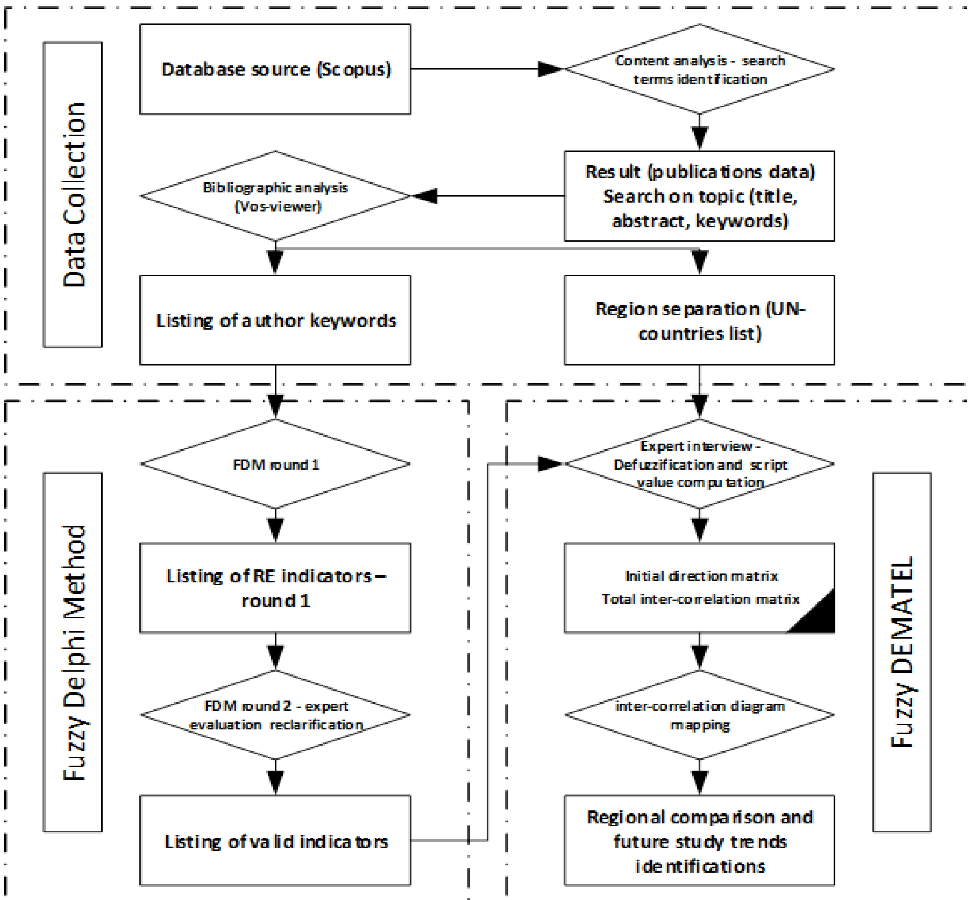
3. RESULT

This section reveals RE in ES data-driven coupling and FDM results. The top important indicators using the fuzzy DEMATEL are indicated for next discussion.

3.1. Data Collection

By using the content analysis, the data-driven result from the Scopus shows a total of 5,238 publications. Author keywords is exemplified to bibliographic co-occurrence coupling through VOSviewer, there are 7,240 listing keywords with 75 keywords with at least 10 occurrence times (see Appendix B). Besides, there are 115 countries/territories is shown, with the minimum articles for each country equals 1. The countries/territories are classified into five geographical regions based on the United Nations (2021), including Europe, Latin America and the Caribbean, North America, Africa, and Asia and Oceania (shown in Appendix C). Particularly, Asia and Oceania are leading in the number of publications with 1996 articles and review recorded, followed by Europe and North America with 1764 and 1105 publications, while the Latin America and Caribbean, and Africa show the lowest record and need for further improvements with only 473 and 537 publications.

Figure 1.



3.2. Fuzzy Delphi Method

The list of 75 keywords is identified as indicators for the FDM. The indicators are measured using the linguistic orientations from experts, then are converted into TFNs (shown in Table 1). A total of 38 indicators are removed from the set with a threshold $p = 0.310$ persisting 37 indicators for the FDM-round 2 (shown in Appendix D). In round 2, there are 19 indicators, whose $V_a \geq 0.307$, are filtered (shown in Appendix E), ensuing valid indicators as the following analysis step input (shown in Table 3).

3.3. Fuzzy Decision-Making Trial and Evaluation Laboratory

From the FDM results, the experts assessed the inter-correlation among indicators by means of linguistic scales in Table 2. The defuzzification technique is employed to convert the TFNs to the crisp value then the initial direction matrix is generated using average method (shown in Table 4). The total inter-correlation matrix is obtained (shown in Table 5), indicating the inter-correlation among the indicators (shown in Table 6). Figure 2 exemplifies the regional and overall inter-correlation diagram using $\left(g+h\right)$ and $\left(g-h\right)$ cuts. The average value of ($g+h$) is employed to sort the important causing indicators that necessitate to concentrate on.

Table 3.

Id	Indicators
I1	Blockchain
I2	Cloud computing
I3	Distributed generation
I4	Economic growth
I5	Energy demand
I6	Energy efficiency
I7	Energy planning
I8	Energy policy
I9	Energy storage
I10	Environmental sustainability
I11	Internet of things
I12	Land use
I13	Machine learning
I14	Reliability
I15	Renewable resources
I16	Resilience
I17	Safety
I18	Smart grid
I19	Uncertainty

The divergences among regions are conveyed. For the Europe, those important indicators are energy policy (I8), reliability (I14), renewable resources (I15), smart grid (I18), uncertainty (I19). The Latin American and Caribbean concentrates on energy demand (I5), energy policy (I8), reliability (I14), renewable resources (I15), uncertainty (I19). For North America regions, the important

Table 4.

	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	I13	I14	I15	I16	I17	I18	I19
I1	0.770	0.528	0.478	0.439	0.474	0.503	0.419	0.527	0.533	0.481	0.531	0.449	0.461	0.466	0.512	0.435	0.499	0.469	0.488
I2	0.528	0.741	0.495	0.526	0.474	0.502	0.364	0.381	0.508	0.393	0.408	0.487	0.494	0.482	0.494	0.479	0.475	0.524	0.443
I3	0.509	0.507	0.757	0.512	0.492	0.523	0.418	0.449	0.472	0.477	0.492	0.460	0.528	0.525	0.512	0.538	0.528	0.552	0.474
I4	0.548	0.528	0.461	0.763	0.515	0.527	0.522	0.515	0.464	0.456	0.536	0.447	0.502	0.492	0.472	0.479	0.571	0.521	0.469
I5	0.502	0.553	0.472	0.461	0.756	0.540	0.478	0.541	0.474	0.443	0.508	0.525	0.520	0.527	0.530	0.588	0.574	0.538	0.474
I6	0.432	0.557	0.447	0.524	0.519	0.765	0.502	0.462	0.520	0.466	0.499	0.411	0.515	0.524	0.498	0.506	0.487	0.466	0.438
I7	0.457	0.453	0.494	0.483	0.524	0.460	0.759	0.577	0.432	0.481	0.461	0.513	0.451	0.593	0.522	0.524	0.538	0.491	0.481
I8	0.559	0.593	0.516	0.549	0.569	0.550	0.462	0.789	0.538	0.502	0.491	0.516	0.586	0.531	0.587	0.548	0.600	0.604	0.545
I9	0.466	0.555	0.468	0.432	0.504	0.518	0.488	0.460	0.762	0.487	0.442	0.471	0.497	0.537	0.452	0.499	0.526	0.523	0.486
I10	0.458	0.566	0.504	0.505	0.447	0.525	0.530	0.500	0.472	0.764	0.505	0.460	0.535	0.489	0.454	0.527	0.555	0.571	0.453
I11	0.453	0.453	0.436	0.501	0.451	0.444	0.461	0.441	0.480	0.440	0.766	0.465	0.470	0.509	0.490	0.549	0.522	0.527	0.499
I12	0.397	0.526	0.405	0.485	0.534	0.466	0.547	0.517	0.523	0.494	0.396	0.762	0.514	0.463	0.491	0.559	0.484	0.488	0.457
I13	0.420	0.523	0.480	0.475	0.471	0.528	0.504	0.559	0.536	0.516	0.421	0.423	1.000	0.450	0.435	0.560	0.451	0.497	0.462
I14	0.454	0.542	0.477	0.540	0.476	0.488	0.545	0.485	0.507	0.488	0.499	0.475	0.484	0.769	0.565	0.525	0.572	0.476	0.532
I15	0.580	0.567	0.519	0.565	0.578	0.589	0.598	0.609	0.560	0.509	0.544	0.526	0.515	0.472	0.760	0.590	0.586	0.525	0.599
I16	0.499	0.541	0.463	0.544	0.465	0.490	0.477	0.512	0.555	0.504	0.523	0.539	0.533	0.465	0.413	0.770	0.372	0.447	0.541
I17	0.567	0.527	0.502	0.451	0.521	0.521	0.474	0.521	0.578	0.462	0.487	0.496	0.541	0.505	0.543	0.329	0.787	0.500	0.364
I18	0.504	0.602	0.566	0.556	0.561	0.545	0.567	0.548	0.548	0.508	0.559	0.506	0.503	0.453	0.598	0.588	0.478	0.761	0.486
I19	0.563	0.610	0.553	0.558	0.553	0.616	0.597	0.564	0.526	0.525	0.539	0.554	0.581	0.503	0.599	0.567	0.528	0.493	0.756

indicators include energy planning (I7), energy policy (I8), renewable resources (I15), smart grid (I18), uncertainty (I19). While the Africa regions' important indicators are economic growth (I4), energy demand (I5), energy planning (I7), energy policy (I8), renewable resources (I15). Finally, for Asia and Oceania, the important indicators consist of energy demand (I5), energy policy (I8), renewable resources (I15), smart grid (I18), uncertainty (I19).

In overall, this study's top important indicators in are energy demand (I5), energy policy (I8), renewable resources (I15), smart grid (I18), uncertainty (I19), respecting incessant responses in the RE system as study trends to attempt the sustainable ES.

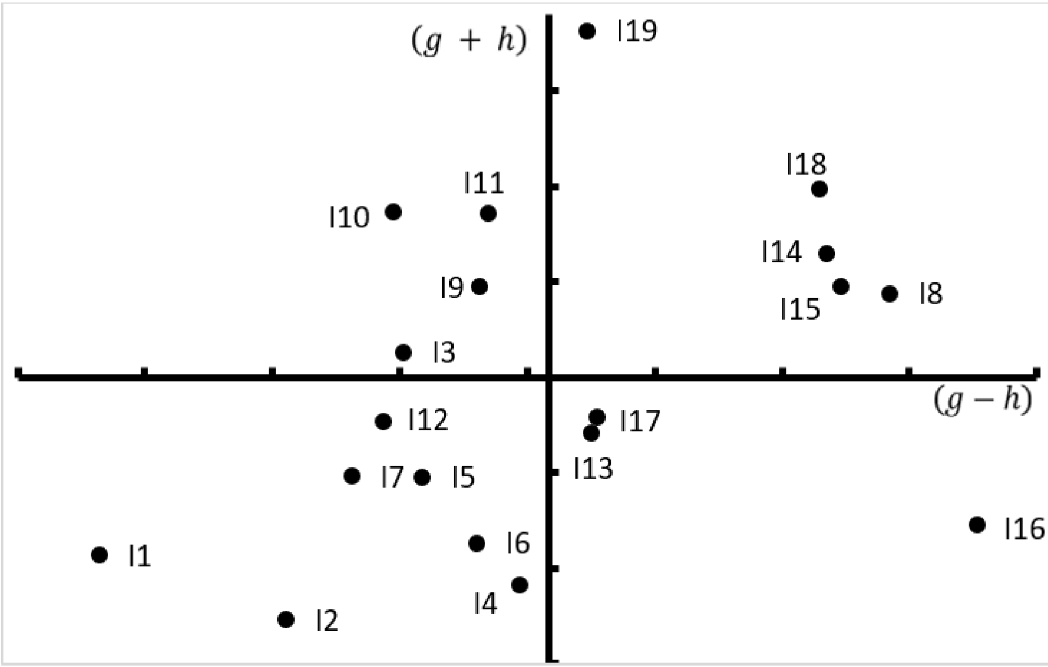
Table 5.

	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	I13	I14	I15	I16	I17	I18	I19
I1	0.548	0.566	0.512	0.527	0.531	0.545	0.516	0.539	0.542	0.507	0.522	0.508	0.548	0.523	0.537	0.541	0.546	0.535	0.510
I2	0.512	0.571	0.500	0.521	0.517	0.530	0.497	0.511	0.526	0.485	0.496	0.498	0.536	0.511	0.520	0.530	0.529	0.526	0.492
I3	0.537	0.578	0.552	0.548	0.546	0.561	0.530	0.545	0.550	0.519	0.532	0.522	0.568	0.543	0.550	0.565	0.562	0.557	0.522
I4	0.544	0.584	0.526	0.575	0.552	0.564	0.543	0.555	0.553	0.520	0.539	0.524	0.569	0.543	0.550	0.562	0.570	0.557	0.524
I5	0.551	0.598	0.538	0.557	0.586	0.577	0.550	0.569	0.565	0.530	0.547	0.543	0.583	0.557	0.567	0.585	0.582	0.570	0.536
I6	0.520	0.572	0.512	0.539	0.539	0.573	0.528	0.536	0.545	0.508	0.522	0.508	0.556	0.533	0.539	0.551	0.548	0.538	0.509
I7	0.531	0.572	0.526	0.544	0.549	0.554	0.562	0.557	0.546	0.519	0.528	0.527	0.560	0.549	0.551	0.563	0.563	0.550	0.522
I8	0.589	0.638	0.575	0.599	0.602	0.613	0.582	0.627	0.606	0.568	0.578	0.574	0.624	0.591	0.606	0.615	0.619	0.610	0.575
I9	0.525	0.574	0.516	0.532	0.539	0.552	0.529	0.538	0.570	0.513	0.519	0.516	0.557	0.536	0.536	0.553	0.554	0.546	0.515
I10	0.537	0.589	0.532	0.552	0.547	0.566	0.545	0.555	0.555	0.551	0.538	0.527	0.574	0.544	0.549	0.568	0.570	0.563	0.524
I11	0.513	0.553	0.503	0.528	0.523	0.534	0.516	0.526	0.532	0.498	0.539	0.505	0.543	0.522	0.529	0.546	0.542	0.535	0.506
I12	0.515	0.568	0.507	0.534	0.539	0.544	0.532	0.541	0.544	0.510	0.511	0.541	0.555	0.526	0.537	0.555	0.546	0.539	0.509
I13	0.527	0.579	0.524	0.543	0.544	0.560	0.538	0.556	0.556	0.522	0.524	0.518	0.613	0.535	0.542	0.566	0.554	0.551	0.520
I14	0.541	0.592	0.534	0.560	0.555	0.567	0.552	0.559	0.563	0.529	0.542	0.533	0.574	0.575	0.565	0.573	0.576	0.559	0.537
I15	0.599	0.644	0.583	0.609	0.611	0.624	0.602	0.618	0.616	0.576	0.591	0.583	0.625	0.593	0.630	0.627	0.626	0.611	0.587
I16	0.532	0.577	0.519	0.546	0.540	0.553	0.531	0.547	0.554	0.518	0.530	0.526	0.564	0.533	0.536	0.582	0.543	0.542	0.524
I17	0.540	0.577	0.524	0.539	0.546	0.557	0.532	0.550	0.558	0.515	0.528	0.523	0.566	0.538	0.550	0.541	0.584	0.549	0.508
I18	0.573	0.627	0.569	0.589	0.590	0.601	0.581	0.593	0.595	0.558	0.574	0.563	0.604	0.573	0.596	0.608	0.596	0.614	0.559
I19	0.596	0.647	0.585	0.607	0.608	0.626	0.602	0.613	0.612	0.576	0.590	0.585	0.631	0.595	0.614	0.625	0.619	0.607	0.602

Table 6.

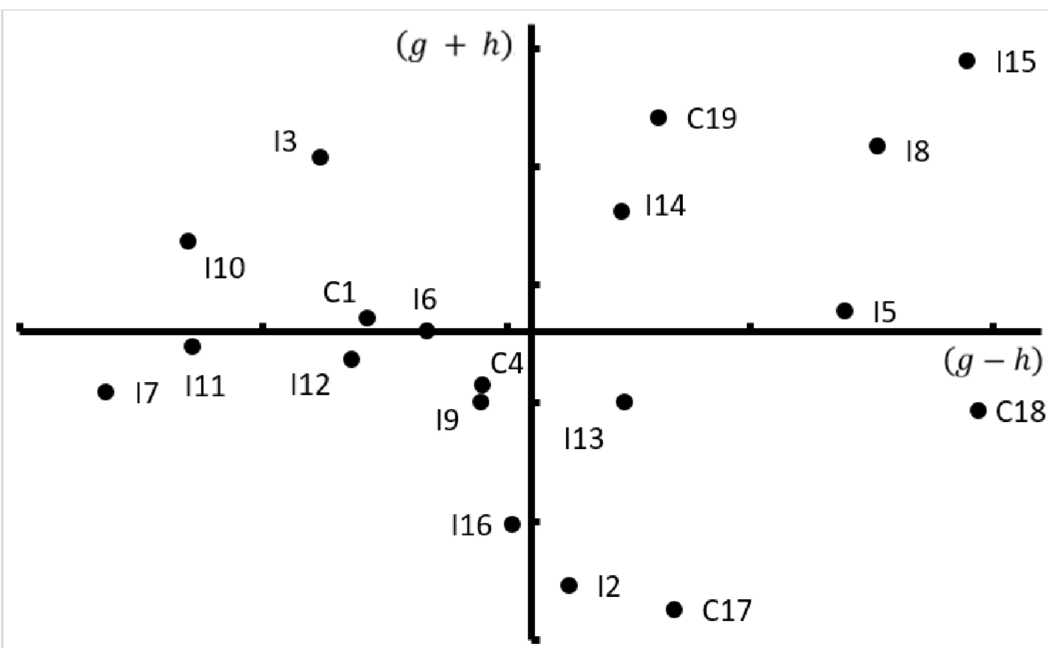
	Europe				Latin America and Caribbean				North America				Africa				Asia and Oceania				Overall			
	g	h	$(g+h)$	$(g-h)$	g	h	$(g+h)$	$(g-h)$	g	h	$(g+h)$	$(g-h)$	g	h	$(g+h)$	$(g-h)$	g	h	$(g+h)$	$(g-h)$	g	h	$(g+h)$	$(g-h)$
I1	8.194	9.124	17.318	(0.930)	6.487	6.427	12.914	0.061	7.750	8.045	15.795	(0.294)	10.625	11.144	21.769	10.196	9.610	19.806	0.586	10.196	10.103	10.330	20.432	(0.227)
I2	8.392	9.660	18.052	(1.268)	6.129	7.198	13.327	(1.069)	7.455	8.459	15.914	(1.004)	10.328	11.929	22.257	9.743	10.841	20.583	(1.098)	9.743	9.808	11.204	21.012	(1.396)
I3	9.322	9.190	18.513	0.132	6.779	6.040	12.818	0.739	8.003	7.742	15.745	0.262	10.513	11.111	21.624	9.796	9.651	19.447	0.145	9.796	10.387	10.139	20.525	0.248
I4	8.941	10.028	18.969	(1.087)	6.463	6.687	13.149	(0.224)	7.867	8.137	16.004	(0.271)	11.622	10.682	22.304	10.084	9.611	19.695	0.473	10.084	10.453	10.548	21.001	(0.095)
I5	9.033	9.554	18.588	(0.521)	6.992	6.902	13.894	0.090	7.904	7.969	15.873	(0.065)	11.501	10.996	22.497	10.396	9.766	20.162	0.630	10.396	10.692	10.565	21.256	0.127
I6	8.967	9.835	18.802	(0.867)	6.522	6.515	13.036	0.007	7.877	8.503	16.380	(0.627)	10.356	11.410	21.766	9.806	10.163	19.969	(0.357)	9.806	10.176	10.801	20.976	(0.625)
I7	8.897	9.414	18.310	(0.517)	6.061	6.316	12.378	(0.255)	8.445	7.878	16.323	0.567	11.249	10.910	22.159	9.986	10.080	20.067	(0.094)	9.986	10.371	10.367	20.738	0.004
I8	10.432	9.991	20.422	0.441	7.373	6.589	13.961	0.784	8.437	7.969	16.406	0.468	11.560	11.119	22.679	10.959	10.005	20.964	0.954	10.959	11.390	10.634	22.024	0.756
I9	9.643	9.172	18.815	0.471	6.427	6.720	13.147	(0.293)	7.716	8.080	15.796	(0.364)	10.607	11.573	22.180	9.462	10.358	19.819	(0.896)	9.462	10.218	10.687	20.905	(0.468)
I10	9.668	8.804	18.472	0.863	6.466	6.080	12.546	0.386	8.058	7.576	15.634	0.482	11.051	10.735	21.786	9.799	9.952	19.752	(0.153)	9.799	10.485	10.021	20.506	0.464
I11	9.852	8.993	18.846	0.859	6.245	6.309	12.554	(0.064)	7.119	7.973	15.092	(0.855)	10.161	10.566	20.728	9.587	10.151	19.737	(0.564)	9.587	9.992	10.253	20.245	(0.261)
I12	9.103	9.333	18.436	(0.229)	6.385	6.497	12.882	(0.112)	8.142	7.631	15.773	0.511	10.747	10.564	21.310	9.113	9.309	18.422	(0.196)	9.113	10.154	10.125	20.278	0.029
I13	9.479	9.770	19.249	(0.291)	6.574	6.868	13.441	(0.294)	8.105	8.394	16.499	(0.289)	10.458	11.473	21.930	9.770	10.492	20.262	(0.722)	9.770	10.372	10.952	21.324	(0.580)
I14	10.412	9.762	20.175	0.650	6.972	6.464	13.436	0.508	7.953	8.232	16.184	(0.279)	10.341	10.610	20.951	9.460	9.535	18.995	(0.075)	9.460	10.585	10.418	21.003	0.167
I15	10.352	9.879	20.231	0.472	7.647	6.500	14.147	1.148	8.745	8.641	17.386	0.104	11.631	10.449	22.079	10.983	9.873	20.855	1.110	10.983	11.554	10.604	22.158	0.950
I16	9.998	10.769	20.767	(0.772)	6.201	7.011	13.211	(0.810)	8.143	7.615	15.758	0.528	10.492	11.179	21.670	9.365	9.999	19.364	(0.634)	9.365	10.300	10.856	21.156	(0.557)
I17	9.533	9.742	19.275	(0.208)	6.185	7.359	13.544	(1.174)	7.863	8.256	16.119	(0.393)	10.943	10.222	21.165	9.951	10.482	20.433	(0.530)	9.951	10.326	10.827	21.153	(0.500)
I18	10.566	9.579	20.145	0.987	6.919	7.251	14.170	(0.333)	8.842	8.015	16.857	0.827	11.211	10.398	21.609	10.237	10.113	20.350	0.124	10.237	11.163	10.657	21.820	0.506
I19	10.525	8.710	19.235	1.815	7.208	6.304	13.512	0.904	9.088	8.396	17.484	0.692	11.919	10.245	22.164	10.654	9.356	20.010	1.298	10.654	11.539	10.080	21.619	1.459
Average			19.085				13.267				16.159				21.822				19.931				21.060	

Figure 2a.



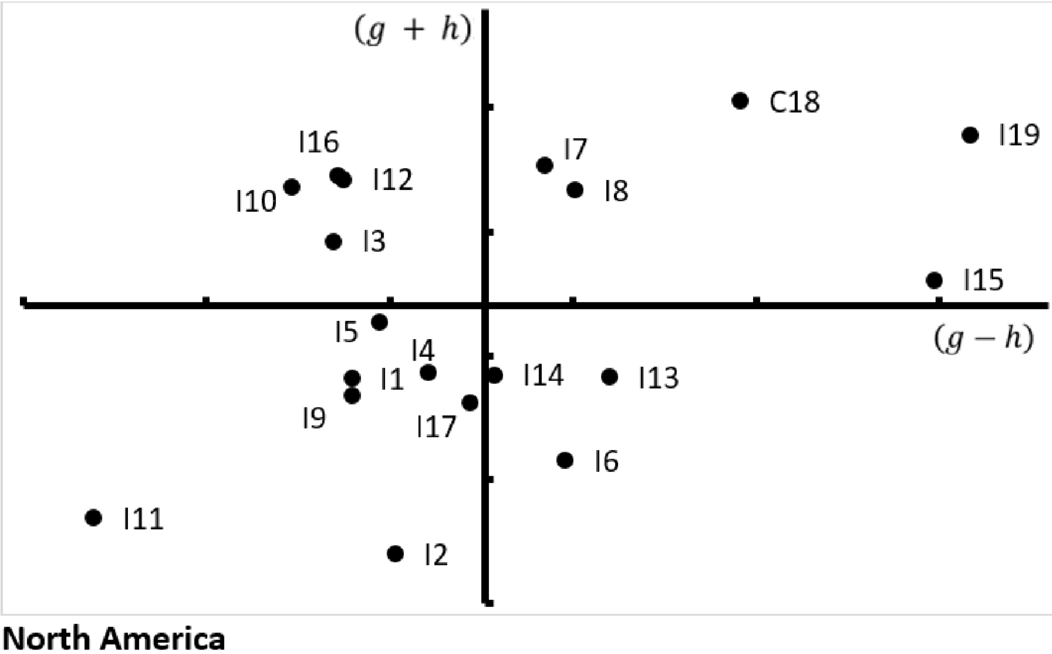
Europe

Figure 2b.



Latin America and Caribbean

Figure 2c.



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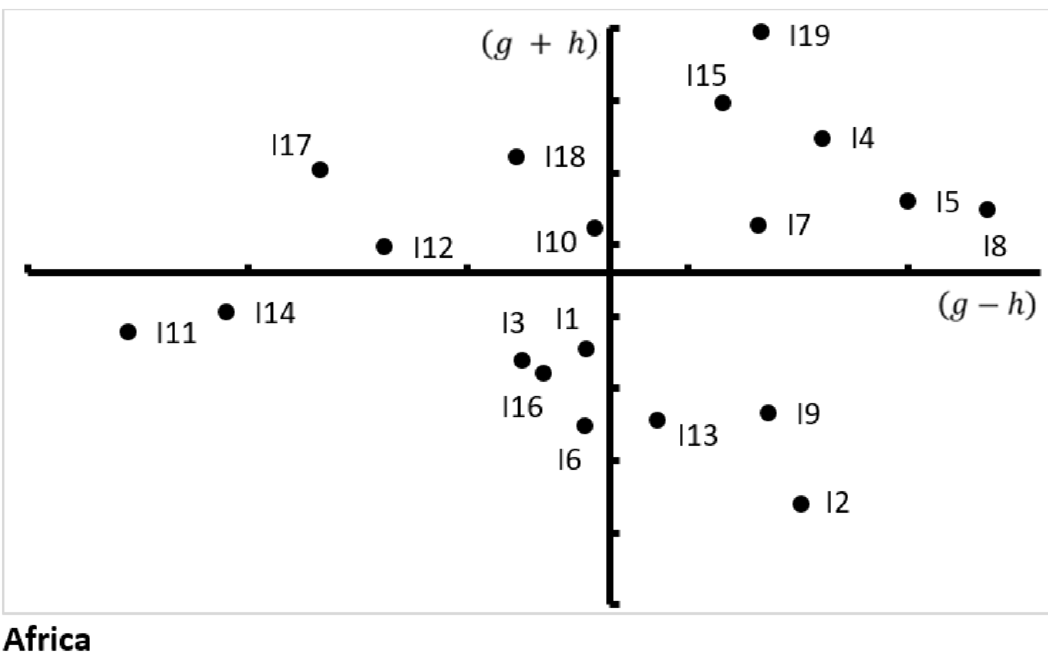

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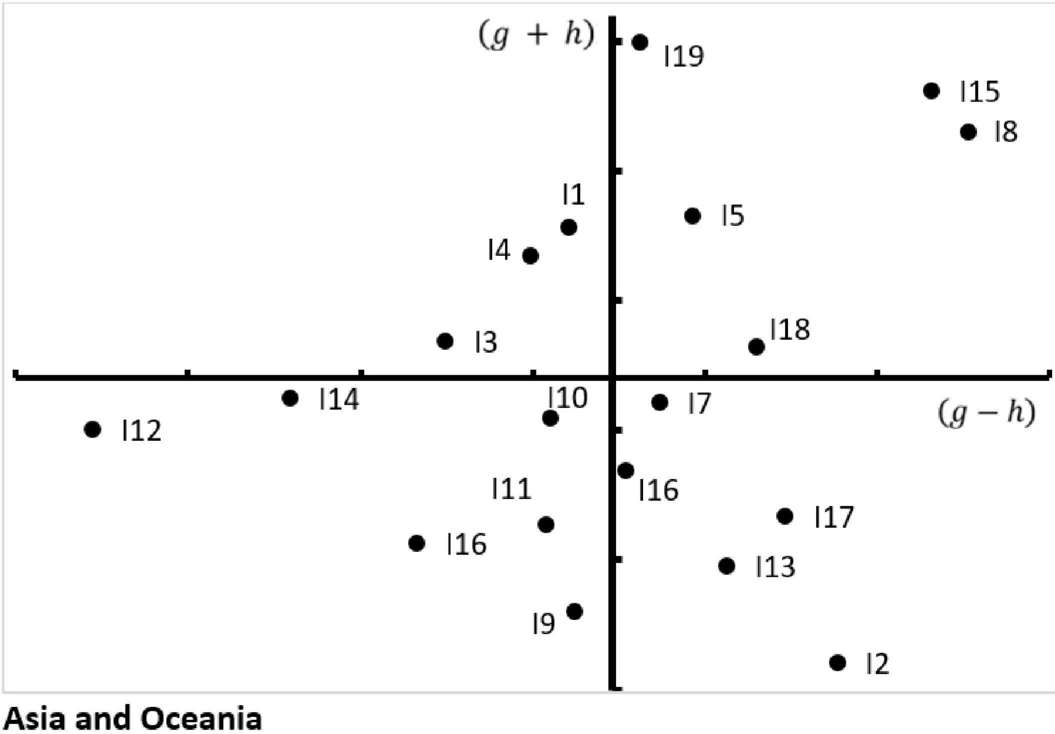

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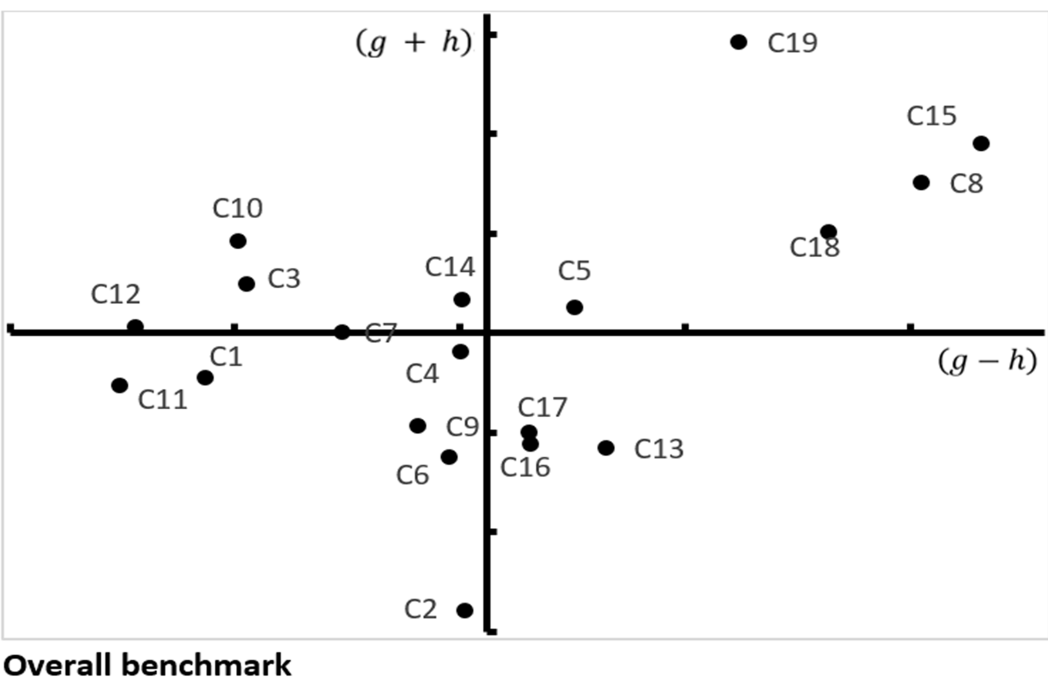

4. CHALLENGES AND OPPORTUNITIES

Motivations for the growing RE to sustainable ES includes energy demand, energy policy, renewable resources, smart grid, uncertainty. These indicators are indicated as critical study trends to approach sustainability performance, which are challenges and opportunities for RE development.

4.1. Energy Demand

The energy demand is generally fulfilled by a recipe of unremitting baseload from coal- or nuclear-powered plants, and other power from renewable sources, for instance, wind and solar power, as required (Vincent et al., 2021). The response for demand is progressively refers to deviations in user's consumption patterns in power systems via fiscal inducements or optimizing consumption to enhance complement power supply. The indicator is formulated as an approach to guarantee reliable and secure the energy system operation during emergency times (Namilakonda & Guduri, 2021). The energy usage is accompanying with numerous complex issues, including energy consumption practices, the consumption history. Therefore, focusing energy demand is essential for both resisting the atypical energy utilization tendencies or sourcing preservation purpose.

However, there is limited reporting data, studies, and investigations on RE demand and substitute supply issues (Kaluthanthrige & Rajapakse, 2021). This accomplishment on RE demand is challenging as the unpredictable future of power demand is unknown with precise statistics (Li et al., 2021a). Integrating uncertainty to discrete situations is important to acquires respectively distinct setup, in which decision make can forecast the demand and costs requirement, and the most efficient technology to respond to the future ES (Scott et al, 2020). Further, the new situation on geopolitics supply-demand balancing is the vital issue to increase the RE usage; still, only few analytical outlines have been developed (Vakulchuk et al., 2020). Throughout the real-time operation, instabilities on the demand or supply side may interrupt the harsh controller execution. For example, the technological barriers count on RE resources such as wind and solar are occasional in accessibility and lead to uncertainty in demand gratification (Pravin et al., 2020). The uncertainties reigning in the human perceptions disputes to understand which should be precisely embodied a consumer approachable likeness (Kaluthanthrige & Rajapakse, 2021). This requires extra investigations on renewables demand as decision makers are unclear about how to handle the upcoming events in uncertainty practices.

There are necessaries for the regulatory administrators to rebuilt the occupational and business settings energy selling agendas such as resilience, spatial and temporal assortment in demand exploitation, and adequate RE generation; while also defining the demanded RE output from respective factors which cannot be regulated (Ahmad et al., 2020). the discrepancy between demand and supply consequences in the high price of energy storage and surplus RE generation that needs to be plunked or abridged to sustain the system, which likely to be aggravated due to high renewable fraction and cost reduction pressure (Kahwash et al.,2021). Yet, penetrating the financial efficiency and RE demand has not been much emphasized (Cihat et al., 2021). The implications in relative sectors developments, for example the potential of disruptive RE technologies, electrification transportation, the demand for perilous materials, and their dependencies on the technological evolution involved in the RE demand transition, also need to be considered.

4.2. Energy Policy

Energy policy is a legal ordinary approved by a government to drive and control energy growth along the environmental safety, adequate supply, and efficient/effective utilization to the population (Doukas et al., 2008). The literatures have argued on the political indicators of ES to reorganize the economy. In this milieu, RE policy is the integration backbone comprises targets, plans, schedules, incentives rules, and regulations proceeded by official legal records for energy development. Significant effort has been made to implement RE generation policy, and form institutional and legislative frameworks for policy application. Particularly, policies are premeditated with more comprehensive regulations and legislation; thus, diminish the fossil energy dependence through a diverse resource of national RE (Adelaja, 2020). The RE policies instruments must contain the standards and regulations, accurate inducements to fascinate stakeholders and customers to the market, and determinate a vigorous power source and sustainability (Ozoegwu & Akpan, 2021). Still, it is improper to argue that the government knowledges would intensively endorse renewables, which is need more visionary and legislation and policies implementation to secured long-term stability, and promote RE as an energy mix portion (Adedoyin et al., 2021).

A successful policy needs a clearly expressed strategies, goals, vision, and engagement tactics. Details should be provided on pecuniary incentives and extents, information modalities and instructions, judicial procedures, and institutional provisions. In addition, the strategies should be constructed on actual objectives, clear time-frame and framework for accurate assessment (Adelaja, 2020). Despite the inordinate courtesy, the politically aware dedication in engage in new assimilate renewables markets lacks of effective and coordinated regulation (Poudineh et al., 2020). Main issues are how existing policy deal with high uncertainty and high innovation. The RE regulations still demands additional rigorous study and evidence components for long-term performance to progress less energy-intensive technologies (Bundschuh et al, 2021). For example, a layout transformation for RE wholesale and retail marketplaces remain gaps in legislation guidelines that detaches and misaligns among each other's, and not prepared to lodge the bulky corpus of RE generation transition (Glachant, 2016). The RE policies identification problems have yet been solved a spot versus fossil fuel market, which should reflect both place bids on their marginal costs (Cieplinski et al., 2021). During operations, RE limitation always happens at a smaller load owing to the lack of effective and fast communication policies to peak the consistency restrictions and maneuver sanctuary. Further adaptable strategies should be obtained, such as time-varying, meteorological conditions, which is grim by physical manipulation (Liu et al., 2020).

Recommendations related to the stakeholders' participation in RE policy adoption should be emphasized (Adelaja, 2020). The absent of RE infrastructure and development policy has created obstacles in many countries leads to determine the legislative discussion of RE utilization (Ahmad et al., 2020). Therefore, an inclusive and appealing energy policy is required to attract more investors. Foreign investors need national energy programs information, inferred from energy policy issues, to make decisions as the country's capacity is lacking (Ozoegwu & Akpan, 2021). Moreover, an immense renewables diffusion in energy mix could result in unforeseen consequences such as adjuncts to acute materials, new geopolitical mechanisms, and the negotiation in RE (Hache, 2018). There are challenges on vision, leadership, collaboration and communication, trust, orders inconsistencies, agency prejudices regarding to regulation. The lack of escalation roles acted by NGOs and private sector, absence of understanding on RE costs and benefits, political position competences, unwarranted effort between government needs and the public demands, and insufficient financial subsidy are unsolved. To tackle these unexpected challenges, future studies are recommended to conduct onset of RE policy elements. If the RE political vision are perceived and powerful enough to meet a big scope of stakeholders' interests, formerly, the institutional conflicts are inhibited or as a minimum alleviated (Adelaja, 2020).

The RE stakeholders and institutions is required to acquire complex verdicts encompassing risk-based approximations regarding to the future energy management and planning. There is an obligation for considering the support mechanisms to support the decision-making instruction all over the RE networks. To progress an empowering liberal RE policies, occasioning reimbursements necessity to be clear by policy-makers, citizens and industries (Adelaja, 2020). Policy adoptions should thoroughly clarify difference RE deployments and offer a robust rationale for optimization approaches to integrating long-term vagueness into market modelling (Scott et al., 2020). Since the lack of studies in RE disposition is attributable to the absence of firm RE policies, understanding the complete magnitude of contests confronted in political implementation is important.

4.3. Renewable Resources

RE magnets ample natural resources which deprived influence on the environment so that many countries are pushy to use these renewable resources (Abdel-Basset et al., 2021). However, scholars have argued that most of energies from renewable resources would be no fewer contrariety than the fossil energies running, and envisions renewables may results in the same or even new severe types of conflicts (Vakulchuk et al., 2020). Attributable to the intermittency and unsteadiness of renewable resources in both secular and longitudinal disseminations, and the strategy and operation designs uncertainty, the optimal operations and robust planning in structuring energy systems are necessary for an efficient energy utilization (Zhou et al.,2020).

The most appropriate RE resources selection is not straight one system preferred over others but be distressed by various issues due to the resources diversity (Wu et al., 2019). Non-renewable and RE resources should blend as the stakeholders benefit from constant power supply with lower prices, while also lessening environmental impacts (Neffati et al., 2021). Thus, develop a mix power grid with high RE diffusion alongside high consistency and reliability, competent power scheduling and facilities, better customer services, and efficiently costs reduction may affix extensively benefits. This remains challenges for the researchers. For example, consumers more refer to consume energy from renewable resources than fossil power, but wiliness to pay for higher prices still is non-existent.

Difficulties on RE, specifically on systemic RE resources structures have been focuses, there is noteworthy attention on the indicator must be occupied, partiality, for each types of resources. Indeed, the consignment on the energy scheme differs during the day and turn into high during the nighttime. A continuous power supply can be abounding to consumer via defining the charging and discharging schedules of RE storage system (Prajapati and Mahajan, 2021). Therefore, studies on the energy storage system can efficiently equipoise the renewable resources production and balances the supply and demand level (Kahwash et al.,2021; Namilakonda & Guduri, 2021). Although various approaches have been exploited, how to maintain the renewable resources system with different progress remained unclear (Wang et al., 2018). The RE systems planning should embrace network measurements, construction and production optimization and structure consistency (Ahmad et al., 2020). Further, RE forecasting can be employed to predict the obtainable capacity of different renewable resources (Abdel-Basset et al., 2021).

4.4. Smart Grid

The worldwide escalation in energy demand, declining fossil energy resources, and carbon emissions impact are coercing the requirement of converting the traditional grid systems into smart grids. Scholars and practitioner are seeking to progress power networks by the smart grid technologies implementation rather than replacing or immense strengthening the grid (Ourahou et al., 2020). Operative smart grid system consists of robust communication structure, smart metering, deep RE sources integration and distributed generation, etc. (Maruf et al., 2020). Its main purpose is to endow the power network by the accurate apparatuses and make it intelligent. Yet, RE deployment in the smart grids has generated numerous cons/pros, if manage properly, this is capable to benefit both energy production and consumption sides, whereas guaranteeing a more efficient feasible and benign energy distribution.

A communicative smart grid must be integrated communication and information technologies occupations. The communication between the different points of the grid makes it conceivable to handle plentiful stakeholders' and consumers' actions. The purpose is to achieve the demand and supply equilibrium while optimizing the network operation, and increasing reliability and responsiveness. Indeed, smart grids possibly optimize the assets used by exploiting new devices to manage the grid closer to its boundaries (Ourahou et al., 2020). Thus, it requires considerable fluctuations to prevailing constellations, associations, and interactions among entirely stakeholders. However, distribution systems are inadequately fortified with advanced interaction technologies due to the large number of infrastructures such as lines, power stations, etc. These intensely challenges represent compulsory architypes within the current energy grid (Rohde & Hielscher, 2021).

Smart grid technology is a platform encompassing numerous innovative high-tech characteristics across the power system (Maruf et al., 2020). Energy management structures based on unrestrained resources is promising for high absorbency adaption to the underdeveloped smart grid technologies and uninterrupted generation; thus, the stakeholders could obtain maximum benefit (Li et al., 2021b). For example, new technical resolutions allow network observation by telecoms, sensors, and data dispensation apparatuses to enhance the network knowledge management and enable operational control (Ourahou et al., 2020). Artificial intelligence and deep learning, which are emerging as research problems, of can be used in value chain to tackle rising data generation and complexity for adapting to actual situations and future smart grid (Boza and Evgeniou, 2021). Big-data machineries and blockchain technology are recognized as opportunities to benefits the power grids (Liu et al., 2020).

Further, smart utilizations, power distributions and manufacturing design; smart grid-substations and micro-grid; as well as sensitive data operation such as rotational energy, safe operating system, boost converter, and productivity transformation are also considered as strategies to accomplish leading-edge of smart grid, and need more precise measurements (Neffati et al., 2021). However, these approaches might collapse to ES due to the unexpected eventualities, the uncertainties and lack of understanding about hinders of the decision makers commitment on investing in energy intensive technologies (Hasankhani et al., 2021, Namilakonda and Guduri, 2021). Therefore, the smart grid impending is complex, and the uncertain RE development, added to the cost rising, still require more efforts on present works.

Prediction proficiencies are cumulative and affecting towards the smart grid construction (Ahmad et al., 2020). Lot of work is required forecasting actions with exact acquaintance to backing RE integration with the traditional grids. Remote programmable and meticulous adjustments are among those technologies is argued to facilitate this process. Forecast errors modeling with likelihood compactness occupations, integrated demand response model involvement to forecast the power output in the extremely unstable zones is missing. Considering the dynamic features, optimization-based synchronization planning model, smart extensive in conservative energy-grids with multiple energies sceneries, and energy substitution are demand to have more estimation.

The institutional order exists as challenges and turn into the constant negotiations subject among players in smart grid developments as there is absence of a common vision and shared characterization (Rohde and Hielscher, 2021). On top of propounding high-tech occasions to assimilate the RE, smart grids are claimed unravel various social opposes, such as empowering new energy consumption practices. All stakeholders, energy providers, households, have to experience ultimate deviations as smart grids comprise miscellaneous socio-cultural procedures.

4.5. Uncertainty

Uncertainty consideration is important in the ES and becomes increasingly significant across both the short- and long-term planning (Scott et al., 2020). In term of fundamental characteristic, the uncertainty is categorized into the epistemic and aleatory uncertainty. The epistemic uncertainty relates to the subjective or reducible because of the knowledge deficiency for the suitable parameter estimation to fix with the performance behavior. The aleatory uncertainty reflects the variability, intrinsic unpredictability stochastic, or the irreducible of the system performance (Hoffman and Hammonds, 1994). These uncertainties carry challenges to correctly describe RE, and rises difficulties in effectual resolutions designing (Liu et al., 2020). The uncertainty of RE has an imperative influence on planning tactic; still, conduct the uncertainty of multiple approaches has always remained a problematic obstacle (Li et al., 2020). The inherent alterations among the epistemic and aleatory uncertainties are being ignored by the academics (Zhou et al., 2020). Current work has suffered from over estimation in excess of the habitually data, and inaccurate RE description, inappropriate policies, and accommodating underrated capability.

Consistent with the sources of the epistemic uncertainty, the epistemic parameter comprises three types, explicitly scenario, inherent uncertain, and design uncertainty. For the scenario parameters, the uncertainties impact on the energy market and energy supply systems is analyzed from the risk assessment (Abdin et al., 2017). Besides, demand side management to reduce the uncertainty is also implied. This gain increasing courtesy on the system efficiency and operation safety; in addition to absolute the potential of energy savings, and the consumer's behavior consideration (Cano et al., 2016). Yet, future uncertainty in RE, such as pricing, will result in higher uncertain level of costs, and energy distribution and consumption. Integrating uncertainty as vagueness scenarios amends biases in the appraised costs among quantity-based approaches (Scott et al., 2020). The verdicts are complex and difficult due to the large amount of hesitating intrinsic in the input's predictions.

Inherent uncertainty is a vital factor of decision-making process, especially at the personal efficacy investment level such as system planning and policy establishment. Thus, how to legalize the RE security in high modernization and high uncertainty is urgent (Poudineh et al., 2020). The future study can focus on tariffs design and regulating the new and old representatives, particularly for system aggregators and operators (Cambini and Soroush, 2019). The optimize integration toward the demand response program also need to be considered (Sheikhahmadi and Bahramara, 2020). For design uncertainty, the RE needs to be promoted with new outlays that support small generator' involvement and increase rivalry ability. However, as RE sources is sporadic, and varies through the time of the day, season, and weather conditions, possibly generate a high uncertainty (Pravin et al., 2020). The flexibility and resilience capability, as the power systems' adaptability, are argued to be effective solutions.

The basic methodology development for uncertainty dissemination integrating the fundamental aleatory uncertainties is exceedingly required for analysis. From the literature, some methodical gaps should be noticed. The lack of reliability data and functioning performance are challenging the unproven technologies (Clark and DuPont, 2018). The RE optimization and parametrical examination via technical viability of the optimal design through deterministic constraints is disputed because the geometric and operating parameters are unidentified. This result in the integration problem of stochastic and deterministic power sources where the former operation needs to be planned/deployed against the uncertain energy distribution latter to meet the demand goal (Pravin et al., 2020). Investigating the long-term uncertainty in optimization modelling can compare and quantify the available solutions. Also, there is need to foster the decision-making flexibility with the suitable scheduling and operation. Even though there are a few works related to the multi-criteria decision-making methods, especially under ambiguous and uncertain conditions, the efficient incorporation of vagueness and unclear information is still a challenging task for a sustainable RE (Abdel-Basset et al., 2021).

4.6. Regional Discussion

While RE has been at the periphery of national level energy policies in developing countries, this studies also offers a regional comparison as the potential to avoid the conventional energy and develop a RE system to each world regions. Particularly, European and Latin-American and Caribbean have implemented the same kind of requirement on RE reliability in both regions. The North America shows its specific need on the energy planning, which the Africa remains much challenges on economic growth and RE planning as countries in this region are mostly still underdeveloped. The Asia and Oceania RE shows the same trend as the overall RE development, and reveal the potential to be one of leader in the field through having the highest number of publications.

In Europe, ES needs a new reinforcement level of vagueness. This need completely consistent power system with transmission reliability to ensure system tolerability, and higher connection with neighboring countries in the regions (Zappa et al., 2019). The authorities are required to reconstruct the business occupations through providing the resilient energy programs, adequately develop time-based and longitudinal assortment in supply and demand system (Ahmad et al., 2020). The reconstruction should begin with improving short-term, cross-border energy trading tariffs, motivate combination and portions development of energy production reliability. The reliability is the energy system ability to distribute energy to all utilization points within conventional standards with desired amounts and system security on dealing with sudden interruption (European Commission, 2014). The RE is reliable, yet they need to be backed up by the traditional sources until exploitation knowledge and the types of RE multiply is strengthen. The reliability of overall RE is not fully dependent on a single source, but more than a few. These different energies must work together to meet the demand without any hesitates. Moreover, Europe desires to keep its headship in RE by promotes investments in the RE production; however, new challenges are going to place alongside with innovation in the energy markets, also re-function for actual participators in future markets (Ghadi et al., 2019). Additional reinforcement mechanism to hasten promoting instrument and investment in RE deployment and technologies is needed (Vakulchuk et al., 2020; Cihat et al., 2021). Future studies may investigate on new interaction forms among RE stakeholders and assist to proposition a normative structure of global architecture such as decarbonization problems, technology transmissions, and financial supporting (Hache, 2018).

The Latin America have been practically promoting RE for the past decades. The region began to enroll in RE following the Europe, but as a result of a significant drop in the technologies costs and advantageous natural environments, most projects do not need direct sponsorships and the benefits obtained from the green energy mixes with an increasing wind and solar energy share and a strong base of hydroelectric power. The Latin America claims to have highly inexpensive development charges, particularly for wind power and recently for solar photovoltaic. However, despite the high potential, this region's RE still tackle difficulties and numerous challenges such as finance, institutional, and market barriers. The uncertain fluctuation and occasional possessions of RE productions harshly rise the operational difficulty (Ren and Dong, 2018). This impacts the RE reliability of in the interconnected and complex networks. Additionally, the lack of principal theoretical scrutiny and empirical reliability implications on ES, and enhancing the energy interconnecting divergence advantages also need to be noticed. Thus, robust collaboration to advance energy transition and assessing improvement through dispersed RE resolutions such as home-based wind and solar technologies is recommended. However, most countries are disinclined to trust for energy among neighbors, considering about a more self-sufficiency than investment expense, and sustainability. There should be energy assistance programs that linked to communal safety network and reliable mechanisms to reduce energy deficit.

There is rising concerns in the North America, especially the United States, about the opposing environmental influences from greenhouse gas emissions cause by burning fossil fuel and power generation, so there is required a modification as an academical planning solve the problem (Steele et al., 2021). From a positive viewpoint, the sustainable energy transition in the region is well ongoing as the provision to the coal, gas, and oil industries is transferred to the sustainable RE as an alternative. Planning trails, and long-term development strategies based on realistic and reliable directions to encourages RE growth are promoted. However, region's energy policy and management, either the energy is from renewable or non-renewable resources, is a mixture of private and public co-decision-making at the regional, national, and local levels. Assimilating RE to enhance the grid system effectiveness with facilitating technologies such as energy storage, responsive load, waste heat, hydrogen fuel cell, and smart grid machineries should have more investigations (Steele, et al., 2021). Further, an enable business environment in uncertainty related to investments risks, as well as technology costs increasing is still missing. RE needs to instigate sustainable energy and climate accomplishment plans to diminish vulnerability from energy insufficiency and to pricing problems; lower energy transfer bottleneck and input costs; promoting cleaner production and low-carbon frugalities to meet a competitive edge. Despite the North America is expected to play key roles in global RE due to its research record, the region still needs to hasten large-scale procurement to achieve better performance by generating inclusive clean energy strategies through syndicating different types of projects planning and enhancing collaboration and cooperation among partners to creating and managing extensive RE knowledge.

In Africa, energy is viewed as an economy wheel, yet this is hindered in a violent deficiency that critical evidence regarding energy generation problem that points between economic development and energy consumption. In the literature, energy production is able to be affected by the uncertain economic policy in term of price fluctuations and strong dependence on other countries, while most studies only focus on energy interconnection and demand determinants (Zafar et al., 2019). Subsequently, there are needs for the region to generate a more advantageous macro-conditions for energy supply with more subventions and investment promotions. Still, most countries in the region heavy depend on non-RE as their focal supply, specified the high-level of population, and energy levels rising to meet the cumulative demand (Adedoyin et al., 2021). The power shortage is still show in Africa, for example, 63% of the Sub-Saharan African residents lack to retrieve power (da Silva et al., 2018). This evidence the region is slow in adopting RE, but may present the opportunities to integrate RE (Adelaja, 2020). The Africa needs to meet fast-growing energy demand and extend up-to-date energy services while improving community's wellbeing and guaranteeing long-term sustainability. Indeed, the region could meet approximately one-third of its energy demand by using the clean, local RE on wind patterns, solar radioactivity, biomass resources, and water power. These approaches allow the region to provide optimal planning for choices or the mixed RE resources, thus, taking full account to sustainable development. Particularly, advanced RE action plans is required to provide motivations to overwhelm traditional beliefs on the energy development, address the technology and information gaps in consolidating the national institutions capacities to promote technological application, as well as captivating positive sites on RE benefits through public instruction.

In the harmony with overall RE trends, the Asia and Oceania are probable to shape new RE centers that front the world order where RE investment and new energy technologies is more proportionately disseminated. Scholars even consider that the region, especially China, may further dominate its position in new technologies and materials implications for global ES and create a threat to others (Vakulchuk et al., 2020). In fact, RE in Asia and Oceania has ordinarily overtaken to Europe and North America as a result of a noteworthy developments progress in China, Australia, and India. However, the RE expansion in developing countries in the regions has been stalled due to insufficient grid structures and obstructive regulations and policies. The national budgets are frequently in short supply due to the high cost in constructing and maintaining the RE infrastructure due to geographical challenges. It is also unclear that RE leadership on how to free the nations from imported energy. At present, most countries are depending on fossil fuel but intense to RE sources transition. All these issues are worthy to in-depth analysis. Overall, the RE stance is tremendously positive while the RE revolution is still in early stage. Future studies should contribute the new collaboration and communication forms between industrial participants and government, or offer a standardizing outline regarding financing, technology transmissions, and decarbonization architecture (Hache, 2018). It is imperative to identify the examining inspections based on the region potential and requirement with better policies, coordination, plans to form a safety investment milieu, and share of the energy mix.

5. CONCLUSION

RE in production in energy security is a tough topic that concerns governments and those interested in resources around the world. There are various indicators might launch between the diffusion of RE, energy security, and sustainable development. However, the literature solely occupies energy security concept in the view of descriptions, and RE differences related to interrelations among regions are rarely discussed. There are 19 indicators among 75 keywords as valid RE indicators in sustainable energy security, in which energy demand, energy policy, renewable resources, smart grid, and uncertainty representing critical study trends in the RE system. Besides, there are 115 countries/ territories is verified and categorized into five geographical regions. European and Latin-American and Caribbean have implemented the same requirement on RE reliability in both regions. The North America shows its specific need on the energy planning, while the Africa still remains much challenges on economic growth and RE planning as countries in this region are mostly still underdeveloped. The Asia and Oceania RE shows the same trend as the overall RE development, and reveal the potential to be one of leader in the field, while the Africa, and Latin America and Caribbean display the need for further improvements.

This study contributes to RE trends and emphasizes on the regional viewpoints of RE development. The RE players may refer this study as decision making consultants. Governments, firms, and professional practicians can regard to available information in this study to propagandize policy approaches, planning based, and practical design to promote innovation on both overall insights and regional implementations. The future studies by identifying the RE challenges and opportunities as:

- The energy demand should put more fiscal stimuluses to optimizing consumption on RE demand and substitute supply issues since there are limited data and unpredictable power demand future. Further, geopolitics supply-demand balancing, technological barriers count on RE resources, regulatory administrators to rebuilt the occupational and business settings, resilience, spatial and temporal assortment in demand exploitation, energy storage, pricing and financial efficiency should be noticed. Potential of disruptive events, electrification transportation, the demand for perilous materials, as well as RE demand transition also need for further investigations.
- The literatures have highlighted the contribution of political indicators on RE development in energy security. Considering the comprising of energies targets, plans, schedules, incentives rules and regulations standards, accurate inducements to stakeholders and customers is needed. Case studies on policies for energy mix, cross-country measurement, econometrics pecuniary incentives and extents, information modalities and instructions, judicial procedures, and institutional provisions is still absenting. There are also lacks of effective and coordinated regulation for long-term energy-intensive technologies, effective and fast communication policies among stakeholders, political position competences.
- Most of energies from renewable resources would be no fewer contrariety than the fossil energies, and envisions renewables may results in the same conflictions or even new severe types of conflicts. The strategy and operation designs uncertainty, optimal operations and robust planning to building integrated RE systems and develop a mix power grid with high RE diffusion is urgent. Improving the reliability, cost efficiency, energy storage system, renewable resources coordination is needed. Moreover, demand response for efficient RE resources, real-time hierarchical power system obstruction, RE systems planning, forecasting on social matters such as environmental concerns and sustainable development should be put more efforts.
- The smart grid should implement robust communication structure, smart metering, deep RE sources integration and distributed generation. The new information technologies and communication also need to be integrated since the grid requires considerable fluctuations to prevailing constellations, associations, and interactions among stakeholders. In addition, new technical resolutions on network observation by telecoms, sensors, and data dispensation apparatuses; network knowledge management and enable operational control, artificial intelligence and deep learning, big-data machineries and blockchain technology should be noticed.
- Conducting the uncertainty of multiple approaches has always remained a problematic obstacle. Robustness of RE data, vagueness scenarios, diverse decarbonization and renewable support policies to be considered. Tariffs design and regulating for new and old energy representatives, optimize integration toward the energy design, flexibility and resilience capability, techno-economic measurement is necessary.

Still, some limitations remain in this study. Promising adequate examination is challenges due to it is incapable for this study to review all 5,238 publications driven from the database. The discussion assessment may insufficient since Scopus also encloses low quality sources (Bui et al., 2021). Upcoming studies are encouraged to occupy more abbreviated databases to improve the results.

The expert committee only includes 30 members, which may cause the subjective references as a result of their experience, understanding, knowledge, and acquaintance to the field. Future study is proposed to cumulative more respondents to evade this problem.

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APPENDIX

Table 7.

Expert	Position	Education levels	Years of experience	Organization type (academia/practice)	Regional location
1	Professor	Ph.D.	15	Academia	North America
2	Professor	Ph.D.	14	Academia	Asia and Oceania
3	Professor	Ph.D.	8	Academia	Europe
4	Professor	Ph. D	13	Academia	Latin America and Caribbean
5	Professor	Ph.D.	9	Academia	Latin America and Caribbean
6	Professor	Ph.D.	16	Academia	North America
7	Professor	Ph.D.	10	Academia	Africa
8	Professor	Ph.D.	11	Academia	Europe
9	Professor	Ph.D.	15	Academia	Latin America and Caribbean
10	Distinguished Professor	Ph.D.	14	Academia	Asia and Oceania
11	Distinguished Professor	Ph.D.	8	Academia	Europe
12	Distinguished Professor	Ph.D.	10	Academia	North America
13	Associate Professor	Ph.D.	9	Academia	Africa
14	Associate Professor	Ph.D.	6	Academia	Europe
15	Associate Professor	Ph.D.	9	Academia	Latin America and Caribbean
16	Researcher & Section Chief (Professor)	Ph.D.	9	NGOs (Research center)	Asia and Oceania
17	Researcher & Section Chief (Professor)	Ph.D.	14	NGOs (Research center)	Asia and Oceania
18	Researcher & Section Chief	Ph.D.	7	NGOs (Research center)	Africa
19	Researcher	Master	8	NGOs (Research center)	North America
20	Researcher	Master	5	NGOs (Research center)	Africa
21	Deputy Director of Institute	Ph.D.	9	Government office	Europe
22	Deputy Director of Institute	Ph.D.	15	Government office	Latin America and Caribbean
23	Researcher	Master	7	Government office	Asia and Oceania
24	Executive manager	Ph.D.	12	Practices	Europe
25	Project manager	Ph.D.	9	Practices	Europe
26	Project manager	Master	11	Practices	North America
27	Project manager	Master	8	Practices	Africa
28	Production Executive	Ph.D.	8	Practices	Europe
29	Business Executive	Master	10	Practices	Latin America and Caribbean
30	Business Executive	Master	7	Practices	Asia and Oceania

The expert committee was approach thanks to the connections of Institute of Innovation and Circular Economy, Asia University, Taiwan.

Table 8.

ID	Label	weight<Occurrences>	score<Avg. pub. year>
1	Anaerobic digestion	14	2014.071
2	Biodiesel	55	2014.673
3	Bioenergy	66	2015.909
4	Bioethanol	22	2013.227
5	Biofuel	29	2014.862
6	Biofuels	50	2014.02
7	Biogas	30	2017.067
8	Biomass	100	2014.17
9	Biorefinery	14	2014.214
10	Blockchain	10	2020.2
11	Circular economy	19	2018.684
12	Clean energy	10	2014.9
13	Climate change	81	2014.358
14	Cloud computing	12	2018
15	Co2 emissions	14	2018.214
16	Desalination	17	2014.706
17	Distributed generation	23	2015.044
18	Economic growth	12	2016.75
19	Economics	15	2013.933
20	Electricity generation	13	2012.308
21	Electrochemistry	11	2016.909
22	Energy consumption	17	2017.588
23	Energy demand	10	2016.6
24	Energy efficiency	77	2015.935
25	Energy planning	10	2015.1
26	Energy policy	70	2014.529

continued on next page

Table 8. Continued

27	Energy security	135	2016.482
28	Energy storage	45	2016.111
29	Energy sustainability	13	2016.539
30	Energy transition	27	2017.889
31	Environmental impact	23	2013.87
32	Environmental impacts	12	2015.417
33	Environmental sustainability	15	2017
34	Fossil fuel	12	2014.083
35	Global warming	14	2014
36	Green building	12	2015.917
37	Green chemistry	23	2016.261
38	Green computing	10	2018.3
39	Green economy	18	2015.611
40	Green energy	19	2016.526
41	Greenhouse gases	10	2014.1
42	Hydrogen production	17	2014
43	Hydrogen storage	11	2015.273
44	Hydropower	22	2015.455
45	Innovation	11	2014.091
46	Internet of things	14	2019.286
47	Land use	11	2013.455
48	Life cycle assessment	38	2015.316
49	Machine learning	10	2019.7
50	Microalgae	15	2016.667
51	Microgrid	13	2018.231
52	Natural gas	14	2015.929
53	Nuclear energy	19	2013.263
54	Optimization	30	2018.1

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Table 8. Continued

55	Photovoltaic	21	2015.762
56	Power generation	11	2016.818
57	Recycling	13	2014.769
58	Reliability	11	2016.727
59	Renewable energy	409	2015.536
60	Renewable energy policy	11	2015.273
61	Renewable energy sources	53	2016.264
62	Renewable resources	11	2014.636
63	Resilience	10	2016.5
64	Safety	14	2014.571
65	Security	17	2014.882
66	Simulation	11	2016.455
67	Smart grid	26	2017.769
68	Solar energy	54	2015.63
69	Sustainability	257	2015.895
70	Sustainable agriculture	10	2016.2
71	Sustainable development	150	2014.533
72	Sustainable energy	55	2015.346
73	Uncertainty	11	2018.182
74	Water	16	2015.563
75	Wind energy	34	2015.706

Table 9.

	Asia and Oceania	Europe	North America	Latin America and Caribbean	Africa
	Afghanistan	Albania	Canada	Argentina	Algeria
	Australia	Austria	United States	Brazil	Burkina Faso
	Azerbaijan	Belgium		Chile	Burundi
	Bahrain	Bosnia And Herzegovina		Colombia	Cameroon
	Bangladesh	Bulgaria		Ecuador	Egypt
	Brunei Darussalam	Croatia		Jamaica	Ethiopia
	Cambodia	Czech Republic		Mexico	Ghana
	China	Denmark		Panama	Kenya
	Cyprus	Estonia		Peru	Libyan Arab Jamahiriya
	Fiji	Finland		Venezuela	Malawi
	Georgia	France			Mauritius
	Hong Kong	Germany			Morocco
	India	Greece			Namibia
	Indonesia	Hungary			Niger
	Iran	Ireland			Nigeria
	Iraq	Italy			Sierra Leone
	Israel	Latvia			South Africa
	Japan	Lithuania			Tanzania
	Jordan	Luxembourg			Tunisia
	Kazakhstan	Malta			Uganda
	Kuwait	Netherlands			Zambia
	Lebanon	North Macedonia			Zimbabwe
	Macau	Norway			
	Malaysia	Poland			
	Maldives	Portugal			
	Nepal	Romania			
	New Zealand	Russian Federation			
	Oman	Serbia			
	Pakistan	Slovakia			
	Palestine	Slovenia			
	Papua New Guinea	Spain			
	Philippines	Sweden			
	Qatar	Switzerland			
	Saudi Arabia	Ukraine			

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Table 9. Continued

	Singapore	United Kingdom			
	South Korea				
	Sri Lanka				
	Syrian Arab Republic				
	Taiwan				
	Thailand				
	Turkey				
	United Arab Emirates				
	Viet Nam				
	Yemen				
Total documents	1996	1764	1105	473	537

Table 10.

Indicators	j_a	i_a	V_a	Decision
anaerobic digestion	0.000	0.500	0.250	Unaccepted
biodiesel	0.000	0.500	0.250	Unaccepted
bioenergy	0.000	0.500	0.250	Unaccepted
bioethanol	0.000	0.500	0.250	Unaccepted
biofuel	0.000	0.500	0.250	Unaccepted
biofuels	0.000	0.500	0.250	Unaccepted
biogas	0.000	0.500	0.250	Unaccepted
biomass	0.000	0.500	0.250	Unaccepted
biorefinery	0.000	0.500	0.250	Unaccepted
blockchain	(0.062)	0.937	0.453	Accepted
circular economy	(0.024)	0.899	0.444	Accepted
clean energy	(0.034)	0.909	0.446	Accepted
climate change	(0.086)	0.961	0.459	Accepted
cloud computing	(0.011)	0.886	0.440	Accepted
co2 emissions	0.000	0.500	0.250	Unaccepted
desalination	0.000	0.500	0.250	Unaccepted
distributed generation	(0.400)	0.900	0.350	Accepted
economic growth	(0.389)	0.889	0.347	Accepted
economics	0.000	0.500	0.250	Unaccepted
electricity generation	(0.334)	0.834	0.333	Accepted
electrochemistry	0.000	0.500	0.250	Unaccepted
energy consumption	(0.030)	0.905	0.445	Accepted
energy demand	(0.311)	0.811	0.328	Accepted
energy efficiency	(0.061)	0.936	0.453	Accepted
energy planning	(0.405)	0.905	0.351	Accepted
energy policy	(0.430)	0.930	0.358	Accepted
energy security	0.000	0.500	0.250	Unaccepted

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Table 10. Continued

energy storage	(0.411)	0.911	0.353	Accepted
energy sustainability	(0.385)	0.885	0.346	Accepted
energy transition	(0.204)	0.704	0.301	Unaccepted
environmental impact	(0.370)	0.870	0.342	Accepted
environmental impacts	0.000	0.500	0.250	Unaccepted
environmental sustainability	(0.326)	0.826	0.332	Accepted
fossil fuel	0.000	0.500	0.250	Unaccepted
global warming	0.000	0.500	0.250	Unaccepted
green building	(0.378)	0.878	0.344	Accepted
green chemistry	0.000	0.500	0.250	Unaccepted
green computing	0.000	0.500	0.250	Unaccepted
green economy	0.000	0.500	0.250	Unaccepted
green energy	(0.375)	0.875	0.344	Accepted
greenhouse gases	0.000	0.500	0.250	Unaccepted
hydrogen production	0.000	0.500	0.250	Unaccepted
hydrogen storage	0.000	0.500	0.250	Unaccepted
hydropower	0.000	0.500	0.250	Unaccepted
innovation	(0.208)	0.708	0.302	Accepted
internet of things	(0.288)	0.788	0.322	Accepted
land use	(0.399)	0.899	0.350	Accepted
life cycle assessment	(0.036)	0.911	0.446	Accepted
machine learning	(0.052)	0.927	0.451	Accepted
microalgae	(0.411)	0.911	0.353	Accepted
microgrid	0.000	0.500	0.250	Unaccepted
natural gas	0.000	0.500	0.250	Unaccepted
nuclear energy	0.000	0.500	0.250	Unaccepted
optimization	(0.421)	0.921	0.355	Accepted
photovoltaic	0.000	0.500	0.250	Unaccepted

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Table 10. Continued

power generation	(0.396)	0.896	0.349	Accepted
recycling	(0.307)	0.807	0.327	Accepted
reliability	(0.331)	0.831	0.333	Accepted
renewable energy	0.000	0.500	0.250	Unaccepted
renewable energy policy	(0.399)	0.899	0.350	Accepted
renewable energy sources	0.000	0.500	0.250	Unaccepted
renewable resources	(0.032)	0.907	0.446	Accepted
resilience	(0.394)	0.894	0.348	Accepted
safety	(0.380)	0.880	0.345	Accepted
security	0.000	0.500	0.250	Unaccepted
simulation	0.000	0.500	0.250	Unaccepted
smart grid	(0.403)	0.903	0.351	Accepted
solar energy	0.000	0.500	0.250	Unaccepted
sustainability	(0.389)	0.889	0.347	Accepted
sustainable agriculture	0.000	0.500	0.250	Unaccepted
sustainable development	0.000	0.500	0.250	Unaccepted
sustainable energy	(0.370)	0.870	0.342	Accepted
uncertainty	(0.363)	0.863	0.341	Accepted
water	0.000	0.500	0.250	Unaccepted
wind energy	0.000	0.500	0.250	Unaccepted
Threshold			**0.310**	

Table 11.

Indicators	j_a	i_a	V_a	Decision
Blockchain	(0.216)	0.716	0.304	Accepted
Circular economy	0.000	0.500	0.250	Unaccepted
Clean energy	0.000	0.500	0.250	Unaccepted
Climate change	0.000	0.500	0.250	Unaccepted
Cloud computing	(0.376)	0.876	0.344	Accepted
Distributed generation	(0.366)	0.866	0.342	Accepted
Economic growth	(0.409)	0.909	0.352	Accepted
Electricity generation	0.000	0.500	0.250	Unaccepted
Energy consumption	0.000	0.500	0.250	Unaccepted
Energy demand	(0.367)	0.867	0.342	Accepted
Energy efficiency	(0.390)	0.890	0.348	Accepted
Energy planning	(0.038)	0.913	0.447	Accepted
Energy policy	(0.082)	0.957	0.458	Accepted
Energy storage	(0.024)	0.899	0.444	Accepted
Energy sustainability	0.000	0.500	0.250	Unaccepted
Environmental impact	0.000	0.500	0.250	Unaccepted
Environmental sustainability	(0.405)	0.905	0.351	Accepted
Green building	0.000	0.500	0.250	Unaccepted
Green energy	0.000	0.500	0.250	Unaccepted
Innovation	0.000	0.500	0.250	Unaccepted
Internet of things	(0.368)	0.868	0.342	Accepted
Land use	(0.394)	0.894	0.348	Accepted
Life cycle assessment	0.000	0.500	0.250	Unaccepted
Machine learning	(0.392)	0.892	0.348	Accepted
Microalgae	0.000	0.500	0.250	Unaccepted

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Table 11. Continued

Optimization	0.000	0.500	0.250	Unaccepted
Power generation	0.000	0.500	0.250	Unaccepted
Recycling	0.000	0.500	0.250	Unaccepted
Reliability	(0.354)	0.854	0.339	Accepted
Renewable energy policy	0.000	0.500	0.250	Unaccepted
Renewable resources	(0.350)	0.850	0.337	Accepted
Resilience	(0.387)	0.887	0.347	Accepted
Safety	(0.307)	0.807	0.327	Accepted
Smart grid	(0.253)	0.753	0.313	Accepted
Sustainability	0.000	0.500	0.250	Unaccepted
Sustainable energy	0.000	0.500	0.250	Unaccepted
Uncertainty	(0.003)	0.878	0.438	Accepted
Threshold			**0.307**	