

Student Details

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Note: Plagiarism of more than 20% will result in negative marking.

Similar answers of students will result in cancellation of the answer for all parties.

Q1	(a)	In Renewable Energy Systems Solar Photo Voltaic and Fuels Cell are among the popular choice of technologies used for Direct Energy Conversion. For your home town of (State your city), which will be the better option to power a 10 KW load. Explain your answer based on its pros & cons, users, applications, availability and market. Back your reasons with valid data, facts and figures.	Marks 10
Q2	(a)	PV Cells performance is greatly affected by a location's climate factors which include irradiance, temperature, humidity and wind. Different locations have different climate conditions. For your home town of (State your city and climate conditions), based on its average climate conditions what techniques will you apply to a PV cell to reduce the effects of climate on the cells performance, reduce losses and increase efficiency. Back your reasons with valid data, facts and figures.	Marks 10
Q3	(a)	Fuel Cells have many types based on temperature, electrolyte and fuel. What would be the best option and the worst option among the types of fuel cell for providing power to Iqra National University (Take the last 3 digits of your student ID to be the average load KW of INU) located in Peshawar. Explain your choices based on the pros & cons, applications, availability and market. Back your reasons with valid data, facts and figures.	Marks 10

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Ans-1 The best choice of technologies used for direct energy conversion (which has mentioned above) is solar photovoltaic (PV) cell. Solar system will be best option to power of 10kw for my home town (Peshawar) the reason has mention below with detail

Solar Photovoltaic (PV) is a technology that converts sunlight (solar radiation) into direct current electricity by using semiconductors.

A solar photovoltaic (PV) cell change sunlight into electrical energy in three general steps:

- Light is absorbed and Electron lose valence shell.
- Lost electron flows and cause electrical current.
- Current is transferred through wires.

A fuel cell is a device that converts chemical potential energy (energy stored in molecular bonds) into electrical energy. A PEM (Proton Exchange Membrane) cell uses hydrogen gas (H₂) and oxygen gas (O₂) as fuel. The products of the reaction in the cell are water, electricity, and heat.

Pros and Cos of Solar Energy:

Advantages

➤ Reduce Electricity Bills

With installation of Solar System one can save a lot of money on electricity Bills. How much you save money depend on the size of your solar System. More ever not only saving money, there are options available that you can sell extra solar energy to a grid. It is much better option

➤ Low Maintenance Cost

Solar energy usually doesn't have high maintenance Cost. It usually requires to be cleaned once in a year. Solar cells have warranty of 25 years. It doesn't have moving parts which doesn't cause wear and tear. Invertor need to be changed after 5 to 8 years because it is continuously changing solar energy into electrical energy.

Disadvantages

➤ Initial Cost

Initial cost of solar System is high. This include buying solar panels, batteries, invertors, wiring and installation cost.

➤ Weather dependent

The efficiency of solar panels drops with low sunlight or during rainy days. Solar efficiency is highly dependent on available sunlight. One should consider solar energy can't be collected during night.

Note Solar system is best option where sunlight is available throughout year.

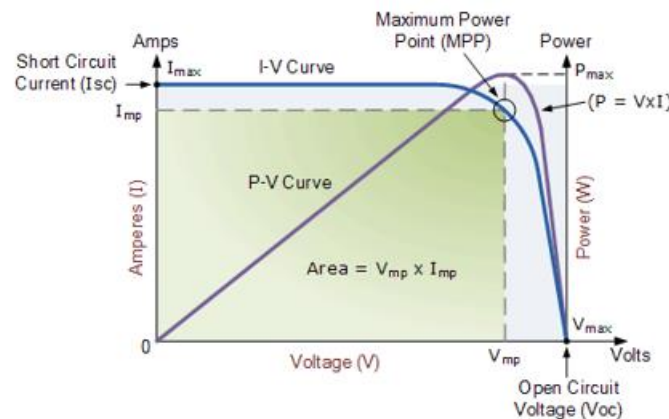
➤ Solar Energy Storage is Expensive

Solar energy should be utilized in right way or it need to be stored. In off grid case during day time produced solar energy should be used and stored in batteries and at night stored energy should be used. While in on grid system during day time energy should be taken from solar and at night take energy from grid.

➤ Use a lot of space

Solar system occupies a lot of space, the more energy you want to gather from sunlight the more panels you will need to install, for this large space will be required.

Solar cell characteristic curve



The above graph shows the current-voltage ($I-V$) characteristics of a typical silicon PV cell operating under normal conditions. The power delivered by a solar cell is the product of current and voltage ($I \times V$). If the multiplication is done, point for point, for all voltages from short-circuit to open-circuit conditions, the power curve above is obtained for a given radiation level.

Applications

LED lighting Powered by Solar

Secondary power backup cars

Solar Power can be used in space

To power calculators and novelty devices

Solar energy can be used to power temporary traffic signs, parking meters trash compactors, emergency telephones, water pumps, and remote guard posts and signals.

Cost-effective solar solutions for remote places

Solar-powered lighting for roadways/highways

Solar System will be best option for my City Peshawar because of multiple Reasons such as:

1) Availability of sunlight:

Peshawar Coordinates is 34.0151° N, 71.5249° E which shows this city has sunlight throughout year. There are regions where there is no sunlight or partial sunlight or for very hours which make Solar System less efficient in those Region. For example, northern artic, southern artic, Sweden, Norway, Iceland and many more are such regions where solar system is not best option.

In Peshawar during summer sunlight is available for 15 hours in average and during winter sunlight is available for 10 hours in average making it most efficient.

2) On grid

As we discussed earlier storing Solar energy in batteries is quite expensive. In Peshawar one can utilize solar energy during day time and can use grid energy during night. Peshawar is an urban city where there is option available for on grid Solar System.

Conclusion:

Installing 10KW solar System will be better option for Peshawar.

Q2	(a)	PV Cells performance is greatly affected by a location's climate factors which include irradiance, temperature, humidity and wind. Different locations have different climate conditions. For your home town of (State your city and climate conditions), based on its average climate conditions what techniques will you apply to a PV cell to reduce the effects of climate on the cells performance, reduce losses and increase efficiency. Back your reasons with valid data, facts and figures.	Marks 10
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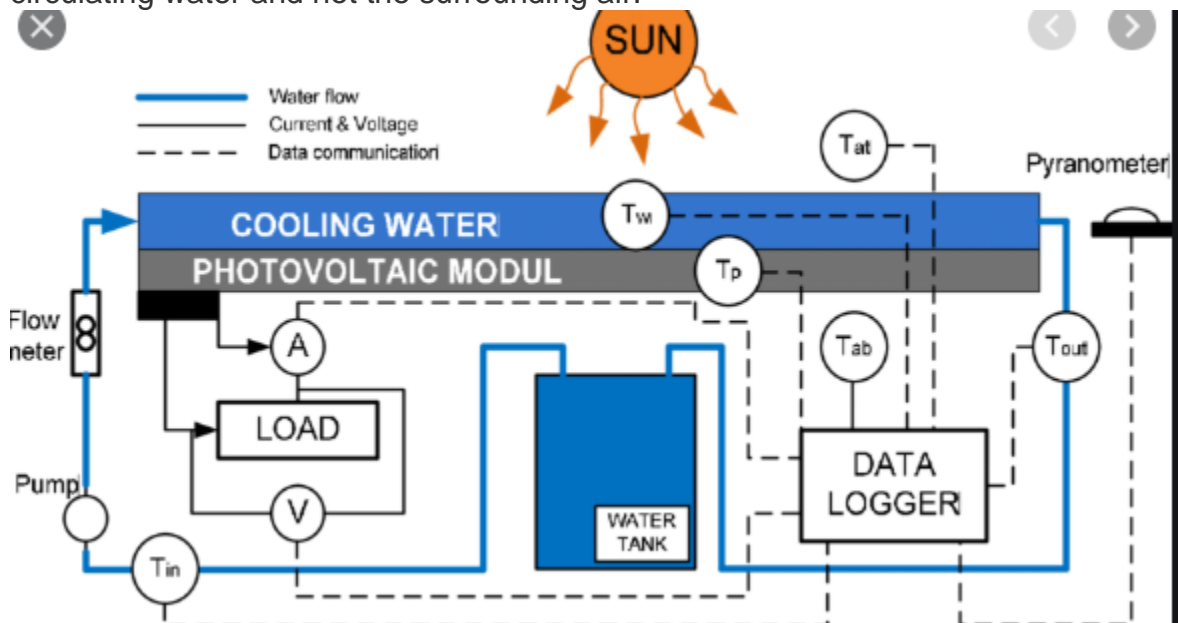
ANS-2: we will choose to select cooling technique (like water cooling) technique apply to a PV cell to reduce the effects of climate on the cell performance, reduce losses and increase efficiency.

Cooling Techniques

As we know electrical efficiency will increase if we decrease panel temperature. So, in recent years cooling techniques have been improved. Most common cooling techniques are active water and air cooling, other cooling techniques include phase-change material cooling and conductive cooling etc. Increase in electrical efficiency depends on cooling techniques, geographical position, size of the module and the season of the year, and usually results in rise of 3-5 % in overall efficiency

1) Improving Photovoltaic Module Efficiency Using Water Cooling

The new water coolers are panels are made of three components. The topmost plastic layer topped with a silver coating that reflects nearly all incoming sunlight, preventing the panel from getting heated up in hot weather. The plastic layer sits atop the second component, a snaking copper tube. Water is passed through pipes in the tube, where it sheds heat to the plastic. That heat is then radiated out by the plastic at a wavelength in the middle region of the infrared (IR) spectrum, which is not absorbed by the atmosphere and instead travels all the way to outer space. Finally, the whole panel is encased in a thermally insulating plastic housing that ensures nearly all the heat radiated away comes from the circulating water and not the surrounding air.



2) Efficiency Improvement of Photovoltaic Panels by Using Air Cooled Heat Sinks

The operating temperature of photovoltaic panels represents an important parameter that influences their conversion efficiency. Decrease in output power will occur in High operating temperatures in the same conditions of solar radiation. The heat sink is conceived as a ribbed wall, realized of a high thermal conductivity material. The heat sink has been studied for different configuration of cooling efficiency, obtained by adjusting the angle between the base plate and the ribs.

3) Thermoelectric cooling method of P.V cell

In thermoelectric cooling method the cooling performance of thermoelectric chillers are being driven by solar cells. Solar energy is clear and limitless and can be collected by solar cells. solar cells are used to drive thermoelectric chillers, where the cold side is connected to the water tank. It is found that 250 mL of water can be cooled from 18.5°C to 13°C. The thermoelectric chiller driven by solar cell is feasible and effective for energy saving issues.

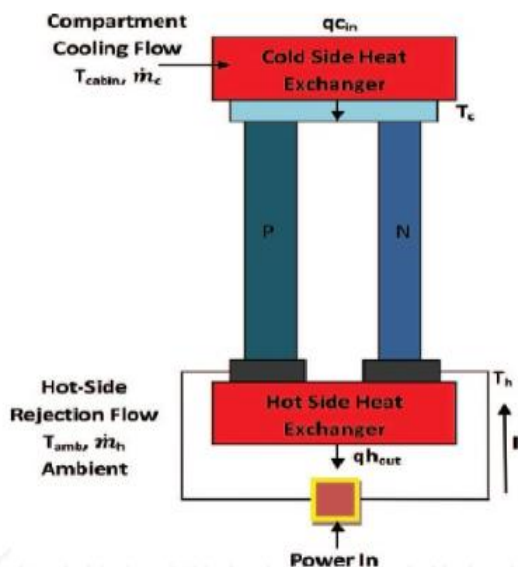
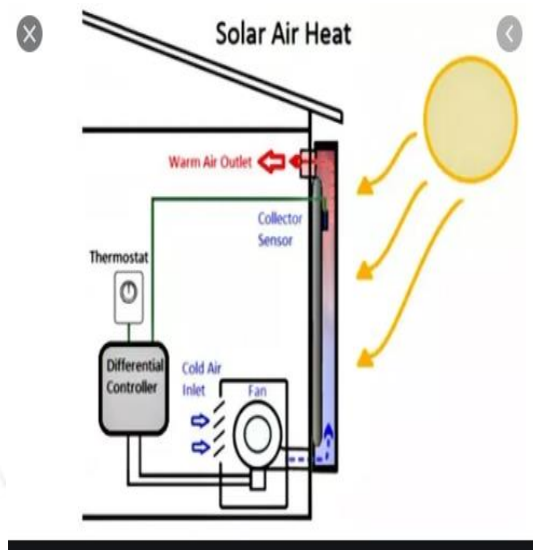


Figure 1: Principle of thermoelectric coolers utilizing semiconductor Peltier effect [2]



Conclusion

By Using air cooling and heat sink temperature of PV cell decrease by 12° C.

In case of air-cooling system, the efficiency of the system does not always increase with increasing the mass flow rate of the air but there is an optimum value of mass flow rate.

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Water spray cooling has a considerable effect on the performance of the PV cell, even for the low flow rate of the water spray the performance of the system enhances remarkably.

- Water cooling has the most impact on the reduction of the operating temperature of the PV cell and improve the electrical performance of the PV panel.
- Cooling system with fins is efficient to reduce the temperature of the PV panel and enhance the electrical efficiency of the PV panel.

Considering my city Peshawar where usually there is no intense air and have plenty of water. So Natural air-cooling system will not be efficient. The most efficient for Peshawar city will be water cooling System because of availability of water.

Q3	(a)	Fuel Cells have many types based on temperature, electrolyte and fuel. What would be the best option and the worst option among the types of fuel cell for providing power to <u>Iqra</u> National University (Take the last 3 digits of your student ID to be the average load KW of INU) located in Peshawar. Explain your choices based on the pros & cons, applications, availability and market. Back your reasons with valid data, facts and figures.	Marks 10
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Ans-3

Best Solution for INU:

Let us suppose INU load is 596KW as per my roll number. The best solution for such a load will be choosing Molten Carbonate fuel cell (MCFC).

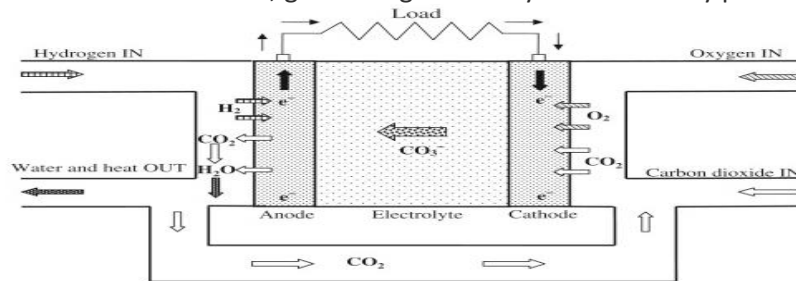
Worse case:

In case of worst selection will be choosing solid acid fuel cell (SAFC). It has high operating temperature compare to Molten Carbonate fuel cell (MCFC). This type of fuel cell operates at very high temperatures (around 1,832 F,1000C) This high temperature makes reliability a problem

Molten carbonate fuel cells (MCFCs) classified as high-temperature fuel cells. It can directly use natural gas without the need for a fuel processor because of its high operating temperature. A schematic diagram below shows the working mechanism of an MCFC is shown in Figure below. MCFCs work quite differently from other fuel cells. The electrolyte in this fuel cell is made of a molten mixture of carbonate salts. The fuel cell operates at 600–700 °C, at which the alkali carbonates form a highly conductive

molten salt, with carbonated ions providing ionic conduction. Two mixtures lithium carbonate and potassium carbonate are currently used.

Anode and cathode These ions flow from the cathode to the anode, where hydrogen is combined with them to yield carbon dioxide, water and electrons. These electrons are passed through an external circuit back to the cathode, generating electricity and heat as by product.



Advantages:

- 1) Because of high operating temperature, there is no need for an external fuel processor.
- 2) MCFC produce heat as by product which can be used to generate high pressure steam which can be used in commercial and industrial applications.
- 3) It has high efficiency.

Why not Solid oxide fuel cell for 596 KW?

1. SOFC operate at high temperature and catalysts are expensive.
2. Exotic material such as ceramic is required because of high operating temperature.
3. The ceramic materials used are expensive to manufacture.
4. Manufacturing costs are high compared to gas turbines.

Applications:

- 1) MCFC most suitable for distributed system
- 2) It is used in large stationary power generation
- 3) MCFC used for alternative power supply for ship.