AN ANALYSIS OF THE ENERGY MIX IN PENINSULAR MALAYSIA IN LINE WITH MALAYSIA'S EXISTING ENERGY POLICY

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ABSTRACT

This paper considers dynamic changes to the energy mix available in Peninsular Malaysia with respect to Malaysia's energy policies and evaluates these on an experimental basis. This research applied a data mining approach, Self-Organizing Map algorithm, for trend cluster analysis time series data. The approach can provide a number of capabilities to uncover relationships between data attributes, uncover relationships between observations, predict the outcome of future observations and learn how best to react to situations through trial and error by using reinforcement learning. Based on the experiment, the test results have shown that the application is able to accommodate large sets of data and produce the expected trend lines in the graphs produced. In addition, a clearer picture of scenarios and the latest energy mix trend in Peninsular Malaysia was successfully obtained. It is shown that the Malaysian government should increase the execution of and improvement in the realization and implementation of energy policy in the country. Besides, Malaysia still has a long way to go in order to fully utilize renewable energy resources.

KEYWORDS: *Data mining; energy-mix; Malaysia's energy policies; renewable energy; Self-Organizing Map*

1.0 INTRODUCTION

The role of renewable energy (RE) as the fifth fuel in the energy mix has been highlighted since the Eighth Malaysia Plan (2001-2005). Shifting from a Four-Fuel Policy based on oil, gas, coal and hydropower to a Five-Fuel Policy with the addition of RE as the fifth source of fuel shows that RE is an absolute necessity for Malaysia. Many policies have been created to provide support to the development of the government's plan, but the extent to which all of these policies and acts have been applied or have boosted the development of RE until now is debatable. Thus, this circumstance needs to be analyzed in detail by reviewing the current policy for RE in Malaysia looking at various resources and published materials.

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Heretofore, most of the researchers are only conducting RE reviews (Alam, Omar, Ahmad, Siddiquei & Sallehuddin, 2013; Mekhilef, Bariman, Safari & Salam, 2014; Basri, Ramli & Abu bakar, 2014) by gathering all the information regarding RE in line with the imposed policies in order to analyze the implementation and development of RE in Malaysia. This type of review process may give some assistance in presenting coherent renewable energy scenarios in Malaysia nowadays but it has a limitation in terms of information available since the reviewing process does not involve any tools to support the results.

In contrast, if the reviewing method is run simultaneously with the data mining (DM) approach Self-Organizing Maps (SOMs) Algorithm (Kohonen, 2001), it may produce accurate scenarios concerning the connection between the policies and the RE mix trend in Malaysia. DM is an efficient technique for discovering valuable, non-obvious information from a large collection of data (Zhang, Jing, Zhang & Wang, 2009). In this research, the energy mix data was obtained from the Energy Commission (Energy Commision). These data consist of the main generation mix applied in Peninsular Malaysia, which includes Coal Steam Turbine (ST-Coal), Oil Steam Turbine (ST-Oil), Gas Steam Turbine (ST-Gas), Gas, Hydro, Distillate and Cogeneration.

2.0 RENEWABLE ENERGY IN MALAYSIA

2.1 Energy Prospect in Peninsular Malaysia

A considerable amount of literature has been published on RE. Most studies have examined RE in terms of technical aspects, such as Aghaei, Thayoob, Imamzani, Piyous and Amin (2013), in which the main purpose of that paper is to design an optimal electrical power generation system using solar energy in Pulau Perhentian Besar Island in Malaysia. In that paper, the authors demonstrated that the RE is capable of supplying the required electrical energy and can be an appropriate alternative energy source instead of using fossil fuel. Moreover, for the estimation of design cost, HOMER software is used to analyze the required solar panels, batteries and converters, which is dependent on the amount of solar radiation.

Akhwanzada and Tahar (2013) specifically conducted research into the RE area which objectively evaluated the capacity investments in the renewable power generation sector by using System Dynamics as the modeling and simulation technique. Solar photovoltaic and municipal solid waste were analyzed from 2012 to 2030 and gave an interesting result; details of the research can be found in Akhwanzada and Tahar (2013). All of the results have important policy implications for long-term energy planning in Malaysia. Husna et al. (2014) have published work in the RE technical area in which four different power generation technologies – nuclear, coal, natural gas and RE – have been used as the candidates for expansion.

This paper adopted an Evolutionary Programming technique in order to determine the optimum generation mix for Malaysia’s additional capacity and the authors concluded that the percentages for this optimal generation mix were coal with 67.90%, natural gas with 22.51%, nuclear with 8.21% and RE with 1.25% (Husna et al., 2014).

However, few researchers have focused on reviewing the latest scenarios concerning RE in Malaysia, especially in Peninsular Malaysia. For now, most researchers who review the latest RE scenarios only do so by gathering all the information based on the various sources and published materials from conferences, international journals and information released by relevant government bodies and miscellaneous resources regarding RE in line with the policies in order to analyze the implementation and development of RE in Malaysia.

Most published papers have focused on the ongoing RE projects. The subjects of these papers are, for instance, the current energy scenario in Malaysia (Ong, 2010), the latest overview of Malaysia's energy sector (Basri, 2014), the development of RE usage in Malaysia (Alam, 2013) and the RE policies in Malaysia (Mekhilef, 2014). These reviews provide clearer scenarios regarding RE in Malaysia nowadays. However, there is a limitation in terms of information available since the reviewing process does not involve any tools to support the results. Thus, it is necessary to establish further investigation into this area with the adoption of analysis tools such as the SOM.

Shahid, Minhans and Othman (2014) reviewed the current state of Green House Gas (GHG) emissions, the measures that have been initiated in Malaysia for GHG emissions reduction in the transportation sector, and the major technical and policy measures that can be adopted by using the data related to road vehicles and GHG emissions from road transportation. All the data were analyzed to reveal the present trends and possible future changes in GHG emissions due to government initiatives. The authors indicated that the present measures might not be enough to reduce GHG emissions up to the set target since the result showed that the rate of decrease has slowed down in terms of the deceleration of GHG emissions from Malaysia's transportation sector. Thus, the study concludes that Malaysia needs more prudent strategies for climate-friendly development of transportation to achieve sustainability goals.

Apart from the above paper, Basri et al. (2014) presented the latest overview of Malaysia's energy sector. The paper discusses the energy mix in Malaysia in detail, including natural gas, coal, hydropower, fuel oil, diesel and RE. The authors also observed the energy policy revolution and the power sector expansion strategy towards secure sustainability (Basri, 2014). From a comparison of historical energy consumption with long-term energy forecast, this study identified two key points in order to secure future power supply in Malaysia.

Firstly, consideration of new energy source, improvement of the energy policy, implementation of new energy policy and power expansion plan must be regularly revised in order to provide sustainable power generation and dependency on individual energy sources. Secondly, the diversification of energy sources in the energy mix is crucial to maintain stable energy production. The authors also stated that the development in the power sector was depicted and based on the current trend for demand and power production; Malaysia has a reserve margin that will only last for the next few years (Basri, 2014). Thus, Malaysia's government has to provide and prepare strategies to ensure sustainable and affordable power supply to support the growth of energy demand.

More recently, in 2014, a brief overview of the current status of RE and provided the RE policies in Malaysia was published. The authors reviewed the RE programs and the building energy efficiency program with green aspects (Mekhilef, 2014). Several programs have been launched by the government to support RE policies in Malaysia, such as the Small Renewable Energy Power Program (SREP) launched in 2001, the UNDP-

GEF Biomass Power Generation & Demonstration (Bio Gen) project launched in 2002 and the Malaysian Building Integrated Photovoltaic (MBIPV) Project (UNDP-GEF) launched in 2005 (Mekhilef, 2014). In addition, Alam et al. (2013) highlighted the development of RE usage in the world, especially in Malaysia. Some initiatives were taken by the government and private sector in order to nurture the development of sustainable energy in Malaysia.

In 2010, Malaysia's population was 28.3 million people and it is growing at a rate of 1.9% per year, which is estimated to reach 31.6 million in 2020 (Siwar, Ahmed & Begum, 2013). Economic development will be affected by the growth of population, urbanization and industrialization, which leads to an increased demand for energy. Malaysia requires an efficient use of energy to diversify energy sources and ensure waste minimization.

Therefore, Malaysia needs to achieve an establishment of safe, reliable and cost-emphasized energy in line with the requirements of future energy demands. Electricity demand in Malaysia is growing in tandem with its Gross Domestic Product growth. Based on the Akademi Sains Malaysia (ASM) Advisory Report (2013) the growth in electricity showed an increment of 3.7% in 2012 compared to 3.2% in 2011, and it was driven by strong demands from the commercial and domestic sectors.

Meanwhile, the average projected demand for electricity is expected to grow at 3.2% for the period until 2020. Based on this prediction, Malaysia is going to need even more electrical energy as it attempts to achieve high-income economy status. As shown in Figure 1, 91% of the energy demand in Malaysia comes from Peninsular Malaysia alone; the study demonstrated that Peninsular Malaysia needs more diverse energy sources compared to Sabah and Sarawak areas (Yahya, 2014).

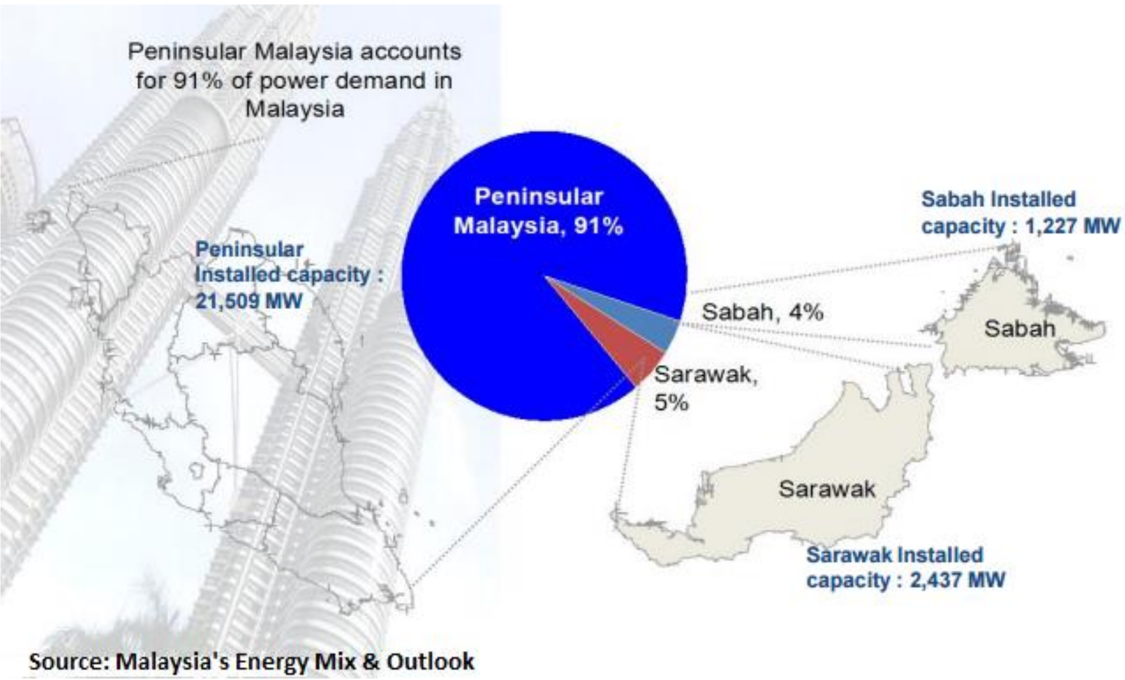

Figure 1. Demand for power in Malaysia (Yahya, 2014)

Many studies on RE in Malaysia have only applied a reviewing process by gathering all the information regarding their interest scope without comparing the information using any analysis tools to support and validate the result. Hence, this research aims to give a new perspective on RE scenarios in Malaysia by also combining the reviewing method with DM to provide analytical scenarios of Malaysia's RE concerning the connection between the policies and the RE mix trend recently implemented in the country.

2.2 Malaysia's Energy Policies

As Malaysia moves towards being a developing country, energy becomes an important contribution to the rapid growth of its economy. Thus, energy consumption will increase accordingly. In order to meet the growth in energy demand, an intensive effort has been introduced to strengthen the security and stability of energy supplies. The consumption of energy has a negative effect on the climate and environment. Therefore, some awareness of the sustainable use of energy in Malaysia has been advocated. In line with these scenarios, Malaysia has formulated a National Energy Policy which consists of three objectives (Yahya, 2014):

i. Supply objective: to ensure the provision of an adequate, secure and cost-effective supply of energy.
ii. Utilization objective: to promote efficient utilization of energy and to discourage wasteful and non-productive patterns of energy consumption.
iii. Environmental objective: to minimize the negative impacts of energy production, transportation, conversion, utilization and consumption on the environment.

Malaysia's energy policies try to inspire RE in the country's energy mix by tackling technological barriers, decreasing associated costs and addressing market failures. These policies are well-organized directly by the country's prime minister. A few policies have been undertaken by the Malaysian government to ensure sustainable energy in the future. The energy policies adopted by Malaysia and the main objective for each policy since 1975 are presented in Table 1 (Mekhilef et al., 2014; Yahya, 2014; Basri et al., 2014)

The improvements in energy policy and elaborate future plans made by energy suppliers and the energy commission are making a contribution to the encouraging progress in the energy sector. Improvements in Malaysia's energy policies have grown over the years since the 1973 world oil crisis. The policies guiding the energy-related activities in Malaysia were illustrated in Table 1 (Basri et al., 2014). Malaysia established energy policies at the right time where in the 1970s oil prices were high coupled with the discovery of oil wells in Peninsular Malaysia.

A National Petroleum Policy was developed in 1975 followed by a comprehensive and significant National Energy Policy in 1979 with three primary objectives: supply, utilization and environment, where each of the primary objectives had its own specific goal, as listed in Table 1. Moreover, with the main goal being to lengthen the life span of the nation's oil and gas reserves, the National Depletion Policy was developed in 1980. After that, the Four-Fuel Diversification Strategy created in 1981 was implemented, with the aim to ensure reliability and security of supply through diversification of fuel (oil, gas, hydro and coal).

Table 1. Summary of energy policies
(Mekhilef et al., 2014; Yahya, 2014; Basri et al., 2014)

Malaysia's Energy Policies	Main Objective
(a) National Petroleum Policy (1975)	i. Efficient utilization of petroleum resources ii. Ensuring the nation exercises majority control in the management and operation of the industry
(b) National Energy Policy (1979)	i. Supply Objective: To ensure adequate, secure and cost-effective energy supply ii. Utilization Objective: Promote efficient utilization of energy and eliminate wasteful and non-productive usage iii. Environmental objective: Minimize negative impacts on the environment
(c) National Depletion Policy (1980)	i. To prolong the life span of the nation's oil and gas reserves
(d) Four-fuel Diversification Policy (1981)	i. Aimed to ensure reliability and security of supply through diversification of fuel (oil, gas, hydro and coal)
(e) Five-fuel Diversification Policy (2001)	i. Encourage the utilization of renewable resources such as biomass, solar and mini hydro ii. Efficient utilization of energy
(f) Renewable Energy (RE) Policy & Action Plan (2009)	i. Outline the major strategies to promote RE in the country. A main highlight is the Feed-in-Tariff (FiT) mechanism
(g) New Energy Policy; under the Tenth Malaysia Plan (2010)	i. Further step to encapsulate all efforts to ensure economic efficiency and security of energy supply ii. To meet the social and environmental objectives in National Energy Policy of 1979

Subsequently, the Five-fuel Diversification Policy, developed in 2001, was created with the main objective being to encourage the utilization of renewable resources such as biomass, solar and mini hydro. This step was taken because the burning of fossil fuels (coal and oil) and natural gas may significantly contribute to the emission of GHG from their combustion; hence, raising the climate change issue. Thus, in addition to the Five-fuel Diversification Policy, the government signed the Kyoto Protocol in September 2002.

The Renewable Energy Policy and Action Plan, developed in 2009, was purposely set up in order to outline the major strategies to promote RE in the country with a main highlight being the Feed-in-Tariff (FiT) mechanism. Finally, with the goal of setting up an additional step to encapsulate all efforts to ensure economic efficiency and security of energy supply, the New Energy Policy under the Tenth Malaysia Plan was created.

This policy was also purposely created in order to meet the social and environmental objectives in the National Energy Policy of 1979. As elaborated in the previous section, high reliance on oil is decreasing gradually in Malaysia since the oil and gas price is too volatile nowadays, as illustrated in Figure 2 (Plus500UK Ltd). Thus, awareness regarding energy security and climate change is leading the Malaysian government to make significant changes in their energy policy.

Figure 2. Price for oil and gas in the world

By introducing the Five-Fuel Diversification Policy, it shows that RE is one of the main and important fuels for power generation nowadays. Nonetheless, to-date, no published researches have conducted their analysis coupled with analysis tools in order to reinforce the facts in their published papers. Therefore, if the reviewing methods were run simultaneously with trend mining using SOMs (Nohuddin, 2012), this method could assist in analyzing and investigating the facts and at the same time produce accurate scenarios concerning the relationship between the policies and the recently implemented RE mix trend in Malaysia.

3.0 METHODOLOGY

The growth of available data in the electric power industry motivates the adoption of the DM approach. Grigoras and Scarlatache (2015) successfully adopted the DM approach by demonstrating an assessment of the RE potential in Romania using a clustering method. The authors applied the K-Means clustering algorithm in order to map the information into the representative zone for the research analysis. Moreover, a study by Chou, Hsu and Lin (2014) showed that DM techniques can be adopted to predict accurate and efficient results for coefficient of performance in the liquid leakage phase by applying the Artificial Neural Networks (ANNs) algorithm.

In the vapor leakage phase, the best model is the Generalized Linear Regression model (Chou et al., 2014). Additionally, Zhang et al. (2009) proved that DM is an effective technique in solving the fault analysis problem. This paper mainly used cluster analysis to resolve quickly and preciously detect fault components and fault sections, and finally accomplish fault analysis.

The DM approach has been developed as a branch of applied Artificial Intelligence (AI) since the 1960s. In the literature, there are many tools available for DM, but the most prevalent are classification methods, cluster analysis, search for association rules, time series analysis, aggregation and approximation methods, dependency analysis, and prediction analysis (Chou et al., 2014, Nohuddin, 2012). Its broad applications include marketing, healthcare, electrical engineering, and many others (Chou et al., 2014; Shaheen & Khan, 2016, Nohuddin, 2012, Grigoras & Scarlatache, 2015; Zhang et al., 2009).

In addition, Grigoras and Scarlatache (2015) comprehensively reviewed DM applications for clustering purposes. Even though a few papers have successfully applied DM in the electrical energy field, DM is rarely applied in energy field research review papers, particularly in papers analyzing the scenarios. Thus, this research was conducted to simultaneously compare the reviewing method with the trend mining technique using Self-Organizing Maps (SOMs) (Nohuddin, 2012). The aim of this experiment is to produce analytical scenarios concerning the relationship between the policies and the RE mix trend in Malaysia.

3.1 Self-Organizing Map

SOM is an unsupervised clustering technique in DM. SOM has been utilized in many research areas. For example, the most promising fields of application for SOM are visualization of statistical data and document collection, process analysis, diagnostics, monitoring, and control, data analysis in commerce, industry, macroeconomics, and finance, and biomedical application including diagnostic methods and data analysis in bioinformatics. Generally, SOMs are designed to reduce the number of data dimensions in some input space by projecting the data onto a *n x m* “node map" with groups of clusters of similar data items together at nodes. The *n x m* number of nodes in the SOM must be specified even if the SOM learning process is unsupervised. Currently, there is no scientific method for determining the best values for n and m. But, the *n x m* values do define a maximum number of clusters, although on completion some nodes may be empty. Firstly, the weight vectors are adjusted using a random number generator. Then, record by record, the algorithm processes the input data and at the same time, for every record, each node “bids" for the record and the record is assigned to the “winning" node. This is done using a distance function. The most common distance function is the Euclidean distance function (Kohonen, 2001), as given in Equation (1):

$$d = \sqrt{\sum_{i=1}^{n}(x_i - y_i)^2} \tag{1}$$

where x_i is the i^{th} value of input data and n is the number of dimensions in the input data. The winning node is chosen randomly if there are two or more weight vectors with the same shortest distance. Then, the algorithm adjusts the neighboring weights of the winning node to reflect the nature of the most recently assigned record. The mathematical function used in this calculation is based on the Gaussian function, as expressed in Equation (2). The magnitude of the adjustment is decreased as the distance from the current node increases (Kohonen, 2001).

$$h_{j,i(x)} = e^{\frac{d_{j,i}^2}{2\alpha^2}} \tag{2}$$

Thus SOM generation is an iterative process; it uses a learning function that decreases with a learning rate ranging between 0 and 1. As the algorithm iterates, it updates and tunes the neighborhood weights with new values. This adaptive process is based on the function , as given in Equation (3) (Nohuddin, 2012):

$$\omega(t+1) = \omega(t) + \alpha(t)\big(x(t) - \omega(t)\big) \tag{3}$$

where ω is the selected “excited" weight in the set of topological neighbors, α is the learning rate in the learning process and t is the current iteration counter. Lastly, a complete map will be produced representing the records in terms of a set of prototypes with one prototype per node. With respect to the work described in this paper, a SOM approach has been adapted to group similar trends, and thus provide a mechanism for analyzing and validating the recent connection between the policies and the energy mix trend in Peninsular Malaysia. Thus, the future prospects of power generation via RE development for the country were examined.

As discussed in the previous section, there are many tools available for DM, but in this research the prominent tool applied is trend mining. SOM Trend Clustering is an application for clustering time series data. The application is competent to cluster and display the time series data into trend bar charts, and also identify trend variations in time series data. The system can process a large number of records as well as smaller data sets. Even though a few papers have successfully applied DM in the electrical energy field, no review papers have conducted their analysis coupled with using analyzing tools in order to reinforce the facts in their published paper. Therefore, adding an analysis using the DM technique adds value to this research.

4.0 RESULTS AND DISCUSSION

In this section, the experimental results are presented and analyzed. A large amount of data is used to evaluate the proposed SOM Trend Clustering. The simulated data were collected from the Energy Commission (EC), Peninsular Malaysia Grid System Operator Website (PM-GSO) (Energy Commision). Daily energy generation mixture with the seven components includes Coal Steam Turbine (ST-Coal), Oil Steam Turbine (ST-Oil), Gas Steam Turbine (ST-Gas), Gas, Hydro, Distillate and Cogeneration data are presented.

The trend mining technique mainly involves three different modules as below:

a) Normalization Data
This module converts data attributes into smaller number ratio. The data are normalized to be values between 0 and 1. Thus, the data format conversion maintains the nature of the data while at the same time permitting the application of SOM algorithms.

b) Organization Data
The data file is organized according to the specified data dimension format where each of the columns represents each of the components; in here the components comprise Coal Steam Turbine (ST-Coal), Oil Steam Turbine (ST-Oil), Gas Steam Turbine (ST- Gas), Gas, Hydro, Distillate and Cogeneration.

c) Clustering Data
This is the identification of some mechanisms whereby the anticipated large number of identified trends could be grouped so as to facilitate understanding. The intention here was to use some form of SOM to achieve the desired clustering. In this research, the 365 data records were grouped into clusters based on similarity equation and clustering were made based on similar energy component mixture or structures. The clustering process involved two processing steps, namely:

SOM Trend Clustering:
This identifies how many types of trend lines exist within the time series data. These trend lines show the type of time series data, such as increasing and decreasing lines, according to the overall time series data.

Trend Cluster Analysis:
This investigates the details of each trend line cluster identified in SOM trend clustering. It also displays a bar chart indicating number of data records contained in each trend line cluster. Therefore, it is possible to track which data records belongs to which trend line clusters.

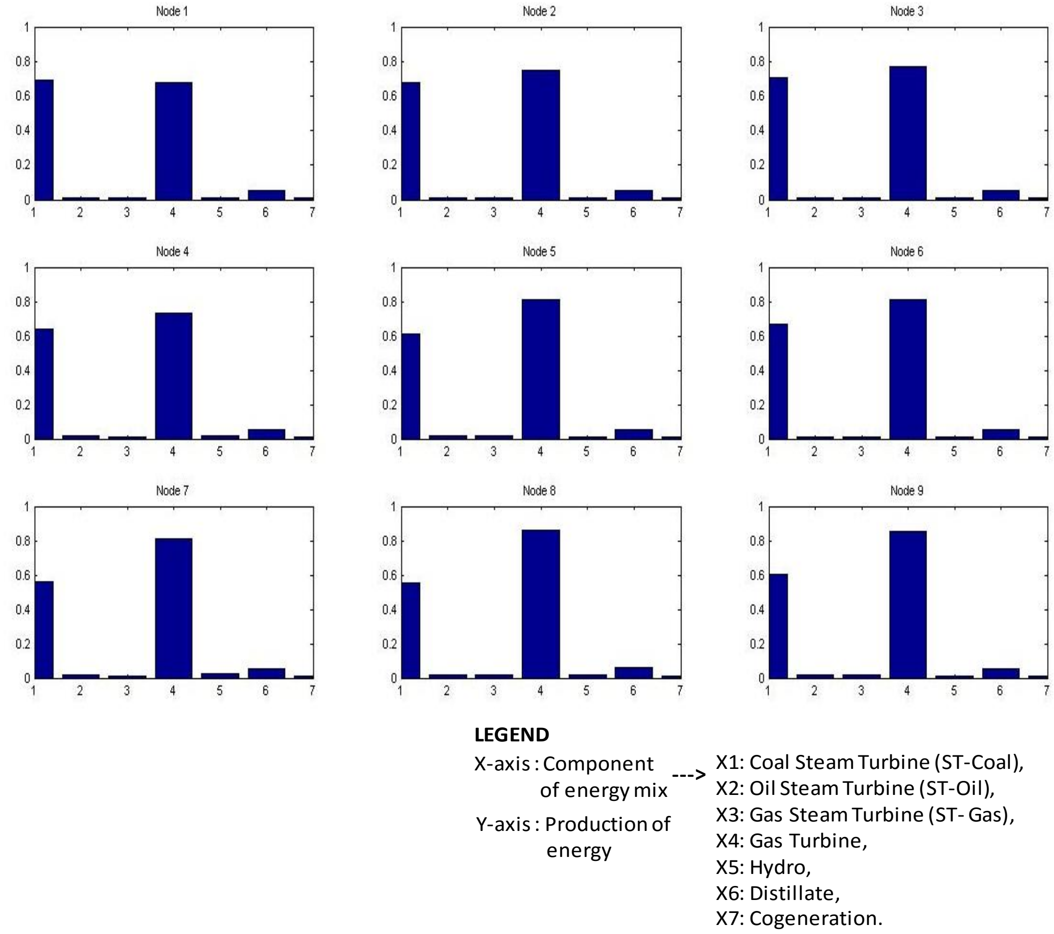

Figure 3. Cluster maps

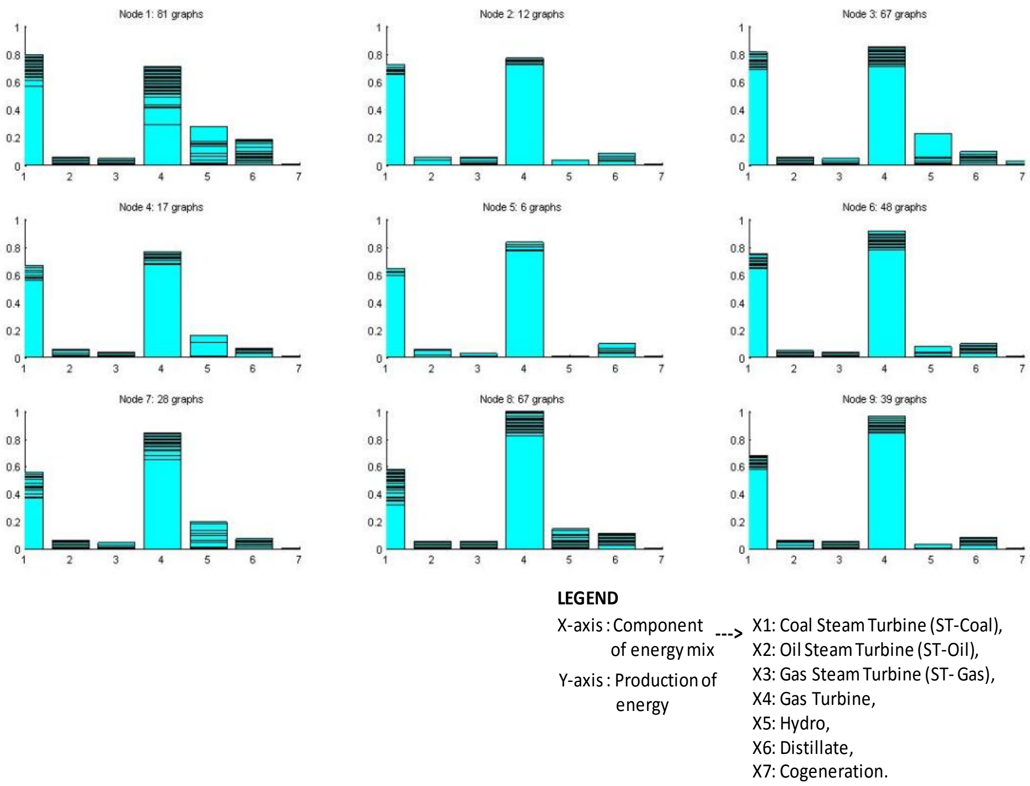

Figure 4. Cluster members' bar charts

The bar charts shown in Figure 3 are the numbers of trend bars which represent the type of component or cluster usage for each day represented by 9 cluster nodes. Based on this figure, the higher energy productions came from the combination of Coal Steam Turbine and Gas Turbine. Figure 4 represents an analysis of each cluster member. Each cluster node has an indicator of how many days there are in it; from here, the results verify that the combination of energy mix in cluster node 1 and cluster node 8 has the highest numbers of days. Thus, at the same time, this result shows that the combination of Coal Steam Turbine and Gas Turbine is the preferred combination of energy generation in Peninsular Malaysia produce in 2014.

Table 2 shows the power production of different fuel type provided by TNB and IPP. The whole power production amounted to 18,542MW. Accordingly, steam turbines for oil and gas are rarely used because they are specifically used for a small plant. This type of power generator normally uses coal, oil or gas as the fuel to heat a boiler, and hence run the turbine to generate the electricity. The value of gas generation displayed in Figure 4 was totally generated by the Gas Plant, which is known as an Open Cycle Gas Turbine (OCGT) or Combined Cycle Gas Turbine (CCGT).

Moreover, distillate generation normally uses a certain standard fuel and is quite expensive. This type of generator is usually avoided by producers unless there is no other option. It can be seen that the Coal Steam Turbine was the most favorite type of generator in producing the energy for Peninsular Malaysia on 28th September 2015 since it has the highest value of energy production compared to the other types of power generation in the list. These values only represent one day of energy mix in Peninsular Malaysia; thus, in order to obtain a clear picture of the recent energy mix scenarios, the whole year's data need to be analyzed. The results from the data processing were compared with the latest raw data for the energy mix applied in Peninsular Malaysia (Energy Commision) relating to the energy policies in Malaysia in order to achieve the main objective of this paper: to analyze the RE policy in Malaysia using the unsupervised DM algorithm.

Table 2. Daily power production of energy mix on 28th September 2015 (Energy Commision)

TYPE	POWER PRODUCTION (MW)
ST-Coal	3,080
ST-Gas	0
ST-Oil	0
Gas	3,848
Hydro	1,732
Distillate	0
Total TNB	8,660
Total IPP	9,882
Total Co-Gen	0
Total System	**18,542**

Table 3 shows that distribution of fuel type of power generated provided by TNB and IPP. There is a small amount (0.47%) of power generated by co-generation system. The total power generation of the energy mix is close to 323,943 MWh. Based on the information explained in Section 2, it has been verified that, even though the Malaysian government has developed a few policies since 1975 to ensure sustainable energy in the future, the process of implementation is still lacking.

Referring to the data collected by the Energy Commission (Energy Commision), the value of energy produced from Hydropower was still very low compared to Coal Steam Turbine and the other sources of power generation in the list. This fact was further strengthened by comparison with the result in Section 4; data experiments using SOM Trend Clustering technique were adopted in order to obtain accurate and indisputable analytical results. The results showed that the Coal Steam Turbine and Gas Turbine are the two most common means of energy generated in Peninsular Malaysia for the year 2014. Thus, it is proven that RE sources in Malaysia still produce very little energy and are not the preferred type of energy generation in Peninsular Malaysia.

Table 3. Daily generation mix on 28th September 2015 (Energy Commision)

TYPE	POWER (MWh)	PERCENTAGE (%)
ST-Coal	68,864	21.20
Gas	67,713	20.85
Hydro	10,322	3.18
Total TNB	**146,899**	**45.23**
ST-Coal	74,626	22.98
ST-Gas	3,295	1.01
Total IPP	**175,502**	**54.04**
Co-Gen	1,542	0.47
Total Co-Gen	**1,542**	**0.47**
Total Generation	**323,943**	**99.74**

5.0 CONCLUSION

The growth of available data in the electric power industry motivates the application of DM techniques. The ability of human operators to analyze large databases manually has been greatly exceeded. Since computers allow the storage of more data, it is only natural to resort to computational techniques to help in discover meaningful patterns and massive structures for large volumes of data. In these conditions, it is necessary to automate the information (knowledge) discovery to assist the human operator.

Thus, this research has combined two methods: reviewing all the latest publications regarding the RE and energy policies in Malaysia then analyzing the data gathered from the process with the SOM Trend Clustering in order to obtain accurate and unarguable data. By combining the two methods, the connection between the policies and the recently implemented RE mix trend in Malaysia can be identified.

The proposed SOM Trend Clustering application was developed to identify and analyze time series data. This application can assist management to identify changes that occur in time series data as well as facilitate researchers in evaluating this type of data. However, there is still a lot of improvement that can be applied to the SOM Trend Clustering application. The system can be further enhanced by developing an online version to make it easier for researchers to investigate wherever they are located. To strengthen the analysis, further experiments will be conducted through the SOM Trend Clustering application in order to find the days in a year which has been clustered according to similarity of energy component. This task will be executed as future work.

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