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A Cluster Analysis of Renewable Electricity Generation Policies in Asian Region Countries Using SPSS Software

Asya Bölgesi Ülkelerinde Yenilenebilir Elektrik Üretimi Politikaları ile İlgili Bir Küme Analizi

Huzaifa Mohammed Adam HARAMEEN
M.Sc. Student, Kocaeli University, Chemical Engineering Department,
hoz2t96@yahoo.com
https://orcid.org/0000-0003-4757-6958

Gülşen AKMAN
Assoc. Prof. Dr., Kocaeli University, Industrial Engineernig Department,
akmang@kocaeli.edu.tr
https://orcid.org/ 0000-0002-5696-2423

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ÖZET

Çalışmada Asya bölgesi ülkelerinde yenilenebilir elektrik üretimi sektörü kapsamlı bir şekilde analiz edilmiştir. Bu kapsamda çalışmada çubuk grafik kullanılarak karşılaştırmalar yapılmıştır. Çalışma kapsamında SPSS yazılımı kullanılarak çeşitli yenilenebilir elektrik üretim türleri için hiyerarşik bir kümeleme analizi yapılmıştır. Bu kapsamda ülkeler, toplam yenilenebilir elektrik üretimine dayalı olarak 7 kümeye ayrılmıştır. Hidroelektrik sektörü açısından Asya Bölgesi ülkeleri, Hindistan ve Türkiye'nin başı çektiği ülkeler toplamda altı gruba ayrılmıştır. Rüzgâr enerjisine dayalı elektrik üretimi sektöründe Hindistan ve Türkiye'nin başı çektiği dört küme tespit edilmiştir. Ülkeler güneş enerjisi üretimine dayalı olarak altı kümeye ayrılarak analiz edilmiştir. İlk kümede Hindistan ve Japonya izole olurken, onu Türkiye takip etmiştir. Arap Körfezi ülkeleri altıncı kümede yer almıştır. Biyokütle elektrik sektöründe, Hindistan ve Japonya'nın ilk kümede olduğu beş küme tespit edilmiştir. Jeotermal elektrikte Endonezya'nın ilk sırada izole durumda olduğu görülmüştür. Japonya, Güney Kore ve Türkiye'nin ilk kümede izole edildiği dalga-gelgit elektrik sektöründe dört küme elde edilmiştir. Bağımsız değişken olarak yenilenebilir elektrik üretimi kullanılarak Asya Bölgesi ülkelerindeki karbondioksit emisyon miktarını tahmin etmek için Çoklu Regresyon Modeli oluşturulmuştur. Bununla birlikte, kesişme değeri ve hidroelektrik faktörü sırasıyla 51.888 ve 3.116 bulunmuştur. Ayrıca, GSYİH ile hidro, güneş, rüzgâr ve biyokütle elektrik üretimi arasında güçlü bir ilişki bulunmuştur.

Anahtar Kelimeler:

Asya Bölgesi,

Yenilenebilir Elektrik,

CO2 Emisyonları,

GSYİH Kümeleme Analizi,

Regresyon Analizi,

ABSTRACT

The sector of renewable electricity generation in Asia region countries was comprehensively analyzed. A comparative study has been conducted with bar chart. A hierarchical clustering analysis was performed for the various renewable electricity generation types using SPSS software. The countries were clustered into 7 clusters based on the total renewable electricity generation. In hydroelectricity sector Asia Region countries were clustered into six groups in which India and Turkey are taking the lead. In Wind electricity sector four clusters were found in which India and Turkey lead. Countries were analyzed by dividing them into six clusters based on solar energy production. India and Japan is isolated in the first cluster followed by Turkey, while Arab Gulf countries were in the sixth cluster. In biomass electricity sector five clusters were founds in which India and japan in the first cluster. In geothermal electricity, Indonesia is isolated in the first. Four clusters were obtained in the wave-tide electricity sector in which Japan, South Korea and Turkey are isolated in the first cluster. Multiple Regression Model was created to estimate the amount of carbon dioxide emissions in Asia Region countries using the renewable electricity generation as an independent variable. However, the value of the intercept and the hydroelectricity factor were found 51.888 and 3.116 respectively. Moreover, a strong correlation between the GDP and the hydro, solar, wind, and biomass electricity generation was found.

Keywords:

Asia Region,

Renewable Electricity,

CO2 Emissions,

GDP Clustering Analysis,

Regression Analysis,

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1. INTRODUCTION

As the modern world is going to be dependence on electricity in almost all of its processes and technologies (e.g. Transportation, education, telecommunication, governmental operation, military, etc.), the demand of electricity has become tremendously huge, which cannot be satisfied economically by the fossil fuel only. On the other hand, the environmental issues related to the electricity generation has become one of the biggest concerns of the future and the next generations. As a result, most of the countries if not all of them have prepared a vision in which renewable energy and fuel alternatives are one of its main subjects, in which world has target 800 GW of renewable power by 2035 (Bassam et al, 2013:187).

United States, EU countries, United Kingdom, and some other such developed countries have already started to manage their renewable energy potential, and they are developing their technologies to exploit the optimum renewable potential which has reached to more than 29% of global electricity generation at the end of 2019. Meanwhile Middle East countries are already having the largest fossil fuel potential, water scarcity, and agriculture dilemma. 80% of their agricultural products are being imported from neighbour countries, the thing that puts more pressure over them to save their petroleum for exporting purpose.

Renewable energy sources in Asia; the most abundant renewable energy sources in the earth planet are: the sun radiation, wind, biomass, hydropower, tide and waves. In Asia solar energy potential is the most abundant; in which Asian countries has the largest potential in the world (Singh et al, 2011:171-175).

Water sacristy in Middle East and north Africa is the biggest. The lake of renewable water resources forces these countries to use expensive and unfriendly environmentally approaches such as ocean and sea water desalination to reduce that shortage. The need of renewable source of electricity to solve this dilemma is very required and necessary. And since Middle East countries can utilize solar potential in its different shapes (i.e. Thermal and photovoltaic).

2. LITERATURE REVIEW

As the world is working to cover electricity demand by using clean energy and restrict the usage of fossil fuels, the commercial value of the renewable energy technologies has become tremendously high. Big and new brand companies entered the market to apply and develop these technologies relentlessly. This statistical study provides these companies with a clear picture of the availability of the renewable resources and technology based on the country in order to set the targeted countries according to the renewable energy category to be applied.

Also the study will identify the Asian countries with a high developing rate in renewable electricity sector from the Asian countries with low developing rate in renewable electricity generation sector by applying a comprehensive comparative analysis. However, these countries can be taken and studied as a case, investigations can be done in-order to observe the most effective factors that affects the developing of the renewable energy technology in both negative and positive way. Moreover, a regression model has been applied to forecast the renewable electricity generation for the Asian countries. That gives both the country and the companies an expectation to build their decision up on it. In addition to that, the study provides the world with the Asian region concern of the environment in which can be they can be monitored.

In addition, a regression analysis will be applied in which a regression analysis was performed to estimate the Carbon Dioxide Emissions production using the different renewable electricity generation. Thus, this helps to predict and adjust the renewable electricity supposed to be generated using a certain resource in order to reach a certain or targeted carbon dioxide emission. Moreover, a correlation analysis was performed to check if the global domestic gross (GDP) of Asia region country is affected by the renewable electricity generation. If it does affect, then that might support the fact that Renewable energy improves human well-being and overall welfare well beyond GDP along with the direct economic effects.

3. DATA DESCRIPTION

A set of categorized electricity generation data based on the country from the past two decades (1999-2019) has been obtained. The data comprises the annual total electricity generation, total annual renewable electricity generation, and the detailed annual generation based on each renewable source. Due to the large number of the

countries that are located in Asia, the countries have been clustered into four groups based on their total annual electricity generation of 2019 to simplify the analysis and to make the study less complicated. Table 1, 2, 3, 4 show the groups in which the first group comprises.

The countries with total electricity generation ranged from 2000 billion kWh to 100 billion kWhr (Table1); The second group generation electricity within the range 99 billion kWhr to 10 billion kWhrs (Table 2); The third 9 billion kWhr to 1 billion kWhr (Table 3); Lastly the rest of the Asian countries with annual total electricity generation of less than 1 billion kWhr (Table 4).

Table 1. Group 1: Total Electricity Generation within the Range of 2000 Billion Kwh to 100 Billion Kwh

COUNTRY	Total Annual Generation in Billion kWh	Total Annual Renewable Generation in Billion kWh
India	1.550,943	283,045
Japan	984,791	216,343
South Korea	552,799	25,676
Saudi Arabia	355,478	0,160
Iran	291,285	16,221
Turkey	290,386	96,690
Indonesia	269,395	49,134
Taiwan	256,464	12,656
Australia	247,694	44,443
Vietnam	230,729	83,930
Thailand	173,088	29,996
Malaysia	159,946	27,957
Pakistan	143,986	44,208
United Arab Emirates	127,921	1,310

Table 1 lists the countries with the lowest annual production in billion kWh from the country with the highest annual production. According to the data obtained, the country with the highest level of production is India with 1.550,943 kWh; The country with the lowest production was United Arab Emirates with 127,921 kWh. In terms of renewable production, India has the highest rate of 283,045 kWh; The lowest rate was found to be Saudi Arabia with 0,160 kWh.

Table 2. Group 2: Total Electricity Generation within the Range of 99 Billion Kwh to 10 Billion Kwh

COUNTRY	Total Annual Generation in Billion kWh	Total Annual Renewable Generation in Billion kWh
Philippines	94,514	22,660
Iraq	77,650	1,857
Bangladesh	73,971	1,375
Kuwait	69,663	0,084
Israel	64,768	1,809
Singapore	50,055	1,668
Qatar	45,161	0,123
New Zealand	43,205	36,319
Oman	35,411	0,004
Hong Kong	34,365	0,093
Bahrain	27,783	0,010
Burma	23,812	14,018
Lebanon	19,984	0,419
Jordan	19,384	2,188
Syria	17,188	0,780
North Korea	15,147	12,688
Sri Lanka	14,845	6,866

Table 2 lists the countries with the lowest annual production in billion kWh from the country with the highest annual production. According to the data obtained, the country with the highest level of production is Philippines with 94,514 kWh; The country with the lowest production was Sri Lanka with 14,845 kWh. In terms of renewable production, New Zealand has the highest rate of 36,319 kWh; The lowest rate was found to be Oman with 0,004 kWh.

Table 3. Group 3: Total Electricity Generation within the Range of 9 Billion Kwh to 1 Billion Kwh

COUNTRY	Total Annual Generation in Billion kWh	Total Annual Renewable Generation in Billion kWh
Cambodia	7,925	4,770
Bhutan	6,891	6,891
Mongolia	6,169	0,457
Nepal	4,941	4,941
Papua New Guinea	4,062	0,822
Brunei	4,037	0,002
Yemen	3,420	0,458
New Caledonia	2,947	0,362
Guam	1,724	0,068
Afghanistan	1,115	0,965

Table 3 lists the countries with the lowest annual production in billion kWh from the country with the highest annual production. According to the data obtained, the country with the highest level of production is Cambodia with 7,925 kWh; The country with the lowest production was Afghanistan with 1,115 kWh. In terms of renewable production, Bhutan has the highest rate of 6,891 kWh; The lowest rate was found to be Brunei with 0,002 kWh.

Table 4. Group 4: Annual Total Electricity Generation of less than 1 Billion Kwh

COUNTRY	Total Annual Generation in Billion kWh	Total Annual Renewable Generation in Billion kWh
Macau	0,617	0
Maldives	0,608	0,003
French Polynesia	0,585	0,203
U.S. Pacific Islands	0,519	0
Palestinian Territories	0,340	0,001
American Samoa	0,163	0
Samoa	0,133	0,043
Solomon Islands	0,106	0,006
Vanuatu	0,070	0,010
Tonga	0,055	0
Cook Islands	0,042	0,011

Table 4 lists the countries with the lowest annual production in billion kWh from the country with the highest annual production. According to the data obtained, the country with the highest level of production is Macau with 0,617 kWh; The country with the lowest production was Cook Islands with 0,042 kWh. In terms of renewable production, French Polynesia has the highest rate of 0,203 kWh; The lowest rate was found to be Macau, US Pacific Islands, American Samoa and Tonga with 0 kWh.

4. RESEARCH METHODOLOGY

As the title suggests, the essential statistical analysis (i.e. mean, line chart, and bar charts) will be applied. In addition, clustering analysis and regression analysis will be done.

4.1. Clustering Analysis

Clustering is the task of dividing the population or data points into several groups so that the data points in the same group are more similar to other data points in the same group than in the other groups. basically, the goal is to separate and categorize groups with similar characteristics. There are many approaches used to cluster the data, but when the analysis is applied for clustering the countries hierarchical analysis seems to be the most appropriate method. The Traditional hierarchical algorithms use a similarity or distance matrix, in which it follows the following algorithm: Compute the proximity matrix, let each data point be a cluster Repeat Merge the two closest clusters, update the proximity matrix until only a single cluster remains. That can be expresses mathematically as;

Distance between pairs xi and xj, each containing p quantitative variables in equation.1:

$$d_{ij} = d(x_i, x_j) \qquad (1)$$

Minkowski Distance can be written as:

$$d_\lambda(x_i, x_j) = \left[\sum_{k=1}^{p} \left|x_{ik} - x_{jk}\right|^\lambda\right]^{1/\lambda}; \lambda \geq 1 \qquad (2)$$

Manhattan City-Block Distance (if = 1);

$$d_1(x_i, x_j) = \sum_{k=1}^{p} \left|x_{ik} - x_{jk}\right| \qquad (3)$$

Mahalanobis Distance is expressed by equation.4;

$$d(x_i, x_j) = D^2 = (x_i - x_j)' S^{-1} (x_i - x_j) \qquad (4)$$

SPSS software has been used to perform the hierarchical cluster analysis.

4.2. Estimation of Co_2 Emissions in Asia Region Countries from Renewable Electricity Generation Using Multiple Regression Analysis

In this study, a linear regression model was used to forecast the electricity generation for each renewable resource. Relationships between dependent and independent variables are analyzed in simple regression analysis. In the multiple regression analysis, there are situations in which the dependent variable is affected by more than one independent variable, as opposed to the simple regression analysis.

Mathematically, a model with multiple independent variables is expressed by equation.5 (Okutkan, 2014:14-26);

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon \qquad (5)$$

4.3. The Effect of Various Renewable Energy in the Gross Domestic Product

Correlation coefficient was used to examine the case. Correlation coefficient is a statistical index of the degree to which two variables are associated, or related. However, we can determine whether one variable is related to another by seeing whether scores on the two variables covary-whether they vary together. The correlation can be positive (Proportional relationship) or negative (Reverse relationship).

There are many kinds of correlation coefficients but the most commonly used measure of correlation is the Pearson's correlation coefficient (r) which range between +1 to -1. Pearson's correlation coefficient can be calculated as (Okutkan, 2014:14-26);

$$r = \frac{n(\sum XY) - (\sum X)(\sum Y)}{\sqrt{(n(\sum X^2) - (\sum X)^2)(n(\sum Y^2) - (\sum Y)^2)}} \qquad (6)$$

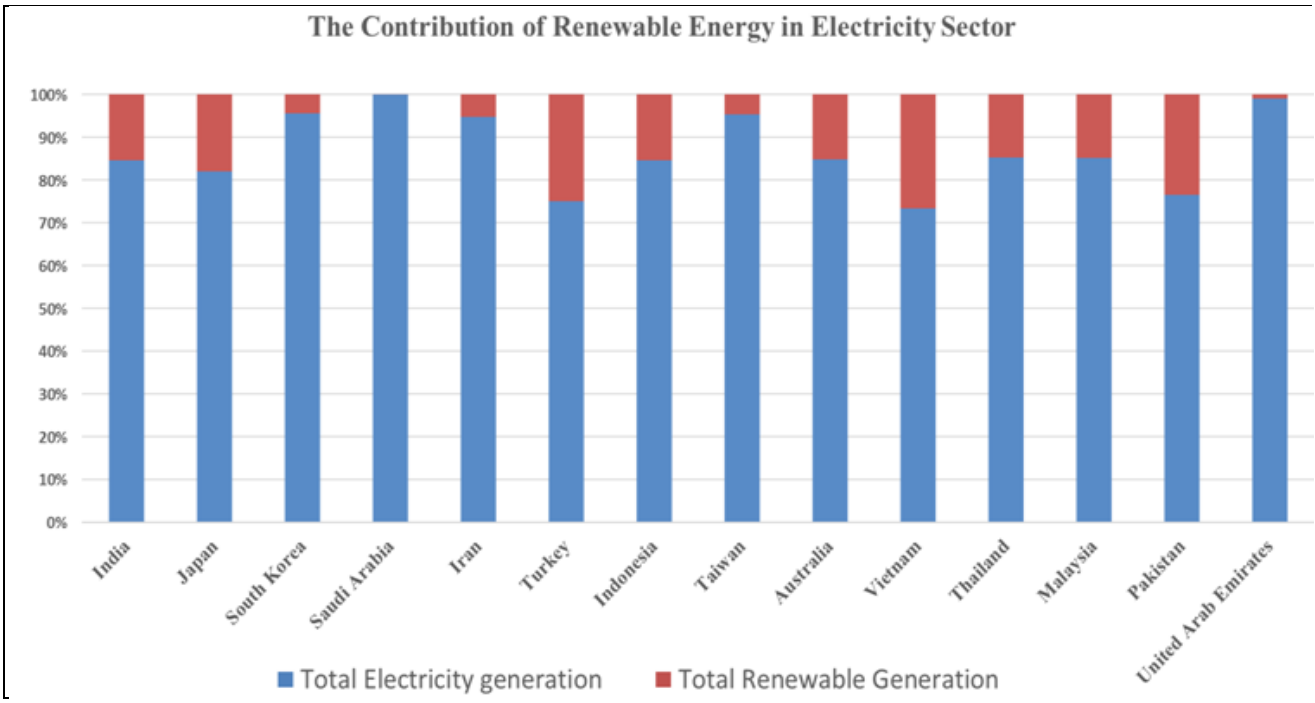
5. THE FINDINGS AND DISCUSSION

In this part of the study, "Simple Statistical Analysis", "Clustering Analysis", "Estimation of CO2 Emission and Multiple Linear Regression Analysis" and "The Affection of Renewable Energy in the GDP" will be covered respectively.

5.1. Simple Statistical Analysis

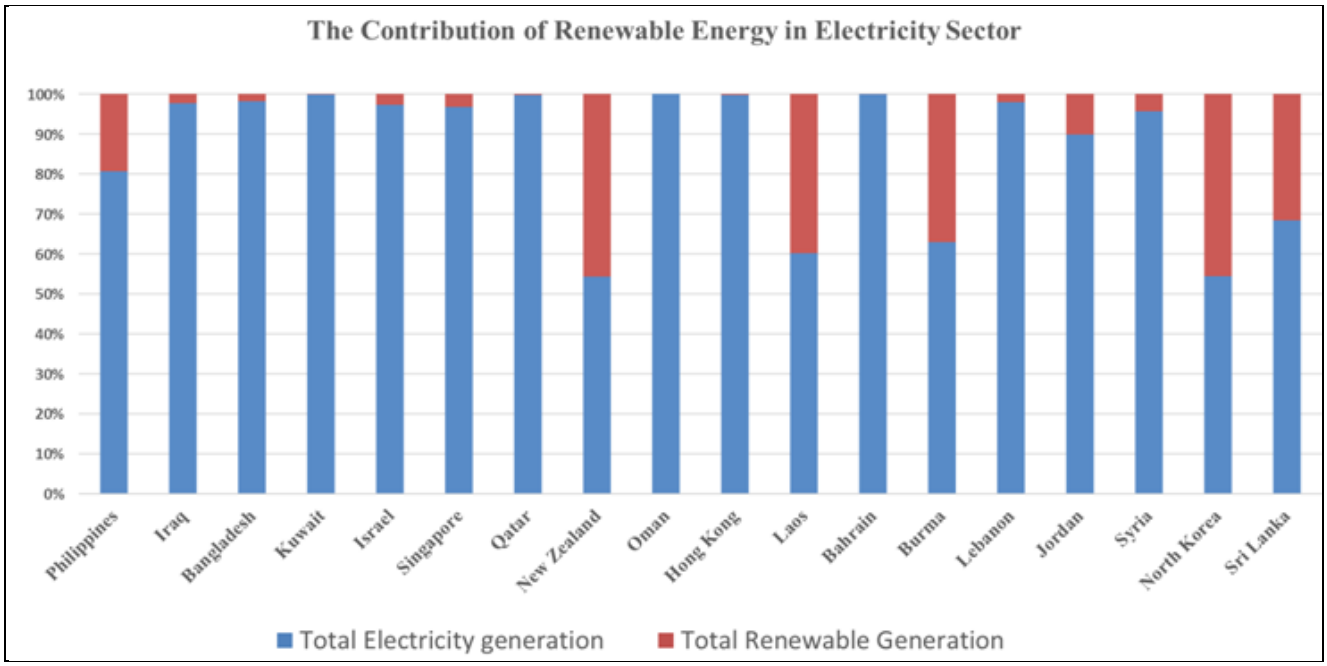
From the simple bar charts we can see that more than the half of the total electricity generation in New Zealand, Laos, North Korea, Bhutan, and Afghanistan is a renewable resource (Fig.1 and Fig.2).

Fig 1. Contribution of Renewable Energy in Electricity Generation for Group 1



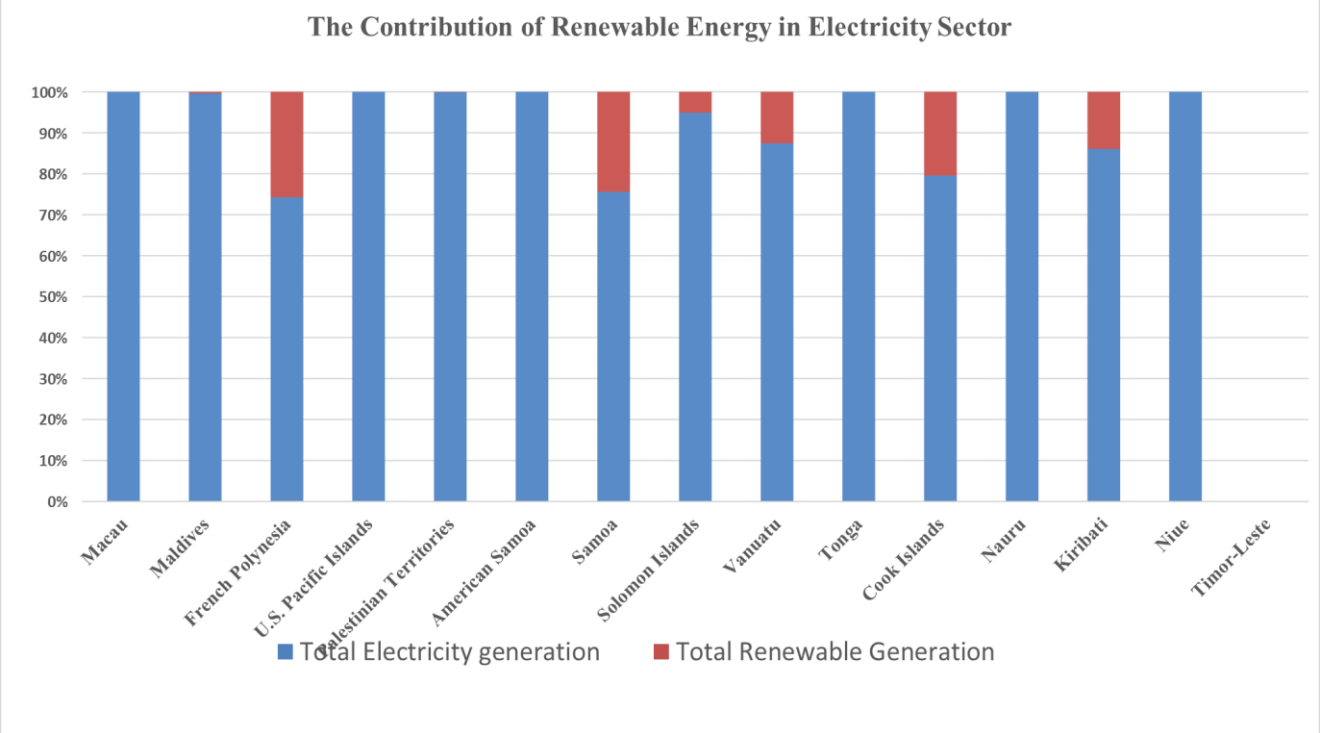
The explanation of that the high hydroelectricity that provided by the dams, in Afghanistan with the help of the International Community, the government of Afghanistan has been attempting to develop a new market oriented approach to the nationwide provision of electrical power since 2009 (Hallett, 2009:2847-2851). Newzland hydroelectricity comprises around 50% of its total electricity generation and it is working on a vision in which %100 of their local electricity generation will be from renewable source. The other mentioned countries depend on hydroelectricity to cover almost the half of their electricity demand.

Fig 2. Contribution of Renewable Energy in Electricity Generation for Group 2



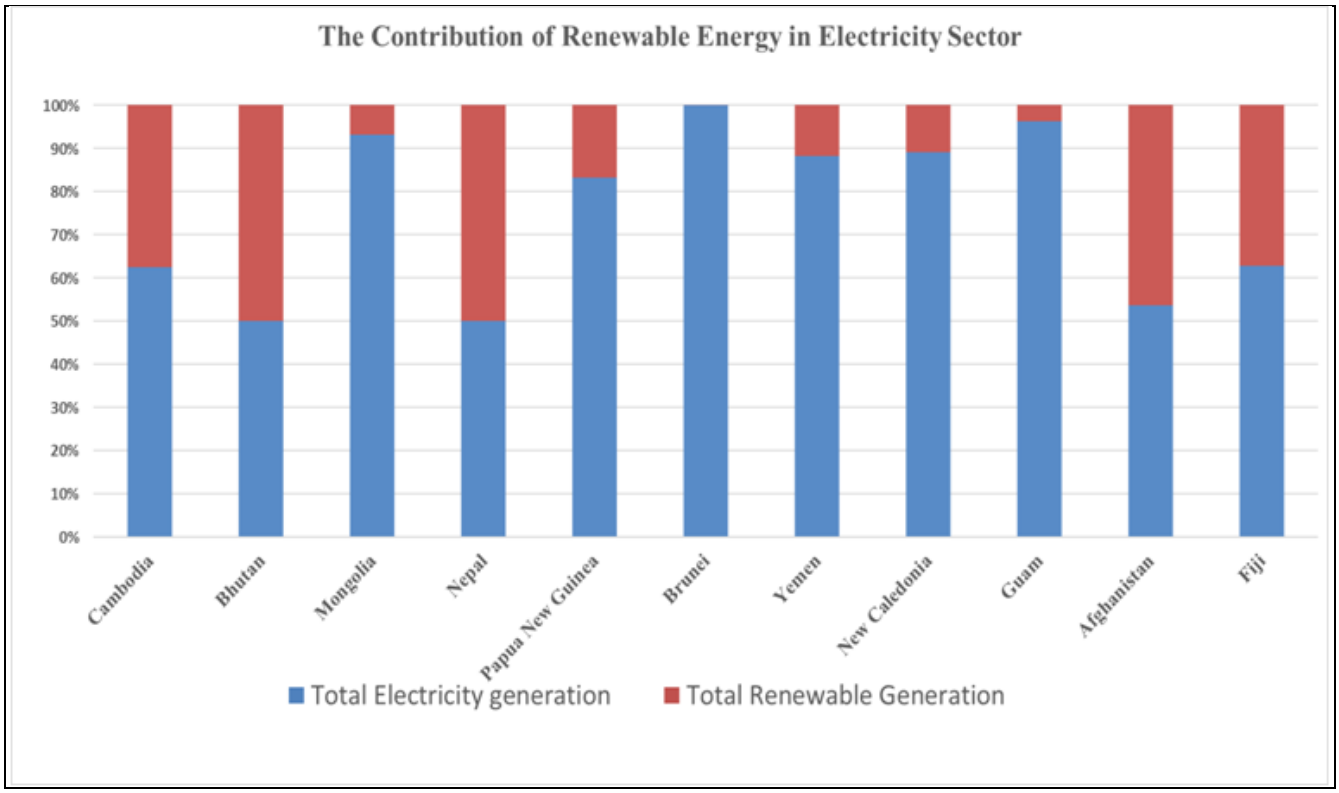
Countries like India, Japan, Turkey, Vietnam, Pakistan, Philippine, and Sri-lanka has relatively very high renewable electricity generation, even though their renewable resource is limited. That is a very clear indicator of the huge concern and the advanced technology that is used in these countries, it tells the hard efforts these countries are applying to drive their electricity to the maximum sustainability and mitigate the environmental impacts. In India, beside its huge hydroelectricity generation the production from non-conventional sources in India during 2013–2014 is about 53.22 billion units and the major contributors are wind and solar with 31.26 billion units and 3.35 billion units respectively which made annual growth in renewable energy up to 22%. Turkey has a relatively a good potential of renewable energy, but it has not begun to exploit this potential until recent years. Turkey is working on reducing the gas consumption by developing wind and solar electricity generation (Çelik et al, 2020:1-12). However, Pakistan and japan have the same scenario.

Fig 3. Contribution of Renewable Energy in Electricity Generation for Group 3



On the other hand, Arab Gulf Countries (*i.e. Saudi Arabia, United Arab Emirates, Kuwait, Bahrain, and Oman*) were seem to be not concern about renewable electricity in which renewable electricity comprises less than 5% of their total generation, and relentlessly consumption of fossil fuel. However, the reason of that is probably can be the availability and cheap price of fossil fuel, the lack of technology (*gulf countries has begun to develop in the last two decades*), or both. As a result, Arab Gulf countries has settled a vision of 2030 (Martin, 2020:24-27) in which renewable energy technology is one of the main agenda of it (Yamada, 2016:785-1141).

Fig 4. Contribution of Renewable Energy in Electricity Generation for Group 2



5.2. Clustering Analysis

Clustering analysis has been performed on the countries based on the renewable resource used. Since China has a very large exceptional electricity generation (more than 1.8 trillion) compared to the other Asian region countries, it was excluded to make the clustering analysis more accurate. The only dendrogram results is presented in this article, the proximity matrix is not studied here as it does not serve the study.

Fig 5. Clustering Analysis of Asia Region Countries Based on the Total Renewable Electricity Generation with the Exclusion of China Using SPSS Software

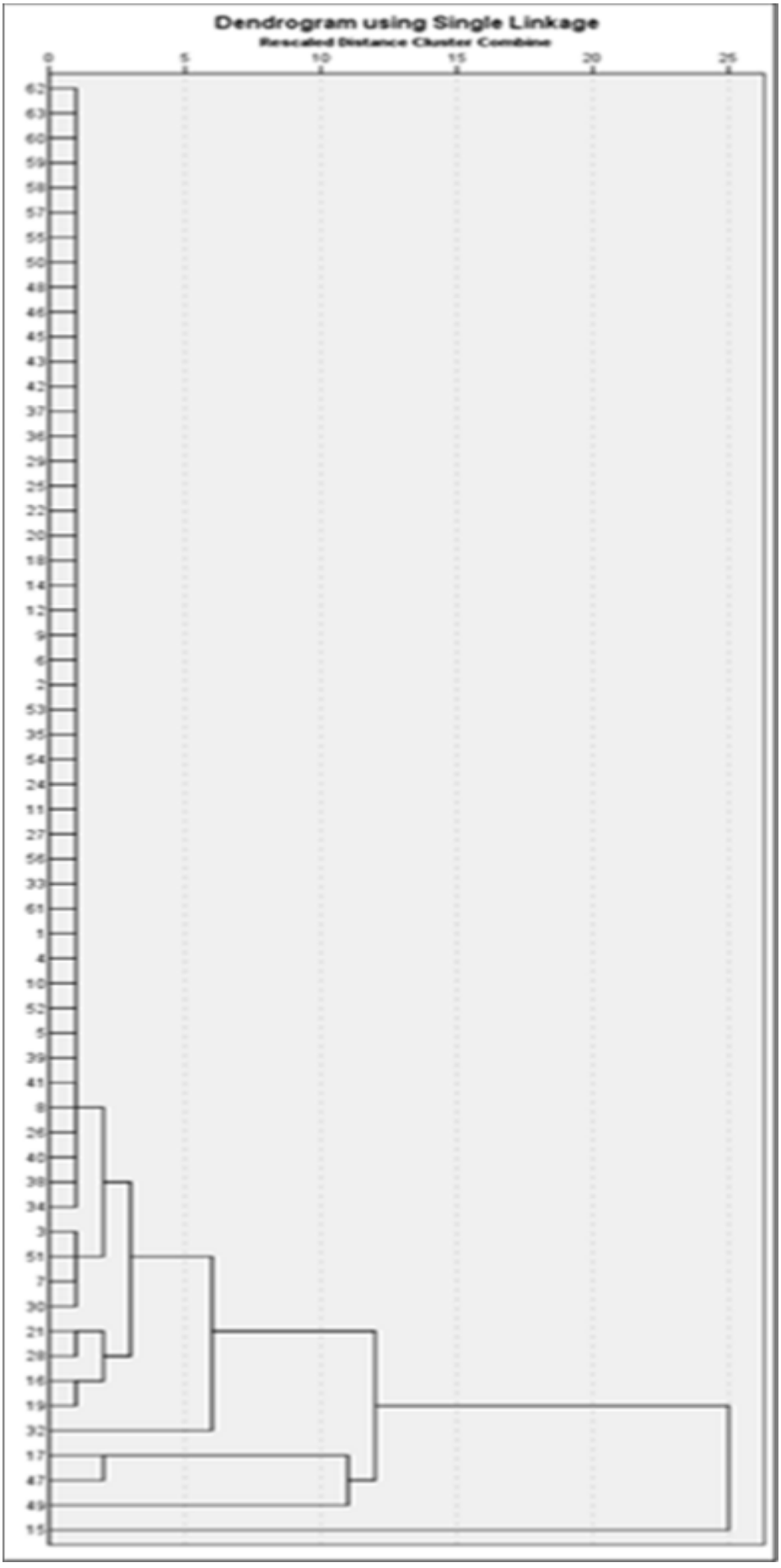


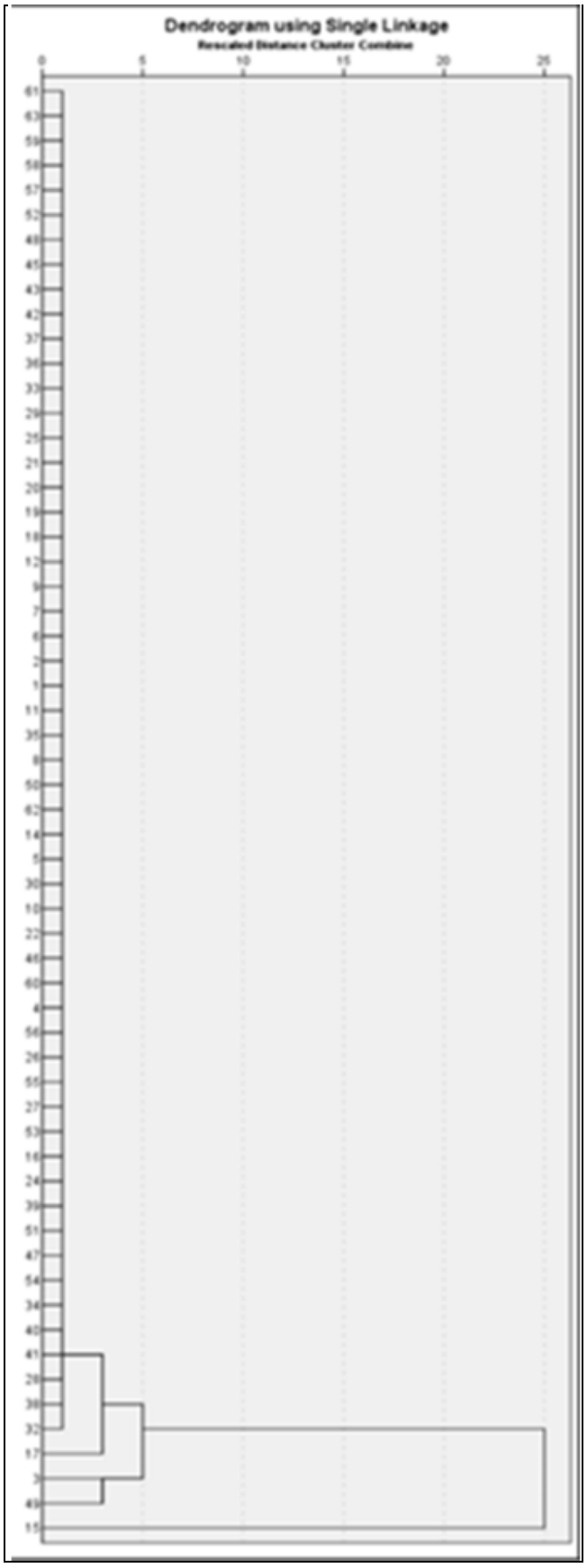
Figure 5 shows that countries are clustered into 7 clusters based on the total renewable electricity generation. Cluster 1 is the greatest generation in Asia region includes China, Japan, and India. The second Cluster is still considered an enormous renewable electricity generation. The gap between the first and the second clusters is the biomass electricity generation as it was explained further within this section.

Table 5. Countries Codes Used for Clustering Analysis

Afghanistan	1	Indonesia	16	Papua New Guinea	33	Turkey	49
American Samoa	2	Iran	17	Philippines	34	Bahrain	50
Australia	3	Japan	17	Samoa	35	s	51
Bangladesh	4	Kribati	18	Singapore	36	Iraq	52
Bhutan	5	Laos	19	Solomon Islands	37	Israel	53
Brunei	6	Macau	20	South Korea	38	Jordan	54
Burma	7	Malaysia	21	Sri Lanka	39	Kuwait	55
Cambodia	8	Maldives	22	Taiwan	40	Lebanon	56
Cook Islands	9	Mongolia	24	Thailand	41	Oman	57
Nuie	9	Nauru	25	Timor-Lrste	42	Palestinian Territories	58
Fiji	10	Nepal	26	Tonga	43	Qatar	59
French Polynesia	11	New Caledonia	27	U.S. Pacific Islands	45	Saudi Arabia	60
Guam	12	New Zealand	28	Vanuatu	46	Syria	61
Hong Kong	14	North Korea	30	Vietnam	47	United Arab Emirates	62
India	15	Pakistan	32	wake island	48	Yemen	63

The countries within the third, fourth, and fifth clusters are countries which started exploiting the renewable resources very recently such as Pakistan, Newzland, and Australia. These countries have great potential and they are in the process of the implementation of their vision in the renewable technology sector in which the average progress is around 2% annually (Zehedi, 2010:2208-2213).

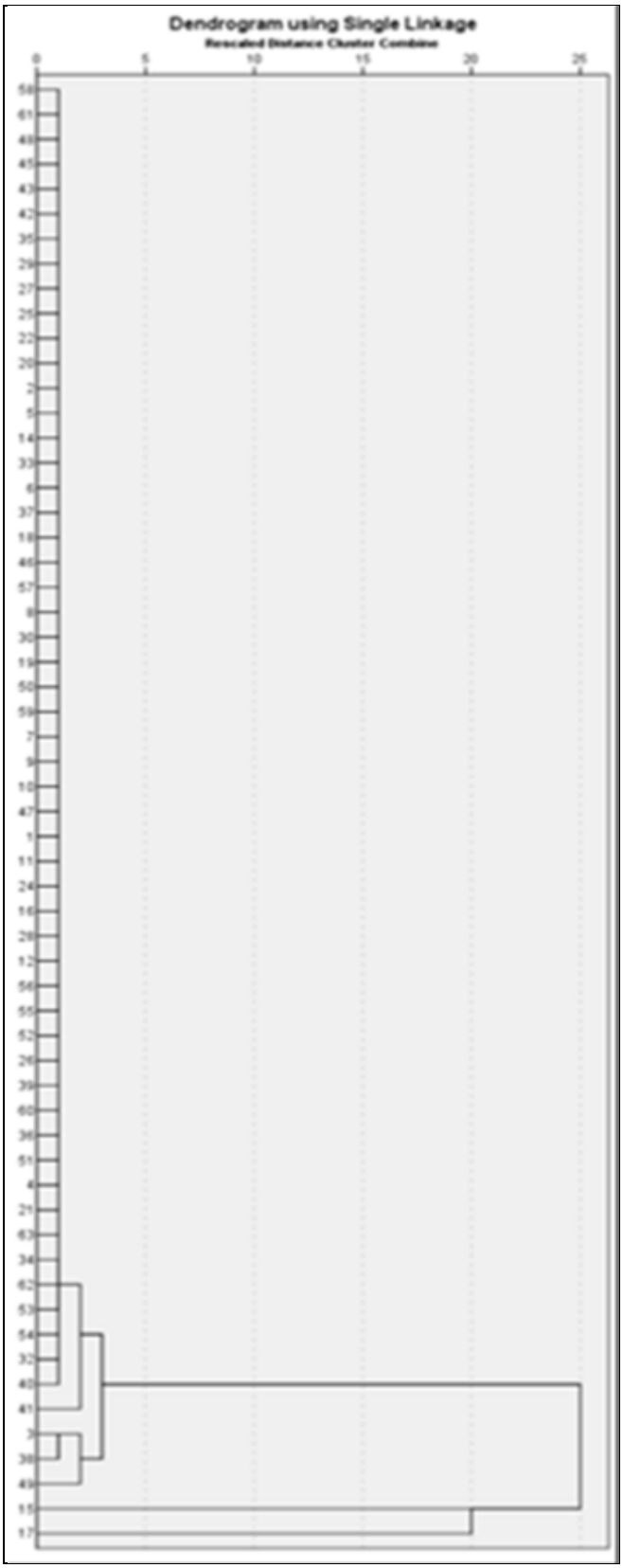
Fig 6. Clustering Analysis of Asia Region Countries Based on the Hydroelectricity Generation with the Exclusion of China Using SPSS Software



In hydroelectricity sector fig.6: Asia Region countries was found to be clustered into six groups. India and Turkey are taking the lead as the largest hydroelectricity producers. Both of India and Turkey has developed their renewable energy sources recently, and until now both of them are experiencing a tremendous growth in

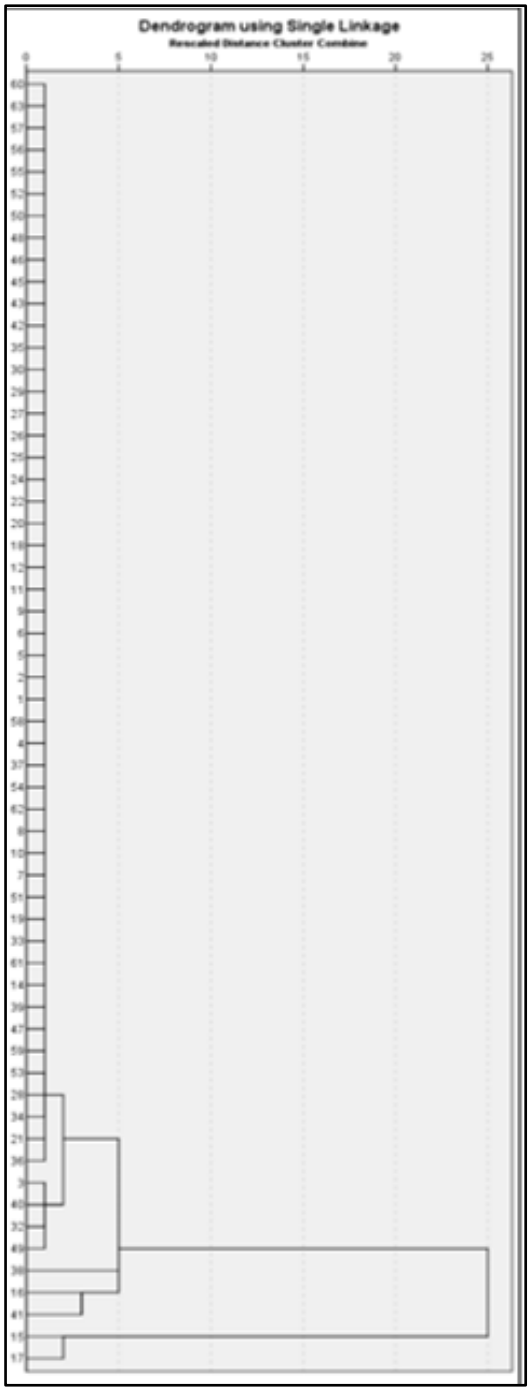
the renewable electricity sector (Sen et al., 2016:25-31; Şahin, 2020:52-62). Vietnam and Japan go along with Turkey. Indonesia, Newzland, Laos, and Malaysia make a group in which the hydroelectricity generation can be considered relatively high (20-30 billion kWh). All of the Arab Gulf countries are completely stripped of hydroelectricity, that is normal as Arab Gulf region has a very limited surface water resources due to the dessert climate.

Fig 7. Clustering Analysis of Asia Region Countries According to the Wind Generation with the Exclusion of China Using SPSS Software



Wind electricity sector: fig.7 shows that Asia Region countries are clustered into four clusters, just like the case in hydroelectricity India and Turkey are in the lead. Electricity generation through wind energy for general use in Turkey was first realized in Izmir in 1986 and further the utilization of wind energy in Turkey has significantly increased since 1998, in which a first big wind plant with 1.5MW (Hepbaşlı et al., 2004:257) was established all of that concern comes from the fact that Turkey has one of the largest potential of wind energy. Australia comes along with Turkey in wind electricity sector, this is a result of the renewable target (RET) program that aims to extend the RET targets to reach 120,000 GWh by 2030 (Valentine, 2010:3668-3675). In Japan The situation surrounding wind and other renewable energy changed dramatically after the Great East Earthquake and Tsunami and the subsequent Fukushima Nuclear Plant Accident in early 2011 (Mizuno, 2014:999-1018). In despite of the fact that Newzland was clustered in the cluster with the lowest energy generation, Newzland has a stunning wind electricity plants. These plants contribute by more than 10% of the total electricity generation within the country (Gholami et al, 2021). Just like the case for hydroelectricity, Arab Gulf countries are not exploiting their wind energy potential.

Fig 8. Lustering Analysis of Asia Region Countries According to the Biomass Generation with the Exclusion of China Using SPSS Software



Biomass electricity sector: fig 8 shows that Asia Region countries were clustered into five clusters. India and japan take the lead again and isolate in the first cluster. However, as it has mentioned earlier in this article Japan and India along with china are the top renewable electricity producers and the gap between this cluster and the second cluster in fig 5 is the biomass electricity generation. The second cluster in fig 8 comprises Thailand and Indonesia. South Korea isolated in the third cluster. Turkey shows a very low exploiting of biomass in electricity generation, agriculture remnant such as grain dust, crop scraps and fruit tree residues are very available in Turkey. Fuelwood seems to be one of the most interesting biomass resource due to its share of total energy production in Turkey is high by 21%. Moreover, the large human and animal dungs in Turkey can be exploiting perfectly to enhance the biogas electricity generation once that is done, Turkey can take the lead in the renewable sector not just in Asia region but even in the world.

Geothermal and tide-wave electricity sector: Fig 9 shows clustering analysis for Asia region countries based on geothermal and tide-wave electricity generation respectively. Indonesia is isolated in the first cluster in geothermal electricity followed with Philippines. Turkey and New Zealand are comprised within the third cluster, while Japan is isolated in the fourth cluster. The nature topography of Indonesia and Philippines makes both of the countries classified as the largest potential behinds the United States while Turkey comes in the fourth place.

Fig 9. Clustering Analysis for Asia Region Countries Based on the: a). Geothermal Electricity, b). Tide and Waves Generation, with the Exclusion of China Using SPSS Software

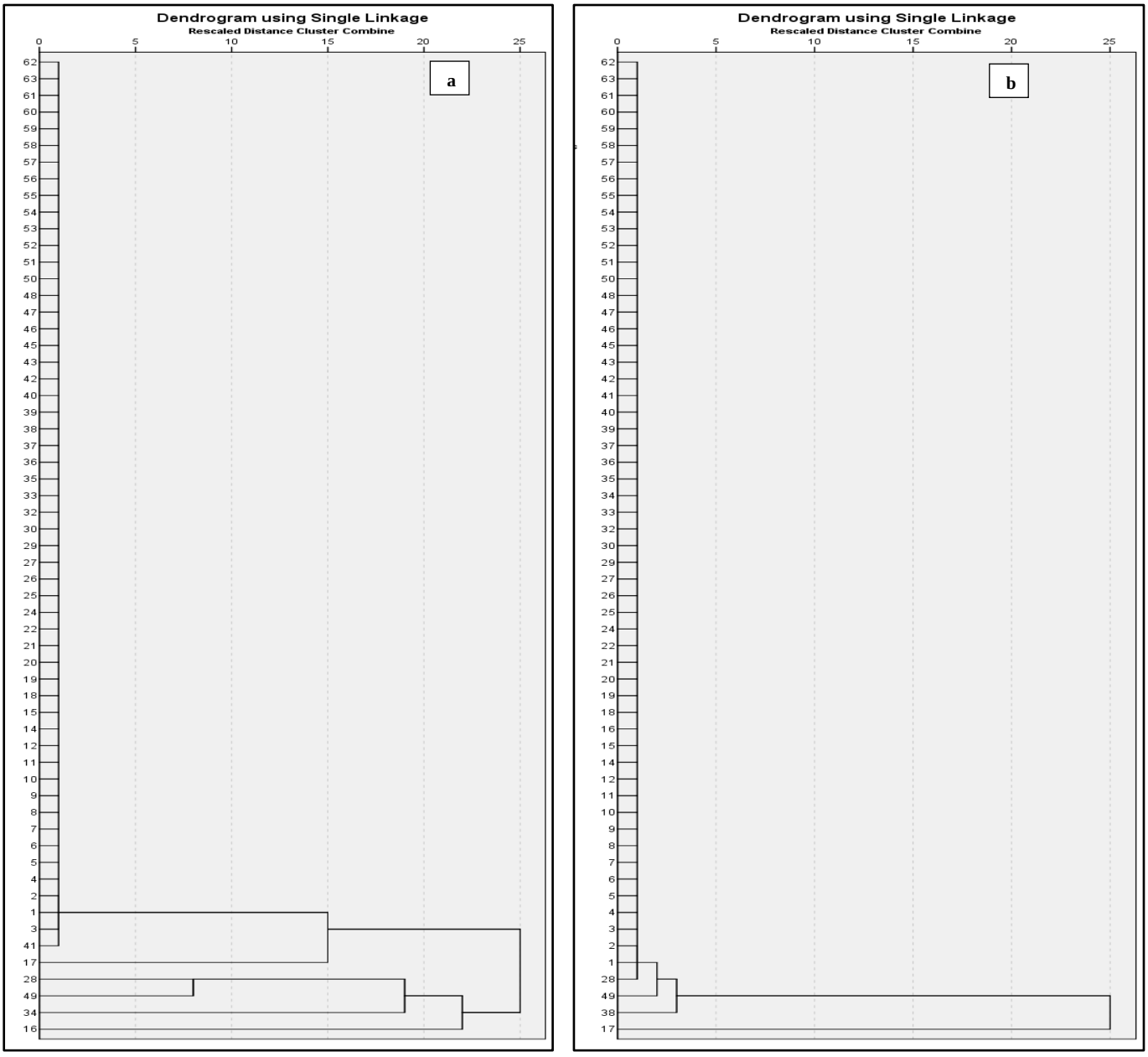


Fig 9 also shows four clusters of countries in wave-tide electricity generation. However, Japan, south Korea, Turkey, are isolated in the first, second, and the third clusters respectively. The rest of the countries were comprised by the fourth cluster.

5.3. Estimation of CO2 Emission and Multiple Linear Regression Analysis

A multifactor linear regression analysis was performed using SPSS software to estimate the Carbon Dioxide emissions using the various renewable electricity generation as independent variables. The data from the year 2019 was used.

Fig 10. The Model Summary of the Regression Analysis for CO2 Emission Using Various Renewable Electricity Generation Approaches

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,995[a]	,990	,989	148,88747

a. Predictors: (Constant), Tide and wave (billion kWh), Wind (billion kWh), Geothermal (billion kWh), Biomass and waste (billion kWh), Hydroelectricity (billion kWh), Solar (billion kWh)

b. Dependent Variable: CO2_Emission

Table 5. the values of R and R2 was found to be 0,995 and 0,990 respectively. This high values tell us that the regression model is very accurate and almost 99% of the CO2 emissions can be predicted using this model.

Fig 11. ANOVA Table of the Regression Analysis for CO2 Emissions Using Various Renewable Electricity Generation Approaches

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	116973466,9	6	19495577,81	879,467	,000[b]
	Residual	1174876,426	53	22167,480		
	Total	118148343,3	59			

a. Dependent Variable: CO2_Emission

b. Predictors: (Constant), Tide and wave (billion kWh), Wind (billion kWh), Geothermal (billion kWh), Biomass and waste (billion kWh), Hydroelectricity (billion kWh), Solar (billion kWh)

ANOVA Table 6 shows a significant value of 0.000, that means there is a significant impact from the independent variables (i.e. Renewable electricity generation) on the dependent variable (i.e. CO2 Emissions).

Table Fig 12. Coefficient of the Regression Analysis for CO2 Emissions Using Various Renewable Electricity Generation Approaches Using SPSS Software

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	51,888	21,856		2,374	,021
	Hydroelectricity (billion kWh)	3,116	1,379	,339	2,259	,028
	Wind (billion kWh)	-1,298	14,213	-,044	-,091	,928
	Solar (billion kWh)	33,290	28,854	,577	1,154	,254
	Biomass and waste (billion kWh)	15,066	8,968	,166	1,680	,099
	Geothermal (billion kWh)	5,479	9,611	,010	,570	,571
	Tide and wave (billion kWh)	-93,314	75,758	-,163	-1,232	,223

a. Dependent Variable: CO2_Emission

According to the significant values in Table 7, the coefficients of the modeled regression are valid only for the Hydroelectricity. The significant value of the constant is 0.021 which less than 0.05, thus it is consider valid too.

From the above discussion the linear regression model is expressed by:

$$\mathbf{Y_i = 51.888 + 3.116\, X_1 + \varepsilon} \qquad (7)$$

or:

$$\mathbf{Annual\ CO_2 Emissions = 51.888 + 3.116 \times The\ Anuual\ Hydroelectricity\ generation + \varepsilon} \qquad (8)$$

Where Annual CO2 emission in MMtonnes CO2 and Annual Hydroelectricity generation in billion kWh.

5.4. The Affection of Renewable Energy in the GDP

Correlation analysis was performed using SPSS software to examine the effect of the renewable electricity generation on the gross domestic product.

Fig 13. Correlation Analysis Table for GDP (Gross Domestic Product) Using Various Renewable Electricity Generation Approaches Using SPSS Software

Correlations

		Hydroelectricity (billion kWh)	Geothermal (billion kWh)	Tide and wave (billion kWh)	Solar (billion kWh)	Wind (billion kWh)	Biomass and waste (billion kWh)	GDP
Hydroelectricity (billion kWh)	Pearson Correlation	1	,004	,042	,953**	,993**	,894**	,942**
	Sig. (2-tailed)		,977	,749	,000	,000	,000	,000
	N	60	60	60	60	60	60	53
Geothermal (billion kWh)	Pearson Correlation	,004	1	,093	,002	-,016	,069	,082
	Sig. (2-tailed)	,977		,478	,986	,905	,602	,561
	N	60	60	60	60	60	60	53
Tide and wave (billion kWh)	Pearson Correlation	,042	,093	1	,309*	-,002	,339**	,176
	Sig. (2-tailed)	,749	,478		,016	,991	,008	,208
	N	60	60	60	60	60	60	53
Solar (billion kWh)	Pearson Correlation	,953**	,002	,309*	1	,949**	,970**	,966**
	Sig. (2-tailed)	,000	,986	,016		,000	,000	,000
	N	60	60	60	60	60	60	53
Wind (billion kWh)	Pearson Correlation	,993**	-,016	-,002	,949**	1	,897**	,949**
	Sig. (2-tailed)	,000	,905	,991	,000		,000	,000
	N	60	60	60	60	60	60	53
Biomass and waste (billion kWh)	Pearson Correlation	,894**	,069	,339**	,970**	,897**	1	,974**
	Sig. (2-tailed)	,000	,602	,008	,000	,000		,000
	N	60	60	60	60	60	60	53
GDP	Pearson Correlation	,942**	,082	,176	,966**	,949**	,974**	1
	Sig. (2-tailed)	,000	,561	,208	,000	,000	,000	
	N	53	53	53	53	53	53	54

**. Correlation is significant at the 0.01 level (2-tailed).

Table 8 shows the correlation analysis table. The value of Pearson coefficient (Pearson correlation) for GDP variable are 0.942, 0.966, 0.949, 0.974 with Hydroelectricity, solar, wind, and biomass respectively. However, that means there is a strong proportional association or relation between the GDP and the amount of electricity that generated by these renewables.

Fig 14. Correlation Analysis Table for GDP (Gross Domestic Product) Using Various Renewable Electricity Generation Approaches Using SPSS Software

Correlations

		Hydroelectricity (billion kWh)	Geothermal (billion kWh)	Tide and wave (billion kWh)	Solar (billion kWh)	Wind (billion kWh)	Biomass and waste (billion kWh)	GDP
GDP	Pearson Correlation	,942**	,082	,176	,966**	,949**	,974**	1
	Sig. (2-tailed)	,000	,561	,208	,000	,000	,000	
	N	53	53	53	53	53	53	54

**. Correlation is significant at the 0.01 level (2-tailed).

In Table 9 (which is part of Table 8), the significant values for Pearson correlation in Geothermal and tide-wave are not significant.

6. CONCLUSION

China, Japan, India, and Turkey have the lead in the renewable electricity generation sector in Asia Region. countries like Newzland, Laos, North Korea, Bhutan, and Afghanistan were found to be the countries with the highest renewable electricity contribution in their total local electricity generation (More than 60%). On the other hand, Arab Gulf countries found to have an infinitesimal exploitation of their renewable resources (less than 1%).

Only nine countries out of sixty-four countries in Asia Region are developed in the renewable electricity generation sector in which they have been clustered in the top five clusters. However, fifty-five countries out of sixty-four in Asia Region are found to be clustered in the least cluster in all of the renewable electricity sector with a very low renewable electricity generation.

Although the limitation in the resources, Japan was able to generate a tremendous renewable electricity and be the second largest produce in Asian region and the third in the world. That shows the exceptional technology that Japan has achieved in the last two decades.

According to International Renewable Energy Agency (IRENA), India is one of the top five countries in renewable technology in the world with over 100 research center of renewable energy. In this study, India was found to be in the first cluster in the clustering analysis for hydro, wind, solar, and biomass electricity generation.

The cluster analysis results were seven clusters, six clusters, four clusters, 5 clusters, five clusters, five clusters, and four clusters for Total renewable electricity, hydroelectricity, wind electricity, solar electricity, geothermal electricity, and tide-wave electricity generation respectively.

Multiple Regression Model was created to estimate the Carbon Dioxide Emissions of Asia Region country using the renewable electricity generation as independent variable. However, the value of the intercept and the hydroelectricity factor were found 51.888 and 3.116 respectively.

There is a strong proportional association between the GDP and the hydro, solar, wind, and biomass electricity generation. That can be explained as follow;

- Solar and wind produce electricity gives electricity with free fuel, and very little maintaining cost. That allows the country to use the fuel saved costs in profitable investments.
- Biomass is produced by wastes, in which the byproduct fertilizer can be sold as raw or used to enhance the productivity in agriculture sector.
- Using renewable sources to generate the electricity reduces the greenhouse gas emissions and some other toxic gases significantly and create clean environment, that results in better health and better physiological status among the civilians. However, that increases the productivity which causes an enhancement in the yield of the local products.

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