Energy Efficiency Indicators Comparison and Analysis in Thailand, OECD and EU 28 Countries

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Abstract: Some energy efficiency indicators for Thailand, OECD and EU 28 countries are analyzed in the period from 1990 to 2012. Both Thailand and mentioned regions have enacted and implemented energy policies which have many common elements and which are by all means devoted to the increase of energy efficiency and wider use of renewable energy sources for the purpose of reducing GHG emissions and to achieve sustainable development. However, the results of the implementation of these policies are very different and point out to the great influence of economic, social and political factors. Energy efficiency depends on numerous mutually independent factors but the greatest problem is in the fact that most important factors cannot be affected by individual countries. This leads to the need to constantly control the implementation of the energy efficiency policy and to make adjustments to it. Very often, these changes are imposed by rough effects of external factors which are the consequence of globalization and the pressure of those who enforce this globalization. This paper offers some answers to possible reasons for the deviation of values and trends of energy indicators in the most developed regions in relation to Thailand.
The complexity of every energy indicator is particularly emphasized, as well as the insufficiency of comparison of their numerical values without the analysis of other "uncounted" factors affecting their numerical values.

Keywords: energy policy; energy efficiency; energy indicators; energy consumption and production.

1. Introduction

There is no doubt that the efficient use of energy is a matter of general interest and it is particularly relevant to the struggle against climate change therefore, amendments need to be made to energy efficiency policy in order to remove market barriers for the implementation and improvement of energy efficiency [7]. Energy policy instruments for the improvement of energy efficiency need to stimulate the market to higher efficiency but in such a way to achieve cleaner environment, higher standard of living, more competitive industry and more reliable energy supply. In addition, they should be in line with actual market requirements and adjustable to changing market demands so that objectives are reached in an optimal way [1, 5-6].

Energy efficiency is determined by a large number of mutually independent factors with different individual effects. For that reason, there is no ideal energy indicator on the basis of which it is possible to estimate the energy efficiency of a region or a whole country. For example, energy intensity also depends on the structure of national economy, which determines the Gross Domestic Product (GDP) and all other economic factors relating to analyzed activity [2-4].

There are excellent energy policies all over the world led by the European Union (EU), which is an undisputed leader in energy efficiency and in the fight against climate change. However, attempts at the global level to reduce energy consumption have given no significant and expected results. Therefore, the promotion of energy efficiency requires new, innovative approaches, the main characteristic of which is flexibility. This means that energy policy should be adaptable and innovative and it should be created, revised and implemented on an ongoing basis.

This paper analyzes values of five indicators for Thailand, OECD and EU 28 countries. The analysis refers to the period from 1990 to 2012. The change trends of energy indicators and their values significantly deviate from values in OECD and EU 28 countries.

On individual examples, the fact that numerical values of energy indicators require deeper knowledge of overall conditions relevant to the operations of energy systems in regions or countries is especially emphasized and analyzed. Such an analysis has been prepared for Thailand, Iceland and Luxemburg and some indicators for these three countries are compared mutually and with 41 countries in the world.

2. Evaluation of energy efficiency in Thailand, OECD and EU 28 countries

Information obtained from the database of the International Energy Agency (www.iea.com) is used for the computation of energy indicators. The values in Thailand are compared with the values of these indicators in OECD counties and with the values in EU 28 counties. The OECD counties are the most developed counties in the world and it seems that measures for the increase of energy efficiency and the utilization of renewable energy sources in EU 28 counties have generated the best results.

It can be said that the goals of the energy policy are very similar in all countries but the ways of achieving them are very different. In other words, drivers and environments in which energy efficiency is to be implemented differ significantly worldwide. The EU, together with some other OECD countries, is the leader in the fight to reduce the impacts of climate change and in related energy efficiency activities. The USA and BRIC[1] countries are the most vocal in defense of their national interests and oppose any firm obligation related to the reduction of CO_2 emissions. Developing countries need support. Energy efficiency is for them a *win-win* situation since the reduction of GHG emissions and energy costs significantly improve their fragile economies. Therefore, energy efficiency in developing countries needs to be immediately integrated into energy policies with a strong supporting mechanism for their implementation.

Energy indicators used are:

1. Energy intensity [toe/thousand 2005 US$][2],
2. Total primary energy supply (TPES) per population [toe/capita],
3. Electricity consumption per population [MWh/capita],
4. CO_2 emission per population [tCO_2/capita],
5. GDP (ppp) per population [2005 US$/capita]

(Purchasing Power Parity (ppp) calculations).

[1] *Brazil, Russia, India and China.*
[2] *Constant 2005 US$. Constant series show the data for each year in the value of a particular base year.*

There is no universal energy indicator and the analysis which is the subject matter of this paper should be based on several indicators. The first and the fifth indicator concern energy intensity and they represent the combination of energy consumption and economic activities and the second and the third indicator are physical values since they are reduced to per capita. The fourth indicator reflects the situation of the environment well and the fifth indicator reflects the economic trend in counties. The changes of these indicators in the period 1990 – 2012 are given in Figures 1-5.

The Figure 1 shows the dependence of energy intensity. In OECD and EU 28 countries, this indicator shows stable growth decrease and small scatter in relation to the trend line. However, when Thailand is concerned, there is a distinctive growth of energy indicators and also a big scatter. Big scatter indicates that the Thai growth of the GDP is still largely coupled from the energy consumption growth. Energy intensity increase is not in compliance with the official Thai energy policy and has probably occurred as the consequence of large investments into the growth of the energy sector. The big scatter of this indicator in case of Thailand is primarily because of the turbulent political situation. Developed countries have managed to completely stop the growth of TPES/population and in this way, among other things, they have reduced necessary investments into the energy sector. The Figure 2 shows changes of TPES/population. In addition to the growth of TPES/population in Thailand and stagnation in OECD and EU 28 countries, it can also be noticed that there is significantly lower TPES/population in Thailand. The difference in the consumption of primary energy per population can be explained by bigger industrial production in OECD and EU 28 countries in relation to Thailand.

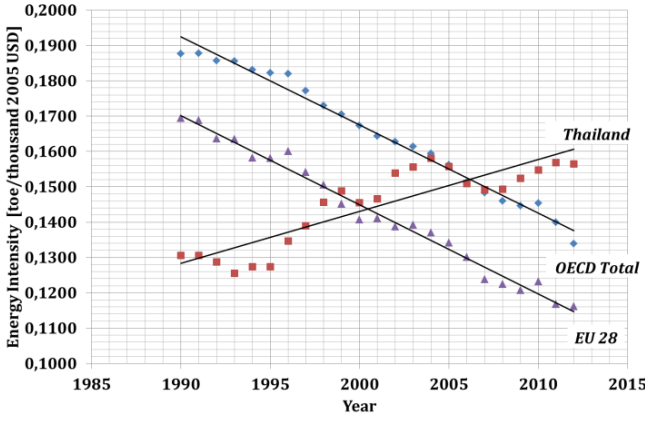

Figure 1. Energy intensity.

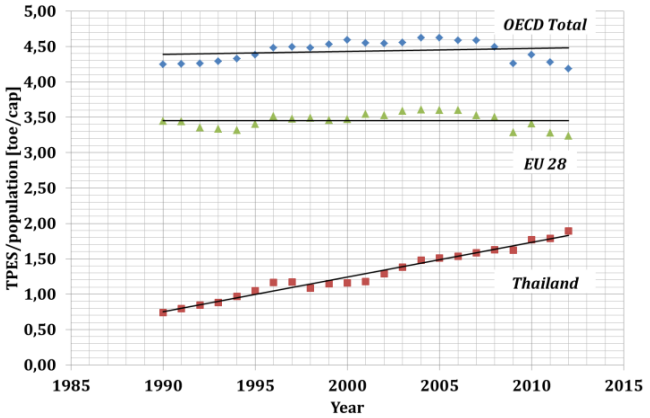

Figure 2. Total primary energy supply (TPES) per population.

The consumption of electricity per population is growing in all three analyzed cases. It should be noticed that the consumption of electricity/population in EU 28 countries is significantly lower in relation to OECD countries irrespective of the fact that the GDP(ppp)/population in these countries is similar. This can be explained by higher energy efficiency in EU 28 countries due to the fact that investments in energy efficiency and renewable energy sources are the highest in EU 28 countries [7]. In Thailand, the consumption of electricity/population, as well as TPES/population, is much lower in relation to above mentioned two groups of countries.

Changes in CO_2 emission per population are shown in Figure 4. It should be noticed that only in EU 28 countries this indicator is falling, which is in line with the statement that the development of energy efficiency and the utilization of renewable energy sources is the highest there. Also, it can be concluded that the effects of the implementation of the official energy policy in Thailand are still insufficient.

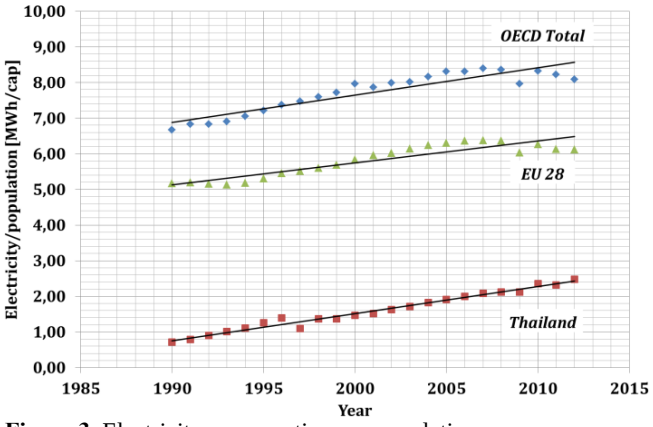

Figure 3. Electricity consumption per population

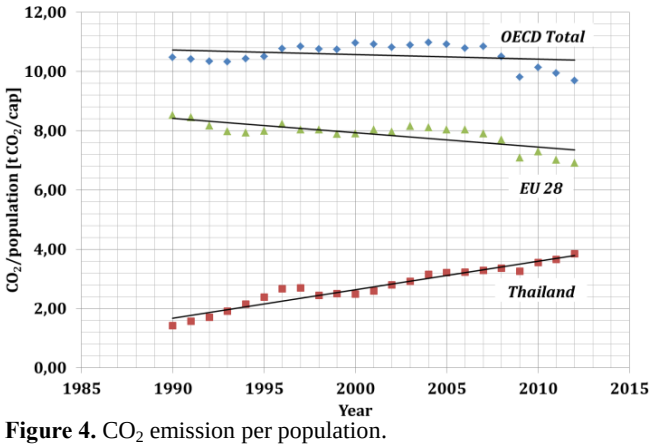

Figure 4. CO_2 emission per population.

It is important to notice that CO_2 emissions in EU 28 are falling although the consumption TPES is practically unchanged. In OECD countries, consumption TPES is also constant while in Thailand, it is growing. However, CO_2 emissions are decreasing more slowly in OECD countries than in EU 28 and they are higher by some 20-25% compared to emissions per population in EU 28. Such a trend confirms the fact that the effects of not only energy efficiency increase but also of the use of renewable energy technologies at the global level are higher in EU 28 than in OECD countries. This can easily be determined from energy balances of these groups of countries since CO_2 emissions are calculated by multiplying the consumption of certain energy carrier with the corresponding coefficient. As far as Thailand is concerned, the growth of consumption TPES does not contribute sufficiently to the growth of GDP (ppp). In addition, CO_2 emissions per population are growing at the same speed as TPES. This is a sign that the effects of the national energy policy are still unsatisfactory.

The Figure 5 shows changes in GDP(ppp) per population. There is a big difference in the level of this indicator between Thailand, OECD and EU 28 countries. Also, its growth is smaller. Low value of this indicator explains not only large energy intensity but also still insufficient investments into the sectors of energy efficiency and renewable energy sources. On the other hand, the growth of energy consumption requires investments into energy facilities, which is additional burden for the economy. Since the growth of primary energy consumption per population in developed countries has been brought to a standstill, the investments into new energy plants are slowed down.

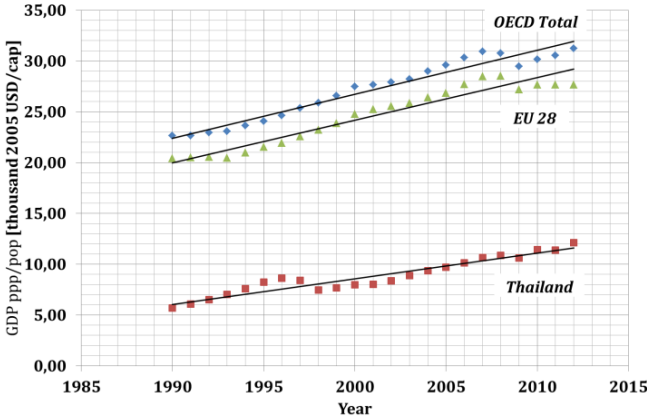

Figure 5. GDP(ppp) per population.

3. About the complexity of energy indicators

It is important to emphasize that energy indicators should not be seen only as numbers but as the reflection of technical, economic, political, social and geographical parameters in a country or region. Let us show that in case of three countries: Thailand, Iceland, and Luxemburg. The Figure 6 shows the dependence of energy intensity versus GDP(ppp)/per capita for 44 countries in the world in 2009. In particular, the value of this indicator in three countries to be specially analyzed is highlighted.

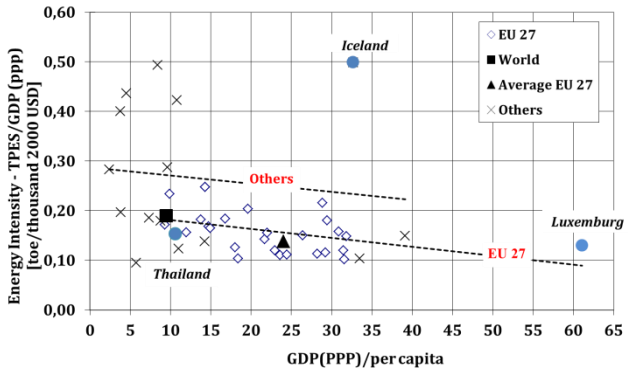

Figure 6. Energy Intensity versus GDP(ppp) per population.

The value of energy intensity for Thailand is very close to the world's average but it is noticeable that there are large deviations in case of Luxemburg and Iceland. For the purpose of understanding such a large deviation, it is necessary to know some other facts for these countries, as well. Below are facts about compared three countries:

- Economy of Thailand is heavily export-dependent, with exports accounting for more than two-thirds of its gross domestic product (GDP). In 2012, the GDP(ppp) was 809 billion US$. The Thai economy grew by 6.5%, with a headline inflation rate of about 3% and an account surplus of 0.7% of the country's GDP. The population of Thailand is about 67 million.

- The economy of Iceland is small and subject to high volatility. In 2012, GDP(ppp) was 16.2 billion US$. With a population of about 320 thousands, this is about 38,000 US$(ppp). Iceland has a mixed economy with high levels of free trade and government intervention. Geothermal power in Iceland is the primary source of home and industrial energy in Iceland. In the 1990s Iceland undertook extensive free market reforms, which initially produced strong economic growth. Aluminium smelting is the most important power-intensive industry in Iceland. There are currently three plants in operation with a total capacity of over 800,000 mil. ton/year, putting Iceland at around 10th place among aluminium-producing nations worldwide.

- The economy of Luxembourg is largely dependent on banking, steel, and industrial sectors. In 2012, gross domestic product was 26.5 billion US$. Luxembourgers enjoy the second highest per capita gross domestic product in the world, behind Qatar. Although Luxembourg in tourist literature is aptly called the "Green Heart of Europe", its pastoral land coexists with a highly industrialized and export-intensive economy. Luxembourg enjoys a degree of economic prosperity almost unique among industrialized democracies. Luxembourg has a population of 525 thousand.

Even these few facts easily explain expressive deviations for observed three countries. In the case of Iceland, enormous primary energy consumption causes large energy intensity. But, the GDP per capita is high, too. Consumption of electricity in the aluminium industry is 74% of the total electricity consumption in Iceland. Since this consumption is connected with industry, it is obvious that the GDP in Iceland is high.

The other huge deviation is in case of Luxemburg where the GDP is extremely high, but the energy intensity is small. Luxemburg is the seat of several institutions and agencies of the EU, and as a very small country does not affect the energy picture of Europe. Banking is dominant support for the economy.

This indicator for Thailand is located in the large group of countries with moderate energy intensity and smaller GDP(ppp)/capita. The industry in Thailand is very diverse. This indicator is close to the global average and is equal to several European countries with lower GDP(ppp)/capita.

For the same countries, the Figure 7 shows the consumption of electricity per population [kWh/capita]. Iceland and Luxemburg are again extreme and their indicators deviate from the general trend due to specificities of their economies. The consumption of electricity per capita in Thailand is lower than in the EU 27, but their position on the abscissa is very unfavorable for Thailand because the GDP is small compared to EU 27.

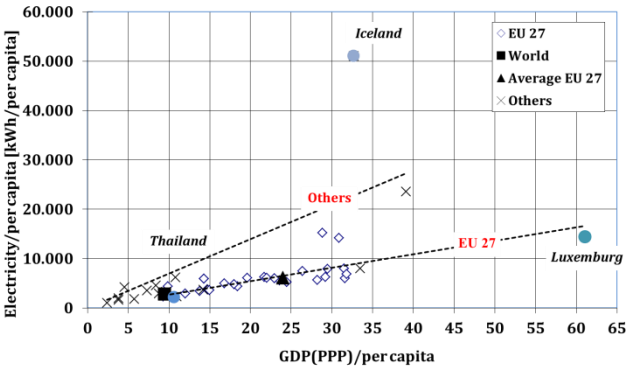

Figure 7. Electricity versus GDP(ppp) per population.

The Figure 8 shows emissions of CO_2/GDP(ppp) versus GDP(ppp) per population. CO_2 emission in Thailand is almost the same as in Luxemburg. But, Thailand produces majority of

electricity from fossil fuels and Luxemburg imports all electricity. It is interesting that this indicator in case of Iceland is low compared to other countries. The reason is in the fact that in Iceland, hydro and geothermal potentials are used for the production of 95% of electricity.

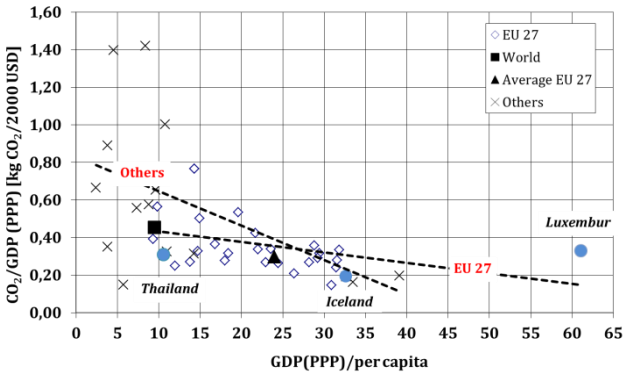

Figure 8. CO2/GDP versus GDP(ppp) per population.

This simple example shows that it is necessary to analyze energy indicators very carefully and that it is not possible to observe their values alone without good knowledge of economic, social and political conditions that can affect and have already affected these energy indicators. Even the time analysis of indicator changes in certain countries should be accompanied by the analysis of conditions.

4. Conclusions

The paper analyzes some of energy indicators and compares their values with the values of these indicators in the most developed counties in the world. The analysis shows that there is a lot of space for the improvement of energy efficiency in Thailand in order to reach the level of these and other indicators prescribed by the official energy policy that has already been achieved in OECD and EU 28.

Considering the role that energy efficiency has in achieving the global goals of combating climate change, it is obvious that actions need to be coordinated at all levels – international, regional and national – in order to secure the environment for improving energy efficiency. The real force for change is at the local level and policies should be such that they can be implemented locally – in households, public services and companies.

Energy indicators cannot be observed isolated only through their numerical values. The analysis without good knowledge of economic, social and political conditions that affect and have already affected these indicators can lead to wrong conclusions. Even the time analysis of indicator changes in certain countries should be accompanied by the analysis of conditions.

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