DESIGN AND APPLICATION OF AN ECOHOUSE BY USING RENEWABLE ENERGY SOURCES

Gulsen Soyhan, Sami Toksoz, Gokhan Coskun, Yalcın Topacoglu,
Burak Gokalp, Dundar Bayram

Abstract: In this study an Ecohouse application which uses sustainable and renewable energy sources with efficiently and effectively was described. In this context, some information is given on renewable energies especially about solar energy in Turkey and describes the importance for Ecohouse. For designing Ecohouse, solar collector, solar and ground source heat pump systems and battery use was considered and described how this system works and applies.

Keywords: Ecohouse, Renewable Energy, heat pump systems

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1. Introduction

Today, energy provision has become one of the basic problems for humanity. Energy requirements increase in parallel with technology developments. Development as a measure of the energy consumption increased the demand for fossil fuel origin also increases with [1]. In Turkey and the world demand for fossil fuels will increasingly have become inevitable to global warming impacts. Between 1980-1999, investigations judged that until 2100 1.8 to 4.0°C increase in temperature is expected. As a source of primary energy use of renewable energy resources are continuing efforts to spread [2].

The rapidly increases of population and growing energy needs of the industry's limited resources against is, energy production and consumption of the gap between growing and available resources are not enough to the environment and human health and prevent adverse effects such as cases in the future are dragging us into pessimism. Global energy consumption expecting to two times more in 2035 three times more 2055 according to 1998. In response to meet these needs now is the fossil fuel reserves are depleted more quickly. Considering the current conditions of energy use by even the most optimistic estimates of oil reserves will be largely exhausted at the latest in 2030 and can not meet the need is considered. It's expecting about 80-100 years coal reserves and about 100-120 years natural gas will be exhaust [3].

Widely using the traditional energy resources, housing, transportation and industrial sector makes the problem even more complex. It's known that big part of Turkey's energy is consumed in the industrial and housing, housing for a large portion of energy used for heating. The difference opened further each passing day between energy consumption and production. Energy consumption by sector statistics is given figure 1.

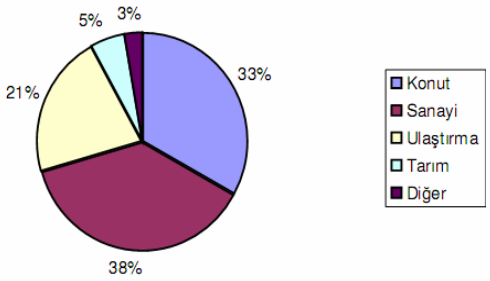

Figure 1. Energy consumption by sector statistics

It's possible to investigate energy sources to in three main headings. The first one is that after being removed from the coal is consumed without any processing, such as natural gas and petroleum resources. They are called as primary energy sources. Obtained from the transformation of primary energy sources are electricity, coke, coal gas, etc. The resulting energy from them is known as secondary energy source. The root of the world energy is solar energy. Third is not exhausted, not falling 'renewable' energy is due. New and renewable energy sources are stated as follows:

- Hydroelectric energy;
- Solar energy;
- Wind energy;
- Geothermal energy;
- Wave energy;
- Ocean thermal energy;
- Hydrogen energy;
- Bioenergy.

As seen in Figure 2, in 21st century, primary energy sources are expected to be consumed by the prediction, natural gas, coal, fossil fuels like oil, will reduce the use and is expected to be finished even. In close future, it is likely to price increase on fossil-based energy sources and the formation of a serious bottleneck in parallel. However, wind, solar, water, air, etc. the use of renewable energy sources are likely to increase rapidly in recent years [2]. Figure 2 shows expected to change for the use of primary energy resources in the year 2100

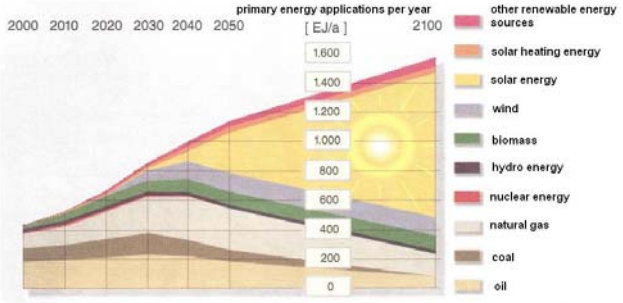

Figure 2 Expected to change for the use of primary energy resources in the year 2100 [2].

2. Solar Energy as Renewable Energy Sources

Renewable energy resource "Nature's own conversion to renewable energy sources may be available the next day the same as" is defined. Fuel oil, gas, coal, bio energy and wind all, is derived from solar energy. Due to the unstable structure and spread of solar energy it's expensive to maintain power directly. But it's clear structure, in terms of costs to provide an effective solution that should not be ignored. Place, massive (large) to have a structure, the solar energy reaching the earth to swallow and stored almost half of energy on by earth. Soil; at heating season, a source at higher temperatures and external air for summer cooling, a lower air temperature by providing a relatively constant temperature all year remains [4]. Turkey, because of its geographical position in terms of solar energy potential is lucky according to many countries. Solar energy potential of Turkey according to months for the duration of insolation is given in Table 1. According to table Turkey's average annual total insolation duration of 2640 hours (daily total of 7.2 hours), average total radiation intensity of 1311 kWh/m2.year (daily total of 3.6 kWh/m^2). In Turkey, the smallest and the largest annual average value of the total radiation of is respectively 1350 kWh/m^2.year in the Black Sea region and 1750 kWh/m^2.year in the Southeast Anatolia region [2].

Table 1. Monthly Average Solar Energy Potential of Turkey [5].

MONTHS	MONTHLY TOTAL SOLAR ENERGY		INSOLATION DURATION	MONTHS	MONTHLY TOTAL SOLAR ENERGY		INSOLATION DURATION
	(Kcal/cm^{2}month)	(kWh/m^{2}month)	(Hour/month)		(Kcal/cm^{2}month)	(kWh/m^{2}month)	(Hour/month)
JANUARY	4,45	51,75	103.0	AUGUST	13,62	158,40	343,0
FEBRUARY	5,44	63,27	115,0	SEPTEMBER	10,60	123,28	280,0
MARCH	8,31	96,65	165,0	OCTOBER	7,73	89,90	214,0
APRIL	10,51	122,23	197,0	NOVEMBER	5,23	60,82	157,0
MAY	13,23	153,86	273,0	DECEMBER	4,03	46,87	103,0
JUNE	14,51	168,75	325,0	TOTAL	112,74	1311	2640
JULY	15,08	175,38	365,0	AVERAGE	308,0 cal/cm2-day	3,6 kWh/m2-day	7,2 hour/day

3. Ecological House With Renewable Energy Sources (Ecohouse)

With Ecohouse design is aimed to develop housing assembly systems which can be easily installed in every house. This work is a solution in terms of importance represents for energy production and consumption between the deficit to grow, rapidly growing population and developing the industry's energy needs against limited resources and be unable to renew existing resources to the environment and human health and prevent adverse effects such as despite negativity to produce.

"Renewable energy sources with Eco-House Design" primary purpose of the study, housing in the heating-cooling energy and electrical energy costs to the minimum level of support, outside of energy to reduce dependence and environmentally friendly energy usage to increase, to spread and make it attractive.

In this context, the most important features of work:

- Using indigenous energy resources for reduction of dependence on foreign energy.
- Reducing carbon dioxide emissions to help protect the environment.
- Related to the promotion of domestic manufacturing sector to contribute to increasing employment.
- Received widespread and strong support from the public

3.1. The Steps at Ecohouse Design

To be able to meet electricity needs in the Ecohouse house Design solar batteries can be installed to the south direction of the roof. Hot water needs are met from mounted solar collectors. To meet the need of home heating and cooling land-source heat pump is intended to be mounted. Polyethylene welded pipes can be laid horizontal or vertical resources at the home garden. If solar collectors can't meet the needs of hot water, heat pumps are provided to circuit into.

Household electrical appliances energy consumption will be measured by power and energy measuring devices. Horizontal and inclined surfaces in the house from the roof of the average values of solar radiation and insulation duration will be measured by using measuring devices called piranometre. Cost and efficiency in terms of single-crystal silicon with different structure, multi-crystalline silicon and thin film amorphous silicon solar battery of the solar system have produced will be compared with energy gain. Solar battery, invertors and charge regulator will be selected by using obtained values. Electric energy production is insufficient to reveal the circumstances will be taken from the network power. Kitchen and bathroom have needs hot water. The hot water demand system will use solar hot water commutator. Solar energy system inadequate heating and cooling purposes in cases where the heat pump will be installed soon. Heat pumps will be connected to the hot water tank.

Thermal heat loss and gain of the house are photos by camera and if it's necessary insulation will be done in the region. Summer conditions and winter conditions in the cooling system that enables us to make heating

mechanism can be installed in land-source heat pumps. The system to be designed for the house of heat loss and gain will be calculated. Save for heat exchange with the six soil properties and soil analysis will be done to determine soil. Source-side heat exchangers will be used in special polyethylene pipe. Installed by the air channels, the space heating, air conditioning, fan-coil, radiator, etc. methods can be used.

With the efficiency of the survey the following questions must be questioned;

1. Total energy savings features of the house how to contribute?
2. Compared with the same size as a standard Turkish Construction how much energy is consumed?
3. For the development of energy efficiency savings to be tried What's the path?

3.2. Systems that used at Ecohouse Design

3.2.1. Solar batteries (photovoltaic cells)

Solar batteries (photovoltaic cells), surfaces in the sun light directly into electrical energy for the semi-conductor materials. Surface square, rectangle, circle-shaped area formed by the solar battery usually around 100 cm ², the thickness between 0,2-0,4 mm. Solar batteries based on work as photovoltaic principle, that falls on the light when electric voltage is formed in the end. The source of the electrical energy of battery, solar is coming to the surface. (Construction and operation of solar batteries) Solar energy, solar battery, depending on the structure of between 5% and 20% with a yield can be converted into electrical energy. To increase the power output of solar battery multi-connected series or parallel to each other is mounted on a surface, the structure of the solar battery module or a photovoltaic module is called. Depending on the demand system is created of the power modules connected in parallel or in series to each other until from few Watt to megawatts [2].

Most widely used material in the production of Solar battery are:

• Crystalline Silicon: Arsenite gallium (GaAs);
• Amorphous Silicon Thin Films: Cadmium Telluride (CdTe), Copper Indium Diselenide (CuInSe2);
• Optical Intensive Cells.

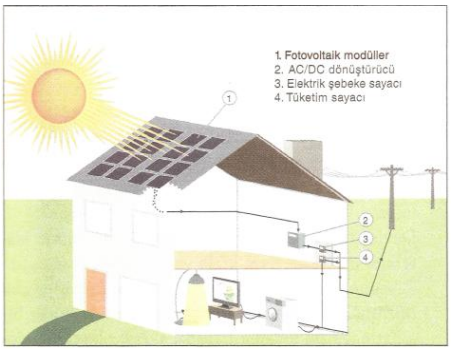

Figure 3. Diagram of the connected photovoltaic systems on the network

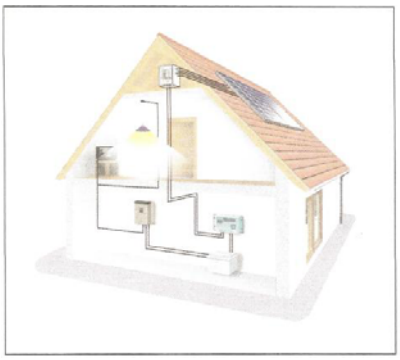

Figure 4. Independent photovoltaic system from the network diagram

3.2.1.1 Implementation of Photovoltaic Systems to Buildings

Buildings can be applied in two ways photovoltaic panels. Previously been made or the roof of the building to the front, ready to install with mounting kits. The new building, the panel also can be used as building materials.

3.2.1.2 Distribution of the Cost of Photovoltaic Systems That Connected to the Network

The following can be used to spread ideas:

- 50% - Photovoltaic panels;
- 15% - AC / DC converter;

- 15% - Cables and various electrical equipment;
- 10% - Installation mounting kits;
- 10% - Installation labor.

Independent systems, as well as battery cost expenditures, and so the costs are engaged as below. Therefore, the initial investment cost is higher than the system is connected to the network.

3.2.1.3 Advantages of Photovoltaic Systems

- Renewable energy;
- Old and new buildings for the installation of the
- Building integrated systems, decreasing the cost of roofing;
- Vary depending on country and state are provided by tax incentives and discounts through the short repayment periods;
- Varies between 25 and 30 years of long life;
- Network of independent power production in that
- Country specific decreasing energy dependence on the outside;
- Panel of the very low maintenance and repair needs;
- Increased energy gain with solar tracking system;
- Continuous improvement technology.

3.2.1.4 Disadvantages of Photovoltaic Systems

- Photovoltaic cells manufacturing technology and systems in the deficit due to losses occurring in the obtained efficiency remain low. This is a very high initial investment costs and long repayment periods that can cause;
- Due to lack of State Facilities promoting and infrastructure systems at the same speed everywhere common;
- Installation of the local environmental factors is very important. Setup with the location of buildings and shading negatively affects the performance of the system;
- Installation is the geographic location directly affects the intensity of solar radiation. Therefore, the less the amount of annual Name of countries, remains low earnings can be obtained;
- Independent system used to store electricity in batteries and the brevity of life need to be replaced with certain period to improve operating costs [2].

3.2.2. Heat Pumps

Heat transition temperature always decreases in the direction is known to be another change; the transition temperature of high temperature low temperature environment is the environment. This is a natural phenomenon, can occur spontaneously. Reverse of this fact by itself can not perform. An environment of low temperature heat from the transition to an environment of high temperatures but can be done with the use of heat pumps. The cooling fluid flows in the cooling cycle. Different fluids has advantages and disadvantages among each other in usage. The conversion is performed with the following elements: a compressor, condensation, throttle valve and evaporator.

4. Simulation and the software

There are several methods in simulating the performance of eco-houses. Some of them are DOE-2 developed in Lawrence Berkeley National Lab in US [6], BLAST developed in University of Illinois [7] and ESP-r developed in University of Strathclyde, UK [8]. By using these codes, it is possible to model all of the design parameters mentioned above [9]. Since they are developed with parameters applicable in US and north Europe, we are working to develop software by using the data available in Turkey, Balkans and Mediterranean region.

Conclusion

70% of energy from abroad, especially for renewable energy resources for our country to do the work in the sector to foreign energy dependence is to reduce a large shareholder.

Turkey, the world's first solar energy efficiency is available in 4 countries. Average 7.2 hours per day, although the sun to see Turkey in the use of alternative energy systems are not widespread. Common practice the use of alternative energy Eco-houses realization contribution to the national resources will be revealed.

Fossil fuel changes to solar and natural energy in Ecohouse. Electricity from the solar energy, the energy required for heating and cooling will be provided entirely from natural sources. Therefore, the dependency on fossil fuels such as in housing will not. Reducing carbon dioxide emissions to help protect the environment and the promotion of domestic production and contribute to increased employment in the relevant sectors will provide.

Acknowledgement

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Bibliography

[1] Reay, D.A., Mac Michael, D.B.A., Heat Pumps, June, 1988.

[2] Isısan No: 375 “Renewable Energy Alternative Systems”

[3] http://www.ekodialog.com/Makaleler/yenilenebilir_enerji_kaynaklari.html

[4] MCNEIL, C.S.L. and CRAWFORD, T.K. Vertical Borehole Groundloop Heat Pump Installation, Advanced Buildings, Newsletter, 1995 Royal Architectural Institute of Canada, Vol. 1, No. 8, 11 Sayfa, Haziran 1995 (http://www.discribe.ca/nordic/projtruro.htm)

[5] General Directorate of Electrical Power Resources Survey and Development Administration (EIE), www.eie.gov.tr

[6] Lawrence Berkeley Laboratory. DOE-2 Supplement

[7] BLAST University of Illinois, Ubrana-Champaign Il, USA

[8] ESP-r ESRU, University of Strathclyde, Scotland

[9] Hyde, R. Bioclimatic housing: innovative designs for warm climates, Earthscan, 2006

Authors' Information

Soyhan Gulsen: Researcher at YETA Association

Toksoz Sami: MSc. Student, Sakarya University, Sakarya, Turkey

Coskun Gokhan: MSc. Student, Sakarya University, Sakarya, Turkey

Topacoglu Yalcin: Researcher at YETA Association

Gokalp Burak: PhD student, Kocaeli University, Kocaeli, Turkey

Bayram Dundar: PhD student, Yildiz Technical University, Istanbul, Turkey