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The Applications of the Economics of New & Renewable Energy: A Case Study of Egypt

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ABSTRACT

Purposes –This research paper focuses on the application of the environmental economics of new and renewable energy in this respect in both the developed countries, and in the developing, then applying this in the case of Egypt. This in fact deals with several pillars that provide for studying the effect of the application of the environmental resource economics on key macroeconomic variables related to development and growth.

Design/methodology/approach –The common acceptable measures of the impact of new and renewable energy on the process of development and that of the growth are researched and analyzed. The analysis covers the effect on key macroeconomic variables. The methodology used in this study provide for a comparative analysis of the case of the developed countries versus that of the developing countries with extended application on the case of Egypt.

Findings, Originality/value - The research work is an original combination of integrated framework of the analysis of the role of the environmental economics of new and renewable energy in the process of economic development and growth. The findings of econometric running of the Egypt's data explored that there is a very strong correlation with a Pearson correlation coefficient of degree one (r = 1) between the GDP and the "New & Renewable Energy Consumption in '000 Current USD" in one hand, and between the GDP per capita and the "New & Renewable Energy Consumption in '000 Current USD" in the other hand.The study made set of recommendations concerning the possible means to help the developing countries.

Key words – The Environmental Economics of New and Renewable Energy, Innovation economics, Research and Development (R&D), Technology, Macroeconomic variables, Gross Domestic Products (GDP).

1. Introduction

During the recent years, the world witnessed several substantial changes. Such crucial changes were evident in the special emphasis given to the environmental economics as related to application of the new technologies that changed the global economy. The strength and magnitude of the environmental economics impacts of the application of new and renewable energy are studied in this research paper.

Such impacts reshaped the global economy and led to provide for new types of investments that were matched with a rapid growth in total investments, in the Gross Domestic Products (GDP), and in the global GDP growth rate.

This boosted the development process all across the world, and enforced new types of investment in all economic sectors. This definitely changed the whole economic system, and reshaped both economic and human development. The whole process is led by the industrial countries through the transfer of technology. This ultimately led to stimulate the direct domestic investment and the indirect domestic investment by providing diversified sources of energy.

This research paper focuses on the application of the environmental economics of new and renewable energy in this respect in both the developed countries, and in the developing, then applying this in the case of Egypt. This in fact deals with several pillars that provide for studying the effect of the application of the environmental resource economics on key macroeconomic variables as related to development and growth.

The relevant study was carried to provide a framework of its applicable results and recommendations. Thus, this study could be considered as the first case study in this connection. This was achieved by identifying –in a precise manner- the main dimensions of the environmental economics of the new and renewable energy practices as related to economic development and growth. Thus, the ultimate objective was to design the proposed framework concerned with achieving a better observation of the effects on the macroeconomic. This ultimately set a method to tackle the main dimensions of the problems of the developing countries in this connection. This required providing recommended solutions to the problems related to the tasks that need to be undertaken to avoid any future similar defaults in case of the developing countries.

2. Methodology of the Study

The research work was concentrating on the study of all relevant aspects of the environmental economics of the new and renewable energy. The main macroeconomic impacts of the application of the new and renewable energy on the position of any country are researched and analyzed.

The common acceptable measures of the impact of application of the new and renewable energy on the process of development and that of the growth are researched and analyzed. The analysis covers the effect on key macroeconomic variables.

The analysis is extended to apply on the application of the new and renewable energy in case of Egypt's macroeconomic position. Then, the methodology used in this connection is extended to cover the possible means to avoid the repetition of the defaults of the developing countries in this connection.

At the end of the study, the results were interpreted accordingly and in conjunction with the elements of the literature review to reach recommended solutions to the problems related to the tasks that need to be undertaken to avoid any future similar defaults in case of the developing countries.

3. Literature Review

In fact, when we study the main elements of this proposed research, we discover that these main elements are directly related to the effect of the environmental economic of new and renewable energy on the economic development and growth in the developed countries versus the position of the developing (less-developed) countries. This research provides a link between them. Such link has not been subject to any previous literature.

This is the main gap in the previous economic literature. Accordingly, no previous case study attempted to advice on how to practically promote the position of the developing (less-developed) countries as related to environmental economic of new and renewable energy.

Environmental Literacy Council (2007) emphasized that the environment and the economic development are interdependent. The key success in this connection is the rational utilization of the resources. Clean energy sources given by new and renewable energy is the main vehicle to attain this objective.

The UNEP (2002) emphasized the need to attain sustainable development by using resources with depleting them. This gave rise to the use of new and renewable energy to replace fossil fuel in producing energy.

OECD (2005) defined innovation as "*the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations*". The Organization for Economic Co-operation and Development (OECD) focused exclusively on product innovation which, according to the Oslo Manual, is defined as "*the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. Product innovations can utilize new knowledge or technologies, or can be based on new uses or combinations of existing knowledge or technologies*". This applies to the new technological methods that are used in providing clean energy through the new applications of new and renewable energy.

Bishop (2004), Botkin & Keller (2008), Harrington & Morgenstern (2004), and Heakal (2003) argued that the marginal benefit from the utilization of the ordinary sources of energy is declining, especially if we consider their environmental adverse impacts, subject to the Law of Diminishing Returns. The Law of Diminishing Returns was first developed in 1767 by the French economist Turgot in relation to agricultural production, but it is currently referred to Thomas Malthus and David Ricardo in its wide range applications. Accordingly, the viable alternative in the long run is the usage of the environment friendly clean sources of energy given by the new and renewable energy sources. According to Kolstad (2010) & Mankiw (2013), this can be enforced by the use of the Pigovian taxes (named after the economist Arthur Pigou) and by the use of subsides to reduce the environmental externalities resulting from the ordinary sources of energy.

Daly (1978) and Simon (1996) suggested that "enough is best," stipulating that economic growth leads to environmental degradation and inequalities in wealth. Therefore a steady-state economy is one in which there is an optimal balance between population and economic activity in order to attain sustainability. They found that eventually the innovations help prices to end up below what they were before. This makes new and renewable energy viable in the long run in terms of price and quantity.

According to Hussen (2004) and Henderson (2012), the cost-benefit analysis (CBA) must consider the externalities as implicit costs associated with the use of ordinary sources of energy, such as fossil fuel. This ultimately gives rise to the need to replace the cost effective alternative of the new and renewable sources of energy.

Pollin, Heintz, and Garrett-Peltier (2009) explored the importance of investing in "clean-energy investments". They analyzed that traditional fossil fuels is the primary source of carbon dioxide (CO2) in the atmosphere which in turn is the primary cause of global warming. This raise the need to expand in supplying energy from new and renewable energy sources such as solar, wind and biomass energy.

It is clear from the previous illustration of the literature review that this study fills a gap in the environmental economic literature by exploring the position of the developing (less-developed) as related to new and renewable energy by taking Egypt as a case study. Then, this study moves to another addition to the literature by setting recommendations to boost the position of the developing countries in this connection.

4. Macroeconomic Impacts of New and Renewable Energy

4.1 The Theory of Clean Energy Growth Rate

Research and development (R&D) is set to be one of the main drivers of the Gross Domestic Product (GDP). Knowing that GDP is the sum of consumption expenditure (C), investment expenditure (I), government purchases (G), and the net exports [exports (X) –imports (M)], such that:

GDP = C + I + G + (X – M) **(Eq. 1)**

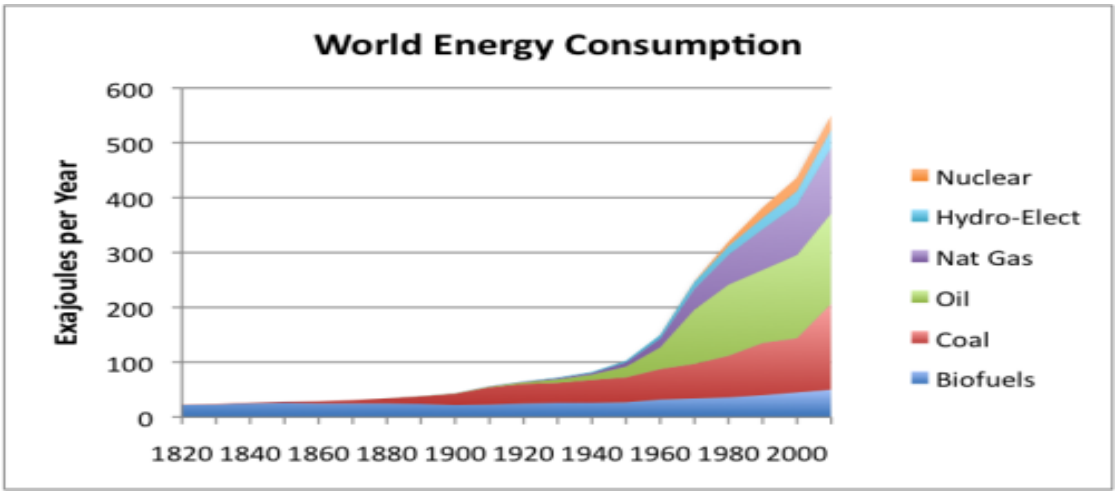
In fact, clean energy is driven mainly by the use of new and renewable energy to replace fossil fuels to attain sustainable economic growth. Thus, innovation as related to productivity of new and renewable energy interprets the economic doctrine of the best utilization of the scarce resources. The growth in I leads to a direct growth in X and to a direct decline in M. In the long run, the accumulation of revenues in the economy matched with growth in investment will ultimately lead to creating new job opportunities and increasing the demand on the new and the existing types of jobs. This will in turn increase the long run real wage levels, which will increase C and savings (S). Therefore, GDP will increase. This situation in the economy of diversified sources of sustainable energy sources will attract domestic investment, especially with the increase in S, and will attract foreign direct investment (FDI) as well. The cycle will be repeated and repeated. It will continue as such as long as the component of the sustainability of clean energy still exists. No doubt that the acceleration in the new and renewable energy as an engine of growth will lead to an accelerated rate of growth in GDP to the extent to exceed the rate of growth in the general price level. This means that actual rate of inflation will decline. This is matched by lower rate of unemployment, and a higher GDP growth rate. This situation of the economy, I would like to call it as "*The Theory of Clean Energy Growth Rate*", whereas new and renewable energy act as a mean vehicle of a comprehensive economic growth as mentioned in the analysis shown here.

4.2 The New and Renewable Economic Position of the Developed Countries In Contrast To That of the Developing (Less-Developed) Countries

New and renewable energy markets in countries expand and shrink subject to the changes in policies, technologies and financial incentives. Alternatively, the recent Wall Street Journal weekly reports of 2015 showed that energy mutual funds are continuing to recover from a slump which started in fall 2014. Annual returns varied dramatically from a high of 15.6 percent for Brown Advisory Sustainable Growth (BIAWX), to a low of -15.8 percent for Guinness Atkinson Alternative Energy (GAAEX). The huge drop of GAAEX was attributed to losses in some of its major weighted holdings.

The following figure (Fig.1) shows the change in the composition of the energy consumption over time across the world:

Fig. 1: World Energy Consumption Over 180 Years Distributed By Types of Energy

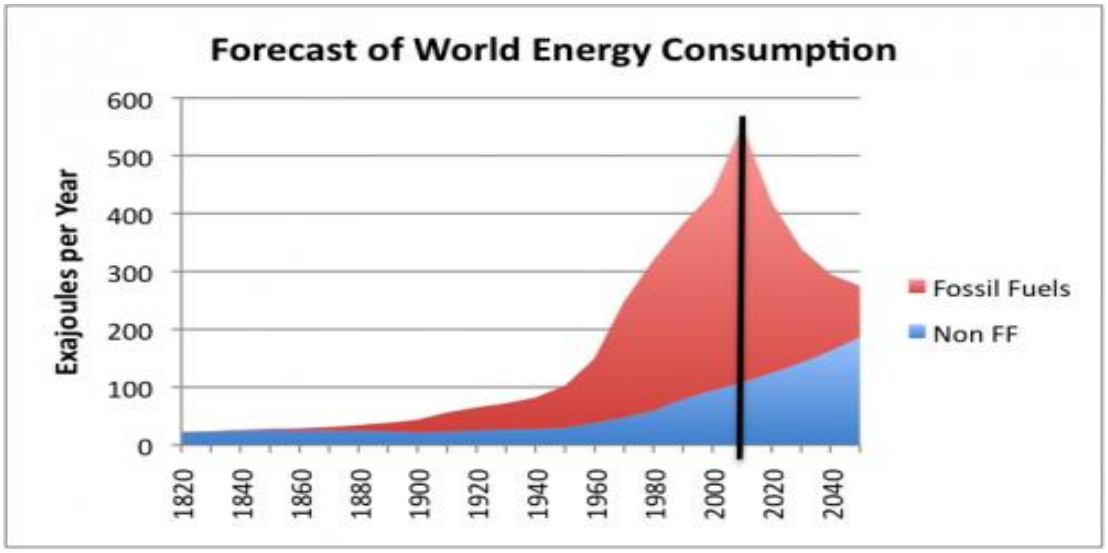


Sources: ***Vaclav Smil Estimates of Energy & BP Statistical Data on 1965 and subsequent***.

The biofuel category also includes wind, solar, and other new and renewable energy sources. Fig. 1 shows that biofuels together with the nuclear and hydro-elect sources did not replace yet fossil fuels.

The world is considering the possibility of reducing fossil fuel use by 80% by 2050 to be replaced by new and renewable energy in order to help prevent climate change. This change will result in positive impacts on the sustainability of the growth of the global GDP.

Fig. 2: World Energy Actual & Forecasted Consumption Over 220 Years Distributed By Types of Energy



Sources: ***Vaclav Smil Estimates of Energy, BP Statistical Data on 1965 and subsequent & Estimates of 80% Reduction in Fossil Fuels by 2050***.

Fig. 2 shows that biofuels together with the nuclear and hydro-elect sources will replace yet fossil fuels gradually. This means that clean energy sources will turn to be the vehicle of development in the long run. Therefore, the GDP growth will depend on new and renewable energy sources in the long run.

It is clear from the previous analysis and the measured findings that there is a direct positive relation between the production of new and renewable energy and development, and sustainability in case of the developed and the developing countries.

Developed countries are the sole supplier of the technology used in producing innovative new and renewable energy. Although new and renewable energy technology is produced through innovation in the developed countries, but still developing countries are moving towards the application of new and renewable energy.

Collectively, developing countries reached almost more than half of global new and renewable power capacity. China, India and Brazil are continuously expanding markets of producing new and renewable energy. Many new and renewable energy markets are growing at high speed rates such as the markets of Uruguay, Thailand, Indonesia, Argentina, Costa Rica, Egypt, Kenya, Tunisia, and Tanzania. Egypt is the most expanding market in its region.[1] This justifies taking Egypt as a case study to represent the emerging new and renewable energy markets in the developing markets

[1] REN21 (2010). *Renewables 2010 Global Status Report* p. 9

5. Application the Economics of the New and Renewable Energy in Case of Egypt

The Egyptian Government announced its 10-year plan to generate 20% of the country's energy production from new and renewable resources by 2020, equivalent to around 7GW of electricity[2], such that wind will represent 12% and hydro/solar energy will contribute 8%.

Electricity is subsidized in Egypt for a population of almost 90 million inhabitants, in addition to the other normal economic activities. Egypt is encouraging the private sector participation, in its new and renewable energy plan, to be accommodated by the Egyptian national grid, which is comprehensive and provides almost all the modern electricity services. The Central Bank of Egypt (CBE) supports the plan by guarantying all financial obligations of the government-owned Egyptian Electricity Transmission Company.

The average wind speeds in the Gulf of Suez is as high as 10m/s. The World Bank identified that Egypt enjoys one of the world's best wind power resources in the Gulf of Suez area with almost 7.2GW could be developed by 2022. Also, additional significant wind power resources could be produced on the banks of the River Nile.

The country's largest wind single project to date is in the Gulf of el Zayt, commissioned in 2009 with a generating capacity of 200MW, with an extension by a 220MW wind farm.

The Government of Egypt (GOE) has allocated 7,600km2 of desert land for the future plan of the wind energy projects, and all land allocation permits have already been obtained by the Egyptian New and Renewable Energy Authority (NREA).

Egypt is enjoys high intensity solar radiation of approximately 2,300 kwh/m2 per annum, with a daily sunshine duration of 9 to 11 sunshine hours. Egypt is planning to increase its production of solar energy from a current maximum of 150MW to at least 1GW of solar capacity by 2020 by offering free land to potential investors to respond to the growing demand for power.

Egypt has substantial hydropower resources, which are used over decades in generating energy by both large-scale and small-scale projects. The country enjoys a strong portfolio of successful existing and planned hydropower projects.

IN ORDER TO UNDERSTAND THE EFFECT OF THE NEW AND RENEWABLE ENERGY ON THE ECONOMY OF EGYPT AS WHOLE THROUGH THE GDP EFFECT AS MENTIONED EARLIER, LET US CONSIDER THE FOLLOWING TWO TABLE WITH ACTUAL FIGURES INCLUDING MEASURES DONE WITH RESPECT TO ACTUAL NEW AND RENEWABLE ENERGY CONSUMPTION OF THE LOCALLY PRODUCED NEW AND RENEWABLE ENERGY AS FOLLOWS:

2 Details of Egypt's existing and planned capacity of new and renewable energy mentioned in this section are based on personnel interviews inside the Egyptian Ministry of Electricity, and inside the Egyptian New and Renewable Energy Authority (NREA), in addition to several issues of the World Bank Year Book, and the Central Bank of Egypt (CBE) Annual Report.

TABLE 1: GDP & NEW & RENEWABLE ENERGY CONSUMPTION IN EGYPT

Year	GDP (in billions of current U.S. dollars)	New & Renewable Energy Consumption (in billion kilowatt-hours)
1980	22.91	6.7
1981	23.41	6.11
1982	25.59	6.27
1983	28.14	6.29
1984	30.64	6.9
1985	34.69	7.02
1986	35.88	7.22
1987	35.04	8.27
1988	36.97	7.28
1989	39.65	7.29
1990	40.51	8.46
1991	41.86	8.55
1992	43.13	9.88
1993	46.58	10.38
1994	51.9	10.64
1995	60.16	11.31
1996	67.63	11.45
1997	78.44	11.88
1998	78.85	12.11
1999	82.92	12.93
2000	84.83	13.17
2001	87.85	13.24
2002	89.69	13.26

2003	**90.71**	**13.37**
2004	**97.63**	**13.41**
2005	**99.84**	**14.16**
2006	**107.48**	**14.2**
2007	**130.48**	**14.29**
2008	**162.82**	**14.3**
2009	**188.98**	**14.37**
2010	**218.89**	**14.4**
2011	**236**	**14.46**

***Source**: The World Bank, 2104, The International Monetary Fund (IMF): World Economic Outlook. 2014, The Egyptian New and Renewable Energy Authority (NREA), & The Egyptian Ministry of Electricity.*

TABLE 2: GDP PER CAPITA & NEW & RENEWABLE ENERGY CONSUMPTION IN EGYPT

Year	**GDP per capita (in thousands of current U.S. dollars)**	**New & Renewable Energy Consumption (in billion kilowatt-hours)**
1990	**5977.25**	**8.46**
1991	**6023.77**	**8.55**
1992	**6137.02**	**9.88**
1993	**6215.27**	**10.38**
1994	**6363.07**	**10.64**
1995	**6556.52**	**11.31**
1996	**6777.77**	**11.45**
1997	**7039.97**	**11.88**
1998	**7210.94**	**12.11**
1999	**7532.1**	**12.93**

2000	**7811.76**	**13.17**
2001	**7959.44**	**13.24**
2002	**8017.05**	**13.26**
2003	**8138.48**	**13.37**
2004	**8332.45**	**13.41**
2005	**8561.17**	**14.16**
2006	**8995.06**	**14.2**
2007	**9471.86**	**14.29**
2008	**9979.97**	**14.3**
2009	**10271.81**	**14.37**
2010	**10620.59**	**14.4**
2011	**10628.75**	**14.46**

Source: The World Bank, 2104, The International Monetary Fund (IMF): World Economic Outlook. 2014, The Egyptian New and Renewable Energy Authority (NREA), & The Egyptian Ministry of Electricity.

Due to the availability of the Egyptian new and renewable energy data until 2011, the corresponding GDP and GDP per capita relevant data of 2011 were also used for consistency in making justifiable comparisons.

The econometric measures used in the analysis of the above mentioned tables are based on the Pearson product-moment correlation coefficient, also known as Pearson's r, which is used as a measure of the strength and the direction of the linear relationship between two variables.

By running these data with the GDP and the GDP per capita of Egypt over the mentioned time series, it is obvious that there is a very strong correlation with a correlation coefficient of degree one (r = 1) between the GDP and the "New & Renewable Energy Consumption in '000 Current USD" in one hand, and between the GDP per capita and the "New & Renewable Energy Consumption in '000 Current USD" in the other hand. Therefore, the usage of "New & Renewable Energy Consumption in '000 Current USD" in this connection provide for arriving at the most accurate reliable justifiable comparable econometric measures in this connection.

6. Results & Discussion

The research work is an original combination of integrated framework of the analysis of the role of the environmental economics of new and renewable energy in the process of economic development and growth. The study explored and measured the impact of the usage of new and renewable energy on the key macroeconomic variables. This was done within an

application approach of the case of the developed countries by taking Egypt as a case study. At the end of the study a purely new set of recommendations were made to add to the economic literature a new set of recommendations concerning the possible means to help the developing countries to maximize their relevant economic benefits.

The findings presented above illustrate the interaction between the major aspects of development as related to the environmental conditions, within the context of comprehensive and sustainable development. The case study of Egypt adds to the literature a missing link between the environmental economic development and growth in the developed countries in contrast to the position of the developing (less-developed) countries.

7. Conclusion

The study was conducted with the purpose of providing an integrated framework of the impact of application of new and renewable energy on the economic development and growth. Analytical tests were made to arrive at the most accurate reliable justifiable comparable econometric measures in this connection.

The econometric measures used in the analysis of the data collected and analyzed all through this research paper are based on the Pearson product-moment correlation coefficient, also known as Pearson's r, which is used as a measure of the strength and the direction of the linear relationship between two variables.

The research work is an original combination of integrated framework of the analysis of the role of the environmental economics of new and renewable energy in the process of economic development and growth. The findings of econometric running of the Egypt's data explored that there is a very strong correlation with a Pearson correlation coefficient of degree one (r = 1) between the GDP and the "New & Renewable Energy Consumption in '000 Current USD" in one hand, and between the GDP per capita and the "New & Renewable Energy Consumption in '000 Current USD" in the other hand.The study made set of recommendations concerning the possible means to help the developing countries.

8. Recommendations

It is, therefore; recommended that developing countries as illustrated by the case study of Egypt need to expand on the production of new and renewable energy to attain a comprehensive suistainable economic growth by applying the followings:

1- Voluntary reduction of fossil fuels.

2- Expanding the production of new and renewable energy.

3- Allocating government funds for new and renewable energy projects.

4- Allocating research funds directed to new and renewable energy.

5- Increase the level of public awareness by launching organized campaigns and guiding the population to the importance of new and renewable energy.

6- Guide the working population to the industrial measures to produce new and renewable energy.

7- Improve the working conditions to provide services and standards as related new and renewable energy.

8- Launching programs to compensate the companies and institutions engaged in new and renewable energy practices, new and renewable energy education, and new and renewable energy training.

9- Irradicating the high technology illiteracy level among labors and specially young labors.

10-Provide technical technological training to the working labor, and provide continous technology education programs to them.

11-Promulgate legislation to support new and renewable energy.

12-Providing tax cuts to the industries producing new and renewable energy.

13-Providing tax cuts to the exporters who export goods produced by using domestic new and renewable energy.

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