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Importance of Renewable Energy in Cold Climate Regions

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ABSTRACT

Fundamental definition of the renewable energy is; the source of energy must be in the nature, sustainable and clean. The fossil sources which are used commonly in the industry have restricted reserves and the polluting potential. The main renewable sources are solar energy, wind power, geothermal energy, hydrogen energy, hydraulic energy and biomass energy. The scope of this research covers detecting the current problems about energy costs and pollution conditions connected with cold climate regions. In this study, technical and legal obstacles of the subject was discussed.

Keywords: Renewable energy, energy, wind energy.

1 INTRODUCTION

It is known that a significant portion of the total energy is used in buildings for heating, air conditioning and ventilation. The ratio of energy consumed in buildings in our country has reached 50% at the total rate. This case demonstrates the importance of saving energy and costs in buildings. To increase the desired level of energy efficiency in buildings, buildings must be addressed as a whole of sub-systems such as mechanical and electrical systems, architectural design, and structural system. The building's energy efficiency, in order to benefit adequately from renewable energy sources, the building energy performance emerges as an important criterion. With the population growth in the World, technological developments are continuously increasing for energy demand. According to data from the US Energy Agency (APEA), a significant increase in energy consumption in OECD countries is unexpected between 2005 and 2040, in the energy consumption of non-OECD countries, an increase of about 75% is observed. Because of the constantly increasing in energy demand of the World, the new investment plans are made to meet this demand. In this context, according to data from the International Energy Agency (IAEA), in non-OECD countries, it is estimated 6.5 trillion dollars of investment to be made in renewable energy sources [1].

In our country, both compatible with the climate, and accordance with the design strategies and concepts, in case of the creation of environmentally friendly building, it was shown that the energy used in buildings could be reduced by 50%. Turkey is a country with considerable renewable energy resources such as biomass and solar hydro, wind, geothermal. Energy demand is gradually increasing in Turkey which is located in developing countries. To meet this need, the new production plant is established in Turkey, Table 1 shows renewable energy sources and power plants under construction based on the date January 2014. From Table 1, it can be seen that Turkey's total capacity of the renewable energy sourced power plants and under construction is 8569.5 MW. In this study; the share and importance of renewable energy sources and their contribution to the economy of the region were discussed by comparing with conventional energy resources consumed in the cold climates in country. Especially, the energy consumed connected with space heating, in this region has the highest rate, and in order to minimize this cost, the effective availability of opportunities in the area of renewable energy sources has been investigated.

Table 1. Turkey's total capacity of power plants under construction based on the date January 2014 [1]

Plant Type	The capacity of the renewable energy sourced power plants and under construction (MW)
Hydraulic	6527,4
wind	1535,9
Geothermal	313,2
Biomass	16
solar	177
Total	**8569,5**

2 EVALUATION OF RENEWABLE ENERGY IN COLD CLIMATE REGIONS

The cold climate region is defined as the region changed between altitudes of 700-2000 m. It is located in cold climate areas cities such as Erzurum, Ağrı, Ardahan, Bayburt, Bingöl, Bitlis, Bolu, Gümüşhane, Hakkâri, Kastamonu, Kars, Muş, and Sivas. In the cold climate region dominating the hard winter conditions, the temperature is below 0 ^{0}C for the almost half of the year. The lowest average temperature is around -20 °C for this region [2, 3]. In the cold climate region dominating the hard winter conditions , in order to minimize energy costs, the renewable energy sources have the important operating criterial such as clean environment and sustainability relatively the conventional sources should be used efficiently in the buildings. The main renewable energy sources can be utilized effectively in the agricultural sector depending on local conditions are solar, wind, geothermal and biomass energy. In order to prevent the environmental problems associated with using fossil fuels directly or indirectly effectively, it should benefit from renewable energy sources [4]. The total renewable energy installed power in Turkey on the date February 2016 is 73427.36 MW, wind 4534 MW, hydraulic is 19127 MW, solar 290 MW, geothermal 635 MW, biomass 345 MW respectively [5]. In this scope of work, how renewable energy sources can be assessed by the help of various technological applications in buildings in this area is discussed below, respectively. The pictures on the wind, solar cell, biomass, hydroelectric and geothermal energy resources is shown in Figure 1.

2.1. The high energy performance buildings

The high energy performance buildings are designed to be fitted with the minimum requirement relatively conventional systems, can get the maximum amount of renewable energy sources such as solar, wind, geothermal, can be used simultaneously with conventional systems, and have automatic operating systems. In The high energy performance buildings, the most important energy-saving component is shell. Although the share in total building costs of the cost of building shell is from 15% to 40%, an impact on the operating cost of building shell may be 40% or more. Therefore, constraints on fossil energy reserves and due to environmental problems, the share of renewable energy in total energy consumption in buildings

is to reach 50% in recent years [7]. Nowadays, the double-walled shell benefited from the maximum amount of solar energy, and used effectively in building shell is one of the new technological applications. The renewable energy source applications such as solar, wind, geothermal, and the hybrid heat pump systems working simultaneously with conventional systems depend on the environmental conditions should be particularly widespread in buildings in cold climate regions.

Figure 1. The pictures on the renewable energy sources [6]

2.2. Geothermal Energy

Turkey ranks 5th in the world in geothermal energy in terms of heating applications. 95% of the geothermal resources of our country has a temperature suitable for heating, and there are 172 geothermal areas with temperatures above 30 ^{0}C. Most of these areas, are located in the west, the northern, western and central Anatolia The sustained power by geothermal energy can be produced. According to recent data, the geothermal sourced power installation in Turkey is around 635 MW. In geothermal applications, an overall increase of 50% was achieved including central heating 62%, greenhouse heating 90%, for the thermal hot springs tourism 23%. Agriculture is the most important source of income for local people in the cold climate. For the low-income people of this region, greenhouses are agricultural enterprises that both contribute significantly to the diversity of products and in the field of employment. Today, considering the rather expensive energy costs, the plant growing in greenhouses is cheaper than conventional methods. A wide variety of products are grown in greenhouses in the many countries in cold climates such as Britain, Netherlands. In particular, the share of the production costs of heating in the greenhouses automatically controlled has risen to 60%. The use of renewable energy sources in the greenhouse should be encouraged to reduce this share. The development of geothermal resources based on greenhouse in our country will make an important contribution to the greenhouse in cold climate region [8, 9].

2.3. Biomass Energy

The easy storability of biomass energy provides advantages over other renewable energy sources. Biomass is grouped generally into agricultural (plant, animal and water), forest, urban and industrial origin sources. Biomass energy is particularly produced from the plants obtained by energy farming. Urban and

industrial sources constituting the other biomass energy sources provide a significant advantage in terms of the environment. Municipal wastes, sewages and industrial wastes have come to the forefront as assessed resource in this context. In our country, it was understood that 2.8 to 3.9 billion m^3 of biogas produced from animal wastes. This potential is equivalent to the annual energy of 24.5 kWh. This value corresponds to approximately 5% of the total national energy consumption. A modern biogas plant consists of three main sections. These are production (reactor), and gas and fertilizer tank. In addition, raw material storage tanks, gas pipes, valves, fittings elements, heating systems, pumps, mixers, separators and filters and so on. elements are in the system [10].

2.4. Wind Power

The energy from the sun to the world by radiation per hour spreads about 174.423.000.000.000 kWh. About 1-2% of this energy is converted into wind energy in the atmosphere. The energy caused by this transformation is more than about forty thousand times from the installed power in Turkey. In order to benefit economically from wind energy in any region, the lowest annual average wind speed should be 5 m/s. In terms of wind power technology, it is draw attention to countries such as Denmark, Spain, and especially in Germany in Europe. Further, U.S. with production capacity takes second place after Germany. In the planning stage regarding wind power in Turkey, there are 40 wind power plants. When 12.000 MW of wind power is taken into operation, it will be prevented from spreading into the atmosphere of 30 million tons of carbon dioxide, 2 million tons of fly ash, 80,000 tons of sulfur dioxide and 40,000 tons of nitrogen oxide. Thus, the wind power plays a very important role in terms of slowing down the process of global warming. For example, the area covered by the 20 turbines at wind power plants is approximately 1 km^2. The area occupied by the turbines is about 1% of this area. Therefore, provided that the buildings is done in a manner not to prevent the wind, the areas outside of the area covered by the turbines can be used in applications such as farmland, livestock and so on. In Denmark, considering that more than 15,000 people employment is only in this sector, it is understand that the native technologies and wind energy in the cold climate regions will make an important contribution to the regional economy in terms of employment [11].

2.5. Solar Energy

The energy intensity from the sun over the world atmosphere is 1.35 kW per m^2. Our country has a high potential for solar energy, and it is known that the total solar radiation 1303 kWh / m^2, the average annual sunshine duration of 2623 hours. Taking into account this high average value, the widening of solar energy in Turkey is very important. It is understood that solar energy should be extended in Turkey. There are low and high temperature applications of solar heating systems. While low temperature applications related to the heating of buildings, with regard to achieving the required temperatures in industrial and agricultural, the high temperature applications extends up to the melting of mineral from steam production as well as these type applications. The most commonly used are flat-plate collectors and vacuum pipe collectors.

The electrical solar collectors called Photovoltaic are solar cell, and these solar cells have a semiconductor diode structure, and in these type of collectors, solar light is converted directly into electricity by benefiting from the photons occurred as a result of photosynthesis. Solar cells made from different semiconductor materials [12]. The advantages of solar cell can be listed as longevity (20 years), low maintenance costs, the absence of environmental pollution, a simple system structure, and very small space. While 90% of the solar cell production in the world produced by U.S.A, Japan and European countries, these works have gained acceleration in Turkey for 15 years and installed power in the country is 290 MW nowadays. The cost of module consists of solar cells is about 4 $/W. The use of solar energy technology in cold climates, the use of both heating purposes and power generation will stimulate the economy in the region and will provide an important contribution to employment. The initial investment and fixed operating costs of renewable energy sourced power plants according to current prices in 2014 are given in Table 2.

Table 2. Renewable energy source plant costs [13]

Plant Type	Initial Investment Costs ($/kW)	Fixed Operating Cost ($/kW-year)
Hydraulic	2936	14,3
Wind (land)	2213	39,55
Geothermal	4362	100
Biomass	4114	105,63
Solar	3873	24,69
Total	**17498**	**284,17**

2.6. Hydraulic Energy

When these plants compared to other types of production, hydraulic plants have the lowest operating costs, the longest operating life and the highest efficiency. Giving priority needed hydropower plants in Turkey could be seen as an economic and strategic approach. According to the data the State Hydraulic Works (DSİ), the gross hydropower potential in the world is 8905 TWh/year for today. Turkey's the gross hydropower potential is about 433 billion kWh [14]. These values, depending on energy prices and emerging technologies are constantly renewed. Taking into account the hydraulic potential of the cold climate region, if the planned investments are completed on time, it is understood that these regions will developed economically.

3 RESULTS

According to the results obtained in this study, the use of renewable energy in cold climate regions will provide substantial benefits to the economy of the country. Our country has rich renewable energy sources, such as solar, wind, geothermal, hydraulic, biomass. In this context, the most important problem in our country is developed native production technologies and minimize of the initial investment costs. It says that there are no significant obstacles for investors on the use of renewable energy sources in terms of legislation. According to the renewable energy law No. 5346, for the entrepreneurs with the renewable energy Authorization Certificate, in the power plants will put into operation until 31.12.2020, the prices indicated in the Table 3 are valid for 10 years.

Table 3. 10 years current unit prices according to Law No. 5346 [11]

Plant Type	Current Prices ($/kWh)
Hydraulic	$7{,}3*10^{-2}$
Wind	$7{,}3*10^{-2}$
Geothermal	$10{,}5*10^{-2}$
Biomass	$13{,}3*10^{-2}$
Solar	$13{,}3*10^{-2}$

According to the International Energy Agency's data (IAEA), it is expected that the total investments of 42.2 trillion dollars will be made in the energy sector of non-OECD countries. These investments are expected to be made in the shares of 17 trillion dollars for energy, 9.4 trillion dollars for oil, and 8.5 trillion dollars for gas, 0.8 trillion dollars for coal, 6.5 trillion dollars for renewable energy sources. In the determined plants, considering the changes in costs of unit energy production, these costs will be realized as for wind (land) (39.16%), solar (26.06%), nuclear (17.28%), and it is seen that are going to increase for coal-fired thermal power plants (%6.9), the energy production unit costs does not change and production unit costs for geothermal energy and the biomass power plants. The total renewable energy installed power in Turkey on the date February 2016 is 73427.36 MW, wind 4534 MW, hydraulic is 19127 MW, solar 290 MW, geothermal 635 MW, biomass 345 MW respectively. In these cold climate regions, the consumption

share of renewable energy sources should be increased in the domestic consumptions as well as in industrial consumptions, and in our country should be developed native production technologies and minimized of the initial investment costs. It says that there are no significant obstacles for investors on the use of renewable energy sources in terms of legislation in our country. If this purposes occur as described above, the low-income people in the region will reach to cheaper and more modern living comfort.

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