



A comparative study of the effects of the economic system on energy consumption

Zaid Al-Moein¹

Petroleum University of Technology, University of Dubai, UAE

Received: 03 July 2019

Accepted: 18 August 2019

Published: 01 September 2019

Abstract

In this paper the critical role of the state economy system on the energy intensity is presented. The classification is obtained through a study on 11 countries energy strategies. These countries include USA, UK, Japan, India, S. Africa, S. Korea, Malaysia, Australia, China, Russia, Saudi Arabia, and as well Iran. Many different economical, social, political, and other parameters that affect state energy intensity were examined. The most relevant parameters for the classification of all these countries are the macro-economic parameters such as the economy freedom index, gross national income and gross domestic product. The countries clearly are divided in three groups, developed countries with free economy systems and low energy intensity, developing countries with semi-free economy and intermediate energy intensity, and countries with almost governmental economy (low economy freedom index) and high energy intensity. Details of different strategies of these three groups are also classified and presented.

Keywords: Energy Intensity; Economy System; Classification

How to cite the article:

Z. Al-Moein, A comparative study of the effects of the economic system on energy consumption, *J. Hum. Ins.* 2019; 3(3): 189-194, DOI: 10.22034/jhi.2019.80910.

©2019 The Authors. This is an open access article under the CC BY license

1. Introduction

Energy is the main resource for the progress and development of each society, city, state or country. The main energy sources in the world are limited and not renewable, and they are not distributed uniformly around the world. The fossil energy sources, including oil, gas and coal are still the main energy resource of the world. The other alternative energy sources have only considered as a complement to the fossil energy. As it is obvious, these resources are short and cannot accommodate the world request of energy for development. These facts have urged all countries in the world to draw plans to optimize their energy consumption. Developed countries, in particular, and after the 1973 Arab countries oil embargo to the west, started these programs and have been able to considerably decrease their energy intensity index,

specially, in the industrial sector in the last three decades.

Developing countries, on the other hand, usually, have only started this program within the last 15 years. Since the state of developing countries is quite different, and includes many different situations, therefore, their plans are not the same and their progress, as well, are not the same and have produced different results. Albeit, many of these countries have tried to use the plans originally designed by developed countries; nevertheless, they had to localize these plans to match their overall situation in all aspects including, cultural, industrial, legislative, and government policies and practices [1,2].

Economic system of these countries and its effect on energy intensity index is studied first, since as will be shown, it plays an essential role in the energy consumption practices helps division of developing countries into two groups [1,2]. Based on the

¹ Corresponding Author Email: z.almoein.l@ud.ac.uae

results of this study, suggestions for Iran are put forward for its energy strategies and policies in different sections.

2. Economic System and Energy Intensity

The countries are listed in table-1 according to their Economy Freedom Index (EFI) based on the World Bank data [3]. As it can be seen, USA and UK have free economy ($EFI > 80$); Japan has almost free economy ($70 > EFI > 80$), South Korea, Malaysia, South Africa have a relatively free Table -1: Economy freedom index [1]

Rank	Country	EFI	Income
1	USA	82	43560
2	UK	81.6	39500
3	Japan	73.6	38500
4	South Korea	68.6	15840
5	Malaysia	65.8	4870
6	South Africa	64.1	4650
7	Turkey	59.3	3200
8	Saudi Arabia	59.1	12510
9	India	55.6	730
10	Russia	54	2200
11	China	54	1100
12	Iran	43.1	1650

economy ($60 > EFI > 70$); Turkey, Saudi Arabia, India, Russia, and China have an economy ruled almost by the government ($50 > EFI > 60$); and Iran economy is ruled by the government ($EFI < 50$).

Also in table 1, the annual income of these countries is listed. Except for, special cases of Saudi Arabia (high oil revenue) and India and China (very high populations), the ranking is valid.

Gross National Income (GNI) of these countries is shown in figure 1, and their energy use per Gross Domestic Product (GDP) is shown in figure 2 [3,4]. Based on 2005 statistics, the GNI per capita of USA is more than 40000 \$, Japan and UK is between 30000\$ and 40000\$, South Korea is 15840\$, Saudi Arabia is 12510\$, Malaysia, Turkey, Russia, Iran and China are between 1000\$ and 5000\$, and the least is India with 730\$ [3,4].

Based on 2004 statistics, energy intensity (EI = energy use / GDP) of UK is minimum with a value of 0.107 Koe/\$, then Japan and USA with $EI < 0.2$; followed by Turkey, South Korea, Saudi Arabia, India and Malaysia with $0.2 < EI < 0.5$ Koe/\$, South Africa 0.53 Koe/\$, China 0.64 Koe/\$, Iran 0.81 Koe/\$ and finally Russian with 0.92 Koe/\$ [3].

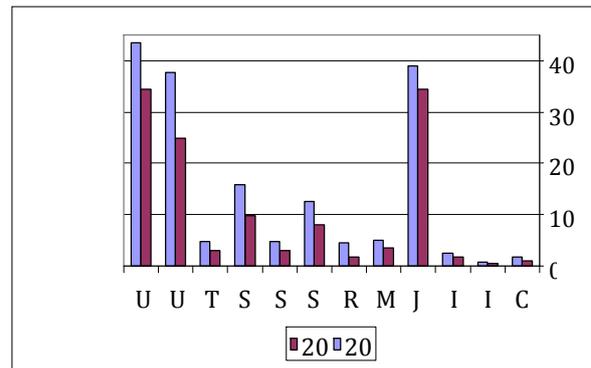


Figure 1. GNI per Capita

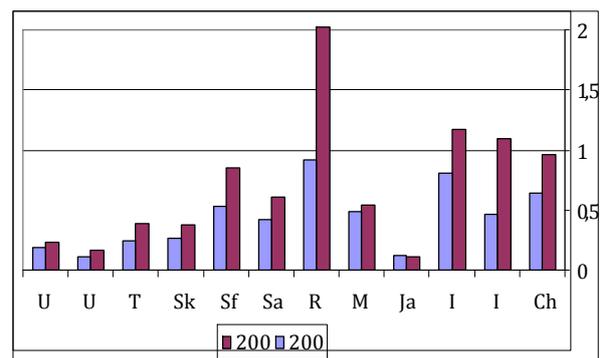


Figure 2. Energy Intensity (Koe / \$)

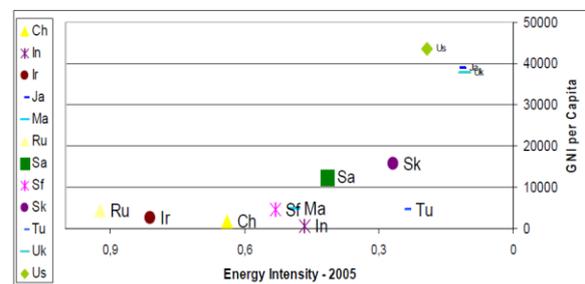


Figure 3. GNI per Capita versus Energy Intensity

Is there any relation between all these parameters? To investigate any possible relation, figure 3 is presented which shows the GNI per Capita versus energy intensity based on 2005 World Bank Statistics. Also, in figure 4, the economy freedom index of these countries is plotted versus the energy intensity, based on the 2005 statistics. As it is seen, these countries can be divided into three groups as shown in table 2 [1,2].

Even though there are some exceptions in these grouping, but, in general, it signifies the relation between economy freedom and energy intensity. As the role of government in economy increases and political – social parameters takeover the techno-economical parameters in making energy related decisions, and also the low effectiveness of government agencies in ruling the economy, the energy intensity increases, while the GNI per capita decreases.

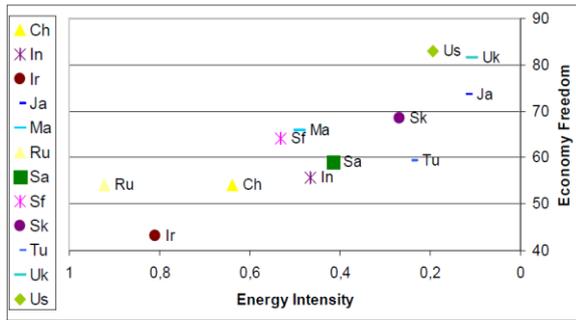


Figure 4. Economy Freedom Index versus Energy Intensity

It should be mentioned that the countries in group one, which are usually called the developed countries, are among the highest consumers of energy, since energy is one of the main resources in development. However, the developed countries use energy logically and optimize their energy consumption.

Table 2. Countries grouping based on the EFI and EI

Group	Country	EI	EFI
1	USA, Japan, UK	Low	High
2	Turkey, South Korea, India, South Africa, Malaysia, Saudi Arabia	Medium	Medium
3	Iran, China, Russia	High	Low

The developing countries are divided into two groups, those in the middle, with medium energy intensity and medium economy freedom index; and the low ranking countries, with high energy intensity and low economy freedom index. Logically, groups two and three countries have to intensify their efforts to decrease their energy intensity. Possible solutions are discussed in the next sections. In the project reports, detailed discussions on these issues for each country are presented [1]. In table 3, the general condition of countries in each group is summarized [1,2].

3. Energy Consumption Reduction Strategies

Historically, the developed countries started their efforts to optimize energy consumption after the first oil shock in 1973. Recently, concerns about the energy related environmental pollutions, and particularly, after Kyoto convention, gave a new direction to their efforts.

Table 3. General economy-energy state

Group	General Condition
1	<ul style="list-style-type: none"> Market economy High annual income Low energy intensity High gross domestic product 30 years energy optimization
2	<ul style="list-style-type: none"> Fast developing countries Transferring to market economy Medium energy intensity 10-15 years energy optimization
3	<ul style="list-style-type: none"> Centralized economy High energy intensity Subsidized energy 10 years energy optimization

The second group countries, started their efforts in the second half of nineties, and in general have followed the same strategies as the first group, with different emphasis on the items. The third group countries, had economy run almost fully by governments. They started their efforts about 10 years ago, but, considering old industries which are highly dependent on the very cheap subsidised energy provided by the government and a non-competitive system would face a very difficult situation [1,2].

All group three countries have aimed for a fast development program, which make taking any action on the energy optimization very difficult.

In table 4, the main energy consumption reduction strategies are presented, which indicates that, as expected, are very similar for all countries, since the main goals are almost similar. Albeit, priorities of countries are different, for example, the main emphasis of energy importing counties is on the energy supply security. The oil rich countries, on the other hand, are focused on decreasing the energy subsidizes, and to increase the energy prices to the world prices, however without social unrests. This, of course has to be done very carefully [1,2].

3.1 Policy Making and Managerial Strategies

These strategies are listed in table 5. Even though, all countries follow their own policies and practice their way of management, it has been tried to show their similar strategies. Logically, these countries follow their main strategies, and therefore, groups two and three countries strategies show similarities to the first group countries.

Table 4. Main strategies

Group	Main Strategies
1	<ul style="list-style-type: none"> Secure energy production and distribution Stable development with an acceptable rate Energy market development in the open market frame Demand-side management to achieve EI standards Meet Kyoto convention requirements on environment
2	<ul style="list-style-type: none"> Same approach as the first group Emphasis on energy security (India, Turkey, South Korea) Less interest in energy market (Saudi Arabia, Malaysia) • Early stages (Saudi Arabia)
3	<ul style="list-style-type: none"> Same approach as the first group Emphasis on energy market system (Russia) Emphasis on fast development (Iran, China)

Table 5. Policy making and managerial strategies

Group	Policy Making and Managerial Strategies
1	<ul style="list-style-type: none"> obligatory energy statistics reporting share investment by industry and government taxing regulations (exemptions and penalties) open market energy system demand-side management energy efficient equipment regulations and standards Strong, active Energy Services Companies (ESCO)
2	<ul style="list-style-type: none"> energy optimization obligation law develop energy optimization standards develop ESCO penalties for high energy consuming industries subvention for efficient industry cooperate in reducing pollution
3	<ul style="list-style-type: none"> correct industrial structure obligatory establishment of energy office in large industry support ESCO development energy data collection system development subvention for energy efficiency projects cooperate in reducing pollution

3.2 Technical Strategies

Technical strategies are listed in table 6. All countries have the same trend, but they are at different stages, considering their current situation. Developed countries, are trying every means to optimize their energy consumption, including application of new technologies to decrease the demand for energy in different sectors. Benchmarking of energy consumption is also another important measure for monitoring energy consumption in these countries [1,2].

Group two countries like South Korea are quite close in technical strategies to developed countries, and, on the other hand:

Table 6. Technical strategies

Group	Technical Strategies
1	<ul style="list-style-type: none"> energy auditing of industries and benchmarking production of energy efficient equipments and processes recovery of wasted energy research and development advanced technology (IT, automation) applications
2	<ul style="list-style-type: none"> industrial energy auditing and optimization waste energy recovery improvement industry energy consumption benchmarking new energy technologies research and development acquiring energy efficient equipments and processes
3	<ul style="list-style-type: none"> industrial energy auditing and optimization industrial technology expansion and improvement loss reduction in energy transfer and distribution energy consumption standards dispose

Saudi Arabia, although does not directly involve in these activities; it imports new technologies, which inevitably decreases the energy demand.

The group three countries are quite involved with restructuring their old industrial sectors. Old industries and governmental officers, should be replaced with new, advanced technologies, and be ruled by private sector.

3.3 Training and Cultural Strategies

These strategies are listed in table 7 for three groups. In developed countries, emphasize is mainly on training of skilled experts, and presenting successful related projects and

experiences to decision makers in public and private sectors to encourage them to invest more in energy optimization.

In the groups two and three countries, still public awareness, at minimum, is as vital as training and presentations. Even in industrial sector, especially in the third group countries, more efforts are needed to attract the interest of management to work seriously on energy consumption optimization. This is especially the case in oil-reached countries, where the energy prices are quite cheap and subsidized [1,2].

Table 7. Cultural and Training Strategies

Group	Cultural and Training Strategies
1	<ul style="list-style-type: none"> Academic program in university Trainings by private and public sectors Educations in schools Public addressing on successful experiences Presentation of successful cases
2	<ul style="list-style-type: none"> Increase public awareness on energy optimization Emphasizing on training of skilled staff and managers Conducting academic programs in universities and schools Carry out related conferences and symposiums
3	<ul style="list-style-type: none"> Increase public awareness on energy optimization Developing educational materials for students Conducting academic programs in universities Carry out related conferences and symposiums

4. Achievements

The developed countries were quite successful in decreasing energy intensity, particularly in the industrial sector. In figures 4 and 5 the relative changes in energy index of USA and UK are presented. As it is seen, the industrial energy index of USA has decreased, almost 35% in 20 years from 1985 to 2005, and in UK from 1973 to 2005, this index has decreased by more than 60% [5,6].

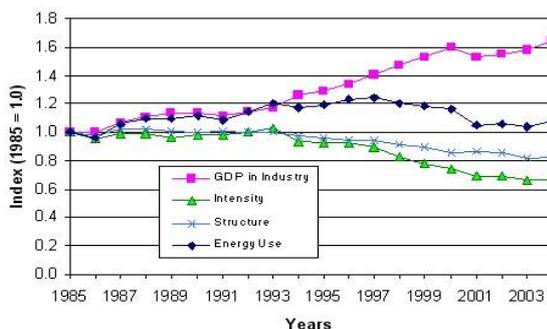


Figure 4. USA industrial sector energy index

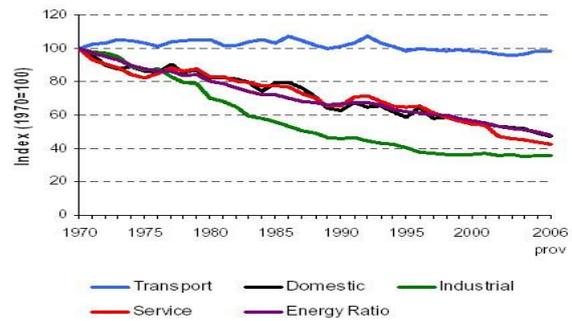


Figure 5. UK different sectors energy index

In figure 6 the changes in the changes in the energy intensity of several countries from 1990 to 2003 are presented. While the mild increase of EI for Turkey, South Africa, Malaysia and India is seen, and mild decrease of EI of Japan is seen, sharp decrease of China EI and sharp increase of Iran EI are dramatic.

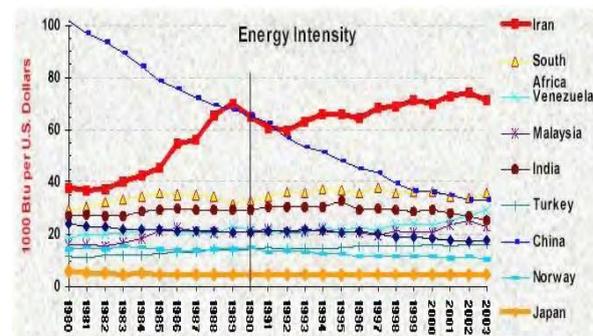


Figure 6. Energy intensity trend

This is because of the sharp increase in China GDP, and sharp increase in Iran energy consumption [7]. The energy intensity of all developing countries, as expected shows an increasing trend, but interestingly, after the year 2000, a falling trend is started, which indicates the relative success of these countries in controlling energy consumption. The oil rich countries, as expected, have a higher energy intensity that should be treated carefully. The third group countries, Iran and China, have the highest energy intensity values, which is mostly because of the ruling of the economy by the government.

5. Improvement Suggestions

Based on the above discussions, the following proposals are put forward for the improvement in energy intensity index and decrease in energy consumption [1,2]:

- Economy freedom and energy market development
- Increased role of private sector in energy market with reliable financial supports from banking system

5.1 Policy Making and Managerial Strategies

- Centralized and comprehensive energy management and policy making
- Taxing system in favor of energy efficient production, distribution and consumption
- Joint programs by the government and industries
- Demand side energy management
- Development of a strong data system with easy access to public and experts
- Developing a strong skilled man power market for energy

5.2 Technical Strategies

- Reduction of energy waste in energy production and distribution
- Acquiring energy efficient equipment and processes (preferably by a sector of the industry, rather than a single buy)
- Annual energy benchmarking practice
- Employing advanced technologies with optimized energy consumption

5.3 Training and Cultural Strategies

- Set out optimized energy consumption
- Training of managers and engineers
- Public education in schools and universities
- Organizing informative, appreciative and specialized conferences on the successful initiatives and projects on energy consumption optimization in different sectors

6. Conclusions

In this paper the current situation of several developing countries energy consumption strategies were examined and evaluated versus developed countries. The main role of economy system in energy consumption reduction was portrayed and developing countries were divided into two groups based on the economy freedom index.

The strategies in three categories of policy making and managerial, technical, and training and cultural of these countries were examined and suggestions for improving the current trend of energy consumption in Iran were presented.

References

1. Afshar, M. 2010. Worldwide Strategies for Energy Consumption Optimization, 3 volumes, Iran.
2. Afshar, M. 2007. Energy Consumption Reduction in Industrial Sector of 18 Countries, Report, Vol. 1 to 4, Iran.
3. World Development Indicator Data Base. 2007. The World Bank Group, web.worldbank.org/WEBSITE/EXTERNAL/DATAS/TATISTICS.
4. International Energy Annual. 2006. Energy Information Administration, www.eia.doe.gov/pub/international/iea.2004.XLS.
5. U.S. Energy Intensity Indicators, DOE, intensityIndicators.pnl.gov/total_industrial.htm
6. UK Energy Sector Indicator, 2007, Energy Intensity. P.15.
7. Achieving China's Target for Energy Reduction in 2010, 2005, LBNL61800 P.4.