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Feasibility Study and Simulation of Utilization of Renewable Energies in a Broiler Industry

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ABSTRACT

This research was conducted to feasibility study and simulation of utilization of renewable energies (solar and biomass) in broiler industry in Khorramabad County. Data was collected by field sampling (for a breeding period in winter 2015-2016) and from organizations. In the simulation of a grid-connected photovoltaic system (20 kW) with PVsyst 6.7 software, the average performance ratio and available useful energy of the system were calculated at 0.785 and 4.75 kWh/kWp/day, respectively. The use of photovoltaic system can cover 25% of electrical energy in broiler production farms in winter season. Also, in feasibility study of combined heat and power system, the potential of biogas production from broiler manure was calculated at 448.5 m^3 per 1000 pieces of broiler. The use of biogas plant can supply 98% of the electrical energy of broiler production farms in winter season. According to the results, the use of renewable energies in the present conditions, despite the reduction of fossil fuels consumption and many environmental benefits, in the broiler industry is not economical.

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INTRODUCTION

The poultry industry is one of the largest industries in Iran. The expansion and development of this industry with the increasing population, increase in the level of income and well-being of the people, followed by the increase in the demand for white meat, in order to the protein needs, seems to be necessary. In the developed countries, in recent years, this industry has made significant progress in managing energy consumption and reducing production costs by using new technologies. On the other hand, high energy consumption is one of the serious problems of poultry farming (Malekipour, 2013). Also, the limitation of fossil resources and the environmental effects caused by their burning has increased the importance of using alternative energy sources, especially renewable energies, in this industry. Therefore, several studies have been conducted in the field of using solar energy and biogas energy (poultry waste) in order to provide electrical energy for poultry units in Iran and the world, some examples of which are mentioned below. Geographically, Iran is located on the yellow belt of the earth, which receives the most amount of sunlight during the day in different months of the year, and with an average of 300 days per year, it is among the countries that receive the most sunlight. Based on the comprehensive GIS atlas of solar energy in Iran, the annual average amount of total solar radiation energy on the horizontal surface in Iran is estimated to be 5.24 kWh/m^2.day. (Haghparast Kashani et al., 2005).

In a research titled using the photovoltaic system to generate electricity for poultry farms, the results showed that 250 m^2 of photovoltaic panels are needed to supply electricity to a poultry farm unit with an area of 500 m^2 (power of electrical equipment: 8.8 kW) (Taghizadegan Kalantari & Aghapour, 2011). Also, in another research that used solar energy to supply electricity to rural poultry farms in Bangladesh, the power required for lighting and ventilation of a model unit with a capacity of 108 pieces of broiler with an area of 9 m^2, was estimated at 30.2 and 1.3 W, respectively, which be supplied by an independent solar power system with an output power of 26.73 W/m^2 (848 W/m^2 during solar radiation) (Md Rostom et al., 2016). In the US state of Georgia, the amount of power needed to provide electrical energy for raising 1000 pieces of broiler was estimated as 1-1.5 Kw, and for a poultry farm with a capacity of 23800 pieces of broiler, it was estimated as 25-35 kW. In research entitled designing and supplying the electric-thermal load of a poultry complex with photovoltaic-thermal cells using PVSOL and TRNSYS software, the results showed that keeping the solar panels cool increases the electrical efficiency by 1.3% and increases 2500 kWh of electric power produced per year (Athari et al., 2014).

In America, there have been many studies and research on biogas production by anaerobic digestion and the construction of power plants for the combined heat and power (CHP) from biogas. The results of these investigations showed that this country is currently able to produce 3 GW of electricity using existing biomass resources (Kramer, 2008). In research entitled biogas production from poultry breeding waste in Nepal, the amount of biogas produced are 116.585 m^3 (28.646 million broiler capacity), and the amount of electricity produced (assuming the conversion of thermal energy into electricity with 15% efficiency) was estimated 550 GWh/year (Singh et al., 2008). Also, the production potential of biogas and methane produced from broiler waste in Iran was calculated as 955.2 and 515.8 million m^3/year, respectively, and the amount of reducing emissions of pollutants caused by its production was 2402398 tons of carbon dioxide (Manesh et al., 2020). In research entitled investigating of manure and energy recycling from a broiler unit in Khorramabad, the amount of waste was calculated as 24900 kg per 15000 pieces of broiler in one breeding period, which by using the biogas produced from it, respectively 78% and 52% of the electricity consumption of poultry farming provided in summer and winter (Amid et al., 2016). Also, in another research entitled energy recovery system design in the egg production industrial complex, using a gas decomposition device, the amount of methane in the produced biogas was determined 57.25% and the amount of carbon dioxide was 61.34%. If this designed system is used, 41% and 43.5% of the electric energy consumed by poultry farming can be covered in winter and summer, respectively (Sedaghat Hosseini et al., 2008).

According to the conducted research and review of information sources in the field of using renewable energies in the poultry industry, as well as the high potential of renewable energies in Iran, the use of these energies in the broiler industry can in the not distant future, it will be profitable from various aspects. Therefore, research titled feasibility and simulation of the Use of renewable energy (solar and biomass) in the broiler breeding industry (in order to provide electrical energy) was conducted in Khorramabad county.

RESEARCH METHODOLOGY

Khorramabad county as the capital of Lorestan province is located with an area of about 4900 km^2 between 32.56^o to 33.51^o north latitude and 47.41^o to 48.57^o east longitude, which is about 30% (93 units) of the active poultry units of Lorestan province are located there (Sepahvand et al., 2019).

The data needed for this research were prepared in both field and organizational ways. Statistics and field information including the length of the breeding period and the amount of manure produced and the income from its sale for one breading period (winter 2015-2016), as well as the amount and cost of electrical energy consumed for 2 breading periods (winter 2015-2016 and summer 2016), was collected from 48 active poultry farmers of Khorramabad county by random sampling in the form of questionnaires and face-to-face interviews. Considering the average capacity of broiler production units in Khorramabad county, the calculations of the use of renewable energy were made in order to provide electric energy for poultry farms with a capacity of 20000 pieces of broiler.

In order to simulate a photovoltaic system grid-connected to provide part of the electrical energy consumed by broiler production units was used the PVsyst 6.7 software. Due to the fact that the information and weather conditions of the desired location (Khorramabad county) were not available in the PVsyst 6.7 software, Metonorm 7.1 software was used to obtain this information.

Solar panel efficiency and system performance ratio were obtained from relations (1) and (2), respectively (Mohammadi et al., 2015).

$$\eta = \frac{I_{MP} \times V_{MP}}{A \times E} \times 100 \tag{1}$$

where η, panel efficiency (%); V_{MP}, rated voltage (V); I_{MP}, rated current intensity (A); A, the area of the solar panel (m^2) and E, the radiation power intensity (W/m^2) which in standard conditions is equal to 1000 W/m^2.

$$PR = \frac{Y_f}{Y_r} \times 100 \tag{2}$$

where PR, the performance ratio; Y_f, specific production (kWh/kWp/day) and Y_r, the energy radiated on the panel surface (kWh/kWp/day).

Geographical conditions of the studied place

The place studied for the construction of the photovoltaic system is located at 33.44^o of north latitude and 48.28^o of east longitude and an altitude of 1148m above sea level. Based on the data of Metonorm 7.1 software, the total radiation intensity on the horizontal surface and the effective radiation of the studied place are 1938 and 2085 kWh/year, respectively (Table 4).

Specifications and simulation parameters to construct the system

At the beginning of the work, in order to simulate the grid-connected photovoltaic system (Figure. 1), a standard type of panel with mono-crystal manufacturing technology was used.

The nominal power of the photovoltaic array is 20.16 kW peak (peak consumption) and the system load characteristics are connected to the grid.

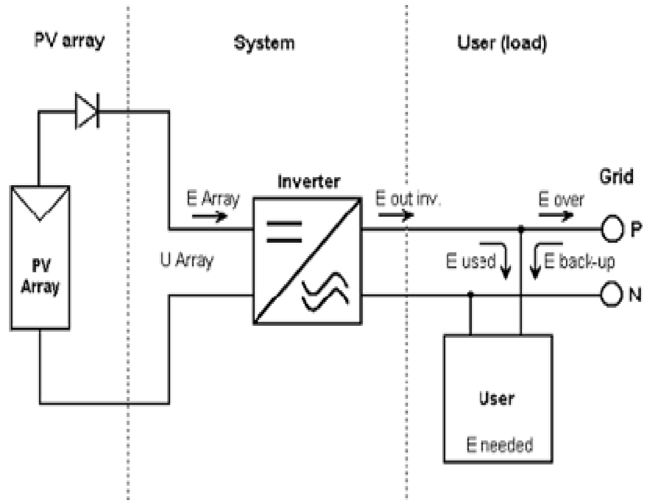

Figure 1. grid-connected Photovoltaic system

Table 2 shows a summary of the specifications of the entire photovoltaic system. The number of panels required for the construction of this system (20 kW) to provide part of the electric energy of broiler production units in Khorramabad county is 56 and their area is 109 m^2. Also, one inverter is required. The nominal power of each panel is 360 Wp and the nominal alternating power (AC) is 20 kW.

Table 2. A summary of the specifications of the entire photovoltaic system

parameter	unit	quantity
Number of panels	Nb	56
Area of panels	m^2	109
Number of inverters	Nb	1
Nominal power of panel	Wp	360
Nominal power of array	kWp	20.16
Nominal alternating current power	kW	20

Tables 3 and 4 respectively show the specifications of photovoltaic panels and inverter (converter) used in the simulation. According to Table 3, the nominal voltage, maximum power point voltage at 60 °C, and open circuit voltage at -10 °C, are 34, 34.1, and 54.7 V, respectively. Also, in Table 4, the operating voltage range is defined between 125 and 700 V.

Table 3. Specifications of photovoltaic panels

Specifications	unit	quantity
Model	-	SN360M-10
Nominal power	Wp	360
Nominal voltage	V	34
Maximum power point voltage at 60 °C	V	34.1
Open circuit voltage at -10 °C	V	54.7

Table 4. Inverter specifications

Specifications	unit	quantity
Model	-	GC-236
Nominal alternating current power	kW	20
Operating voltage	V	125-700

In this part of the research, the potential of biogas production from broiler waste, as well as the feasibility of constructing a CHP system from biogas in order to provide a part of the electrical energy consumed in broiler production units were investigated and parameters such as the volume of the digester, the volume of sediment pond, the volume of methane produced, the volume of the gas tank, the electrical and thermal energy produced, and the amounts of compost and liquid fertilizer (produced water) were calculated.

The volume of the digester and the volume of the sediment pond were obtained from relations (3) and (4), respectively (Sedaghat Hosseini et al., 2008).

$$V_D = S_d \times RT \quad (3)$$

where V_D, digester volume (m^3); S_d, the volume of daily production material (m^3/day) and RT, the hydraulic retention time (day).

$$V_t = \frac{s_t}{\rho} \quad (4)$$

where V_t, sediment pond volume (m^3), s_t, the volume of daily produced material (kg) and ρ, density (kg/m^3).

The characteristics of manure produced in broiler production units at the end of the period are given in Table 4.

Table 4. Characteristics of manure produced in broiler production units at the end of the period

components	quantity (%)
Total solids	78
Volatile solids	69
Moisture content	22

RESULTS AND DISCUSSIONS

Considering the amount of electric energy consumption in broiler production units, weather conditions and the intensity of solar radiation in Khorramabad county, a 20 kW solar system has been simulated using PVsyst 6.7 software and in terms of techno-economic and environmental parameters were investigated.

Figure 2 shows the monthly average losses and useful energy produced by the photovoltaic system. According to the figure, the losses of the photovoltaic array is 1.09 and the losses of the system including the inverter and ... (losses of the DC part, from the radiation losses to the DC cable) are equal to 0.22 kWh/kWp/day. Also, the total useful energy produced at the output of the inverter (electrical energy injected into the grid) is 4.75 kWh/kWp/day. The highest and lowest electrical energy injected into the grid is assigned to the months of August and December, respectively (Table 5).

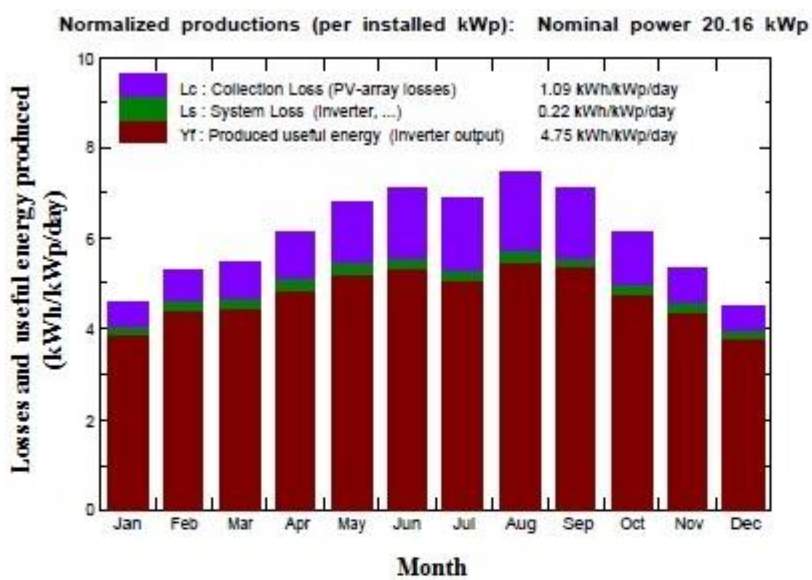

Figure 2. Average monthly losses and useful energy produced by the photovoltaic system

Figure 3 shows the performance ratio of the photovoltaic system in different months of the year. The average annual performance ratio of the system is equal to 0.785. The highest and lowest performance ratio is assigned to the months of January and August, respectively, with values of

0.853 and 0.734. The amount of electric energy injected into the grid is 34.97 MWh/year and the specific production is 1735 kWh/kWp/year (Table 4). In a research titled Optimal design studies of a 100 kW grid-connected photovoltaic power plant in Tehran using PVsyst software, the performance ratio factor and the energy injected into the grid for this power plant were estimated to be 1 and 161 (MWh), respectively (Shams et al., 2013).

Considering that the meteorological data input to the software, such as temperature, rainfall, number of sunny days, etc., as well as parameters related to system design, such as inverter efficiency, losses, etc., can undergo changes over time. be changed Therefore, the software performs the calculations based on the Gaussian probability and determines in what range the output of the software can change due to the mentioned reasons. Figure 4 shows the probability distribution of the amount of energy injected into the grid by the system. The amounts of energy injected into the grid by the system at the probability levels of P50, P90 and P95 are 35, 33.6 and 33.2 MWh, respectively.

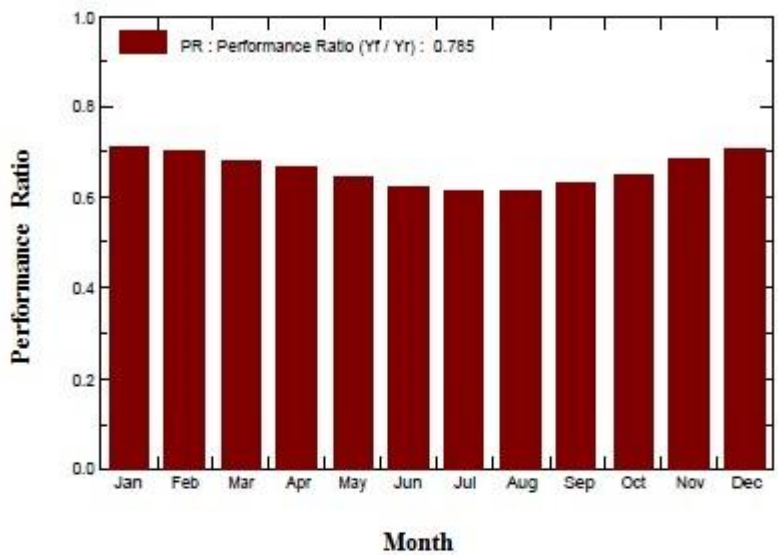

Figure 3. Photovoltaic system performance ratio

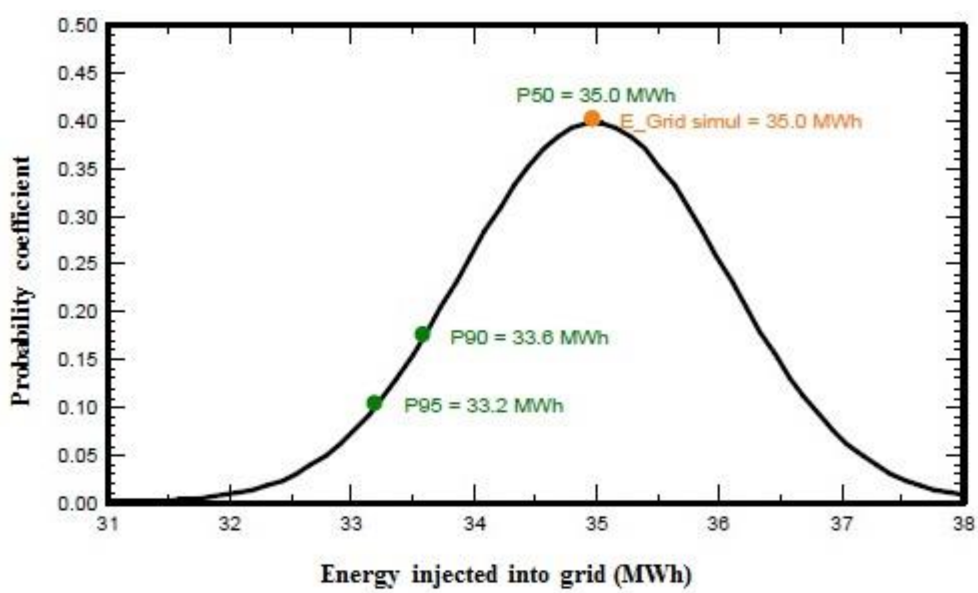

Figure 4. Probability distribution of the amount of energy injected into the grid by the photovoltaic system

Table 5. Balances and main results of the photovoltaic system

	GlobHor (kWh/m^2)	DiffHor (kWh/m^2	T Amb (°C)	GlobInc (kWh/m^2	GlobEff (kWh/m^2)	EArray (MWh)	E_Grid (MWh)	PR
January	90.70	32.68	3.93	141.10	133.60	2.54	2.43	0.85
February	106.50	39.54	6.86	147.70	140	2.61	2.49	0.84
March	143.20	58.53	11.15	169.60	160.10	2.91	2.78	0.81
April	174.10	70.77	14.86	183.40	172.60	3.10	2.96	0.80
May	220.50	64.41	20.95	209.90	197.10	3.41	3.26	0.77
June	236.30	62.62	26.62	213.20	199.90	3.37	3.22	0.75
July	230.90	68.28	30.37	213.10	199.90	3.31	3.17	0.74
August	226.60	53.11	29.83	230.90	217.70	3.57	3.42	0.73
September	183.30	47.25	24.34	213.30	201.60	3.39	3.25	0.76
October	140.60	39.72	18.98	189.60	179.80	3.12	2.99	0.78
November	101.00	27.81	10.39	159.40	151.00	2.76	2.64	0.82
December	84.30	28.88	6.06	139.80	132.40	2.49	2.39	0.85
Year	1938	593.58	17.09	2210.9	2085.5	36.59	34.97	0.78

Legends:

GlobHor: Horizontal global irradiation
DiffHor: Horizontal diffuse irradiation
T Amb: Ambient Temperature
GlobInc: Global incident in coll. Plane
Effective Global, corr. for IAM and shadings
EArray: Effective energy at the output of the array
E_Grid: Energy injected into the grid
PR: Performance ratio

Figure 5 shows the energy diagram (losses of the entire system from radiation to the injection of electrical energy into the grid) of the photovoltaic system. The total intensity of horizontal radiation on photovoltaic panels in Khorramabad city is equal to 1938 kWh/m^2/year. Radiant energy on the horizontal surface after changing the angle of the panel (33 degrees) has increased by 14.1%, respectively by deducting 0.1%, 2.7%, and 3% of the losses due to global incident below the threshold, IAM factor on global and Soiling loss factor, its final value (effective radiation) reaches 2085 kWh/m^2/year. After converting solar energy into electricity by photovoltaic cells, the nominal energy, including 18.44% efficiency of photovoltaic panels in standard test conditions (STC) is 42 MWh. The energy produced is in the nominal state, but in the real power plant we will not have nominal conditions, so the real state must be simulated. Therefore, things like annual losses, changes in efficiency due to changes in radiant power intensity, thermal losses, electrical losses due to shading, panel quality, panel mismatch, and cable ohmic losses are taken into account in the direct current section and the annual energy produced by the power plant will decrease from 42 MWh to 36.59 MWh (virtual energy). After deducting the losses of the inverter from the virtual energy, the amount of energy available at the output of the inverter is equal to 35.07 MWh, and finally, the amount of energy injected into the grid after deducting the ohmic losses of the output cable from the inverter to the meter is equal to 34.97 MWh be.

Figure 6 shows the daily input/output diagram of the photovoltaic system, whose horizontal axis shows the amount of total radiant energy on the surface of the panel on a daily basis, and whose vertical axis shows the electric energy injected into the grid. Obviously, in systems connected to the grid that is independent of the load, the more concentrated this diagram is, the perfect and ideal design we have. The statistical population of the number of days in which the amount of energy received per square meter unit at the optimal installation angle of the panel (33 degrees) is formed has a high density, especially since the radiation reaches more than 4 kWh/m^2.day, the injection energy to the grid increases to more than 60 kWh/day.

The electrical energy produced by the photovoltaic system can supply about 25 and 39 percent of the electricity consumption of broiler production units in Khorramabad during the winter and summer seasons, respectively. In the US state of Delaware, using 620 photovoltaic systems of 1.5 kW (930 kW) installed in poultry farms, 1828 MWh of electricity is produced annually, which can be 3.7% of the electricity consumed by poultry farms. duration of the investment return period of each photovoltaic system in the mentioned state was estimated between 7.3-12.7 years (Weitz & Hiruma, 2005).

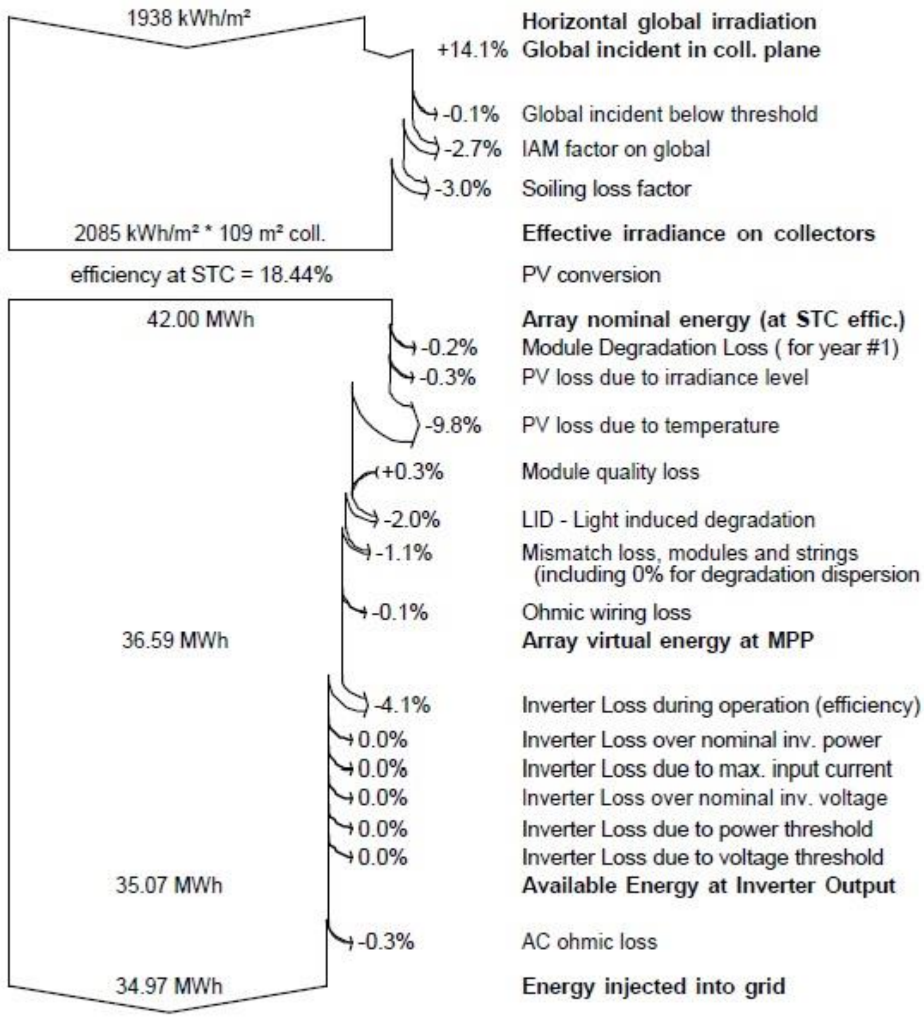

Figure 5. Loss diagram of the photovoltaic system over the whole year

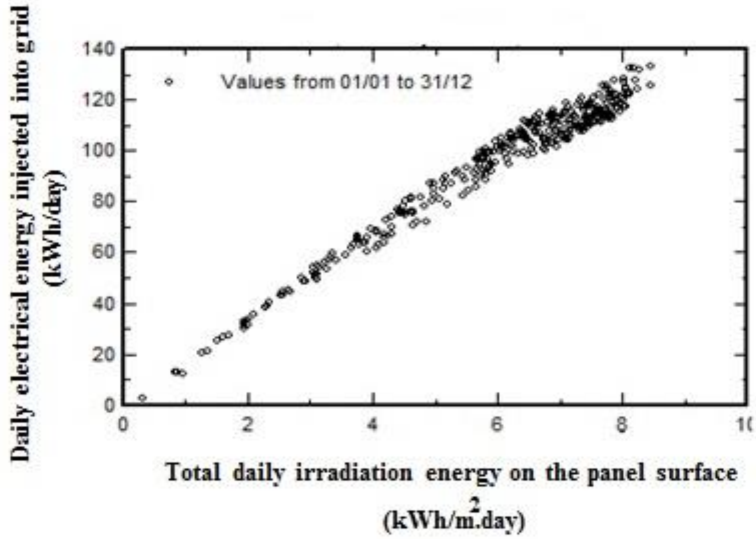

Figure 6. Daily input/output diagram of the photovoltaic system

The initial investment cost for the construction of the aforementioned photovoltaic system, excluding the cost of the land required for its construction, is about 15000 $ (on average 750 $ per kW of power) or 750 $ per 1000 pieces of broiler. Assuming that the electrical energy produced by the system will provide an average of 30% of the electricity consumed by poultry units (4 breeding periods per year), the income from the sale of electrical energy to the grid (purchased by the government) at the price of each kWh is 0.066 $ (Anonymous, 2018), 47.6 $ per 1000 pieces of broiler. Also, the income due to saving in electric energy consumption in the units was calculated as 2.08 $ per 1000 pieces of broiler. The total income from the sale of electrical energy to the grid by the photovoltaic system and the income from the saving in electrical energy consumption is 49.68 $ per 1000 pieces of broiler. Considering that the annual net profit from investing the initial cost of construction of the system by the poultry farmer in Iranian banks with an interest rate of 15% (112.5 $ per 1000 pieces of broiler) is more than the total income from the sale of electrical energy to the grid and income It is caused by the saving in the consumption of electricity (without deducting the fixed and current costs of the system) in the poultry units, it can be seen that the production of electrical energy by the photovoltaic system in order to supply a part of the electrical energy of the poultry units is not economical for the poultry farmers.

According to the calculations of the PVsyst 6.7 software, for the construction of the aforementioned system with a lifespan of 20 years, about 1850 kg of carbon dioxide will be released into the environment annually. Also, the emission of 19167 kg of carbon dioxide will be prevented annually. The reduction of carbon dioxide emissions by the photovoltaic system in order to provide a part of the electric energy of broiler production units for a breeding period in the winter season was calculated as 176.6 kg per 1000 pieces of broiler.

In this part, the feasibility study of the construction of the combined heat and power system (CHP) from biogas for broiler production units, with a capacity of 20,000 pieces during a breeding period (winter season) was carried out. The average amount of manure produced in broiler production units for a breeding period (51 days) was estimated to be 34241 kg. According to the characteristics of Table 1 and the amount of manure produced at the end of the period, the amount of manure produced is 671 kg/day and the amount of total solids (TS) is 523 kg/day.

Anaerobic digestion systems required for waste disposal and energy production are composed of various components. The scale of the system is calculated by specifying parameters such as daily feed, hydraulic retention time, and daily gas production (Maleki-Ghelichi et al., 2017).

Sediment pond: The daily produced manure must first reach a concentration of 8% of organic matter and the floating material and sand in it must be separated due to the possibility of getting stuck in the system. For this purpose, 5788 L of water should be added to the ingredients. In total, 6459 kg of solution enters the tank daily, and taking into account the density of 1.06 g/cm^3 (Sedaghat Hosseini et al., 2008), the volume of the sediment pond was calculated to be 6.1 m^3. Considering a 20% confidence factor, the final volume was 7.3 m^3.

Anaerobic digester: The volume of the digester was 77.5 m^3 according to the amount of production materials of 6459 L/day and the retention time of 12 days (Imani Chegini et al., 2010), and considering a 20% confidence factor, it was calculated as 93 m^3. The shape of the digester is cylindrical and its roof is fixed and its material is metal (steel) (Maleki Ghelichi et al., 2017).

Gas purification and storage unit: a. Biogas purification: Biogas consists of a mixture of methane and carbon dioxide along with a small amount of water vapor, hydrogen sulfide, and other gases. The presence of methane impurities in biogas while reducing its calorific value causes corrosion in different parts of the system. Therefore, it is necessary to use suitable filters to remove impurities.

b. Gas tank: The volume of the gas tank depends on the amount and intensity of gas produced daily. Considering that the volume of gas produced is 0.38 m^3 per kg of *volatile solids* (vs) (Imani Chegini et al., 2010), the amount of biogas produced daily is 175.9 m^3 and the amount of methane gas produced in biogas is 56 Its percentage is equal to 98.5 m^3. Taking into account the 20% confidence factor, the volume of the gas tank was calculated as 118.2 m^3.

Electricity and heat production unit: About 45% of the biogas energy produced in the winter season is used for heating the digester (Sedaghat Hosseini et al., 2008). Considering that one of the products of CHP systems is thermal energy, in this research thermal energy was used to heat the digester and bring the materials inside the digester to operating temperature. Considering that the calorific value of methane is equal to 9.94 kWh/m^3, the energy produced by burning methane in the generator, which is in the form of electrical and thermal energy, will be equal to 979.1 kWh/day. According to the electrical (34%) and thermal (45%) efficiency of the CHP generator engine, the amount of electrical and thermal energy of the system will be 332.9 and 440.6 kWh/day, respectively (the total thermal energy produced by the system, it is used for heating the digester).

Produced compost and liquid fertilizer: From the daily amount of 523 kg of total solids entering the digester, according to Table 1, about 463 kg (Volatile solids) is digested and the rest is removed from the digester after the retention period. Therefore, after the retention period, 5996 kg of material with total solids of 1% is removed from the digester. The digested material is first entered into a storage tank and then it is dewatered using a filter press. The output of the filter press is a compost mixture with 50% dry matter. The surplus production water, which is 5876 L, is stored separately in a tank to be used as a liquid fertilizer (production water) in agriculture.

Table 6 shows the Products of the CHP system from biogas for a breeding period (51 days) of broiler in the winter season. The electrical and thermal energy produced in the system of CHP is 848.9 and 1123.5 kWh per 1000 pieces of broiler, respectively. By using the electric energy produced by biogas, about 98% of the electricity consumption of the poultry unit can be provided in the winter season. Assuming the same amounts of manure and biogas produced during the above-mentioned period for a breeding period in the summer season, the electrical energy produced can supply the entire electricity consumption of the poultry unit. Also, out of 1123.5 kWh of thermal energy produced in the summer season, 449.4 kWh of it is used for digester heating. In the case of using an electricity production system of biogas in poultry units (thermal energy is not taken into account), after deducting the energy required for digester heating, the electrical energy produced can supply about 54 and 100 percent of the electricity consumption of broiler production units during the winter and summer seasons, respectively. The amount of compost and liquid fertilizer (produced water) produced by the system is 306 kg and 15 m^3 per 1000 pieces of broiler, respectively. Figure 7 shows the Mass balance of the proposed system of CHP from biogas.

Table 6. Products of the CHP system from biogas for a breeding period of broiler in the winter season

Product	Unit	Quantity	
		20000 pieces	1000 pieces
Electrical energy	kWh	16978	848.9
Thermal energy	kWh	22470	1123.5
Compost	kg	6120	306
Liquid fertilizer	m^3	300	15

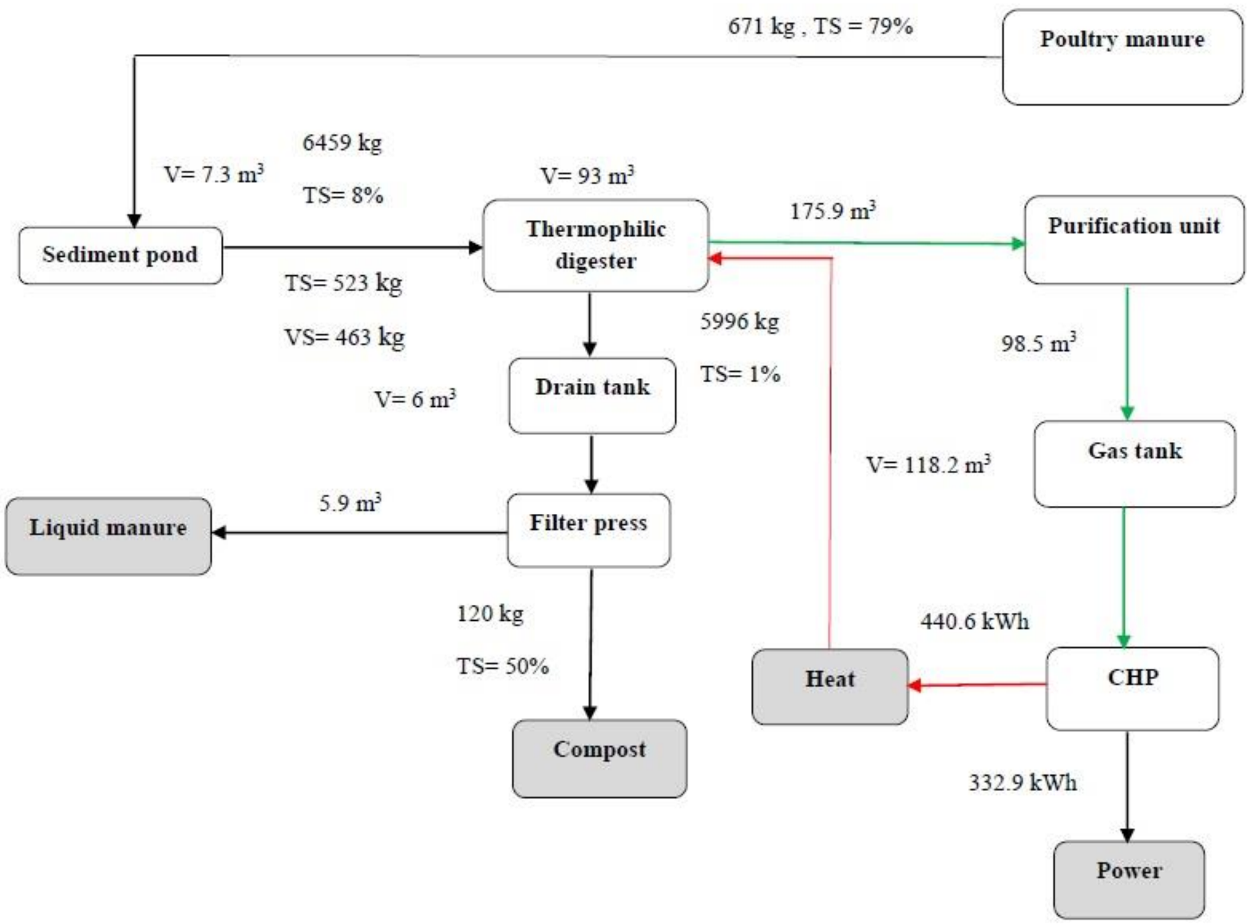

Figure 7. Mass balance of the proposed system of CHP of biogas

Electric energy, thermal energy, compost, and liquid fertilizer (produced water) are salable products of the system. Considering the use of electrical energy and thermal energy produced to provide part of the energy consumption of poultry units, also regardless of the value of liquid fertilizer (produced water), the only product that can be sold in the system is compost. The amount of income from the sale of compost produced at the price of 0.016 $/kg, 5.1 $ per 1000 pieces of broiler was calculated. Also, the income due to saving in electric energy consumption in broiler production units in the winter season is 2.48 $ per 1000 pieces of broiler. The total income from the sale of compost and the income from saving electricity consumption was calculated as 7.57 $ per 1000 pieces of broiler. By comparing the income from the sale of manure collected at the end of the period (18.18 $ per 1000 pieces of broiler) and the income from the construction of the system (without deducting the fixed and current costs of the system for one breeding period) it can be found that producing energy from waste is not economically for poultry farmers, and the sale of bedding manure is a priority. For this reason, the continuation of the economic calculations of the feasibility of constructing a system of CHP from biogas was waivered.

The system of CHP from biogas reduces the emission of greenhouse gases in two ways:

1-Preventing the release of methane into the atmosphere

2- Preventing the release of carbon dioxide due to the consumption of electrical energy in the units Poultry farming by producing electricity and heat from biogas.

Considering that the global warming factor of methane is 21 times that of carbon dioxide and its density is 0.716 kg/m^3 (Salmani et al., 2017), the amount of emission reduction related to preventing the emission of methane into the atmosphere, 3776.8 kg of carbon dioxide was estimated per 1000 pieces of broiler. Also, the reduction of carbon dioxide emissions due to the production of electric energy and thermal energy from biogas in order to provide part of the electric energy of broiler production units in the winter season was calculated to be 653.4 kg per 1000 pieces of broiler.

CONCLUSIONS

The results of this research showed that the use of photovoltaic and biogas (CHP) systems can supply 25% and 98% of the electrical energy consumed by broiler production units in Khorramabad city in winter, respectively, and the amount of carbon dioxide emissions reduced by 176.6 and 653.4 kg per 1000 pieces of broiler, respectively. The results of the economic evaluation of the photovoltaic system showed that the annual net profit from the investment of the initial cost of construction of the system by poultry farmers in Iranian banks (average interest rate of 15%) is more than the total income from the sale of electrical energy to the grid and the income comes from the savings in the consumption of electric energy in the poultry units, therefore, the production of electric energy by the photovoltaic system in order to supply a part of the electric energy of the poultry units is not economical for the poultry farmers. Also, the comparison between the income from the sale of manure collected at the end of the period and the income from the construction of a CHP system showed that the production of energy from waste is not economical for poultry farmers and the sale of bedding manure is a priority. According to the results of this research, preparing and providing the necessary conditions for the use of renewable energy the government through the establishment of protective laws and the provision of financial incentive packages (such as free facilities, bank facilities with low repayment rates and etc) to poultry farmers can play a significant role in increasing their willingness to use renewable energy.

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