THE FEASIBILITY OF USING SOLAR ENERGY IN ORDER TO SUPPLY THE POWER OF WATER PUMPING STATION TABRIZ-IRAN AND CONSIDERATION OF LOSSES AND ENVIRONMENTAL BENEFITS USING THE RIGHT SOFTWARE

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ABSTRACT

Water pumping systems, is including cases that the supply of energy from the national grid is sometimes difficult. The high consumption of these systems often entails a lot of pressure on the power grid and fossil fuel power plants, which increase emissions and environmental pollution. Therefor in most cases, supply energy requirements of this type of systems, specially solar systems, are among the topics studied of scientist. The 800 Kw photovoltaic power plant in the region of TABRIZ pumping station with a two-axis sun tracker method to increase 100% energy absorption It has been suggested. The results of this design with consideration types of electrical losses and geographic location of the area and hardware equipment and environmental benefits to design and implement a photovoltaic energy supply system Quantitatively and qualitatively based on PVSYST software estimated.

Keywords:
solar water pump, photovoltaic plant, power losses, environmental benefits

1. INTRODUCTION

Nowadays considering the standard sources of electric power supplies such as fossil fuels have been encountered restrictions due to undesirable environmental effects. In recent years, the issue of warming and global energy policy has been a part of a special topics at international meetings. Developed countries are trying to reduce greenhouse gas emissions released from various industries. For example, EU (European Union) has committed to provide more than 20% of its energy consumers through renewable energies[1], [2].
Renewable energies can be mentioned as wind, solar, hydraulic, geothermal and biomass energies. In this context, in recent years, solar energy and photovoltaic systems have been considered more as agree energy source due to ease of installation, no greenhouse gas emission and also their fairly long lifespan (about 25 years)[3].
One of the places that may cost a lot of energy through power distribution networks for a variety of reasons, such as the alot of far distance of the transmission lines and environmental issues, you can point to water pumping stations.
It is possible , the construction of solar power plant without the need for power lines and fossil fuels. Therefore, a study of how to use photovoltaic power plant in the supply energy of water pumping stations is essential arrives.
If the pumping station is more than 530 meters from the power grid, use the PV pump system it will be economic.

2. LOCATION CASE STUDY

Water pump station of Tabriz started working in February 2011. This station is located in the south eastern part of the TABRIZ city. The pumping station in the region of Tabriz with coordinates 38.5° N, 46.18° E and 1884 kwh/m2 average annual radiation and 37.5 mm average rainfall and with 13.2° C average in a land with an area 16290 m2 there have been.

Its geographical location is such that there is no high buildings around the station that makes shading problems in the station area. The special feature of this station, which has made it appropriate for implementation of the PV energy supply systems, is the existence of an open land with a large area near it. Fig.1

Fig.1. Location of Water Pump Station.

As you consider, in the case of shortage of space foe solar panels layout, the surrounding lands can be used with a little cost.

3. TECHNICAL CHARACTERISTICS

The capacity of the water pump station of Tabriz is about 342 liters per second. There are four water pumps in the station which is a type of horizontal centrifuge electro-pump with direct coupling to the electromotor. Each of the four electropumps is the same and the capacity each of them is 250 kilowatts. Fig.2.

Fig. 2. Electropumps available at the station.

An example of a horizontal centrifuge electro-pump with direct coupling to the electromotor is shown in more detail in Fig. 3.

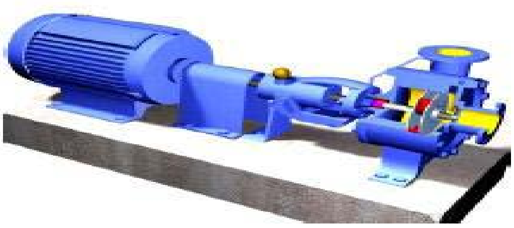

Fig. 3. horizontal centrifuge electro-pump with direct coupling to the electromotor.

The technical characteristics of the electro pumps present in the station are given in Table 1. The numbers in the table got of the electromotor plaque and possibility there is a mismatch with the actual measured value for them. According to research, in normal mode, each electro-pump phase consumes about 320 amps and total power required for the station at the peak of consumption is 800kw.

Table 1. Electrical characteristics of station electropumps.

Characteristic	Value	Unit
POWER	250	KW
VOLTAGE	380	V
CURRENT	453	A
Frequency	50	HZ
velocity	1480	RPM
PF	0.87	--
Weight	1720	Kg

It is worth mentioning that control circuit of pumping station that is responsible to control different parts including connecting and disconnecting of automatic valves on the pumps, control the height of tanks and etc, is a type of PLC Omran Sysmac CPIL and all the electro pumps have been started up by a soft starter model Telemecanique Altistart 48 and the support soft starter doubles system reassurance when there is a breakdown or repairs too. There is a capacitor bank with 13 three phase capacitors of a type of Siemens 4RB5 for correction power factor in the input. The number of the capacitor stairs is 7 (6 pairs of capacitors and one single capacitor) that concerned system increases or decreases stairs fully automatic proportional to calculated power factor.

4. SYSTEM HARDWARE ESTIMATION

The design of the on- grid photovoltaic system is such that, simultaneously and in parallel with the grid, the production power it does. Direct conversion of solar energy into electricity is done by photovoltaic panels. The inverter converts the DC power produced by the photovoltaic panels to to the AC power with voltage and frequency fits of the grid.

If the DC power produced by the photovoltaic system is greater than the local consumption

requirement, the surplus is injected into the global electricity grid and at night or when there is not the possibility of using solar energy, the electrical power required by the site is provided by the national electricity grid.
In this section, taking into electrical characteristics of station electropumps and power station, hardware estimation for PV system done by appropriate software.
PV system included 267 strings that there is 10 modules in series of type YL300P-35b and 92 units inverters of type SUNNY BOY 8000 US-12-277 as on grid it has been suggested. Fig.3.

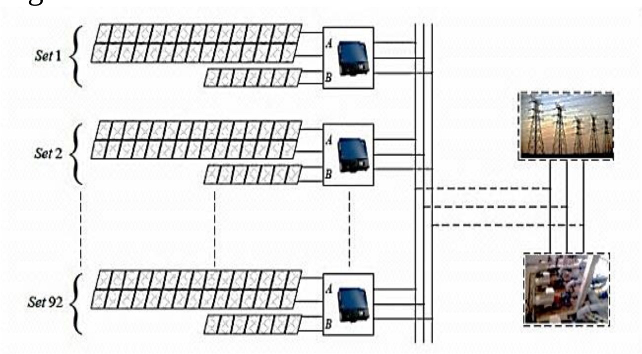

Fig. 3. General system structure

The general profile of YL300P-35b [4] module is presented in Table 2.

Table 2. Electrical characteristics of YL300P-35b

Characteristic	Value	Unit
Pmax	300	W
Voc	45.27	V
Isc	8.837	A
Vmp	36.27	V
Imp	8.271	A
Module area	1.940	m^2
Weight	25.50	Kg

With the reviews, the yingli solar company's modules are among the most advanced types of modules, therefore according to the history and quality of the products, the module was chosen by the that company.
The general profile of SUNNY BOY 8000 US-12-277inverter is presented in Table 3. One of the most important features of this inverter is the existence of a maximum power point tracking system for the installed panels. By changing atmospheric conditions at any moment of the day, the power output of the modules is locked to its maximum [5].

Table 3. Electrical characteristics of SUNNY BOY 8000 US-277

Characteristic	Value	Unit
Nominal pv power	8.6	KW
Maximum pv power	10	KW
Maximum pv current	30	A
Maximum efficiency	96.5	%
Nominal AC power	8	KW
0perating voltage	300-480	V
Weight	65	Kg

5. PV SYSTEM MODELING

The solar panels mounted at 800kw. This panels are installed in such a way that structure to structure and leg center to center distanceis at 4m. The distance between panels (panel to panel)is of 25mm. Distance between grounds to lower edge of the module is 400mm. To have a better yield panels are cleaned twice in a month. This panels are installed in such a fixed tilted plane(Plane tilt/azimuth = 36° / 0°). The solar power plant mounted in Sub-array PNom = 801 kWp and modules area = 5181 m² in the 267 strings of 10 modules in series, 2670 total.
The inverters power rating is 8.00 kwac and 82 units, total 656 kwac(PNom Ratio = 1.22).
The performance of grid connected solar photovoltaic power with the PVSYST software. PVSYST software is one of the simulation software developed to estimate the performance of the solar power plant. It is able to import meteo data from many different sources as well as personal data. The software is capable of evaluating the performance of grid- connected, stand- alone and pumping systems based on the specified module selection.
The performance parameters are developed by International Energy Agency (IEA) and PVSYST data for analysing the performance of solar PV grid interconnected system. Many performance parameters are used to define the overall system performance with respect to the energy production, solar resource and overall effect of system losses[6].
Normalized productions (per installed kwp) showed in Fig.4 and Fig.5.

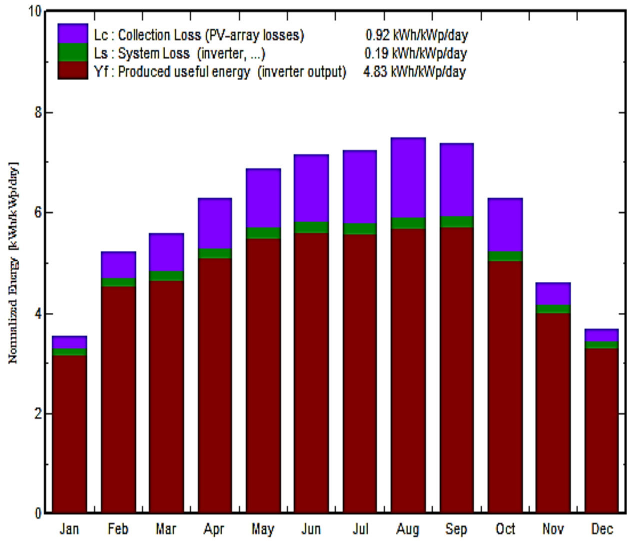

Fig. 4. Nominal power 801 kwp

	GlobHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	EffArrR %	EffSysR %
January	67.1	-2.05	109.8	107.6	82.2	79.0	14.45	13.88
February	96.8	1.42	145.9	142.9	106.1	102.0	14.03	13.50
March	140.7	7.13	172.8	168.6	120.4	115.8	13.45	12.93
April	175.7	11.95	188.4	183.6	127.6	122.7	13.08	12.57
May	225.4	17.29	213.3	207.5	142.3	136.8	12.88	12.38
June	241.8	22.42	214.9	208.9	140.5	135.1	12.62	12.13
July	245.3	25.92	224.1	218.0	144.0	138.4	12.40	11.92
August	226.2	26.12	231.9	226.4	147.2	141.6	12.25	11.78
September	182.9	21.15	221.4	216.5	142.8	137.3	12.45	11.97
October	134.7	15.17	194.3	190.2	130.5	125.6	12.96	12.47
November	84.3	6.56	138.3	135.8	100.3	96.5	14.00	13.47
December	65.5	0.78	113.9	111.7	85.6	82.3	14.50	13.94
Year	1886.4	12.88	2169.1	2117.6	1469.5	1413.1	13.08	12.57

Fig. 5. 800kw balances and main results

Legends:
Glohor: Horizontal global irradiation
TAmb : Ambient Temperature
GlobInc : Global incident in coll. Plane
GlobEff : Effective Global, corr. for IAM and shadings
EArray : Effective energy at the output of the array
E_Grid : Energy injected into grid
EffArrR : Effic. Eout array / rough area
EffSysR: Effic. Eout system / rough area

6. PERFORMANCE RATIO

The total amount of energy that is injected in to the grid for the entire year is 1413.1 Mwh. The annual average value of Performance Ratio (PR) is nearly 81.3%. The highest value of PR is found in the month of December and the lowest PR in the month of August. System malfunction can be deducted based on the PR values. Lower PR is attributed to the incorrect operation of the system and inverter malfunction. Fig.6.

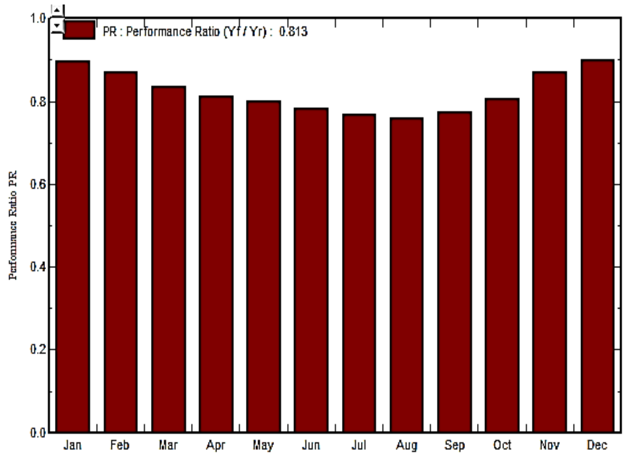

Fig. 6. Performance Ratio

7. LOSS DIAGRAM

Annual global horizontal irradiation is 1886.4 kWh/m2. Global incident energy that is incident on the collector plane annually is 2169.1 kWh/m2. Total energy obtained from the output of the PV array is 1469.5 kWh. Annual Efficient Eout array/rough area obtained is 13.08%. In the same way annual Efficient Eout system/rough area is 12.57% . Therefore, some energy is lossed. The solar energy incident on the solar panels will convert into electrical energy. After the PV conversion, the nominal array energy is 1469.5MWh. Array virtual energy obtained is 1469.5MWh. After the inverter losses the available energy obtained at the inverter output is 1413.1MWh. The results are presented in Fig.7.

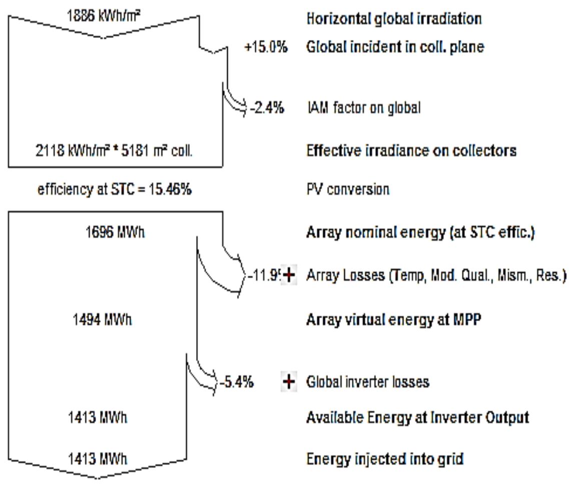

Fig.7.Loss diagram over the whole year

8. GREENHOUSE GAS EMISSION

For fossil power plants, greenhouse gas emissions 360-575 gco_2eq /KWh are calculated. Major greenhouse gas emissions at these power plants caused by gas processing, exploitation of piping, compressors, transportation systems [7, 8].

Due to the, differences in these factors in different countries, greenhouse gas emissions will also be different. According to this, we consider the worst conditions. that's mean the best fossil power plant with 360 gco_2eq / KWh is assumed and assuming that the station is working 24 hours in 365 days a year at maximum power.

In the first state if 100% of the pumping station energy is supplied through the grid. greenhouse gas emissions are calculate :

800kw*24*365*360 gco_2eq / KWh=2522880 $kgco_2eq$/year

In the second state, 20.164% energy of pumping station supplied through the pv system and 79.836% energy of pumping station supplied through the grid. greenhouse gas emissions are calculate:

800kw*0.79836*24*365*360 gco_2eq / KWh=2014166.4768 $kgco_2eq$/year

That's mean: 508713.5232 $kgco_2eq$/year decreases.

9. CONCLUSION

A performance study of 800 KW peak grid connected solar photovoltaic power plant proposed at Water pump station of Tabriz/IRAN was evaluated on annual basis. The following conclusions are drawn from the study.

This research different coefficients of light reflection from the environment and with PR 81.3% annual performance ratio there have been.

Simulations show that around 20.164% Station energy required by the solar power plant and 79.836% by the grid will be supplied.

Simulations have shown space and weather conditions are suitable for the construction of a solar power plant with fewer losses that in the proposed system about 508713.5232 $kgco_2eq$/year decreases.

Our proposed pv power plant 1413Mwh/year energy is injected into the grid and because the nearest consumer is the same water pumping station so this energy is consumed by the station.

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