SUSTAINABLE ENERGY DEVELOPMENT: COUNTRIES AND STRATEGIES

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Overview

Growing oil prices, exhaustion of oil stocks, problems with meeting the increasing demand for electricity, climate change as a result of oil and coal burning to get energy contribute to the fact that the leading countries of the world use the concept of sustainable development more and more often while forming their energy policy. The European countries with the similar characteristics often place emphases in energy policy on implementation of different strategies: energy saving, nuclear power development, use of the renewable energy resources , introduction of the advanced low-carbon technologies of energy production, increase of country's electrification level, maximum use of local energy resources. The author made a hypothesis that there are groups of the countries with a similar level of certain factors development for which application of a certain set of strategies within the concept of sustainable energy development is the most effective. The experience of the most successful countries from each group is to be analyzed, thus, the research will give the chance to bring correcting elements in energy policy of the other member countries of the group.

Method

The author defined the classification criteria of the countries which predetermine the possibility of application of this or that strategy: 1) the level of economic development (the indicator – GDP per capita in thousands of US dollars); 2) the amount of harmful emissions in the atmosphere (the indicator – CO_2 emissions in metric tons per capita); 3) the electrification level (the indicator – access to electricity in % of population); 4) the stock level of energy resources (the indicator – % of domestic primary energy usage (coal, natural gas and oil) for electricity production).

To analyze the specified indicators data on 149 countries for 2010 was collected. The official site of the World Bank, energy statistics of the UN Department of Economic and Social Affairs, the IEA energy statistics of OECD countries were the sources.

Each classification criterion was divided by the author into 3 categories: low, medium and high. The interval for each row was defined on the basis of the range of variation. The upper bound of the "low" category was calculated taking into account the minimum value of the indicator and the interval. The upper bound of the "medium" category was defined on the basis of the interval and the value of the upper bound of the "low" category.

Table 1 – Classification criteria in terms of 3 categories division

Category	The level of economic development (GDP per capita in thousands of US dollars)	The amount of harmful emissions in the atmosphere (CO_2 emissions in metric tons per capita)	The electrification level (access to electricity in % of population)	The stock level of energy resources (% of domestic primary energy usage (coal, natural gas and oil) for electricity production)
low	Less than 34.003	Less than13.457	Less than 39	Less than 33.33
medium	34.003-68.007	13.457-26.883	39-69.5	33.33-66.67
high	More than 68.007	More than 26.883	More than 69.5	More than 66.67

Using the software package SPSS the author made a cluster analysis to sort out groups with the similar level of the specified indicators. Squared Euclidean distance was chosen as the similarity degree because it allows taking into account large differences.

Results

12 clusters were sorted out as a result of the cluster analysis.

1 cluster: countries which have low level of economic development, low amount of harmful emissions in the atmosphere, medium electrification level, low or medium stock level of energy resources (Angola, Cameroon, Pakistan, Namibia, Ghana).

2 cluster: countries which have low level of economic development, low amount of harmful emissions in the atmosphere, low electrification level, low or medium stock level of energy resources (Afghanistan, Benin, Cambodia, Ethiopia, Madagascar, Zambia).

3 cluster: countries which have low or medium level of economic development, low amount of harmful emissions in the atmosphere, high electrification level, low stock level of energy resources (Albania, Belarus, Belgium, Cyprus, Finland, Italy, Ireland, Latvia).

4 cluster: countries which have low level of economic development, low amount of harmful emissions in the atmosphere, high or medium electrification level, high stock level of energy resources (Argentina, Greece, Czech Republic, Poland, China, Russian Federation, New Zealand, Serbia).
5 cluster: countries which have low or medium level of economic development, low amount of harmful emissions in the atmosphere, high electrification level, medium stock level of energy resources (Bulgaria, Germany, Hungary, Iraq, Slovenia, Venezuela, UK).
6 cluster: countries which have medium level of economic development, medium amount of harmful emissions in the atmosphere, high electrification level, high stock level of energy resources (Australia, Canada, US, UAE).
7 cluster: countries which have low level of economic development, medium amount of harmful emissions in the atmosphere, high electrification level, high or medium stock level of energy resources (Bahrain, Oman, Kazakhstan, Saudi Arabia).
8 cluster: countries which have high level of economic development, low or medium amount of harmful emissions in the atmosphere, high electrification level, low stock level of energy resources (Switzerland, Luxembourg).
9 cluster: countries which have low level of economic development, low amount of harmful emissions in the atmosphere, low electrification level, high stock level of energy resources (Mozambique, Zimbabwe, Tanzania, Democratic Republic of Congo).
10 cluster: countries which have low or medium level of economic development, high amount of harmful emissions in the atmosphere, high electrification level, high stock level of energy resources (Kuwait, Trinidad and Tobago).
11 cluster: countries which have medium or high level of economic development, low amount of harmful emissions in the atmosphere, high electrification level, high stock level of energy resources (Denmark, Netherlands, Norway).
12 cluster: countries which have high of economic development, high amount of harmful emissions in the atmosphere, high electrification level, high stock level of energy resources (Qatar).

Conclusions

For each cluster a certain set of energy policy strategies will be the most effective. It is possible to define an optimum set of strategies for each cluster by analyzing the most successful countries in the aspect of sustainable energy development.
The European countries got in the following clusters: 3, 4, 5, 7, 8, 11. For example, Denmark which belongs to the 11^{th} cluster plans to become completely independent of fossil fuels by 2050 thanks to expansion of the current energy efficiency policy and the use of renewable energy resources, also to creation of environmentally friendly transport sector and advance of smart grid. Germany which belongs to the 5^{th} cluster plans to decrease primary energy consumption by 20% by 2020 and by 50% by 2050. The proportion of energy consumption covered by renewable energy resources in Germany is to rise to 30% by 2030 and to 60% by 2050. In Switzerland which belongs to the 8^{th} cluster the main emphasis is made on energy saving. Saving electricity is supported by partial funding of projects with longer payback periods.
Change of indicators values of a certain country can cause change of its belonging to a cluster that respectively will predetermine rationality of the certain energy strategy application.

References

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