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Nudging International Sustainable Practices Confirmed with Renewable Energy Consumption

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ABSTRACT

The study explores the resemblance of the countries based on renewable energy consumption (% of total energy consumption). A simplistic clustering approach is applied to implement the segmentation using the gap statistic method. The paper deals with the comparability of countries from the perspective of income level and geographical distribution. The clustering-based results reveal that the values of most mean clusters representing major economies have deteriorated over the past few years. The high and upper-middle income countries are found to be not following sustainable practices, while low and lower-middle income countries are relying much on renewable energy consumption. The outcome is also presented as clusters for geographical distribution and a cross-section distribution of income level-region for all economies sampled. The study may assist in policy-making in the wake of the global clean energy transition.

Keywords: Renewable Energy; Sustainable Practice; Clustering; Energy Transition
JEL Classifications: Q20, Q43, Q48

1. INTRODUCTION

In this decade, renewable energy has attracted academicians due to its link with climate change and less dependency on traditional fuels. The importance of renewable energy rest in addressing global clean energy (Lowitzsch et al., 2020; Yan et al., 2020) and environmental challenges (Zafar et al., 2020; Yan et al., 2020). The existing literature on renewable energy has focused on diverse but salient research areas like the convergence of renewable energy (Bhattacharya et al., 2018; Saba and Ngepah, 2022), adoption of renewable energy technologies (Makki and Mosly, 2020), impact on firm performance (Rastogi et al., 2020), renewable energy development (Huang and Liu, 2017; Gómez-Muñoz and Porta-Gándara, 2002), etc. The different nations have made efforts and policies related to energy conservation and clean energy and, as a result, have gained different levels of outcome (Bhattacharya et al., 2018; Makki and Mosly, 2020). Sometimes outcomes may not describe the efforts. Therefore, the study utilizes the renewable energy consumption measured with respect to total energy consumption in percentage form. This measure can gauge the efforts of the world and the process made so far.

Investigating the efforts and comparing them for all nations is a devious task. The study, first, aims to compare the 177 economies with a relevant parameter and puts forth its contribution. Comparing 177 different economies is a work of its kind. Secondly, the paper contributes by suggesting a more relevant parameter for study. Renewable energy productivity is ruled out as a parameter because a country may produce more renewable energy but still can choose to consume it less than traditional energy. This way, anyone can raise the issue of sustainable practices in that country. Therefore, the study employs renewable energy consumption as a more relevant and practical parameter. Using this parameter gives us leverage over the existing literature that considers energy productivity (Bhattacharya et al., 2018) and the absolute value of energy consumption (Rastogi et al., 2020). Nevertheless, we should not utilize the absolute values of renewable energy consumption as it might be higher as per the demand of big economies and lower for a comparatively small country's needs. The measurement problem is in absolute terms, which does not make it comparable to other economies. The issue of comparability of countries from the sustainability point of view is a long-standing one. In comparison, we have fetched the parameter from the World Bank database, bringing down every figure of renewable energy consumption in percentage form to total energy consumption.

The third contribution of our research work is based on controlling external factors while analyzing the data. The paper employs a simple method unaffected by other macroeconomic factors like Gross Domestic Product, Per capita Income, Gross national expenditure, etc., and socio-economic parameters, e.g., population and poverty level. The prominent scholars (e.g., Zafar et al., 2020; Yan et al., 2020; Bhattacharya et al., 2018; Saba and Ngepah, 2022) have exploited these factors in their study but left the rest as it is impossible to consider all macroeconomic, socio-economic, technological, and political factors in consideration. Clustering works in isolation without needing to control these previously mentioned factors. Previous studies have suggested different algorithms in clustering. The fourth contribution of the work lies in applying gap statistic as a robust method to form clusters. The papers (Gómez-Muñoz and Porta-Gándara, 2002; Rastogi et al., 2020) apply the Elbow method for clustering, which only calculates the Euclidean distance; the silhouette method that provides the average linkage without considering the variance, maximum and minimum differences, etc. However, the gap statistic does not average out the function, retains the k-means function, and compares the intra-cluster variations for different k levels.

Lastly, the paper utilizes the simplistic approach to highlight the underlying problem in the world energy transition. The existing literature showcases the complex methods, e.g., club and stochastic convergence (Bhattacharya et al., 2018), and multinomial logit model (Saba and Ngepah, 2022), to present the evidence in the world energy transition. Still, our study emphasizes the comparatively simplistic approach consistent with the principle of parsimony.

The rest of the paper follows: Section two describes the relevant literature on renewable energy consumption. Section three explains the methodology, while section four presents the results and discusses the outcome. Lastly, the conclusion follows.

2. LITERATURE REVIEW

The discussion on renewable and clean energy areas is not new, but the pertaining literature is limited to only the last decade. Renewable energy convergence is a relatively new concept; a few studies focus on this niche area. Bhattacharya et al. (2018) analyze the convergence of energy productivity across Indian states and territories and suggest that all states and union territories should have different energy policies as per the area since they belong to different clubs with different patterns of convergence. Along the same line, Saba and Ngepah (2022) explore the factors that drive renewable energy source convergence for 183 countries, which include agricultural value added, foreign direct investment, trade openness, land, information and communication technology, population, and institutional quality. Besides cost, government regulation, infrastructure, and public awareness, renewable energy technology is one factor that affects the willingness to adopt renewable energy (Makki and Mosly, 2020).

The literature on one of the sub-domain, i.e., renewable energy development, is well-researched and still expanding. Gómez-Muñoz and Porta-Gándara (2002) analyze the local patterns of wind based on cluster analysis techniques to assist in modeling renewable energy systems more accurately. Yan et al. (2020) develop a hybrid method to optimize the design of distributed energy systems, which can decrease the total cost by 23.65% and carbon emission by 75.32%. Developing renewable energy systems and analyzing their efficiency is one thing, but adopting those technologies and practices is another aspect of renewable energy development. Makki and Mosly (2020) have conducted an exploratory study to provide insights into the willingness to adopt renewable energy technologies as the key to renewable energy development. At a macro level, Xu et al. (2019) select the four external parameters, i.e., economic, political, social, and technical factors, to measure renewable energy development and suggest different strategies and policies based on geographical continents to strengthen the development of renewable energy in the world. Considering firm-level studies, firms practicing sustainable development and endeavoring climate change strategies are achieving far better accounting performance than non-practicing firms (Michalisin and Stinchfield, 2010). Rastogi et al. (2020) uncover that net profit margin is the important driving factor of return on equity in Indian renewable energy companies, while no specific single driver for the United States renewable energy companies.

Renewable and traditional energy are linked, but the gap between these needs to materialize to transit into a better sustainable world. A few mentionable works are linking both horizons. While related to renewable energy consumption, a few previous exciting works exist. Huang and Liu (2017) attempt to compile the conclusions from various research sources to exhibit the reconfigured socio-spatial arrangements adopting and consuming renewable energy in China than traditional energy. Adopting renewable energy technologies reduces the consumption of public electricity utilities and hence, costs (Makki and Mosly, 2020). Kacperska et al. (2021) perceive European Union countries for renewable energy sources in transport, electricity, and heating and cooling and ascertain that renewable energy made up about 34% of electricity consumption in the European Union. Countries need more renewable energy development and less consumption of fossil fuels, which is the main reason for environmental degradation (Zafar et al., 2020). Zafar et al. (2020) also point out the factors stimulating carbon emission intensity: Foreign direct investment, education level, income level, and urbanization. The suggested future research areas in India may be related to electricity consumption, urbanization, and energy productivity (Bhattacharya et al., 2018).

3. METHODOLOGY

The latest data for renewable energy consumption (% of total energy consumption) is extracted from the World Bank website from 1990 to 2019. After filtering for the countries sampled from the countries available, we have gathered data for 177 countries grouped into five clusters according to the *k*-means clustering method. In technical words, gap statistic searches for the optimal number of clusters by comparing the expected value of the null reference distribution of data with total intra-cluster variations (e.g., cluster density) for various *k* levels. This information about resemblance is captured by maximizing the gap statistics for the optimal number of clusters, *k*:

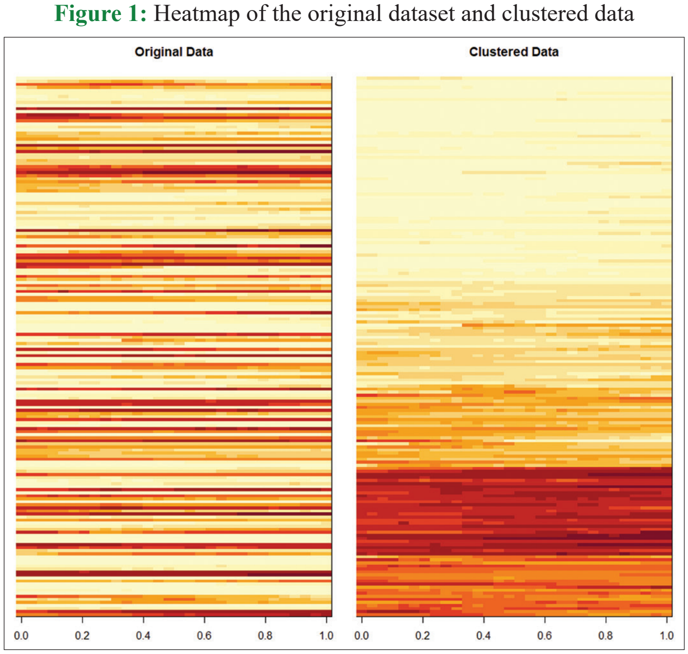
$$Gap_n(k) = E_n^*\{log\ (W_k)\} - log\ (W_k) \quad (1)$$

where, E_n^* is the expectation from the null reference distribution and is determined via bootstrapping (B). The above equation (1) expresses the deviation of observed W_k value from its expected value of the null reference distribution of data. $log\ (W_k^*)$ from the bootstrapping (Monte Carlo Simulation) presents a standard deviation, sd_k, which in turn measures simulation error, $s_k = sd_k \times \sqrt{1+1/B}$. The smallest *k* is identified as the number of optimal clusters such that $Gap(k) \geq Gap(k+1) - s_{k+1}$.

4. RESULTS AND DISCUSSION

Figure 1 depicts the heatmap of the original dataset of renewable energy consumption (% of total energy consumption) and clustered data. The left side of the heatmap suggests that the original dataset has different color codes and is clusterable. The right side of the heatmap exhibits the clustered data converted from the original data. Although, this is just the initial check and a crude way to determine whether the proper cluster can be formed with the renewable energy consumption dataset.

Figure 1: Heatmap of the original dataset and clustered data



The heatmap cannot discover the optimal number of clusters. Still, there are various ways to identify the optimal number of clusters, i.e., elbow method, silhouette method, gap statistics method, etc. The Elbow and silhouette method has the disadvantage of quantifying global cluster characteristics only. In contrast, the Gap statistic method is a more elegant procedure for data with no obvious clustering. It compares the intra-cluster variation for distinct values of k using Monte Carlo Simulation.

Figure 2 – Panel (a) shows the scree plot of the optimal number of clusters as per the gap statistic method that suggests five clusters. The same can be observed from the heatmap of clustered data (not very obvious but perceivable). The Elbow and silhouette methods provide k = 1 and k = 2, respectively. The optimal number of clusters can be wrong as these two methods are naïve for observing intra-cluster variation. We utilize the five clusters suggested by the gap statistic method to perform k-means clustering. It is evident from Figure 2 – Panel (b) that five obvious clusters have no overlapping properties and are without any outlier data point. These clusters possess information on renewable energy consumption (% of total final energy consumption) for 177 countries.

The clusters' characteristics are extracted from the descriptive statistics and mean clusters mentioned in Table 1. The cluster rankings can be formed with the help of the mean and median. Renewable energy consumption (% of total energy consumption) is directly linked with its production capacity. If less renewable energy is produced via different channels, less renewable energy will be consumed in the percentage of total energy production and consumption, respectively. Noting this point from the data pattern, Cluster 5 is the worst cluster which consumes less renewable energy versus total energy use.

In the same way, cluster 1 is the best cluster from the sustainability point of view. Standard deviation tells us about the inter-cluster variation, which is maximum in cluster 2 while minimum in cluster 5. The dataset has only 30 data points as the number of years, and it is most obvious that it may not follow a normal distribution, which is evident from all clusters. But cluster 1 and cluster 5 follow a normal distribution with a 10% significance level. Kurtosis reveals that all clusters are platykurtosis, having lighter tails than the normal distribution. All cluster series is autocorrelated as per Ljung-Box statistics. Minimum and maximum values can describe the range of the clusters.

The mean clusters are plotted against the time horizon in Figure 3, which exhibits that cluster 5 has a gradual slope, which is good for the countries trying to rely more on renewable energy year by year. Cluster 4 has a neutral trend, while clusters 1, 2, and 3 have a decreasing slope or trend. It might not be a good sign for future energy consumption.

Plotting every country as per Income group presents us with the hidden facets of clusters where each cluster's percentage range indicates the clusters' ranking order based on renewable energy consumption percentage. Figure 4 plots each country

Figure 2: Panel (A) Scree plot of the optimal number of clusters as per gap statistic method (left) and Panel (B) k-means clustering for renewable energy consumption (% of total final energy consumption) (right).

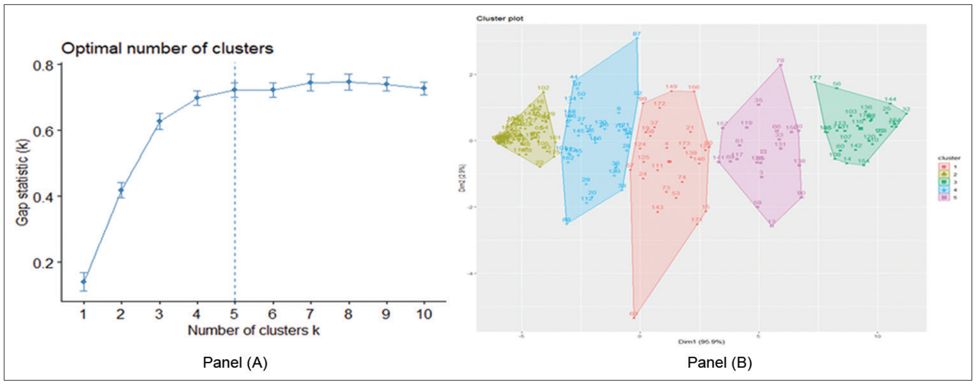


Figure 3: Plot of clusters mean across years

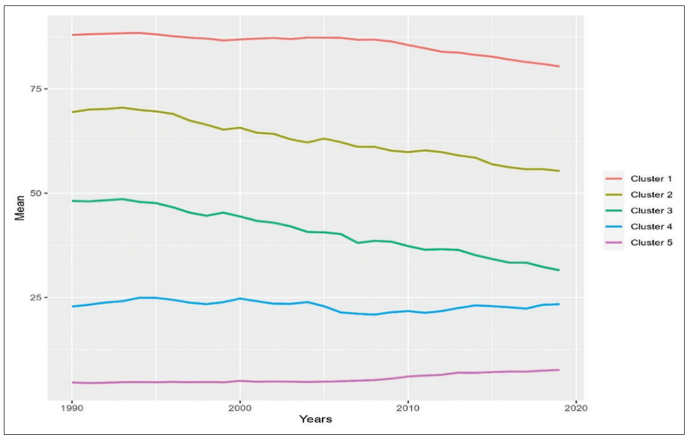


Table 1: Descriptive statistics of k-means clusters

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Mean	85.8876	63.0849	40.8757	23.0405	5.5042
Median	86.9181	62.5708	40.6685	23.2354	4.8558
SD	2.4082	4.9156	5.4663	1.1478	1.0777
Minimum	80.411	55.322	31.5204	20.8934	4.4411
Maximum	88.428	70.5154	48.5852	24.9255	7.6221
Skewness	−0.9405	0.0608	−0.0775	−0.2437	0.7773
Kurtosis	−0.5422	−1.3136	−1.4082	−0.985	−1.1406
JB	5.0675	1.8064	2.1343	1.2186	4.6198
	(0.079)	(0.405)	(0.344)	(0.544)	(0.099)
LB - Q stat	78.659	102.99	108.69	61.449	95.121
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	30	30	30	30	30

The p values for Jarque-Bera (JB) test and Ljung-Box (LB – Q stat) are reported in the parenthesis. The critical value of the JB test at 5% level is 5.99. N denotes the number of observations in each cluster.

as per Income group to each cluster, and Table 2 provides its counts. The countries' codes are per the World Bank database, and Country Names are mentioned in Appendix 1. Reading the results for every country is impossible in this standalone research work. Still, the reader should read it in light of a specific country's economic situation (e.g., exchange rate, fiscal deficit, international borrowings, etc.). Thus, we are highlighting the major points from the results and not interpreting country-specific.

The best cluster 1 surprisingly does not have any country from the high-income level and only one country from the upper-middle income group. Low-income countries have a major portion (65.51%) in cluster 1 depicts that most low-income countries follow sustainable practices. Cluster 2, the second best cluster, has its major proportion from the lower-middle income countries (70%), while the rest Income groups hold just a 10% proportion each for cluster 2. Lower-middle income countries have a 50% proportion in cluster 3, which is neither the best nor worst cluster for sustainable practices. The worst cluster 4 and 5, with low renewable energy consumption percentage, has the maximum number of countries from high-income and upper-middle income countries. These two income groups have 77.14% and 85.07% of cluster 4 and 5, respectively. These results simply depict that high- and upper-middle-income groups are not following sustainable practices in terms of renewable energy and rely much more on traditional energy consumption; the reverse is true for low- and middle-income-income groups.

Figure 5 plots each country's geographical region to each cluster, and Table 3 provides its counts. Countries from Sub-Saharan Africa region have a majority of their share distributed among cluster 1 (56.82%), cluster 2 (20.45%), and cluster 3 (13.64%), which proves sustainable practices and development by these countries. Cluster 1 also has 86.2% proportion from Sub-Saharan African region countries. From a renewable energy viewpoint, sustainable practices have split the geographical region into two parts: Countries either follow sustainable practices rigorously (lies in clusters 1 and 2) or do not follow them intensely (lies in clusters 4 and 5). More countries from East Asia and Pacific, Europe and Central Asia, Latin America and Caribbean, Middle East and North Africa, and North America are titled towards cluster 4 and 5. Sub-Saharan African countries are titled towards cluster 1. While South Asian countries are more or less equally distributed in each cluster.

Table 4 presents the cross-section distribution of income groups and regions for sampled countries. It exhibits an interesting comparison of countries from the same income group and region but at different clusters. We uncover the results only for a few economies, while readers can read this table to compare the rest

Table 2: Number of countries in each cluster as per income group

Income group	Cluster 1 (80-89%)	Cluster 2 (55-71%)	Cluster 3 (31-49%)	Cluster 4 (20-25%)	Cluster 5 (4-8%)
High income	-	2	3	16	35
Upper middle income	1	2	10	11	22
Lower middle income	9	14	13	7	8
Low income	19	2	-	1	2

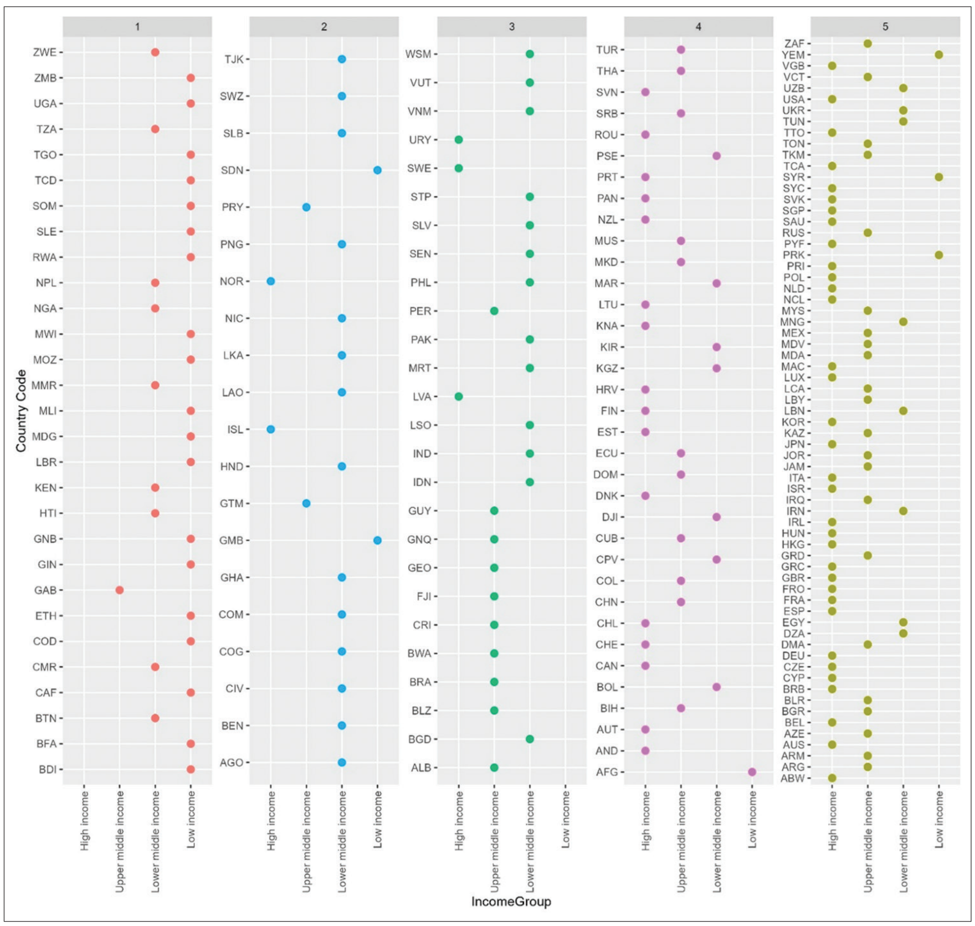
Note: Each cluster's range of renewable energy consumption (% of total energy consumption) is given in parenthesis.

Table 3: Number of countries in each cluster as per region

Region	Cluster 1 (80-89%)	Cluster 2 (55-71%)	Cluster 3 (31-49%)	Cluster 4 (20-25%)	Cluster 5 (4-8%)
East Asia and Pacific	1	3	6	4	12
Europe and Central Asia	-	3	4	16	26
Latin America and Caribbean	1	4	7	8	13
Middle East and North Africa	-	-	-	3	12
North America	-	-	-	1	1
South Asia	2	1	3	1	1
Sub-Saharan Africa	25	9	6	2	2

Note: Each cluster's range of renewable energy consumption (% of total energy consumption) is given in parenthesis.

Figure 4: Countries classification as per income group in each cluster



of the countries. Bhutan and Nepal lie in cluster 1, while both are from the same Income group and region. Same way, Cameroon, Kenya, Nigeria, Tanzania, and Zimbabwe also rest in cluster 1 with the same Income group and region. Indonesia, Philippines, Vietnam, Vanuatu, and Samoa are comparable with the same pattern. India, Pakistan, and Bangladesh also reside in the same cluster 3. As per cluster 4, China and Thailand are comparable; Colombia, Cuba, Dominican Republic, and Ecuador are comparable; Andorra, Austria, Switzerland, Denmark, Estonia, Finland, Croatia, Lithuania, Portugal, Romania, and Slovenia are comparable. Concerning cluster 5, Australia, Hong Kong, Japan, Korea, Rep., Singapore, etc., are alike for renewable

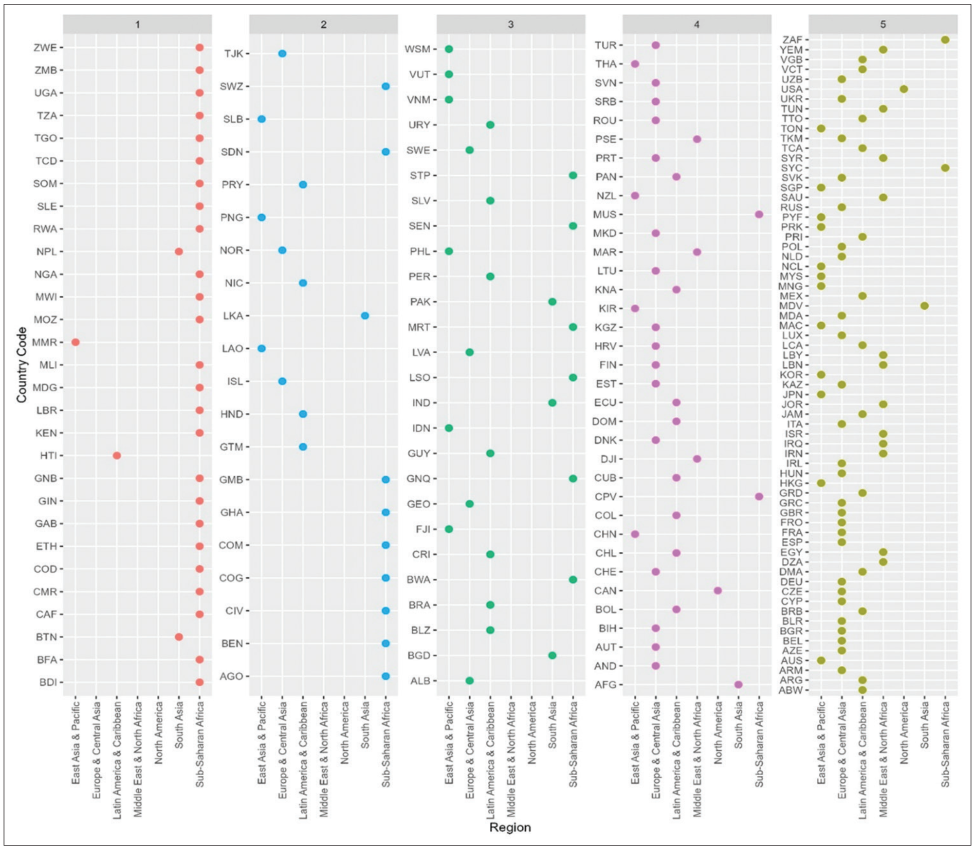
Table 4: Cross-section distribution of income group-region

	High income (56)	Upper middle Income (46)	Lower middle Income (51)	Low income (24)	177
Cluster 1	-	-	MMR	-	East Asia and Pacific (26)
Cluster 2	-	-	LAO; PNG; SLB	-	
Cluster 3	-	FJI	IDN; PHL; VNM; VUT; WSM	-	
Cluster 4	NZL	CHN; THA	KIR	-	
Cluster 5	AUS; HKG; JPN; KOR; MAC; NCL; PYF; SGP	MYS; TON	MNG	PRK	
Cluster 1	-	-	-	-	Europe and Central Asia (49)
Cluster 2	ISL; NOR	-	TJK	-	
Cluster 3	LVA; SWE	ALB; GEO	-	-	
Cluster 4	AND; AUT; CHE; DNK; EST; FIN; HRV; LTU; PRT; ROU; SVN	BIH; MKD; SRB; TUR	KGZ	-	
Cluster 5	BEL; CYP; CZE; DEU; ESP; FRA; FRO; GBR; GRC; HUN; IRL; ITA; LUX; NDL; POL; SVK	ARM; AZE; BGR; BLR; KAZ; MDA; RUS; TKM	UKR; UZB	-	
Cluster 1	-	-	HTI	-	Latin America and Caribbean (33)
Cluster 2	-	GTM; PRY	HND; NIC	-	
Cluster 3	URY	BLZ; BRA; CRI; GUY; PER	SLV	-	
Cluster 4	CHL; KNA; PAN	COL; CUB; DOM; ECU	BOL	-	
Cluster 5	ABW; BRB; PRI; TCA; TTO; VGB	ARG; DMA; GRD; JAM; LCA; MEX; VCT	-	-	
Cluster 1	-	-	-	-	Middle East and North Africa (15)
Cluster 2	-	-	-	-	
Cluster 3	-	-	-	-	
Cluster 4	-	-	DJI; MAR; PSE	-	
Cluster 5	ISR; SAU; SYR	IRQ; JOR; LBY	DZA; EGY; IRN; LBN; TUN	YEM	
Cluster 1	-	-	-	-	North America (2)
Cluster 2	-	-	-	-	
Cluster 3	-	-	-	-	
Cluster 4	CAN	-	-	-	
Cluster 5	USA	-	-	-	
Cluster 1	-	-	BTN; NPL	-	South Asia (8)
Cluster 2	-	-	LKA	-	
Cluster 3	-	-	BGD; IND; PAK	-	
Cluster 4	-	-	-	AFG	
Cluster 5	-	MDV	-	-	
Cluster 1	-	GAB	CMR; KEN; NGA; TZA; ZWE	BDI; BFA; CAF; COD; ETH; GIN; GNB; LBR; MDG; MLI; MOZ; MWI; RWA; SLE; SOM; TCD; TGO; UGA; ZMB	Sub-Saharan Africa (44)
Cluster 2	-	-	AGO; BEN; CIV; COG; COM; GHA; SWZ	GMB; SDN	
Cluster 3	-	BWA; GNQ	LSO; MRT; SEN; STP	-	
Cluster 4	-	MUS	CPV	-	
Cluster 5	SYC	ZAF	-	-	

Note: Color denotes the clustering characteristic based on the range of renewable energy consumption percentage in each cluster: 80-89% to Cluster 1, 55-71% to Cluster 2, 31-49% to Cluster 3, 20-25% to Cluster 4, and 4-8% to Cluster 5

energy consumption; Ukraine and Uzbekistan are equivalent; Belgium, Cyprus, Germany, Spain, U.K., Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, etc. are comparable; Israel, Saudi Arabia, and Syrian Arab Republic are alike. There are many more comparable groups formed and observable in Table 4.

Figure 5: Countries classification as per region in each cluster



5. CONCLUSION

The study advances the work in the renewable energy field with the contemporary issue of comparability of the countries with recent trends and future outlooks. The paper employs the k-means cluster analysis with the gap statistic method for the income level and geographical distribution of the different economies. It also ventures into the cross-section distribution of income level-region based on clusters formed. We discover that most nations with low and lower-middle income groups utilize more renewable energy than those with high and upper-middle income groups. Although, we evident the paramount role of these big economies in the policy-making of COP-26 & COP-27 (most countries are Paris Agreement signatories) and the Intergovernmental Panel on Climate Change (IPCC). Still, they fail to set an example as per the cluster formation in our analysis for renewable energy consumption. South Asia and Sub-African nations are achieving quite well, opposite the generally perceived mental set. On the other hand, most countries from Europe, North America, Latin America, East Asia, Middle East are not looking too outstanding as per the analysis. The analysis also filters out countries with the same income level and geographical area considering the cross-section distribution of Income level and region.

The research work can be utilized for paving the future path for renewable energy development. Renewable energy consumption can be increased with the minimum usage of fossil fuels for every country's public utilization with the proper prospective policies. This might not happen until we know where we rest and where we can proceed. The study suggests the past and future roadmap for the countries sampled based on the comparable approach. Future research work may consider socio-economic parameters to cement a better approach that can control the demography of the countries.

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Appendix 1: Country code (as per World Bank database) with country name in each cluster

Cluster 1		Cluster 2		Cluster 3		Cluster 4		Cluster 5	
Code	**Country name**	**Code**	**Country name**	**Code**	**Country name**	**Code**	**Country name**	**Code**	**Country name**
BDI	Burundi	AGO	Angola	ALB	Albania	AFG	Afghanistan	ABW	Aruba
BFA	Burkina Faso	BEN	Benin	BGD	Bangladesh	AND	Andorra	ARG	Argentina
BTN	Bhutan	CIV	Côte d'Ivoire	BLZ	Belize	AUT	Austria	ARM	Armenia
CAF	Central African Republic	COG	Congo, Rep.	BRA	Brazil	BIH	Bosnia and Herzegovina	AUS	Australia
CMR	Cameroon	COM	Comoros	BWA	Botswana	BOL	Bolivia	AZE	Azerbaijan
COD	Congo, Dem. Rep.	GHA	Ghana	CRI	Costa Rica	CAN	Canada	BEL	Belgium
ETH	Ethiopia	GMB	Gambia, The	FJI	Fiji	CHE	Switzerland	BGR	Bulgaria
GAB	Gabon	GTM	Guatemala	GEO	Georgia	CHL	Chile	BLR	Belarus
GIN	Guinea	HND	Honduras	GNQ	Equatorial Guinea	CHN	China	BRB	Barbados
GNB	Guinea-Bissau	ISL	Iceland	GUY	Guyana	COL	Colombia	CYP	Cyprus
HTI	Haiti	LAO	Lao PDR	IDN	Indonesia	CPV	Cabo Verde	CZE	Czechia
KEN	Kenya	LKA	Sri Lanka	IND	India	CUB	Cuba	DEU	Germany
LBR	Liberia	NIC	Nicaragua	LSO	Lesotho	DJI	Djibouti	DMA	Dominica
MDG	Madagascar	NOR	Norway	LVA	Latvia	DNK	Denmark	DZA	Algeria
MLI	Mali	PNG	Papua New Guinea	MRT	Mauritania	DOM	Dominican Republic	EGY	Egypt, Arab Rep.
MMR	Myanmar	PRY	Paraguay	PAK	Pakistan	ECU	Ecuador	ESP	Spain
MOZ	Mozambique	SDN	Sudan	PER	Peru	EST	Estonia	FRA	France
MWI	Malawi	SLB	Solomon Islands	PHL	Philippines	FIN	Finland	FRO	Faroe Islands
NGA	Nigeria	SWZ	Eswatini	SEN	Senegal	HRV	Croatia	GBR	United Kingdom
NPL	Nepal	TJK	Tajikistan	SLV	El Salvador	KGZ	Kyrgyz Republic	GRC	Greece
RWA	Rwanda			STP	São Tomé and Principe	KIR	Kiribati	GRD	Grenada
SLE	Sierra Leone			SWE	Sweden	KNA	St. Kitts and Nevis	HKG	Hong Kong SAR, China
SOM	Somalia			URY	Uruguay	LTU	Lithuania	HUN	Hungary
TCD	Chad			VNM	Vietnam	MAR	Morocco	IRL	Ireland
TGO	Togo			VUT	Vanuatu	MKD	North Macedonia	IRN	Iran, Islamic Rep.
TZA	Tanzania			WSM	Samoa	MUS	Mauritius	IRQ	Iraq
UGA	Uganda					NZL	New Zealand	ISR	Israel
ZMB	Zambia					PAN	Panama	ITA	Italy
ZWE	Zimbabwe					PRT	Portugal	JAM	Jamaica
						PSE	West Bank and Gaza	JOR	Jordan
						ROU	Romania	JPN	Japan
						SRB	Serbia	KAZ	Kazakhstan
						SVN	Slovenia	KOR	Korea, Rep.
						THA	Thailand	LBN	Lebanon
						TUR	Türkiye	LBY	Libya
								LCA	St. Lucia
								LUX	Luxembourg
								MAC	Macao SAR, China
								MDA	Moldova
								MDV	Maldives
								MEX	Mexico
								MNG	Mongolia
								MYS	Malaysia
								NCL	New Caledonia
								NLD	Netherlands
								POL	Poland
								PRI	Puerto Rico
								PRK	Korea, Dem. People's Rep.
								PYF	French Polynesia
								RUS	Russian Federation
								SAU	Saudi Arabia
								SGP	Singapore

(*Contd...*)

Appendix 1: (*Continued*)

Cluster 1		Cluster 2		Cluster 3		Cluster 4		Cluster 5	
Code	**Country name**	**Code**	**Country name**	**Code**	**Country name**	**Code**	**Country name**	**Code**	**Country name**
								SVK	Slovak Republic
								SYC	Seychelles
								SYR	Syrian Arab Republic
								TCA	Turks and Caicos Islands
								TKM	Turkmenistan
								TON	Tonga
								TTO	Trinidad and Tobago
								TUN	Tunisia
								UKR	Ukraine
								USA	United States
								UZB	Uzbekistan
								VCT	St. Vincent and the Grenadines
								VGB	British Virgin Islands
								YEM	Yemen, Rep.
								ZAF	South Africa