

# Survey the Effect of Renewable Energy on Sustainable Development in Selected Countries over the World (Case Study: Electricity)

Narciss Aminrashti<sup>1</sup>, Cyrus Hezhabri<sup>2</sup>

<sup>1</sup>Assistant professor of the Islamic Azad University Central Tehran Branch, faculty of economic and accountancy (IAUCTB), Tehran, Iran.
<sup>2</sup>Postgraduate in planning systems economics of the Islamic Azad University Central Tehran Branch, faculty of economic and accountancy (IAUCTB), Tehran, Iran.

## ABSTRACT

Today energy sector plays a key role in achieving sustainable development and it is one of the most important indicators of economic development.

Increased demand for fossil fuels and the impending completion of these resources and its following, forecast for global energy price increases due to the limited fossil resources, and faced the world with energy crisis. Hence the importance and necessity of changing the current system of production and consumption of energy and replacing it with renewable energy resources to meet future global energy needs for survival, evolution and development appears. The main objective of this study is to evaluate the impact of renewable energy and on sustainable development, recognizing the status of renewable energies in electricity production and achieving sustainable development. In the present study, the impact of renewable energy on sustainable development through panel – data, using fixed effects and for a period of 7 years (2001-2007), is examined. The findings of this study show that the variables in the model, the expectations are that there is a connection between renewable energy and sustainable development. Renewable energy in terms of technical, environmental and economic benefits plays an important role in the world's future energy combination. So the renewable energies is one of the most effective and influential ways on developing sustainable energy. **Keyword:** Renewable energy, sustainable development, electricity.

**JEL classification:**  $Q_{20}$ ,  $O_{10}$ ,  $Q_{40}$ .

#### **1. INTRODUCTION**

The world will face energy crisis in the future. Increase of demands for fossil fuels and imminent completion of these resources and following that forecast of the increase in world price of energy due to limitation of fossil fuels has encountered the world with energy crisis. Therefore, the importance and necessity of changing the present system of consumption and production of energy and to replace it with renewable energies in order to response to energy needs of the world in the future, for existence, completion and development will be manifest. On the other hand, if the present processes of using fossil fuels continue, the extensive and necessing of greenhouse gases in the atmosphere will quicken the process of changing climate of the world and intensify the phenomenon of earth temperature rise. According to scientists, the temperature of the globe will averagely increase 6°C until 2030. Thus, in order to protect the residential globe from these irreparable dangers, it is necessary to use renewable energies in all countries of the world.

Furthermore the necessity of variation in the way of using of fossil fuels for their desirability and more useful applications is another important factor which manifests the necessity of usage of new energy resources.

It is noteworthy that environmental problem and difficulties resulting from fossil fuels are a major threat to countries which don't have advanced technology. Therefore, diversification of a country's energy resources, which it needs to prosper, and application of new energy resources in order to reach economic, social and environmental developments and following that access to steady expansion are included in overall policies in energy sector and the entrance of private sector in arena of producing new energies and governments patronages (aids) are considered the important strategies in developing usage of renewable energies.

Corresponding Author: Cyrus Hezhabri, Postgraduate in planning systems economics of the Islamic Azad University Central Tehran Branch, faculty of economic and accountancy (IAUCTB), Tehran, Iran, E-mail: Cyrus \_ hezhabri @yahoo.com

### 2. LITERATURE SURVEY

Energy is the building block of human activities. National security of all the countries in the world depends upon surely access to energy. Indeed the importance of energy is manifest because it is the locomotive of national development.

Development, in its broad meaning, refers to a process that developed countries have paced in the last two centuries. This process has had two main achievements: industrialization and new organization of society or civil community. Science means understanding the procedure and principals of phenomena, thus recognizing the procedures and principals of expansionism formulate a knowledge by which the process of development will be carried out in seediest procedures and with the least mistakes. Therefore, understanding the rules and rubrics of energy consumption (usage) in the process of expansion is the first and necessary (might of) condition for every right programming and policymaking about energy. The experience of using new economic policies in different countries of the world has shown that hasty implementation of these policies without deep theoretical and practical survey or recognition of other countries and conformity of policies with specific conditions of each country will result in undesirable consequences.

In order that the development to be permanent in the long run, it should take into account the limitations that created by environment and national resources. The view that considers environment conservation as an obstacle for economic development is a parochial one. If environmental limitations are disregarded, accurate development of human activities requires consideration of environmental and present resources limitations in the region (limitations of environment and present resources of the region) in all steps of programming and management[9].

## 2-1. Economic and social factors effecting emission of greenhouse gases

The relationship between economic growth and development, and environment is one of the important and complex issues, so that the quality relationship between energy sector, environment and economic growth, is one of the basic axes of every country's sustainable development. Economic literature includes a strong relationship between the level of economic activities (economic growth) and energy consumption, because energy as the locomotive of most of the productive and service activities, has a major role in economic growth and development. Some of the ecologic economists such as Nair and Ayres claim that energy is the only and the most important growth factor, the believe that (from their point of view) work force and capital are mediator factors which their correct application requires use of energy [21]; while neo-classic economists believe that energy by the effect that is put on work force and capital, and has an indirect effect on economic growth and don't has a direct effect on economic growth [20].

However, according to all of the policymakers, over use of energy especially fossil fuels, for the purpose of economic growth and also lack of enough efficiency in use of it will increase the environmental pollution; as one of the important factors of air pollution is emission of CO<sub>2</sub>, which is one of the important greenhouse gases, is the result of fossil fuels in production, commercial, service and house hold sectors [1].

According to Myer and Kent, about the relationship between energy consumption and environment pollution, after industrial revolution by over using of energy both average profitability of work force and destruction of environment increased. Therefore, adoptive policies in energy sector and environment have close relation with each other and energy sector plays a major role in environmental diversification (in changing the condition of environment) [14].

It is noteworthy that economic growth is one of the important factors regarding the source of environmental effects, because increase of economic growth, will increase the use of natural resources and on the other hand production of low quality products increase environmental pollution. In this regard many studies have been conducted such as environmental Kuznets curves. The meaning of this curve is derived from Kuznets idea (1995) about a relation in the form of an inverted U between capitation income and inequality of income distribution, which appeared for the first time in 1990 and spontaneous with studying potential effects of signature of north America free trade agreement on environment by Grossman and Krueger (1991) and also Shafik & Bandyopadhyay's study 1992 which propagated in the report of universal development of 1992. In this report it has been noted that:

If technology, interests, and investment are considered permanent in the environment, increasing the spectrum of economic activities will undoubtedly result in destruction of environment. Also with increase of income per capital, demand for the increase of the quality of environment and investment will increase thus, one cannot say that certainly economic growth will result in environment destruction[11].

Bekerman also says that economic growth in its primary phases will result in environment destruction, but in the end the best and may be the only way of preserving and increasing the quality of environment in countries of the world and bringing wealth for them, is economic growth [6].

Proponents of environmental Kuznets hypothesis believe that at upper levels of development, economical structure move towards new industries and technologies. Compounding parameters and pollutant energies will be adjusted. Also, cognition of environment will gradually increase and suitable environmental rules will be enforced an also paid expenses for preserving and increasing the quality of environment will increase. So, the effect of economic growth on environment can be divided into three parts:

- 1. Criterion effect
- 2. Structural effect

3. Technological effect [5, 22].

#### 2-2. Economic development and pollution of environment

Environment and natural resource provide much of the productive factors, and production process, in addition to desirable product (used products) will produce undesirable outputs (environment pollutants). If the extent of these output don't be controlled and they be unsuitable, the damage of these undesirable outputs will be more than profits of desirable products; in a way that costs of damages to environment create unparalleled damages and endangers the sustainable development.

According to many scientists upper levels of economic activity (production or consumption) requires more energy and first hand materials (primary materials) and therefore create a great deal of secondary waste materials. Increasing derivation of natural resources, accumulation of waste materials and centralization of pollutants will go upper than the bearing capacity of the globe and finally will result in its destruction. Indeed despite the increase in the level of income we see decrease of human welfare. In addition, destruction of natural resources will finally endanger economic activity. Therefore, in order to preserve environment and even preserve economic activities, economic growth should be stopped and the world should move toward economic in a steady state [16].

On the other side of improve the quality of environment depends on economic growth. In other words in this view growth is a precondition to improvement of environment quality [17].

But, environmental Kuznets curve shows the relation between capitation income and destruction scales of environment in the form an inverted U. According to this hypothesis the relationship between economic growth and quality of environment, whether positive or negative, is not permanent in development course of a country. In fact, when a country reaches an extent of income when demands of people for a cleaner environment and their effects for effective infra structure increase, the sign of this relation will change from positive to negative. Environmental Kuznets curve describes a dynamic process of change. It means that at the lower levels of development both the quality and the extent of environmental destruction will be limited to effects of continues economic activity on natural resources and also on the amounts of dissoluble waste materials. But when technological surge happens, or the intensification of deduction in natural and agricultural resources, the depletion of natural resources and also the production of waste material will speed up. At upper levels of development, structural changes towards industry and related services of information, better technologies and increasing demand for improvement of environment quality will result in a monotone decrease in the process of environmental destruction [13,19].

#### 3. Theoretical concepts of the notion of sustainability in development theory

Development and sustainable development will be reviewed from different points of view. Today, the idea of steadiness is considered one of the contemporary styles and its formation returns back to 1970s in response to widespread interventions in environment and energy crisis. Sustainable development can be defined as the balance between environmental, economical and social issues, and its effectiveness depends on protecting and increasing the quality and quality of using resources, skills and community. Development includes the forward economic and social change; a development course which is physically dynamic can be traced theoretically even in an inflexible social and political context (situation); but physical will not be provided, unless development policies take in to account factors like access to resources and distribution of profits and expenses. Even the notion of physical steadiness shows social equality among generations, (an issue) which should logically be expanded for the equality in every generation [7].

Steadiness, in its broader sense, refers to the ability of society, ecosystem, or every kind of present systems to continue the application in unlimited future, without necessarily weakening resources which system depends on them or imposition of more burden on them [10]. On the other hand, system's ability for preservation and perpetuity depends inevitably on success which it acquires in creating relation with the

external environment; in other words steadiness of system depends totally on the capability of it for compatibility and conformity, change and response to environment and as environment perse is always in a state of change (diversification), this process of compatibility and conformity should be a dynamic and sensitive process. Thus, steady system needs to a useful internal function and to compatible relation with environment, in better word it needs internal and external steadiness (in relation with environment) in order to function as a steady system. The nation of sustainable development shows this undeniable truth that consideration related to ecology can and should be used in economic activities. These considerations include ideas of creating logical context in which the claim of development for the purpose of increasing the quality of all aspects of life can be challenged [15,18].

#### 4. Conducted studies

Aviral kumar tiwari, in this study, under the title of VAR structural analysis on renewable energy consumption, real GDP and CO<sub>2</sub> diffusion in India between1960-2009, Evidence has showed that a positive impulse (shock) in consuming renewable energy resource will increase the right GDP and will decrease emission of CO<sub>2</sub> and also a positive shock on the right GDP has a very high positive effect on propagation of  $CO_2$ . In another study which has been conducted with the title of comparing performance of renewable and nonrenewable sources on economic growth and CO<sub>2</sub> diffusion in Europe and Eurasian countries )PVAR approach) for A period of 1965-2002 has showed that increasing the rate of renewable energies has a negative effect on growth rate of GDP and increases propagation of CO<sub>2</sub>. Generally we conclude that renewable energies have a positive effect on the growth of GDP and in order to reach higher economic growth, increase of economic and employment productivity and a clean and permanent environment, it is necessary to decrease the usage of nonrenewable energy resource[3,4]. Susana silva and et.al in their study under the title of examining the impact of renewable energy sources on economic growth and CO<sub>2</sub> diffusions: a SVAR approach for the period 1960-2004 which they conducted in Denmark, America, Portugal, Spain concluded that except America, in other countries, increase in the proportion of renewable energies for producing electricity may at first endanger economic growth but will decrease propagation of CO<sub>2</sub>; Therefore, these countries need to support renewable energy resources with other policies (like management of suppliant and energy preservation)[23]. Yusuf bayraktutan and et.al in a study they conducted with the title of renewable electricity generation and economic growth: Panel-Data analysis for OECD members for the period 1980-2007, concluded that the rate of production of electricity from renewable resources has composed about 17-20 percent of total electricity production of all resources during the past years of study. The production rate of electricity for the above countries two fold (doubled) and production of electricity from renewable resources shows an increase of 70 percent [24].

#### 5. Observing the processes of renewable energies

The emergence of other energy crisis in the world, like the crisis of 1979 can be for seen. These crisis are not related only to provision of energy. But will include an intricate compound of environmental problems. Renewable energies are those which are produced from natural resources such as: air, rain, underground steaming, sun shine or sea wave and can be renewed in a short time. The electricity produces by these resources is called green electricity [12]. Clean energies have been one of the most dynamic and competitive sectors of renewable energies in financial and investment affairs with a growth rate of 630 percent since 2004. Countries like china, Germany and India have been good investors because they followed national policies in their agenda that supports standards of renewable energies. Researchers believe that by adopting suitable and effective strategies, the idea of replacing renewable energies will the present and usual resources will take effect in the next 40 years. According to the last studies conducted in the air and space centre of Germany, in 2050 and with the improvement of output of renewable systems more than 70 percent of the world's needed electricity will be produced by renewable resources. That is to say that in 2090 we will see complete turn of the world towards renewable energies and decrease of %99 of environmental pollution and their replacement with clean energies.

It is expected that during the years 2007 - 2009, the capacity of world's electricity will increase with a rate of 1.7 percent from 4428 GW in 2007 to 2009 in 2035. The average growth rate of the capacity of electricity in OECD countries and non OECD countries in the above mention period will be 0.7 and 2.5 percent respectively. Also, during that period, the highest capacity will be related to sun power houses with 7.9 percent and the lowest will be related to power houses with liquid fuel with a growth of -0.8 percent. During that time the average yearly growth rate of other power houses will be: weather power houses 6.1 percent, geothermal 3.2, hydro electricity 2.0, coal burning 1.8, unclear 1.6, gas fired power house 1.2, and other renewable 3.2 percent. According to scenario of reference to renewable energies as an electricity

resource with a yearly growth of 3.0 percent, will be the speediest growth. The proportion (ratio) of renewable from all productive electricity of the world will reach from 18 percent in 2007 to 23 in 2035. More than 80 percent of this growth comes from hydro electricity and weather power houses. We forecast that the production of weather power houses of the globe will increase from 165 TW/h in 902 TW/h in 2020 and to 1355 TW/h in 2035, and its average of growth will be 7.8 percent. Despite the fact that the ratio of sun power houses in production of electricity is very low, but it has and will show considerable growth. Production of this power houses will reach from 6 TW/h in 2007 to 125 TW/h in 2035 and its average yearly growth will be 12.7 percent [21].

#### 6. Introducing the model

The main frame work of paneled model is:

 $Y_{it} = \alpha_i + \beta X_{it} + \epsilon_{it}$ (1) In this section for the purpose of computing the effect of renewable energies on sustainable development (case study: electricity), the compound data will be used in the following from during the period 2001-2007:

 $Y_{it} = \alpha_i + \beta_1 HER_{it} + \beta_2 HDI_{it} + \beta_3 RENTOTAL_{it} + \beta_4 RGDP_{it} + \varepsilon_{it}$ (2)

In which the variables include: Y (sustainable development), for Y we use variables of energy consumption of transport relative to GDP; green gas diffusions and real GDP per capita, growth rate and total which we accessed them with normalization taxonomy and degree of development and use it as a dependent variable in this model, RENTOTAL (weight of renewable resources on total production of electricity) will be computed from the following equation: 

$$RENTOTAL = \frac{REN}{REN + OTHER}$$
(3)

Her (heritage index), HDI (human development index), RGDP (real gross domestic production) are used as explanatory variable in this model. Totally, 16 countries<sup>1</sup> out of 26 European countries which have been used in this survey are selected in this survey (research). Data of variables (indexes) of sustainable development, real GDP, production of electricity from renewable resources and total electricity have been derived from statistical collection of Euro- state and data of human development index is derived from the report of human development and heritage index derived from heritage unit.

#### 7. Applying the model and analyzing the results

Computing the models with application of fixed effects strategy, which in its consideration takes into account the individual differences between countries. Yet, adoption of this strategy has been done after taking two tests which include redundant fixed. Redundant fixed effects-likelihood Ratio and correlated fixed effects-Hausman test.

Variable	Coefficient	T-Statistic	Prob
С	-1.8536	-3.2101	0.0018
HER?	0.0099	3.2302	0.0017
HDI?	1.0115	2.1090	0.0295
RENTOTAL?	0.9119	1.9332	0.0563
RGDP?	0.00000146	3.4527	0.0008
$\mathbf{R}^2 = 0.83$	$\overline{R}^2 = 0.79$	D.W= 1.32	F= 24.14967 Prob: 0.00000

Table1: The result of computed model is included in chart

Source: Authors calculation

#### interpreting coefficients:

Positive but little coefficient of heritage index (0.009) shows that the increase of sustainable development for per unit of the increase in heritage index. In other words, in these countries, the extent of increase in sustainable development per every unit of increase in heritage index implicitly shows that these countries have a suitable economic environment or collection of compatible policies with economic relaxation. As it is noted, coefficient computed for HDI variable is 1.01 and shows that human development index means which is more than solely emphasizing economic growth, and other aspects of human's life quality, is considered as the criterion and standard of development. As we can see, computed coefficient for real GDP variable is 0.00000146. Thus it's positive albeit little coefficient shows the increase of sustainable development or in other words it may be said that these countries are in the second phase of environmental

<sup>1)</sup>Belgium, Switzerland, Czech Republic, Estonia, Finland, United Kingdom, Hungary, Ireland, Latvia, Lithuania, Netherlands, Norway, Poland, Romania, Slovenia, Sweden

Kuznets curve. Coefficient of weight of renewable energies which constitutes the basics of our study is 0.91 and shows that sustainable development increases for every unit of increase in the weight of renewable energies. In other words one of the effective factors in moving towards sustainable development is development of energy systems which are cheap, secure and compatible with the environment.

#### 8. Summary and conclusion

In order to response to the research question and with regard to the aims of research in the form of compound data and after conducting requisite tests with the fixed effects strategy, the following results have been reached:

The variable heritage index is influential variable in increasing the level of sustainable development. In other words, these countries, the extent of increase in sustainable development per every unit of increase in heritage index implicitly shows that these countries have a suitable economic environment or collection of compatible policies with economic relaxation.

The variable HDI is considered as an effective variable in increasing the level of sustainable development which has the following characteristics:

With regard to basic elements of the model of human development, however the relation between economic growth, social and environmental aspects of development will be recognized, unilateral consideration of economic growth will inevitably result in a sustainable development. Therefore, development anxiety in the new paradigm is the multilateral happiness of human generation. Sustainable development will not be brought about, unless we provide economic development, social development and environmental preservation.

The variable of RGDP is an effective variable in increasing level of sustainable development and with regard to the above results it can be said that countries which are surveyed are placed in the second phase of environmental Kuznets curve. Thus the following points are important:

I. The more the level of income increases during the process of economic development, in opposite more derivation of natural resources and increasing environmental destructions will decrease human welfare.

II. The course of quality improvement is parallel with economic growth, and in order to improve environmental standards, we should move towards economic growth.

Identifying positive and meaningful effects of electricity from renewable energy on sustainable development, therefore:

-Renewable energies have external positive effects, Including environment and security of providing electricity in the long run.

-Renewable energies with the least pollution of greenhouse gases, the least production of dangerous waste materials and with the least hidden expenses, bring about the lowest environmental problems in comparison with fossil fuel systems. Coefficient of variable of renewable energies is positive in this research that has the following points:

I. Energy sector, have a key role in access to sustainable development and are one of the important indexes (criteria) of economic development. In fact the manifest importance of energy especially renewable energies are for this reason that it (energy) is the locomotive (stimulus) of national development.

II. Demand for electricity has recently been increased which is the quickest growth in energy consumption.

Therefore, renewable energy in terms of technical, environmental and economic benefits plays an important role in the world's future energy combination. The renewable energies is one of the most effective and influential ways on developing sustainable energy.

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## Appendix 1: FIXED EFFECTS TEST

Dependent Variable: Y? Method: Pooled Least Squares Date: 06/23/12 Time: 13:29 Sample: 2001 2007 Included observations: 7 Cross-sections included: 16 Total pool (balanced) observations: 112

Variable	Coefficient	Std. Error	t-Statistic	Prob.
С	-1.853675	0.577436	-3.210182	0.0018
HER?	0.009913	0.003069	3.230241	0.0017
HDI?	1.015600	0.459360	2.210901	0.0295
<b>RENTOTAL</b> ?	0.911976	0.471736	1.933236	0.0563
RGDP?	1.46E-06	4.24E-07	3.452767	0.0008
Fixed Effects (Cross)				
BELGIUMC	0.562859			
SWITZERLANDC	0.241592			
CZECHREPUBLICC	0.034938			
ESTONIAC	-0.852036			
FINLANDC	0.665121			
UNITEDKINGDOMC	-1.632964			
HUNGARYC	0.408016			
IRELANDC	0.591281			
LATVIAC	-2.122723			
LITHUANIAC	0.556330			
NETHERLANDSC	0.690932			
NORWAYC	-0.770325			
POLANDC	0.423173			
ROMANIAC	0.277823			
SLOVENIAC	0.491386			
SWEDENC	0.434594			

Effects Specification

Cross-section fixed (dummy variables)						
R-squared	0.832983	Mean dependent var	0.473571			
Adjusted R-squared	0.798491	S.D. dependent var	0.217267			
S.E. of regression	0.097531	Akaike info criterion	-1.656864			
Sum squared resid	0.875128	Schwarz criterion	-1.171417			
Log likelihood	112.7844	Hannan-Quinn criter.	-1.459903			
F-statistic	24.14967	Durbin-Watson stat	1.326403			
Prob(F-statistic)	0.000000					

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