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Research Article

RENEWABLE ENERGIES IN THE SETTLEMENTS (A STEP TOWARD A CLEAN CITY)

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Abstract: *As a result of the energy crisis of fossil fuel in the world, and pollution that comes from using these types of fuels, humans need to find clean and affordable energy to survive, impelling communities which produce their energy to carry out new initiatives. The use of wind, water, earth, solar and other clean energy has become possible, and finally, the world is on a path that requires new research in this field. Between the urban and social elements, per capita energy in the housing sector is allocated the highest consumption in the world, and this sector has the greatest amount of energy consumption in Iran as well. Researchers are presenting new solutions in addition to the usage of technology in the production of renewable energies, making closer to reality the reproducible ideas about using parts of buildings and natural forces around the buildings. This study is an attempt to explore the surrounding natural forces and materials that are used in construction, alongside the study of books and valid and scientific global websites that discussing the idea of using new technologies along with the existing energy production. Using renewable energy, homes have been made from special materials, where the manner of design adjusts to the environment (like solar energy), but can still function in any condition. We have seen that by studying the available information, biogas and photovoltaic systems are also intended to (in addition to their own sufficiency) and lead to saving energy. The day is coming that single municipal buildings will manage to make their fossil energy usage reach zero.*

Keywords*: fossil energy, photovoltaic, biogas systems*

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1. Introduction

The increasing mortality of fossil fuels, the push for diversifying energy sources, the development and energy security, and finally, environmental issues are all problems caused by the consumption of fossil fuels on the one hand , clean and reproducible sources of new energy are coming from the sun, wind, environmental conditions, and biomass methods on the other hand led to universal, serious attention paid to the development and expanded use of nuclear energy and increasing the share of the resources in the energy of world capacity. In this regard, in the architecture and design fields, they are emphasizing low consumption patterns, and most experts are wording towards these goals for buildings [1].

2. Materials and Methods

In this research, we examined the effort to produce maximum energy using the two methods: taking advantage of the Sun's light energy, and maximum biomass energy production by natural forces around the building. This small energy production pattern is to be used in the future public buildings of Iran. Because of the geographic position of Iran and Tabriz, the amount of radiation of the sun and the

perfect platform of this part of the world, we believed that there was a high percentage possibility of success of this goal [Author].

2.1. Biogas

Biogas consists of gases caused by the fermentation of animal and vegetable waste away from oxygen and produced by the effects of anaerobic bacteria activity that includes about 60 percent CH_4, a flammable gas, and rest of it consists of 30 percent CO_2 and a small percentage of N_2, O_2, H_2, H_2S and moisture. In some cases, biogas contains combinations of siloxane as well (Table 1). A remaining by-product is compost or organic fertilizer used in agriculture, prized for being rich in nutrients.

Table 1. The overall composition of biogas [Author]

The overall composition of biogas		
Percentage	**Formula**	**Combination**
50–75	CH_4	Methane
25–50	CO_2	Carbon dioxide
0–10	N_2	Nitrogen
0–1	H_2	Hydrogen
0–3	H_2S	Hydrogen sulfide
0–0	O_2	Oxygen

The main composition of biogas is methane, a flammable gas that composes between 60-70 percent. Methane is a colorless and odorless gas that if one kcal of it is burned, it, produces 252 cubic feet of thermal energy, which in comparison to other fuels, is a significant figure. Two other combinations, especially the hydrogen sulfide (H_2S) compound (which has a negligible contribution) is a poisonous compound. Another important advantage of methane fuel is that it does not produce toxic and hazardous gases like CO while burning, so it can be used as a healthy and secure fuel in home environments.

As previously mentioned, 60-70% of biogas is methane, and this high percentage of methane distinguishes biogas as an excellent source of renewable energy for succession of natural gas and other fossil fuels. Today it is used for heating factory boilers, in motor generators to produce electricity, home heating and cooking [2].

The use of biogas production in Iran is not a general application so far and is in the laboratory stage; while in the countries of Western Europe, Southeast Asia, and especially China and India, this technology is very impressive and these countries benefit by using this technology. Due to the diversity of existing systems in the producing of biogas, it is essential to look at specific examples of use. Here are a few cases that related to the final project:

2.1.1 The production pattern of household waste of biogas:

The overall structure of biogas machines has been established with two input and output ponds, a fermentation tank (hazm), and a gas tank that take into account different circumstances such as: weather, culture, economics and technology. In terms of the type and quality of the application, there are different systems in the world, and four common types are [3];

1. Biogas device floating is known as the pig model.
2. Biogas device with a fixed dome tank is known as the Chinese model.
3. Biogas device with a high ratio of length to width is known as the Taiwan model.
4. Anaerobic compost

The raw materials of biogas are organic wastes-plant, waste, animal waste, human waste and sewage plant sludge.

2.1.1.1 Biogas device with floating hood

This device is used widely in India and thousands of devices of this kind are producing power in India. Raw materials, after mixing with water, go from an input pond into the fermentation tank that is located underground, and after gas production, fermentation material moves to the outlet pond that is located on the side of inlet pond and productive gases are collected in the metal gas casing that is located on the reverse of tank openings (Figure 1,2).

The overall picture of this device is as follows:

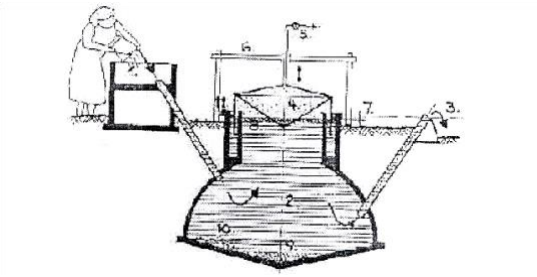

Figure 1. Biogas device with floating hood [4]. 1-Mixing tank with the entrance pipe. 2-Fermentation tank. 3-Weir flow from pipe output. 4- Tank holder of gas floating in liquid level . 5-Gas output with the bend of main pipe. 6-Help structure for a gas tank. 7-The difference of height equals to gas pressure of water in centimeter. 8-The floating layer of fiber when used as food. 9-Thick sludge. 10-Permanent layer of sand and rocks.

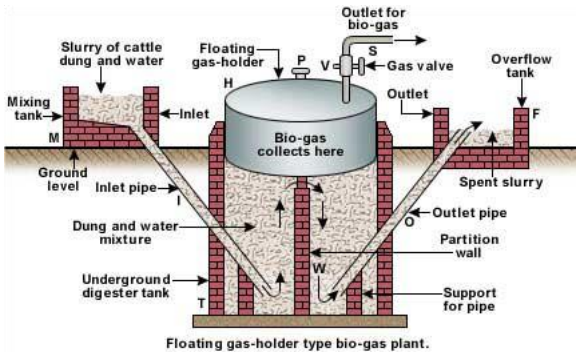

Figure 2. Biogas device with floating hood [5].

2.1.1.2 Biogas unit with fixed tank: (Chinese model)

Since these devices' origins are originally Chinese, the Chinese model is popular. This machine is built with a tank dome and underground gas tank fermentation is common due to fitting deep in the earth; this system increases efficiency in terms of savings in location and space needed and stabilizes the temperature and resistance of the device in cold areas which makes it important (Figure 3).

Thus, the gas chambers and fermentation are next to each other. A reservoir is built and the gas chamber is covered with a brick or concrete dome, and a valve is mounted on the gas tank. The Indian model is based on this device, but in this case the produced gas will climb the dome, and the pressure of gas production takes place when the consumption of fermented material in the discharge chamber propels the material exiting the outlet of the basin. This adjusts the gas pressure inside the dome, because

when the pressure increases, more material is removed. If the internal pressure is reduced during consumption, fermented material returns into the tank outlet valve to compensate pressure defects.

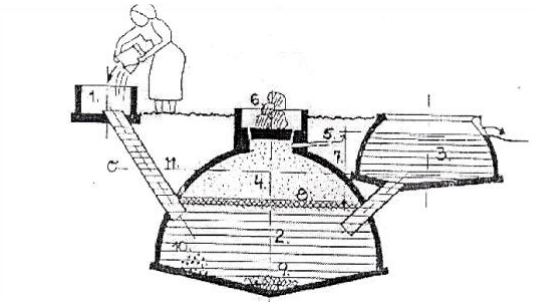

Figure 3. Biogas unit with fixed tank, (Chinese model) [6]. 1-Mixer with input. 2-Fermentation tank. 3-Outlet tank. 4-Gas holder tank. 5-Gas pipe. 6-Input plug (that is inhibited with the use of the weights). 7-Differences of height equal to the difference of water pressure in cm. 8-Clear layer. 9-Permanent layer of thick sludge. 10-Permanent layer of stone and sand. 11- Source line (zero) filling height of tank without gas pressure.

2.1.1.3 Biogas unit Taiwan model

This device can be built from different materials such as metals, PVC and fiberglass. The ratio of the length to the width in this system is large. The stream type is plug flow and hydraulic. Microbial retention time is the same due to the lack of returned mud, about 60 days (Figure 4).

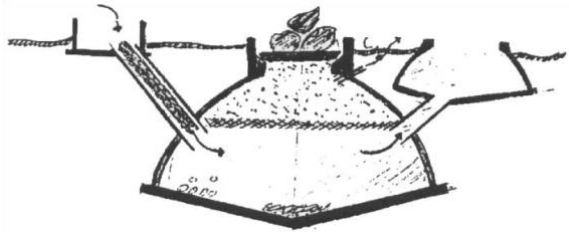

Figure 4. Biogas unit Taiwan model [7].

2.1.1.4 Anaerobic Compost:

Anaerobic compost is a sequence of processes by which microorganisms break down biodegradable material in the absence of oxygen. The process is used for industrial or domestic purposes to manage waste or to produce fuels. Much of the fermentation used industrially to produce food and drink products, as well as home fermentation, uses anaerobic compost.

Anaerobic compost is used as part of the process to treat biodegradable waste and sewage sludge. As part of an integrated waste management system, anaerobic digestion reduces the emission of landfill gas into the atmosphere. Anaerobic digesters can also be fed with purpose-grown energy crops, such as maize, this method is widely used as a source of renewable energy. The process produces a biogas, consisting of methane, carbon dioxide, and traces of other 'contaminant' gases. This biogas can be used directly as fuel, in combined heat and power gas engines or upgraded to natural gas-quality biomethane. The nutrient-rich digestate also produced can be used as fertilizer.

With the re-use of waste as a resource and new technological approaches that have lowered capital costs, anaerobic digestion has in recent years received increased attention among governments in a number of countries, among these the United Kingdom (2011), Germany, Denmark (2011), and the United States.

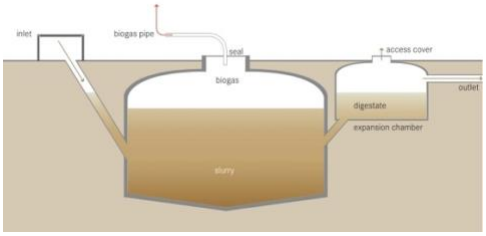

Figure 5. The Anaerobic Compost system for producing biogas [8].

2.2. The use of sun energy in the production of electricity (Photovoltaic Systems)

Solar energy is one of the broadest sources of renewable energy in the world. The energy from the sun falls on the Earth every hour, and exerts more than the total energy that the inhabitants of the Earth use in one year. To take advantage of this energy source, we should look to its scattered high efficiency and low cost to be converted to usable electric energy. In this method, by using specific technologies, energy is derived from sunlight to electrical energy conversion.

The condition caused by light radiation without using motion mechanisms that produces electricity is a photovoltaic phenomenon, and any system that uses this principle is called the photovoltaic system. A solar cell is a non-mechanical instrument that is usually made from a silicon alloy. When photons hit a photovoltaic cell, photons absorb energy to produce electricity. When the semi-conductor body, an object with a finite heat exchanges capability, absorbs the sunlight, the electrons of atoms of the object are moved. In order to build to a specific level, the object causes the front surface of the cell to attract electrons, So the electrons naturally migrate to the surface. When the electrons leave their position, holes are formed. Since the number of electrons is large and each one carries a negative charge to the front surface of the cell, load balancing between front and hind surfaces cannot maintain their balance, and an electric potential difference, like the positive and negative poles of a battery, is created. When the middle way between the two levels is -related, electricity is flowing. The use of photovoltaic panels in advanced countries is rapidly expanding. The photovoltaic panel in cases of cloudy weather can also produce electricity, although the output is reduced. In a very low light overcast day, a photovoltaic system may receive 5 to 10 percent of the normal days of sunlight, as a result its output as well as disseminate is low. The solar panel produces more power in the lower temperatures. Of course, PV systems, on winter days, produce less energy than summer days (Figure 6) [9].

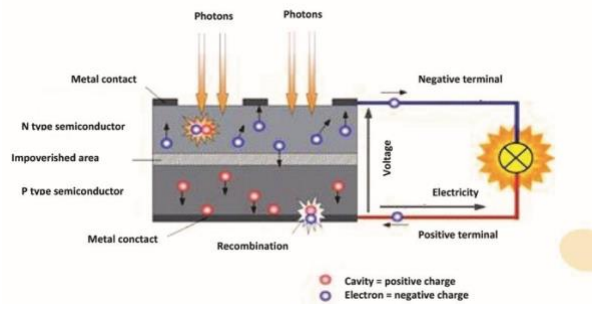

Figure 6. Analysis of the photovoltaic system [10].

Photovoltaic systems are one of the most consumed new energy applications. From the series and parallel cells, as long as there is sun, a reasonable voltage can be achieved. A collection of series and parallel cells are called a photovoltaic panel.

Generally, a photovoltaic system is composed of four main components:

1-solar panel
2-battery
3-power converter (inverter)
4-charge controller (Department of Electrical and Rural Energy Studies).

2.2.1 The solar panels in terms of the structure are divided into three major groups:

2.2.1.1 Polycrystalline solar panel

Multiple crystal solar panels or multiple silicon crystals are a key part of the solar panels' construction. These panels have lower lifetimes and prices compared to single crystal solar panels and are made from multiple crystal or silicon blocks that have less efficiency in absorption of solar energy compared to a single-crystal panel, but the cost of their manufacturing is lower. Use of them will be more cost-effective where space limitations are not an issue. This product is more appropriate for use in areas with dry climates [11].

2.2.1.2 Monocrystalline solar panel

Single crystal solar panels, in terms of history, are older than polycrystalline panels, but yields are higher than a few crystal panels. The single-crystal panels usually have a higher price and variations in manufacturing technology. According to the spatial limits on the solar system, these panels are more widely used, but this panel, due to fragility and hardness, should be installed and used in a more secure location. Ambient temperature is also a factor on the performance of this panel, that is, at temperatures above 50° C output drops appreciably (Figure 7) [12].

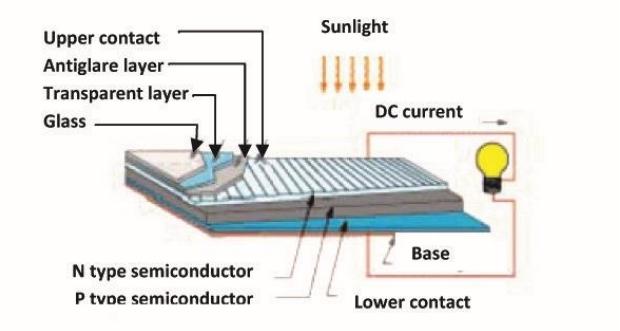

Figure 7. Analysis of the Monocrystalline cell [13].

2.2.1.3 Thin film solar panel

Thin-film solar cells, also called photovoltaic thin film cells, are solar cells of one or more thin layers of photovoltaic material on the layer below. This range in layers of thickness is very wide, ranging from a few nanometers to tens of micrometers. This product is for use in areas with more wet weather.
-Modules:

Each module usually has 20 to 40 solar cells that are connected to each other for series and parallel model. Each module has a maximum of 18 watts and the area is between 200 to 800 cm^2.
-Arrays:

A collection of photovoltaic modules and the retainer module frame for electrical or mechanical rides.
-Voltage regulation and control system:

Since the supply output electricity of the systems is DC, it should be turn out by the devices called inverter to AC, so that it enters the network.

-Energy storage in batteries:

Due to changing intensity of the sun's radiation during the day and in different seasons, it should be used in conjunction with a battery to save additional energy.

2.2.2 Photovoltaic systems use a variety of methods:

2.2.2.1 The grid connected systems:

In this way, the resulting electrical energy from photovoltaic systems' national network of power will be injected to the national grid (using direct current converter electric alternating current, such as the inverter connected to the network) In accordance with the specifications for the level of voltage, frequency, and phase difference.

2.2.2.2 The stand-alone systems:

This kind of application is able to provide the consumer required electric power energy without the need of a national network of electricity. In this way, the required electrical energy which can fit with high reliability can be installed and set up by using photovoltaic panels, storage and control systems, as a unit of power plants with a lifespan of 30 years.
Placement decisions of the panels in the roof of the buildings is located in the figure below:

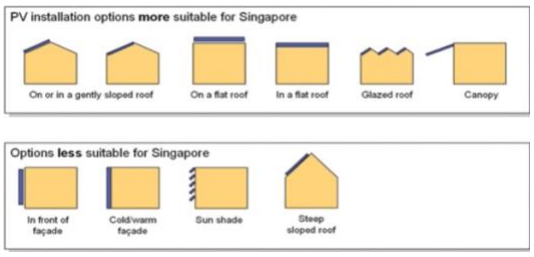

Figure 8. Placement decisions of the Panels in the roof of the buildings [14]

3. Results and Discussion

The selected systems in line with the production of renewable energy (Figure 9):

1. Photovoltaic system (monocrystalline solar 60 cell panel)

   The reason for choosing this model among the photovoltaic systems discussed in the article is its high efficiency, advanced manufacturing technology, easy installation and no need for much space. The photovoltaic system used in this building is a 60-cell monocrystal with dimensions of 100 x165 cm, and depending on the exact efficiency of the cells in them, they have an output of between 270 and 300 watts in standard conditions. Just a year ago, standard 60-cell panels were more like 250 or closer to wattage, but with advances in technology, the wattage of panels has increased to 300-350.

2. Biomass system (biogas)

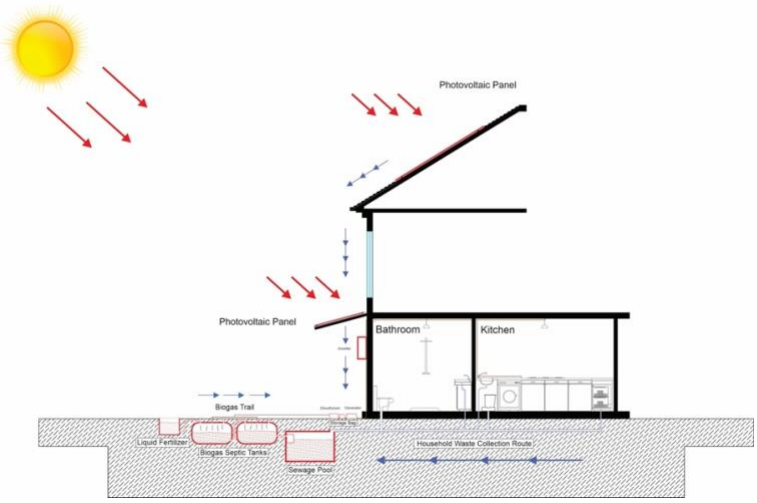

Figure 9. Selected systems [Author]

3.1. Photovoltaic system:

Solar panel energy is sent by light-sensitive cells to the electric voltage converter and then the energy is stored. Finally, it is necessary to use solar systems to load up electric charges. Based on the time it will be necessary to use an AC-DC inverter for AC loads and a DC-DC inverter for DC loads. In some of the systems (for the protection of the solar panel and batteries) it is also used as a charging control as well, which helps to avoid extra charges of batteries powered by the panel and also avoid draining batteries in the event that there is no production by the panel.

In household usage, this system well suits the needs of the building; furthermore, the possibility of storing the energy generated by this method is also available, which not only helps the building to be self-sustaining, but helps power requirements around building supplies as well (Figure 10, 11) [Author].

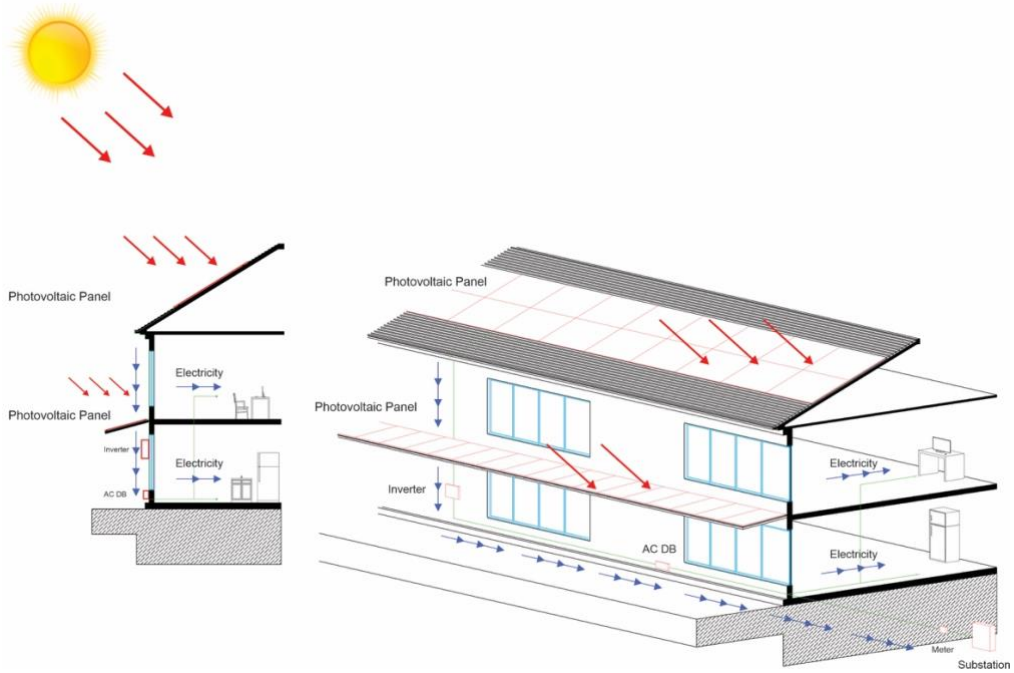

Figure 10. Overview of the photovoltaic system [Author]

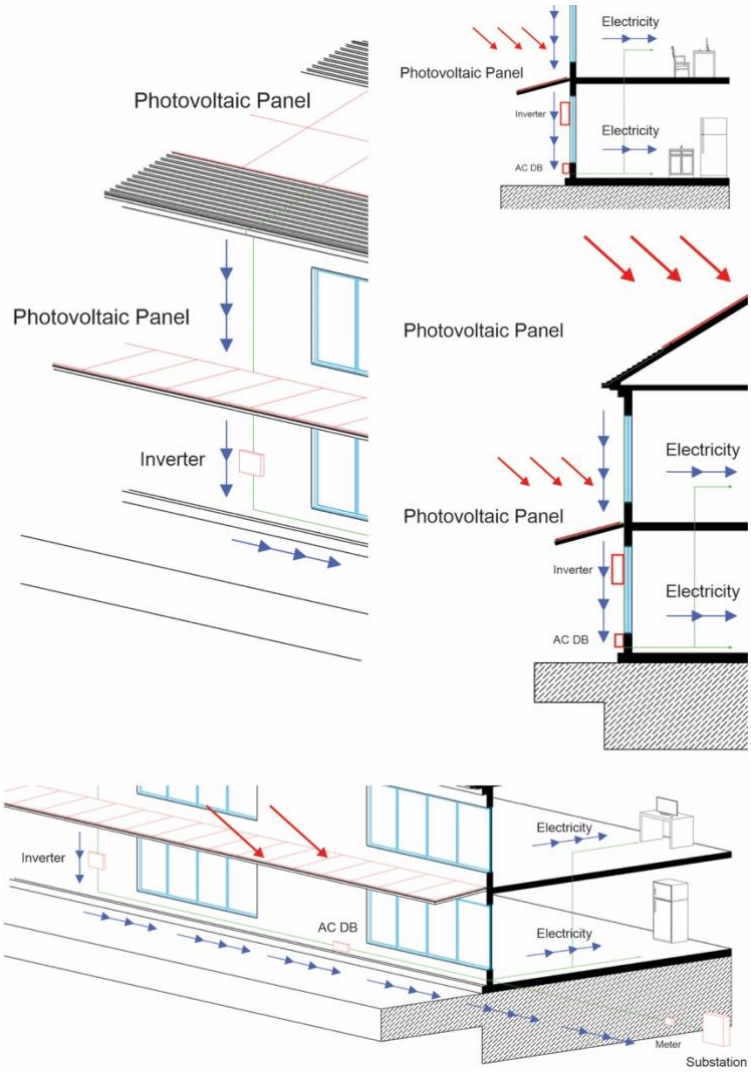

Figure 11. Large sections of the system [Author]

3.2. The biomass system (biogas):

This system collects all solids or liquids from kitchen wastes, which then go to the reservoir under the ground next to the building. Then these materials and fluids collected in the tank by the pumps to the tankers near the tanks. First, the material in the primary tank remains until the fermentation and the resulting gas from fermentation (biogas) has been redirected by the tube to the top and the sides of the desulfurize device. The resulting gas is then transferred to a storage container and then goes to the required places such as generator, electrical kitchen equipment, by pumps.

However, in the second part of the production phase in the preparation of biogas, the tank as shown in Figure 2, produces less biogas than first tank. The major product of this fertilizer tank is for gardening and agricultural use of the same house. In the final part of the above stages, non-potable and pretty clean water is obtained, which is also used in the building (Figure 12, 13) [Author].

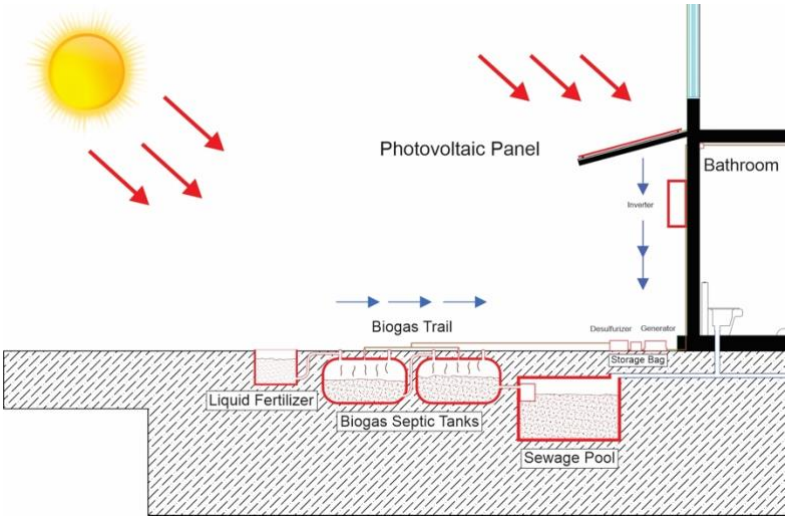

Figure 12. Section of designed biogas system [Author]

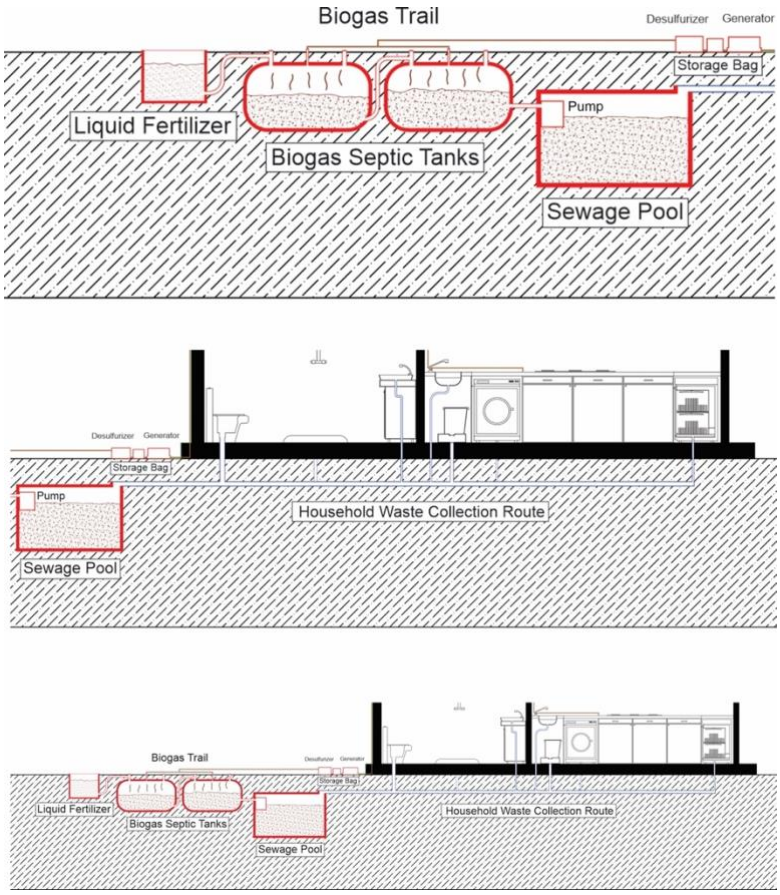

Figure 13. Zoom in biogas systems [Author]

4. Conclusion:

According to the systems and energies that were reviewed and tested in this research, we concluded the following:

1) Iran has vast resources for the production of biogas. With the usual values, the efficiency of biogas takes into account animal waste, waste of agriculture, urban sewage and garbage, and food industries and then applies the resulting coefficients. On average, biogas produces about 35/16146 million M^3, the equivalent of 323 petajoules of energy. Unfortunately, in spite of simple technology and productive potential of the biogas reactors, there is not a proper use of any of these sources in the country. Very few units exist due to the lack of proper guidance and administrative problems, and so do not have good efficiency [Author].
2) productive rural biogas uses animal manure digest, human sewage digest and three productive reactors of industrial waste. These numbers are in comparison with the number of units in the rural areas of biogas in India and Nepal (5000000, 2700000, 37000, 10) is liked at zero.

The most important factors in the development of biogas in Iran include:

1) Low energy prices
2) Lack of any specific reference to this type of energy
3) The lack of participation of the people and adequate training

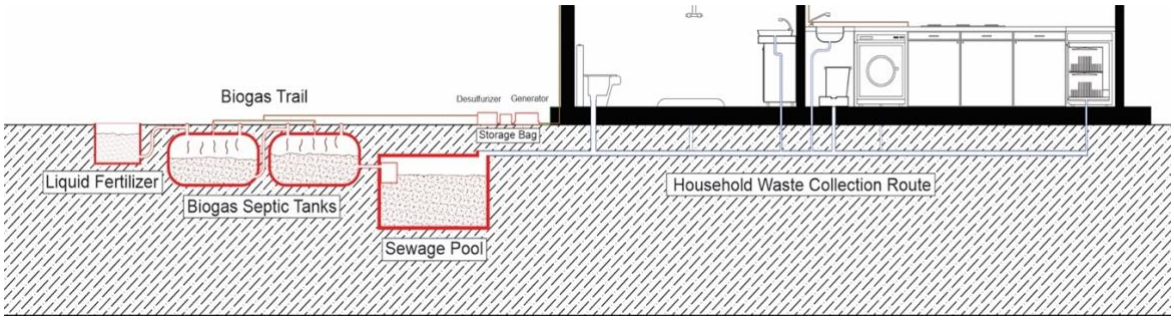

Figure 14. biogas system [Author]

Solar energy produces no carbon dioxide and is essentially limitless. Iran is located between 25 to 40 degrees north latitude and is located in an area that receives more direct sunlight than many other parts of the world. The amount of solar radiation in Iran has been estimated to be between 1800 to 2200 kilowatts per hour, which is of course higher than the global average. In the annual average, it is reported that more than 280 days are sunny in Iran, which is very impressive.

In this regard, the use of a photovoltaic system could be very fruitful in this climate and according to the facilities that this system puts in the amount of generating power at our disposal (production of electricity by the photovoltaic systems are usually 2-50 kilowatts), use of this system planning in the housing sector cannot fully free this community's consumption sector from fossil fuel dependency.

Properties of solar energies:

1) Solar energy is inexhaustible.
2) It is a clean energy and it does not cause damage to the environment.
3) Due to the lack of moving parts, it is easy to maintain.

4) It can fit the design to the capacity of the need.
5) It is a good fit with climatic conditions of Iran and has the ability to work in a wide range of temperatures and humidity.
6) It has low depreciation and high lifetime of structures [Author]

Authors' Contributions

A.A: Conceptualization, Formal analysis, Writing, Resources, Conclusion, Original draft preparation (60%)
M.K: Conceptualization, Methodology, Conclusion, Investigation (40%).
All authors read and approved the final manuscript.

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