Energy management and sustainable development

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Abstract

Energy is one of the most fundamental issues for sustainable development. Sustainable development is a changing process, circuiting investment, orientating technology and institution for compatible with the needs of the present and the future.

In order to achieve sustainable development and make improvement in efficiency services, optimal and efficient ways for using energy must be evaluated and practiced. The weakness in efficiency of production process, transmission, distribution, consumption and not dependency on reliable energy needs sustainable development policy. In other words, sustainable development and environment production depend on the optimal use of energy resources especially for renewable energy.

In this article, energy and its trend of changes are discussed at first. Then the importance of energy in creating sustainable development is discussed. The goal of this study is to introduce data and to evaluate other countries' experiences as well as using these experiences for macro policies in different fields and dimensions for improving efficiency.

Keywords: energy management, sustainable development, improving efficiency.

1 Introduction

In economic terminology the concept and process of economic development is quite familiar, however in recent decades there have been many concerns about the significance and necessity of a sustainable development process. Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

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- the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and
- the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

Energy is central to sustainable development and poverty reduction efforts. It affects all aspects of development social, economic, and environmental including livelihoods, access to water, agricultural productivity, health, population levels, education, and gender-related issues. None of the Millennium Development Goals (MDGs) can be met without major improvement in the quality and quantity of energy services in developing countries. UNDP's efforts in energy for sustainable development support the achievement of the MDGs, especially MDG 1, reducing by half the proportion of people living in poverty by 2015. Through an integrated development approach, UNDP works to help create enabling policy frameworks, develop local capacity and provide knowledge-based advisory services for expanding access to energy services for the poor.

The role of energy is not limited to these examples only and certainly energy has fundamental role in the process of sustainable development. If we believe in sustainable development and its principles, we have to consume resources in such a way that the next generation can also benefit from them. If industry wants to move in a stable path, we need to consider energy management today. Also the close connection between energy and environment has led to more in- depth attention to energy saving issue.

Energy and its management are necessary to gain sustainable development. As a result, findings new ways to achieve optimal consumption in dealing with use of permanent technologies and recycling materials would be necessary. In the present essay energy management, Energy efficiency, Sustainable energy and the methods of achieving it in order to attain sustainable development will be analyzed.

International organizations have referred to energy as the main factor in sustainable development in the third millennium. At a word summit for sustainable development in 2003, UNDP has issued a statement focusing on the issue of sustainable energy while referring to the main messages of the meeting as energy and its role in development, some of which are mentioned here:(Mcdad [1])

1. Energy is a basic element in poverty reduction, job creation, livelihood and expanding opportunities.
2. Energy is not just electricity; and clean fuels have a particular significance.
3. The definition of sustainability, especially in the field of energy, is wider than the environment.

2 The role of energy in achieving to sustainable development

From development viewpoints the significance of energy can be briefly summarized as follows: (World Bank [2])

2.1 For social and economic development

Energy services are vital in order to reduce poverty and achieve the millennium goals. All people need energy for cooking, heating, lighting, cooling, transportation, communication, information services and education. In health clinics, electricity makes it possible to refrigerate vaccines, operate medical equipment and provide lighting after sunset. The World Health Organization said that almost 200 thousand people lose their lives as a result of the carbon produced by sooty stoves each year. Instead of traditional polluting fuels which lead to polluted urban air, clean fuels must be used.

2.2 For macroeconomic stability

Encountering efficient transformation in energy part in order to guarantee economic growth and poverty reduction is generally considered the first point of focus in the developing countries' energy section policy. Energy security can be attained through expansion and diversity energy sources and reduce dependence on high and unstable fuel prices. This will lead to less reliance on imported fuels, improvement of balance of payment and financial liberation which can be used in other projects.

2.3 For the environment

Clean energy for development and climate changes must be considered an urgent challenge that gives warning to reduce greenhouse gases. To have an environment with the least amount of carbon, we need to take an aggressive program on energy production and end-use efficiency improvement, significant penetration renewable energy technologies and fuel switching. Renewable energy in off-grid electricity service can help the dispersed rural population with relatively low income and demand levels to gain access to lighting and power services. These energies can be used inside and outside of the grid and increase the security of energy supply.

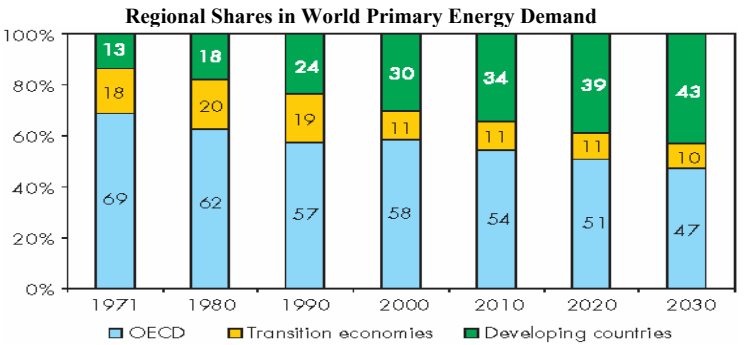
Effective measures to increase energy efficiency will reduce the costs in presenting services and improve the quality of air in homes, and also, by decreasing energy cost, improve competitiveness in large and medium-sized firms. In this regard sustainable management of the natural forest can transform the traditional fuels resulting from indiscriminate cutting of trees to renewable energy resources. Meanwhile it can lead to considerable progress in village and ecosystem rehabilitation and carbon sequestration.

3 A review on energy development in the next two decades

With regard to the massive foreign investment that has been made in China and India in the past years, these two countries have had drastic changes on the global energy system. These changes are noticeable both in terms of absolute number of energy consumption and by the share and weight of each of them in the market. As the two countries get richer, people can enjoy better living facilities as a result of economic growth which indeed is considered a positive factor. But the increasing global demand for energy can also be seen as a serious alarm.

It is estimated that the global primary energy needs until the 2030 will reach 55%, compared to 2005 with 1.8% annual growth rate. Thus the energy demand will increase up to 17.7 billion tons of crude oil compared with 11.4 billion tons in 2005. Developing countries that have a faster population and economic growth will account for more than 74% of this global increase by the year 2030 and from that number up to 45% would be China's and India's share. OECD countries will take over one-fifth and transitional countries 6% of this increase. Developing countries will have 47% of the market in 2015 and more than half of it in 2030. This figure is currently 41%. Almost half of the increase in global energy production is conducted toward producing electricity and one-fifth of it is spent on transportation (OECD/IEA [3]). As shown in figure 1, the share of developing countries from primary energy demand in the world will increase from 30% in 2000 to 43% in 2030.

Thus it is governments' responsibility to execute a strong, immediate and comprehensive plan to put the world on path for sustainable development. Energy management is an undeniable necessity to achieve sustainable development. In the near future, measures to improve energy efficiency as a result of energy management would be consider as the cheapest and fastest way to control the demand for energy and CO^2 emission.



Source: IEA, *World Energy Outlook 2002*

Figure 1: Regional shares in world primary energy demand.

4 Environmental consideration of energy demand

The increasing amount of CO^2 and other greenhouse gases jammed in the atmosphere due to using fossil fuel results in increased temperature and climate changes. According to the scenario mentioned about rising energy demand over the period 2005–2030, carbon dioxide will have a 70% increase and compared to 22 billion tons, its current level, will reach 38 billion tons.(OECD/IEA [3]), (Cliniand and Ortis [5]). Figure 2 shows that the process of carbon dioxide emission over the past years until 2030 according to different regions in the world. Due to the mentioned changes in the energy market, the classification of polluting geographical region in the word will also change.

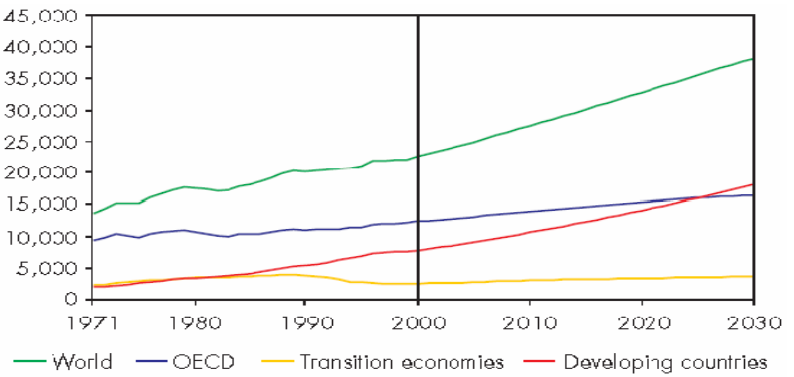


Figure 2: Energy-related CO^2 emission in the world (million tonnes).

On an historical basis, OECD countries have been the biggest producer of greenhouse gases. In the year 2000, these countries produced 55% of carbon emission in the world, while the share of developing countries would rise to 47% and will be known as the areas where the heaviest volume of pollution is released and OECD countries' share will decrease to 43% (Cliniand and Ortis [5]), (OECD/IEA [6]).

Unlike the past three decades, the emission of pollutants will grow faster than energy consumption and this issue highlights the necessity of careful and efficient planning in energy management and energy consumption by all the countries to sustainably maintain and manage the environment. By energy management that leads to efficient use of fossil fuels in industry, building, transportation and changing the condition toward using renewable energies, the amount of pollutants can be controlled and reduced (OECD/IEA [3]), (Cliniand and Ortis [5]). The importance of maintaining and managing the environment is such that nowadays environment requirements are considered as the determinant economic growth rate in the energy sector. In fact, energy consumption is increasingly affected by environmental regulation and the behaviour of consumers can change according to their awareness of the environment. Most of these changes have happened as a result of the increasing influence of NGOs

with regard to the environment and serious efforts to prevent the destruction of the ecosystem and human health and will, hopefully, end in stronger regulation to reduce pollution of the ecosystem. All these issues lead human knowledge to the idea of the optimum use of energy, its management and increased efficiency in consumption. (OECD/IEA [6]), (Fatih [8]), (Gan [9])

5 Energy management and sustainable development

The concept of energy management includes energy efficiency, energy saving, energy tariff and determining the appropriate type of energy and its price. A close link between energy and the environment has highlighted the issue of energy management. The fundamental goal of energy management is to produce goods and provide services with the least cost and least environmental effect.

The objective of energy management is to achieve and maintain optimum energy procurement and utilization, throughout the organization and: to minimize energy costs/waste without affecting production and quality, to minimize environmental effects, Energy Audit is the key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. Globally we need to save energy in order to:

- Reduce the damage that we are doing to our planet, Earth. As a human race we would probably find things rather difficult without the Earth, so it makes good sense to try to make it last.
- Reduce our dependence on the fossil fuels that are becoming increasingly limited in supply

Any of the mentioned methods of energy management would in a way lead to an increase in energy efficiency. Over a long term period this increased efficiency would have many effects on the economy by reducing costs and making stable energy for developing. In the following part the influence of efficiency on sustainable development will be discussed.

6 Improving energy efficiency

Energy efficiency provides a unique opportunity to raise some important challenges relating to energy which are energy security, climate change and economic development. Existing experiences show that efficiency in energy has considerable benefits. If an efficient policy in the energy sector had not been used from 1973, global energy consumption would have been 50% more than the current level. It is estimated if influential measures on energy efficiency costs are executed until 2030, more than 83 Exa J (Exa=10^{18}) energy can be saved (OECD/IEA [10]). Improving energy efficiency which is the result of energy management can be achieved through different ways in the fields of production,

distribution and consumption. Better insulation of buildings, using improved equipment and improving efficiency and modernization in the industry sector of factories are considered the best of such measures (World Bank [7]).

These measures can be used in the economic part of any country but, in spite of saving costs, the implementation of such measures face several barriers. Ignoring of firms from the existing facilities, lack of enough funds to finance, lack of favourable regulation, small projects and lack of appropriate and accessible technology in the desired region are among the most important barriers. The solution to these problems is in differentiating them from one another, for example adjusting regulation, improving technology, setting real price and liberalization in the market.

7 Finding and benefits of energy efficiency

Any country and any energy sector has some fields for energy saving. Energy can be more effectively supplied by improving efficiency in power plant and transmission system. According to an estimation of the International Energy Agency (IEA), the effect of improving energy efficiency in member states has shown considerable progress during the past decades. However, due to the increased use of many diverse home appliances in recent decades, the rate of energy efficiency improvement from 1990 has been equal to half of this parameter in past decades. In figure 3, the hypothetical consumption level in the absence of measures related to efficient use is shown in contrast with the actual consumption.

Base on IEA's forecast in the book "The Prospect of Energy Technology", the current rate of energy efficiency improvement must be at least double the current figure to have a realistic situation in relation with sustainability of energy in the future (OECD/IEA [11]).

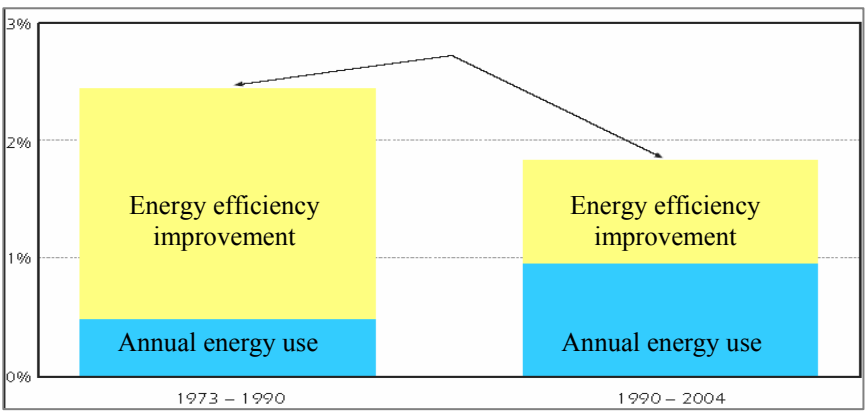


Figure 3: The effects of improvement in energy efficiency on final energy consumption (percent).

The demand for energy services in member states during the period of 1990–2004 has risen annually with the average growth of 1.8%. However, at the same time, in countries the rate of GDP's growth was 2.3% which shows energy consumption activities have grown more slowly than the overall economy. Thus, half of the increase in demand for energy services has been supplied by the increase in energy consumption and the other half has been compensated for through improvement in energy efficiency with the annual average of 0.9% in the period of 1973–1990 an estimated 2% (OECD/IEA [6]). All these measures lead to a considerable amount of saving in energy demand and supply.

According to IEA estimates, energy consumption in building and transportation industries can be reduced to 33% by 2050. The lighting sector in developing countries has great capabilities for energy saving and quality improvement. The growth of lighting consumption in these countries has been twice (3.6%) the growth in industrial countries (1.8%) (World Bank [12]).

8 The macroeconomic effect of energy efficiency

Based on the claims of energy efficiency, improvement on the large scale can result in increased overall efficiency and GDP. The studies of economic input–output models show that consumer and enterprise owner have used the benefits from energy saving once more in economic activities. For example, a 15% reduction in energy consumption during 1995–2010 in UAS caused 770 thousand new jobs which is equal to a 0.44% increase in overall employment rate and 14 billion dollars of wages equal to 0.27% increase in 2010 revenue.

Through postponing the need to build new power plants and fuel saving, energy efficiency can reduce the demand for financial resources in the developing countries and also operation and maintenance costs. Companies improve their financial performance and take advantage of benefits by creating effective competition in the private sector. Less energy consumption leads to public interest since it reduces pollution and improves working conditions by providing better lighting and clean air.

With regard to considering climate change, energy efficiency would be the best, cheapest and fastest way to reduce the destructive effects of it in the next decades. To summarize the macroeconomic effects of energy efficiency in a few sentences, it should be mentioned that with regard to the related fields of these measures, achieving sustainable economic development would be possible. Since economic development involves four main factors of economic growth, poverty reduction, energy security and environmental sustainability. Cooperation of the mentioned factors through measures that caused energy efficiency can lead to sustainable development.

9 Long term ways of achieving sustainable energy

There are two main ways of achieving sustainable energy: macroeconomic planning in the field of energy and operational measures on a micro level. From a macroeconomic view point, using clean and low-carbon energies and

expanding related infrastructures can be named and the most prominent ones are mentioned bellow:

Electricity generation from natural gas: it seems that a share of natural gas in electricity production will be highlighted until 2050 and reach 28% from the current 23%, so that generated electricity in that year would be more than twice the same production level in 2033 (OECD/IEA [11]). CO^2 production from natural gas is roughly half of coal per kilowatt hour electricity. Considering the advance made in power generation technologies the efficiency of combined cycle power plants has reached 60% and using these technologies would significantly reduce pollution level.

Energy production from renewable resources: until 2050, the share of these resources such as hydro-electric projects, wind, solar energy, etc., would reach from the current level of 18% to 34% which would lead to pollution reduction in the range of 9% to 16% in CO^2 (OECD/IEA [11]). Hydroelectric plants which are considered the cheapest energy resource in some regions have great capabilities for growth particularly in small scale. These power plants are considered as the largest renewable energy resources and each country much its maximum ability of water resources. The capital cost of these power plants are low and based on estimates, the cost in member states is 2400 dollars for creating energy per MW capacity and production and operation cost would be 0.3 to 0.4 dollars for every KW per hour. With regard to potential technical capacity of creating small hydro plants in the word, which is around 150 to 200 GW and production cost 0.02 to 0.06 dollars per KW –hour, lower than production cost level, but only 5% of this global capacity has been used.

According to drastic reduction of costs through the use of wind plants, the massive use of these resources has become more attractive. The cost of turbine construction per KW is at best estimated 0.04 dollars which compare to other energy resources has been assessed as competitive. With regard to the advances a head of this technology, it is expected that using these turbines increase rapidly. In some regions, this energy is considered the second renewable resources (OECD/IEA [15]).

There are many cases in micro-level tat have great capability for efficient energy consumption. In many countries, the new buildings can save energy up to 80% more than other ones. In England, for example, improving construction standards reduce energy consumption to 60% from 1965-2005 (Geller [13]).

Using better isolation, ventilation and refrigeration system can improve performance from 30% to 40%. The maximum attainable saving in lighting system from 30% to 60% is achievable. Industry and transportation sectors are also very important, since they consume major petroleum products and saving in these sectors are the fastest way to achieve energy efficiency and prevent pollution emissions (OECD/IEA [11]).

Improving energy efficiency through preventing network transmission casualty is also another major method. Network transmission casualty is very high in developing countries. In Asia electricity networks, for instance, the discrepancy between produced and consumed electricity, the total rate of network casualty is almost 43% and in Latin America around 51%, which are

unbelievably high [16]. In this regard, using appropriate conductors and equipment which have less heat production and, as a result, less energy casualty would be influential. The technical casualty rate in the USA is 6% to 7%, this figure is 3 to 5 times more in developing countries. The fields of improving energy efficiency in different sectors are shown in table 1.

Table 1: The opportunities for energy efficiency in important consumption sectors.

Sector Name	The opportunities for energy efficiency
Building	Overall building design, better insulation
Industry	Industrial progress, recycling waste heat
Cities and Municipalities	Regional heating system, using energy combination, efficient lighting system in passages
Agriculture	Using pumping system and advance irrigation
Energy Supply	New power plant: integrated cycle, integrated gasification combined cycle (IGCC), and using other advance combustion system. renovating current establishment: in the field of energy production including water plants
Transportation	Advanced petrol and diesel engines, extensive urban transport system, using CNG
Households	Using efficient equipment

A very effective and useful measure that is experienced in many countries is to introduce and use standards and energy labels on energy consuming appliances which have been invented and executed by Collaborative Labeling and Appliances Standards Program (CLASP). These measures were so effective that it has been said: investing in standards and labeling is more effective than investing in energy production. From 1999 (when the organization was founded) 21 cases of new standards have been introduced which are executed in 54 countries. According to estimates, using these standards will prevent 90 TW/H energy and 86 million tons of carbon dioxide emission by 2014. For example, China has managed to save 33.5 TW/H or almost 9% in the household electricity sector.

10 Role of government in creating a stable policy encouraging low-carbon energies and effective on energy efficiency

New energy technologies might be more expensive than the current equipment, even with the assumption of total commercial function. Therefore, if there is no economic incentive no significant results would be made. There are different ways to achieve these goals in the form of national or international plans and

also through fiscal and regulatory measures. Both developed and developing countries need such incentives. Also, developed countries have a significant role in helping developing countries to improve and transmit technical knowledge, expanding capacities and research and developed cooperation.

Fortunately in recent decades, particularly in the last few years, policy makers have understood the importance of energy security and the environmental impacts of in efficiency.

In their technical and economic support, international organizations and institutions have declared making energy consumption efficient as one of their priorities that matches the development goals in the third millennium and by providing financial and technical facilities, have taken serious steps on this path. An international bank group, one of these institutions, has invested up to 1.3 billion dollars in 40 countries from 1990 in the field of energy efficiency (Word Bank [12]).

IFC has also considered measures for private sector investment that shows the significance of establishing and maintaining energy and finally, determine achieving sustainable development. So, from a national scale, governments' roles and responsibilities are more fundamental and they have to execute coherent policies and encourage society to use existing experiences. These measures can be different for every country's condition and its priorities. The strategies that governments can use to improve and promote energy efficiency include:

- Using tools based on policies and guidelines.
- Setting necessary regulations for making energy services efficient.
- Organization support and underpinning financial structure.
- Using market mechanism.

A successful overall strategy would aim at:

a. Reducing the gap between energy demand and supply.
b. Improving energy efficiency and conservation by lowering energy and resource intensity.
c. Achieving the optimal energy mix.
d. Diversifying sources of energy supply.
e. Investing in energy infrastructure development.
f. Shifting to alternative and renewable sources of energy.
g. Encouraging innovation and competition through research and development.
h. Reducing vulnerability to energy price fluctuations.
i. Achieving good energy sector governance.

11 Conclusion

With regard to global energy market transformation in future decades and the fact that the major share of global energy will be consumed in developing countries with rapid growth in some of energy consumption sectors, it is necessary that all countries, particularly developing countries, put developmental

policies in energy security and pollution reduction in agenda. Energy has substantial peculiarities which, in the case of crisis, can make the greatest impact on other sectors. This impact does not only include economic sectors, but also affects social, health and, more important than others, the environment. As a result, energy management is the central issue for creating sustainable energy. With sustainable energy we will have sustainable development. Creating energy security and promoting efficiency, which is due to good energy management, can bring about unbelievable positive effects. In this regard, governments should:

- Through policy making, promote clean energies and expand capacities in renewable energies.
- Create regulatory and fiscal incentives, creating research fields, development and using the market mechanism using investment advice of international institutions.

Prepare the ground to establish an influential and efficient system.

Considering the following can help us through energy efficiency plans for achieving sustainable development along energy management:

- Improving energy efficiency is the main factor for creating wealth in countries.
- Success in management and improvement in energy efficiency which depends on governments' attitudes.
- Energy efficiency is the largest, cheapest and fastest way to prevent destruction of the environment.

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