

Q2 ^{ANS} :-

PV cells performance is greatly affected by a locations climate factors including irradiance, temperature, humidity wind and dust. As we know different locations have different climate conditions which effects greatly on the performance of the PV cells.

As the conditions in peshawar is humid and hot it has great impact on the performance of the PV cells.

1:- HUMIDITY FACTOR :-

Humid weather can degrade the solar panels efficiency and performance. This is true for both crystalline silicon cells and thin film modules. The Average humidity in peshawar is approximately 40% which results in a minimal layer of water vapours or in the form of water droplets at the front solar cell directly facing sun. There have been approximate losses of about 15-30% due to the water vapours reflecting or refracting the sunlight causing the incident photons reflected back from the cells surface. The humidity brings down the utilization of solar energy approximately to 55-60% from just 70% approximately of Utilized Energy.

The required solar panels should be designed in such a way which could be made to have less effects of humidity level on the power rating.

One can use the edge sealants and low ionic conducting materials to reduce the humidity factor, which will increase the Overall efficiency.

TEMPERATURE

2. IRRADIATION FACTOR :-

The irradiation and temperature has a great impact on the efficiency and performance of the PV cells. The efficiency of the PV cell is decreased with increase in temperature. The standard solar cell conditions are solar radiations is equal 1000 W/m^2 & temperature usually 25°C .

As the temperature in peshawar is different in different months so the PV performance changes significantly. The average temp in peshawar is 40°C which is a high temp.

The PV cell has maximum efficiency of 18.5% at 25°C and minimum at 80°C .

In Order to increase the efficiency and reduce losses in the PV cells one can use water cool system to cool solar panels down has been found to be an effective method. The water cooling system will be able to improve the energy output of these panels by approximately 10-15 to 20%.

3. IRRADIATION FACTOR :-

out of 100% energy coming out from sun approximately 30% energy is either reflected back or is absorbed by clouds, oceans and land masses.

At 3000 W/m^2 Irradiation the electrical power increases by about 190W compared with 63W at irradiation level of 1000 W/m^2 .

The irradiation depends on the orientation

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The irradiance was high at tilt angle of 34° which is equal to the latitude of Peshawar Pakistan, so for best efficiency we have to set the solar panels at an angle of 34° .

4. WIND FACTOR:-

Using air as a coolant was found to decrease the solar cells temp by 4.7°C & increase the solar panel efficiency by 26%.

Here in Peshawar the average wind speed is about 4.9 mph.

In order to overcome the negative impacts of high temperature the panels should be installed a few inches above the roof top so that continuous air flow can cool the panels. By doing this we can decrease the temperature impact on the PV cells there by reducing the losses and increasing the efficiency. Solar panels cooled by air upto 1°C are 0.05% more efficient.

Q3

Ans

These fuel cells are best suited for large-scale stationary power generators that could provide electricity for factories, houses or towns. As these types of fuel cells are operated at very high temperatures of around 1000°C . As temperature of Peshawar is high in summer and reaches almost $47-48^\circ\text{C}$. The SOFC will be a best choice for providing power to Isra national University located in Peshawar.

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The high temperature in SOFC makes reliability a problem, but it also has an advantage. The steam produced by the fuel cell can be channeled into turbines to generate more electricity. This improves the overall efficiency of the system.

The load of the Iybra National University is 913 kW which is a high load. For this load we will use stationary power generators power plant which has 1 MW centralized power production.

It has high efficiency of 60% and fuel flexibility. We can use a variety of catalysts available in the market.

The operation time of SOFC is 40,000 hrs.

Operation time	40,000 hours
Degradation	< 1% in 1000 hours
CYCLING	> 50 (thermal)
Start up	4 - 5 hours
Cost	\$100/kW

All these specifications makes solid fuel cells a better choice to power the Iybra National University.

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The phosphoric acid (PAFC) cell will be the worst option to power the Iqra national University.

The PAFC has a temperature range of $600 - 700^{\circ}$ it has a power range of $100 - 400$ KW module. it has 40% which is less than SOFC.

PAFC are widely used for CHP applications, in particular for household basis CHP generation but they work at low temperatures such as less than 100° and 200° , so that both of them need an external fuel reformer in order to use fuel other than pure hydrogen and they have a low tolerance for CO, and exhibit operation with electrical efficiencies only in the low range of about 30%. So due to these reasons high temp cells are more suitable for the larger residential block basis CHP generation and in particular for these applications, SOFC are the best candidate.

The PAFC has lower current and power as compared to SOFC.

Q1

Due to energy crises all over the world the need of renewable energy resources has been increased.

Solar PV cells and fuel cells are the two major resources of the renewable energy resources.

Both systems have their own advantages & disadvantages depending ^{upon} the climate factors such as irradiance, temperature and dust deposition and the initial cost.

If we design a 10 kW power system for both the PV cells and fuel cells and then compare it, the best option will be the fuel cell depending on the climate factors.

The fuel cell is an important part of the future energy sources for residential and commercial applications.

There is no direct relation b/w fuel cell and weather conditions.

From the other hand, the intermitent of the sunlight make a limitation to the PV cells because of unreliability & intermitent.

Since fuel cell is not influenced by external factors like sunlight, heat, dust deposition mismatch factor in PV UPS/inverters system makes it a reliable source of energy.

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Solar PV has become more viable today still fuel cell based system is no way inferior the reason is that the solar facilities may produce no power at all some of the time which could lead to an energy shortage if too much of a power comes from solar PV installed.

The initial costs for both of the systems is high.

The price of solar PV cells in Pakistan is 12.5 /KW and that of the fuel cell is about 5000 - 7000 /KW.