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A Review of the Use of Renewable Energy in Industry to Reduce Pollution

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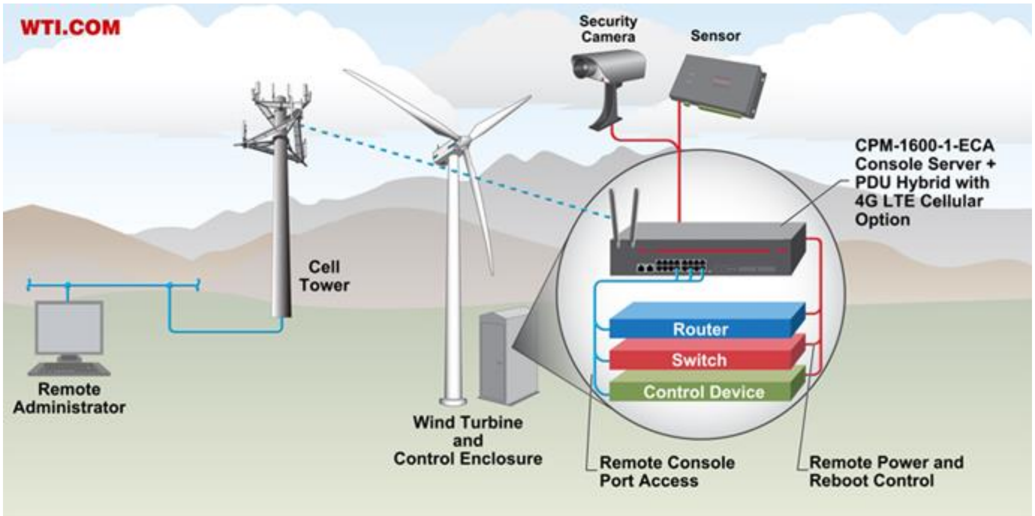
ABSTRACT

These days, the increased global warming due to the adverse effects of greenhouse gases is one of the most significant issues. One of the most common energy efficiency structures is the combination of wind turbines and photovoltaic systems. Increasing the use of renewable energy may results in economic growth, job creation, increased national security, protection of consumers against rising prices, a shortfall in the global fuel market, and a significant reduction in pollutants that cause global warming and greenhouse effects. Therefore, the problem facing electricity market policymakers is how to bring renewable energy into the electricity market to play its role well in the future market. The mentioned properties of renewable energies have caused them to be used on a large scale today. Wind energy, and solar energy are the most available energies among renewable energies. However, one of their problems is their dependence on environmental and climatic conditions. Combining two energy sources can overcome the weakness of each of them. Today, the combined power generation system has become one of the most promising solutions to meet the electricity needs of different regions. One of the most basic needs in a hybrid system is to ensure the continuity of nutrition by storing additional energy from renewable energy sources. A combined energy system based on alternative technologies that work in parallel with renewable sources can be a suitable solution for small productions.

GRAPHICAL ABSTRACT



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Introduction

The use of fossil fuels to supply the fuel needed by power plants and their rapid depletion increases environmental pollution. According to estimates, for the Production of each megawatt-hour of energy with diesel fuel, 21.3 kg of oxides, carbon, and carbon monoxide and 675 kg of carbon dioxide enters the air [1-3]. The reduction of fossil fuels has led to renewable energy sources such as wind, solar, and geothermal as clean, inexhaustible, unlimited, and environmentally friendly resources [4-6]. The advantage of renewable energy is that it is replaceable and ubiquitous, and non-polluting (Figure 1) [7]. Disadvantages of this energy include its low density and variability, which leads to high initial costs due to the need for land occupation and storage or backup power [8-10]. A hybrid energy system consists of two or more energy sources. Combining two energy sources have proven that energy production can be more efficient if combined. Hybrid power plants are usually on the agenda in remote areas. Today, the use of hybrid energy is a common problem due to rising fossil fuel prices.

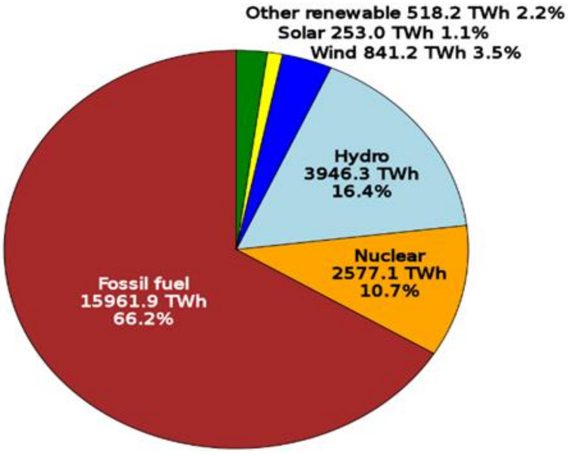

Figure 1: World electricity generation by source [11]

There can usually be different combinations of two or more energy sources, but the most important is the combination of two or more renewable energies, including solar and wind energy. Combined energy is commonly used to generate electricity for domestic use and mills [12]. The use of hybrid energy is a method that has been considered in recent years. Combined power plants have proven to reduce the disadvantages of fossil fuels and can provide the energy needed in remote areas without harming the environment. Therefore, the construction of solar wind power plants can be a good idea (Figure 2).

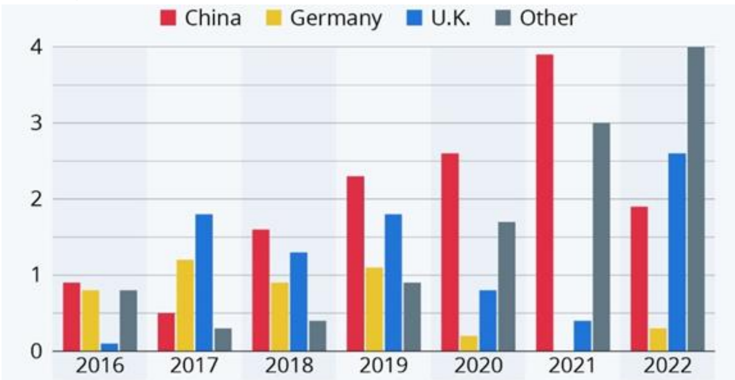

Figure 2: Offshore Wind Farms Continue Growth [13]

Wind power plant location with EC software

To determine the best place to build a wind farm in EC software, we proceed according to the following steps:

Step 1- Enter the goal, criteria (indicators), and options.

In this decision, the purpose of selecting the best place for wind power plant (Select best place for wind power plant), criteria including wind speed, price of land, complex transit zone and lack of existence of tall structures (The lake of tall structures).

Step 2 -Now, from the tables related to the pairwise comparison matrix, we enter the numerical judgments between the indicators and the options.

Step 3-After entering the numerical judgment between the indicators and options, the software calculates the relative weight of the indicators and the relative weight of the options concerning each of the indicators.

Finally, EC software calculates the final weight of each option and ranks the options according to the decision goal (Figure 3).

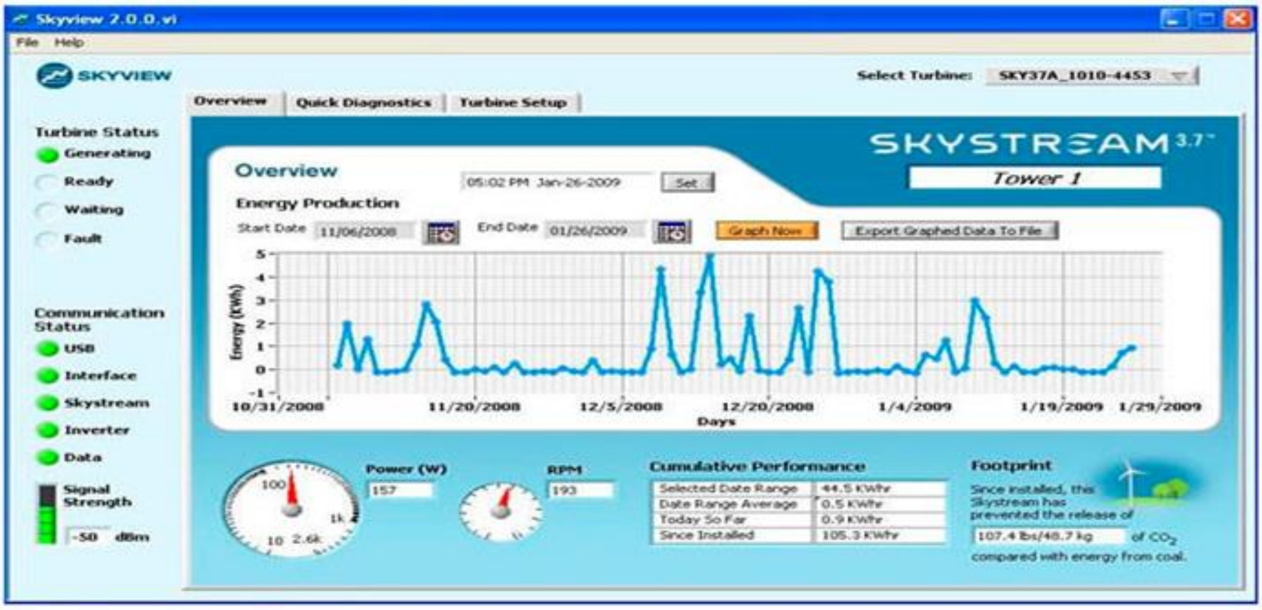

Figure 3: Software monitoring review [14]

Sensitivity Analysis

This section examines the sensitivity of ranking options to changes in the weight of criteria. In the case of a hierarchy of three levels, the sensitivity analysis of the target node will show the sensitivity of the options to the criteria below the target. Suppose the problem has more than three levels. In that case, sensitivity analysis can be applied from levels below the target and show the sensitivity of the options to the criteria and sub-criteria. There are 5 graphic modes in EC software for sensitivity analysis [15].

* Based on performance
* Dynamic
* Based on Gradient
* Two-Dimensional
* Based on difference (Difference)

Location of solar power plant with EC software

In determining the best place to build a solar power plant, all the steps will be repeated in the previous section. However, with the difference that the goal will change accordingly, you have to use your pairwise comparison matrices when entering numerical judgments between indicators and options. Finally, after calculating the relative weights of the indicators and options, EC software calculates the final weight of the options in terms of purpose and ranks them [16].

Location of combined solar wind power plant with EC software

At the end of this section, we choose the best place to build a combined wind power plant with EC software from the available options. All steps will be repeated as in the previous sections. The critical difference between this section and the previous sections is that the number of criteria. This decision increases and the reason is that the purpose of the decision is to determine the optimal location for the construction of a combined power plant and in which wind speed and solar radiation indices will play a decisive role (Figure 4).

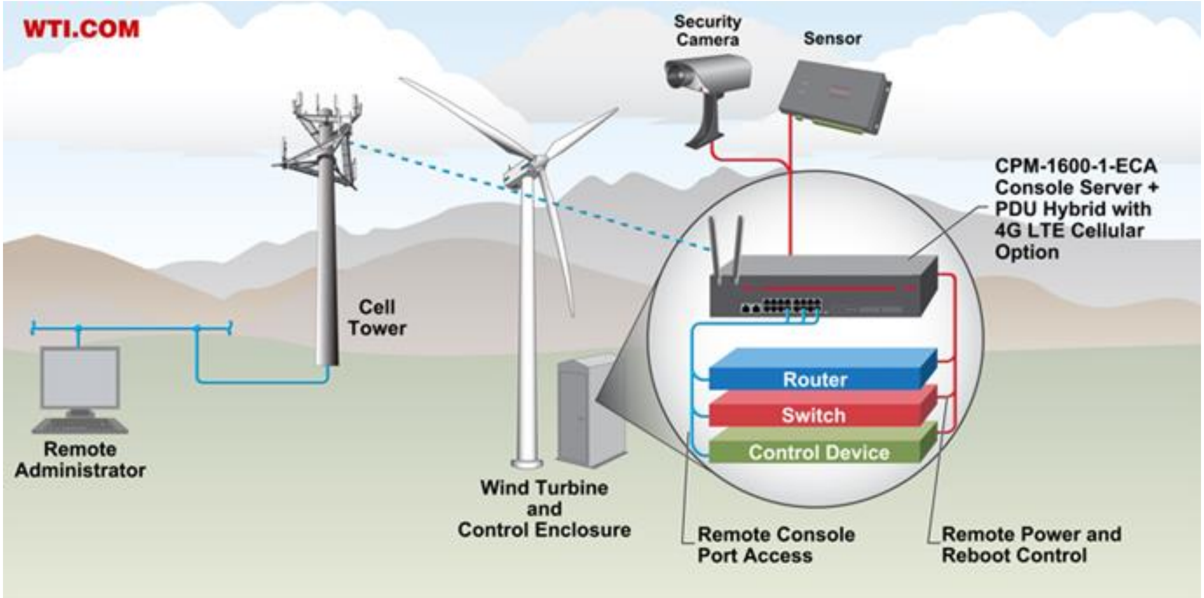

Figure 4: Managing Network Devices in Wind Turbine Tower Applications [17]

Check the combined power system

A combined power system combines two or more technologies for power generation. These systems can be considered independently or connected to the power grid. In grid-independent systems, the energy storage capacity must be large enough to respond to power changes in load and energy sources. Network-independent systems with related loads can be considered as small networks. Among renewable energies, wind and solar are the most available energies. However, one of their problems is their dependence on environmental and climatic conditions. Combining wind and solar energy sources with each other can overcome the weakness of each of them [18].

Wind Turbine Model

When the air fluid collides with velocity V (which is equivalent to wind speed), it rotates the rotor through the turbine blades, where the turbine absorbs part of its kinetic energy absorbs part of its kinetic energy, and finally, the airflow at velocity V_0 (which is less than the inlet velocity). (V), comes out of the vanes, the lower the air outlet velocity (V_0), the more wind energy is received by the turbine.

The mass of air that passes through the blades in one second (m) is (Equation 1):

$$m = \frac{\rho . A(V + V_0)}{2} \quad (1)$$

where in:

ρ= Air density

V = wind speed in front of the rotor

A = area of air passage between the blades

V_0 = wind speed behind the rotor

On the other hand, the wind power extracted by the rotor depends on the mass of air passing through the blades, which is calculated according to Newton's second law as follows (Equation 2).

$$p = \frac{1}{2} m (V^2 - V_0^2) = \frac{1}{2}\left[\rho A \frac{V + V_0}{2}\right](V^2 - V_0^2) \quad (2)$$

Of course, the ultimate wind power (P_0) is equal $\frac{1}{2}\rho A V^3$.

The turbine does not fully receive it does not fully receive it does not fully receive it, so the ratio of extractable power to ultimate power will be as follows:

$$C_p = \frac{1}{2}\left[1 - (1 - (\frac{V_0}{V})^2)\right](1 + \frac{V_0}{V}) = C_1\left(C_2 - C_3\theta - C_4\right)\exp\left(-C_5\right) \quad (3)$$

It will C_p therefore be a function in proportion $\frac{V_0}{V}$ so $\frac{V_0}{V}$ that the smaller it is, the closer C_p it will be to the final value of one.

Table 1: Value of Parameters

C_1	0.5
C_2	$\frac{116}{k_\theta}$
C_3	0.4
C_4	0
C_5	$\frac{21}{k_\theta}$

As it is clear that the coefficient K_θ has been used to calculate C_5 and C_2 the coefficients, further studies showed that in the theoretical state, the maximum value $\frac{V_0}{V}$ is equal $\frac{1}{3}$, so the ratio is calculated to be 0.59 *i.e.* that in the theoretical state 59% of wind energy by the turbine Wind turbines can be extracted. Still, this ratio is 0.2 to 0.4 for built turbines (Equation 4).

$$K_\theta = \left[\frac{1}{\lambda + 0.08\theta} - \frac{0.035}{\theta^3 + 1}\right]^{-1} \tag{4}$$

Finally, the power generated by wind turbines is obtained from Equation 5:

$$P_{wind} = \frac{1}{2}\rho.A.v^3 C_P(\lambda, \theta) \tag{5}$$

In the above ρ relation of air density in terms of *kg/m³*, A is the area of air passing through the blades, v is the wind speed in terms of m/s , C_p is the power factor, θ is the step angle, λ is the velocity ratio (Equation 6).

$$\lambda = \frac{\omega R}{V} \tag{6}$$

The ω rotor's angular velocity is R, the radius of the rotor blades, which λ can be said to depend on the operating point of the wind turbine to extract the maximum output power. Wind turbines are divided into three categories in terms of power in operation:

1- Small wind turbines: These turbines can generate up to 10 kW.

2- Medium wind turbines: Generally, the power of these turbines is between 10 and 520 kW.

3- Large wind turbines: These types usually include several centralized wind turbines with a production capacity of 520 kW and above [19].

Photovoltaic array

The term "photovoltaic" is a combination of the Greek word "photos" meaning light with "volt" meaning the generation of electricity from light. The discovery of the photovoltaic phenomenon is attributed to the French physicist Edmond Becquerel, who in 1839 published an article presenting his experiments with a battery (Wet Cell). He observed that the battery voltage increases when silver plates are exposed to sunlight. It is no secret that today the use of solar energy for its unlimitedness, reliability and easy access, relatively simple technology, and environmental friendliness has a special place among other energies and its application in photovoltaic systems. It has become entirely pervasive for conversion into electrical energy.

Photovoltaic arrays have an excellent potential in the form of hybrids to provide the required electrical energy. The advantages of using these systems include prevention of environmental pollution, no need for extensive transmission and distribution lines, and ease of maintenance and operation. In general, the essential characteristics of PV systems that have become widespread are: the amount of energy received from the sun is 10,000 times more than human needs, photovoltaic cells are made of silicon, which is the second most abundant element on Earth. They are nothing but motion and have low repairs and long life, and it has no problem converting energy because it has no waste and CO_2. A photovoltaic cell is a P-N bond, which, like a diode, is made up of semiconductor materials. When light strikes a photovoltaic cell, energy carriers are generated, which generate an electric current if the terminals are short-circuited. Because the emitted light has photons of different energies, only those photons can produce energy carriers that can break the covalent bond between the semiconductor electrons [20].

The production speed of energy carriers depends on the material of the semiconductors and the wavelength of the light emitted to them. Therefore, generating electricity by a photovoltaic cell is: absorbing light, producing and transmitting energy carriers, and the accumulation of energy carriers at the terminals of a photovoltaic cell. Photovoltaic systems consist of three main parts:

1- Solar modules or panels convert solar radiant energy into electrical energy. Silicon solar cells are divided into three categories: single crystal silicon, polycrystalline silicon, amorphous silicon, the main constituent of most solar cells on the market is a thin layer of silicon. According to the physical properties of semiconductors, an electric field is created on the outer surfaces of a cell by the decomposition of the parent substance into impurities of (type N) such as phosphorus and (type P) such as boron to the parent substance, according to the laws governing the physics of materials. The donor can generate electricity against radiant energy (sunlight). The output current and voltage of these cells is DC. A set of these cells that are arranged in series and parallel to each other is called a photovoltaic panel or module.

2- The intermediate part or the desired power part, manages and induces the electrical energy obtained from photovoltaic systems based on the design, following the needs of the consumer. This equipment is mainly prepared from charge controller, battery, and inverter based on the consumer's needs and according to the system designer, design and specifications [21].

3- Consumer or electric charge includes all electrical consumers, including direct electricity consumption (AC, DC) in proportion to consumption.

The main reasons for paying attention to the photovoltaic industry in the last decade and its annual growth are as follows: lack of need for fossil fuels and refueling problems, especially in difficult areas, production capacity at the place of consumption, reduction and saving of transmission costs and distribution of electrical energy and no need for a national electricity network, the possibility of installation and commissioning in different capacities, per the consumer needs, appropriate lifespan and ease of operation, the possibility of installation on facades or roofs and the ability to store energy in batteries.

The following are the mathematical models governing solar cells:

The relationship between output voltage U and load current I can be shown as follows:

$$I = I_L - I_D = I_L - I_O\left[exp\left(\frac{U + RI_S}{\alpha}\right) - 1\right] \quad (7)$$

I_L is the optical current, I_0 saturation current, I charge current, U output voltage, R_s series resistance, α voltage thermal coefficient.

Current I_L

$$I_L = \frac{\phi}{\phi_{ref}}\left[I_{L,ref} + \mu_{I,sc}\left(T_c - T_{C,ref}\right)\right] \quad (8)$$

That ϕ solar radiation in watts per square meter $\frac{w}{m^2}$, ϕ_{ref} reference radiation (usually assumed to be 1000 $\frac{W}{M^2}$), $I_{L,ref}$ reference light flux in conditions (1000 $\frac{W}{M^2}$, 25 °C degrees Celsius), T_C *PV* cell temperature, reference temperature (25 °C assumed in this study), $\mu_{i,sc}$ is the thermal coefficient of the short-circuit current, which is in terms of ($\frac{A}{C^\circ}$).

Saturation flow I_0

$$I_o = I_{0,ref}\left(\frac{T_{c,ref}+273}{T_c+273}\right)^3 + exp\left[\frac{e_{gap}N_S}{q\alpha_{ref}}\left(1 - \frac{T_{c,ref}+273}{T_c+273}\right)\right] \quad (9)$$

$I_{0,ref}$ reference saturation current, e_{gap} material band gap (ev 1.17 for silicon material), N_s number of PV series cells, q electron charge (1.60217733×10^{-19} c), α_{ref} reference value α.

The flow $I_{0,ref}$ is also obtained according to the following relation (Equation 6):

$$I_{o,ref} = I_{L,ref}\,\exp\left(-\frac{U_{oc,ref}}{\alpha_{ref}}\right) \quad (10)$$

$U_{oc,ref}$: PV module open circuit voltage

Thermal coefficient α

$$\alpha_{ref} = \frac{2U_{mp,ref} - U_{oc,ref}}{\frac{I_{sc,ref}}{I_{SC,ref} - I_{mp,ref}} + \ln\left(1 - \frac{I_{mp,ref}}{I_{SC,ref}}\right)} \quad (11)$$

$U_{mp,ref}$: Maximum power point voltage in reference conditions.

$I_{mp,ref}$: Maximum power point current in reference conditions.

$I_{sc,ref}$: Short circuit current in reference conditions.

Dynamic Model of Solar Cell

Usually in most papers for dynamic modeling of a photovoltaic cell, a capacitor is added in parallel to the static model, the size of which depends on the cell's output voltage. In the above model, the series resistor is omitted due to its small size, and the parallel resistor is omitted due to its large size. Also, since the photovoltaic cell is supposed to operate at the maximum power point and the voltage changes are limited, the capacitor size in the proposed model is considered to be equal to 40 Nano farads per square centimeter.

$$I_{(v)} = \frac{I_x}{1-\exp\left(-\frac{1}{b}\right)}\left[1-\exp\left(\frac{V}{b.V_x}-\frac{1}{b}\right)\right]-C\frac{\partial_v}{\partial_t} \quad (12)$$

The above relation reveals that, like the static model, the voltage-current characteristic of a photovoltaic cell will be different with changes in temperature and radiation intensity. On the other hand, unlike the static model, the voltage-current characteristic will be different in terms of temperature and constant radiation intensity due to the presence of a capacitor to change the pattern of voltage increase or decrease. However, due to the lack of capacitive properties in the behavior of photovoltaic cells, this phenomenon is difficult to observe. However, on a large scale, this phenomenon is apparent and plays a crucial essential role in the dynamic analysis of the photovoltaic system. In this modeling, solar arrays without a tracking system are used. The installation and replacement costs for the kw1 system are estimated at $ 3,000 and $ 2,500, respectively, which can be seen in Figure 5 of the solar array cost curve.

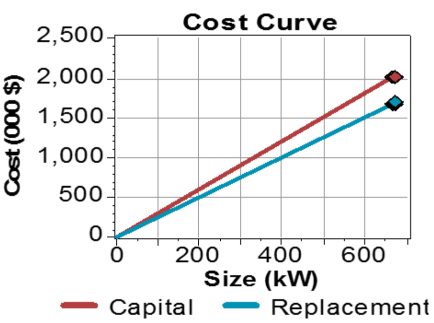

Figure 5: Solar array cost curve

Hybrid system analysis and sensitivity analysis

HOMER software uses the Final Net Cost Equation (NPC) to calculate the system life cycle. The final net cost is the difference between the present value of all costs required over the life of the project and the present value of the revenue generated. All expenses and income are valued at a fixed interest rate throughout the year. In this assessment, to consider the effect of inflation in the calculations, it is applied by calculating the real interest rate due to inflation and the effect of an interest rate change on the final net cost. The real interest rate *i* is calculated according to Equation (13) so that i' is equal to the nominal interest rate and f is the inflation interest rate.

$$i = \frac{i'-f}{i+f} \quad (13)$$

The final net cost is the main output of the economic calculations of this software, which is calculated from Equation 14.

$$C_{NPC} = \frac{C_{ann,tot}}{CRF(i,R_{pro})} \quad (14)$$

$C_{ann,tot}$, tot is the total annual cost, R_{Pro} is the project life, and i is the actual interest rate. CRF is the return on equity factor for N years defined as Equation 15.

$$CRF(i,N) = \frac{i(1+i)N}{(1+i)N-1} \quad (15)$$

Another critical parameter in the economic calculations of distributed generation units and the selection of the optimal combination calculated by HOMER is the average cost of one-kilowatt hour of useful energy produced (COE) by the system. In optimization, the best combination is chosen from among the possible arrangements. The best possible combination would meet all the pre-determined constraints with the lowest net final cost. In HOMER, possible scenarios are simulated, then arranged based on the lowest final net cost. Finally, the achievable arrangement with the lowest final net cost is introduced as the optimal arrangement [22].

Hybrid System Simulation and Analysis

Before performing the simulation, a search space of component size and the hybrid system must be defined for HOMER so that the software can examine the different arrangements.

The importance of energy in the economic policies and planning of countries worldwide has changed over time. Before 1970s, the general perception was that energy resources were abundant and, as a result, there was little concern about supply continuity and its effects on economic life. After the sharp rise in oil prices in 1973 and the developments that followed the rise in oil prices, there was an intense concern, especially among policymakers and planners in major energy-consuming countries. The discussion of energy economics quickly took its place in the circles. Opened scientific and executive. Today, energy plays an essential role in the development of any country. Energy is the most essential input of the industrial production sector, i.e. the industrial sector, petrochemicals, power plants, and the like, and in the non-productive sector, such as the housing sector, it is an essential commodity. Despite having rich oil and gas reserves, Iran's domestic market is facing increasing demand for energy carriers [23].

Energy carriers play a vital role in the country's energy consumption basket and are one of the main economic growth and development economic growth and development. As a result, proper energy management on both supply and demand, in the long run, seems necessary. According to the global survey results in 2004, Iran is the eighth country in the world in terms of energy intensity, with an energy intensity of about 956 tons per million dollars. It is ranked 16th among countries with medium economies. In the same year, the average energy intensity in the world was about 250 tons per million GDP and 850 tons per million dollars in countries with medium economies.

In Iran, the relative abundance of energy resources has led to higher energy consumption and intensity than countries with similar structures and fewer energy resources. In other words, energy commodities justify Iran's somewhat high per capita consumption and energy intensity. Of course, given the abundance and richness of Iran's energy resources, this country can have an advantage in energy industries and economic activities, and even high energy intensity may seem reasonable to some extent. However, statistics show that the energy intensity in the country is higher than in most OPEC countries. Although in recent years, the share of natural gas (with less pollution) in the country's total energy consumption has increased, it should be noted that in general, high levels of energy intensity can have adverse effects on the environment. By adopting appropriate energy supply and demand policies, old cars, engines and equipment can be discarded and replaced with new ones, especially in the energy-intensive sectors, namely household and commercial, transportation, industry, and Power generation reduces energy intensity while increasing energy efficiency [24]. In general, several reasons for the increase in energy consumption and intensity in Iran in recent years are population growth, inefficient energy management, low efficiency of devices, and a high tendency to consume more energy, especially in the manufacturing sector. Energy is one of the factors production is vital in the industrial sector and is a factor facilitating the service process in non-manufacturing sectors. Energy is also an influential welfare factor in the domestic sector and an important political and policy tool at all levels of macroeconomic society. This productive-welfare factor is often used to implement coercive policies in countries. Given this, the proper use of energy should always be considered an essential principle of macroeconomic policies of society. Non-renewable energy (such as oil and gas) is a significant part of the energy portfolio for countries whose oil and gas are their most important national wealth (OPEC members). Oil and gas exports should accelerate and facilitate the flow of long-term investments in various sectors of the macroeconomics. Using the available statistics and information, the average annual growth of world GDP per capita from 1999-2004 has been about 4.8%.

Meanwhile, the average annual growth of this critical economic component in Iran is 8.9% and has increased from $ 1588 in 1999 to $ 2432 in 2004. Energy consumption as an important factor of Production can play an influential role in Increasing GDP. Therefore, it is essential to study the relationship between energy consumption and GDP, especially in economic sectors. Explaining this relationship leads to the introduction of another variable called energy intensity. The relationship between them helps clarify the country's energy sector policies. GDP growth is a process whose main axis is to increase GDP.

When GDP growth increases significantly, there is increasing pressure on resources. In this regard, the demand for raw materials and energy increases. If it is not possible to exploit more than any of the mentioned resources in parallel with the increase in Production, Production will face a bottleneck. In this regard, the relationship between GDP and consumption of various energy carriers such as petroleum products, natural gas, and electricity as essential factors of Production, has attracted the attention of many economic analysts. Limiting energy consumption, especially petroleum products such as gasoline, as well as reducing energy intensity to reduce environmental pollution is at the top of the government's economic policies, and on the other hand, given the close relationship between GDP and energy intensity, between energy intensity and GDP and environmental pollution can be a good guide for policymakers in the country's energy sector and economy. For economic Production, producers need physical inputs and resources from the environment to produce goods and services, which also cause some damage to the environment from this perspective. The role of the environment and energy resources in economies is less considered. Resources are considered "free gifts of nature" and environmental damage in the form of "external consequences". Today, the world faces a series of environmental crises, many of which are sometimes irreparable (such as species extinction) and, if repairable, very costly (such as air pollution, groundwater).

The fact is that many of the environmental crises and problems result from a set of policies, wasteful use of energy and environmental resources and the discharge of pollutants from human activities in the environment, and ultimately the failure to calculate the true value of environmental resources. The costs of environmental degradation are part of macroeconomic policies.

The above set of issues and problems has confronted the world community with the question of the extent to which the capacity of energy resources and environmental resources on the planet, allows humans to work without limits? The drastic reduction of energy and environmental resources due to improper exploitation and non-observance of economic logic in their exploitation has caused the degeneration and scarcity of many energy and environmental resources. For this reason, many economists have come to believe that if the international community is to make optimal use of resources, it must place environmental resources among other scarce resources. Economic rationality governs the use of other inputs of production. Should also consider energy and environmental resources [25]. On the other hand, given that environmental resources belong to all generations and its preservation is a public duty for future generations, so long-term benefits should take precedence over short-term benefits. This underscores the need to increase resource production efficiency [26].

Conclusion

According to existing theories in the field of GDP and energy, it is expected that energy consumption will decrease in times of recession and increase in times of economic prosperity. According to statistics available in some years, despite the negative growth of GDP, but energy consumption has grown positively, the conclusion that can be drawn is that there is no close relationship between these two variables at the macro level, and this is primarily because the significant consumer of energy in the country is not in the real production sector. A more realistic macro-energy growth trend can be achieved if energy consumption in non-productive sectors becomes more rational. In many years when the economy has been experiencing negative growth, energy consumption energy consumption growth has slowed down, but not negatively.

From this, it can be concluded that following the country's economic growth, energy demand also increases, but with the decrease in economic growth or its negativity, energy demand in the country has not decreased at the same rate. If it has decreased with a break, it has been up to two years. This stickiness in the consumption habits of energy demand in Iran has been one of the main reasons for the increase in energy intensity in the country. Among most countries in the world have a high energy intensity. Energy intensity is one of the critical indicators for a comparative study of how energy is used in countries. By using this index, energy efficiency can be considered in production activities.

On the other hand, energy efficiency indicates the amount of production per a certain amount of energy consumption. In general, reducing the intensity of reference energy will improve energy efficiency. Explanatory factors often lead to changes that these developments and changes have nothing to do with how energy efficient the product. These changes can be structural or behavioral or for various reasons, including the climatic characteristics of land. In general, these factors refer to structural components that change energy intensity without reflecting energy efficiency (in other words, these factors reduce energy intensity without increasing energy efficiency, and vice versa). Structural changes in the economy will cause fundamental changes in the composition of the economy and all sectors of energy consumption, which will affect the energy intensity component. These changes are such that they do not affect energy efficiency.

For example, in the industrial sector, a change in policy from the production or expansion of energy-intensive industries (for example, metal products and petrochemical industries) to less energy-intensive industries will reduce energy intensity. Still, these changes do not mean improving energy efficiency. Changes in the composition of activities are also an essential factor in changing energy intensity without affecting energy efficiency. For example, the move from productive activities (which should consume a lot of energy per unit of production) to service activities (which consume much less energy per unit of production) reduces energy consumption and energy intensity. For example, when the population migrates from cold regions to tropical regions, the intensity of heating energy will decrease in winter, especially in the residential and commercial sectors; however, the intensity of cooling energy or air conditioning will increase in summer, which will have a definite effect on intensity. Will have total energy. Therefore, changes in the structure of an industry, mobility of manpower and population, and changes in the size of households are the structural components within the term explanatory factors. Changes in energy consumption per unit of production can be due to behavioral factors that do not, in principle, indicate an improvement in energy efficiency. Studies show that heating energy consumption increases with age, while the efficiency of home appliances does not change. The intensity of energy in the house increases to create a suitable and comfortable space for living.

In many cases, it becomes complicated to distinguish between human behavioral changes and structural changes in the context of studying changes and changes in energy intensity. Sometimes, some uncontrollable changes cause changes in energy intensity (without changes in energy efficiency). Climate change is also having a definite effect on the energy consumption of households and the commercial sector. According to the above, in many cases, energy intensity in countries is formed within the framework of the national economy of that country, which is based on different sectors of the economy and the specific characteristics of the explanatory factors. Therefore, it is necessary to study the energy intensity index taking into account all the factors affecting this crucial economic component. Countries like China and the United States are on the verge of declining energy intensity. After an experience is accumulated in the world of research and knowledge and technology to control energy consumption and productivity in the world, countries that have not benefited from this knowledge and technology can benefit from it at a lower cost and faster. In other words, find a higher leap forward than the reference countries of these experiences. Therefore, it seems that if OPEC wants to use the experience of countries such as China and the United States, it will have faster leaps in reducing its energy intensity. Let's not consider energy intensity and assume that OPEC will now go through the same process as the industrialized, developing, and middle-class economies of the world in one of their most energy-intensive situations, one of the most pessimistic. We have envisioned the trends in the effectiveness of OPEC's energy reduction policies. It should be noted that OPEC will save a total of about 60,000 million barrels of crude oil equivalent if it adopts policies to reduce energy intensity and save or increase energy efficiency.

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