

Department of Electrical Engineering
Assignment

Date: 20/04/2020

Course Details

Course Title: Direct Energy Conversions Module: _____
Instructor: Engr SHAYAN TARIQ Total 30
Marks: _____

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

QNO 1

In Renewable Energy Systems Solar Photo Voltaic and Fuel Cell are among the popular choices of technology used for Direct Energy Conversion. For your hometown which will be the better option to power a 10 kW load.

Answer:-

Fuel Cell

Efficiency

The fuel cell theoretical efficiency is 83% based on hydrogen higher heating value. The actual fuel cell efficiency is much lower because of various losses.

Cost

One company commercially offers fuel cells power plants for about \$ 3000 per kW (US).

Solar Photo Voltaic

My home town is Karak. I prefer solar system however its efficiency is lower than fuel cell. The reason is that;

⇒ Its energy is free of cost for years rather than initial cost.

⇒ The climate of my home town is very suitable for solar power plant.

⇒ In our home town there is no problem of space for solar panels because we living in village and sir you ~~know~~ the villages home.

⇒ With the grace of Allah we have normally a sunny day of average 10-14 hours.

⇒ The temperature of our area is suitable for solar panels.

Efficiency

Typical solar panel efficiency of crystalline solar cell available today may be around 20%.

Cells with efficiency upto 46% have been demonstrated in Labs.

Life time

It can last 30 years or more with only about 1% or 2% degradation per year.

Pros of Solar Energy

- i) Big ~~advange~~ advantage of solar energy that it is free from noise and air pollution.
- ii) It lower or completely balance electricity bill.
- iii) Earn money back on your investment.
- iv) It can reduce carbon footprint.
- v) Combat rising electricity cost.
- vi) It can improve the value of your home.
- vii) Low maintenance.

Cons of Solar Energy

- i) Initial cost is high.
- ii) Require large space.
- iii) Space with no shading.

User of Solar Energy

It is used in wide range of devices. In expensive lawn ornaments where solar cells are available at hardware store less than one dollar.

Small photo voltaic devices used as optical sensor are inexpensive.

On the other extreme solar cell power the NASA Mars.

Applications

- => Water pumping
- => Remote lightning System
- => Satellites
- => Water heater
- => Solar Fan, Freezer, Iron etc.
- => Power plant
- => Toys, Watches etc.

Emerging Technology

The last category is emerging technology solar cell. One advantage of organic solar cell is that their processing may not require as high of temperature as the processing of solar cell made from PN junction of inorganic semiconductor.

Availability and Market

Easily available in market.

Most solar cell produced today around 80% of the market are silicon cell in this technology.

General Estimate For 10kW Solar Plant

Total PV voltage = Load voltage \times Safety factor

$$" \quad " \quad = 10000 \times 1.25$$

$$" \quad " \quad = 12500 \text{ W}$$

i) Number of panels = $\frac{\text{Total PV wattage}}{\text{Single PV module wattage}}$

$$= \frac{12500 \text{ W}}{390 \text{ W}}$$

Number of pannel = 32 panels each of 390W

ii) Inverter size

The inverter should be 25 - 30% greater the total PV wattage.

~~Invet~~

$$\text{Inveter size} = 15.625 \text{ kW}$$

iii) Roof Space

One panel of 390W require approx space of 21 square foot.

$$\text{Space } \square \text{ for 32 panels} = 32 \times 21$$

$$= 672 \text{ Sf}$$

So for 10kW solar panel we require space of 672 square foot.

QNO 28

Answers

PV Cell performance is greatly affected by climate conditions.

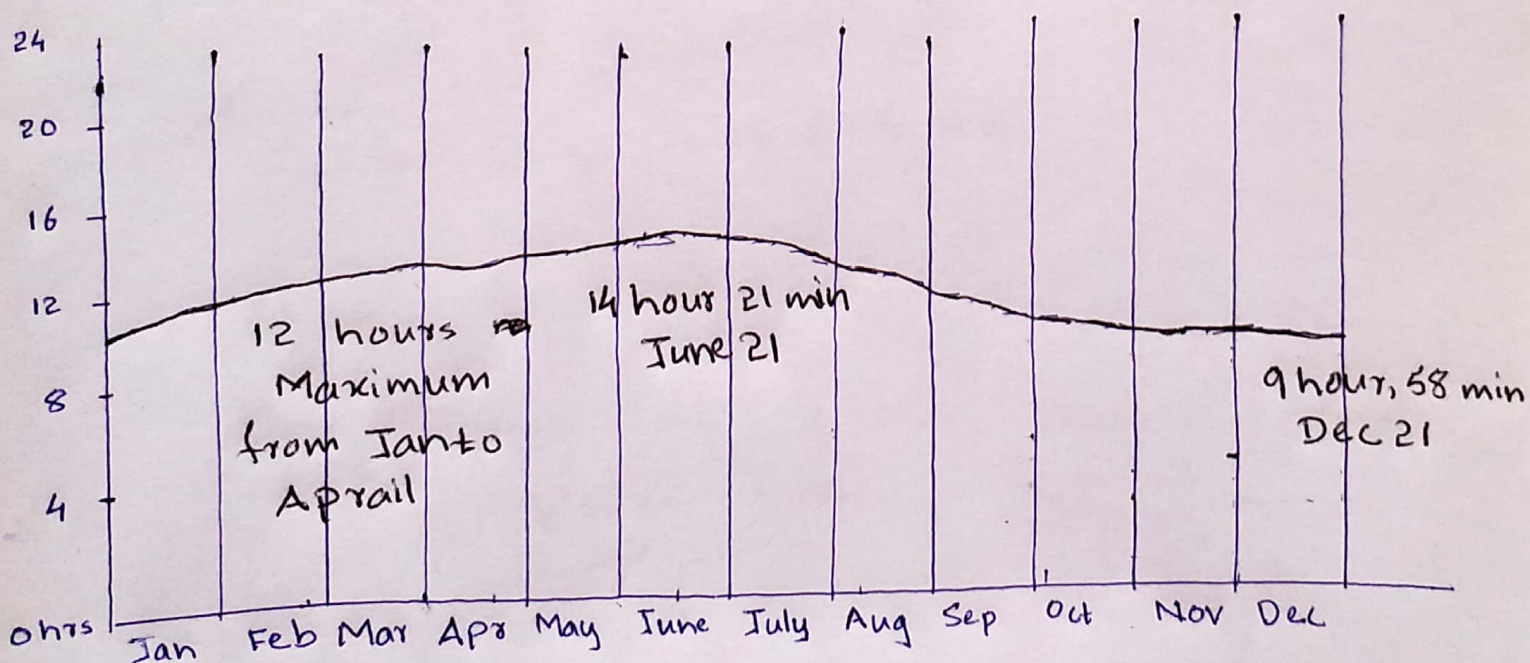
In Karak the summers are long, sweltering and clear and the winter are short, cold, dry and short.

Temperature

The average low and high temperature of Karak ranges from 15.7° to 42.3° , which is suitable for solar panels.

Sun Irradiance

The length of the day in Karak varies significantly over the course of the year. In 2020 the shortest day is December 21, with 9 hours, 58 minutes of daylight. The longest day is June 21, with 14 hours, 21 minutes of daylight.



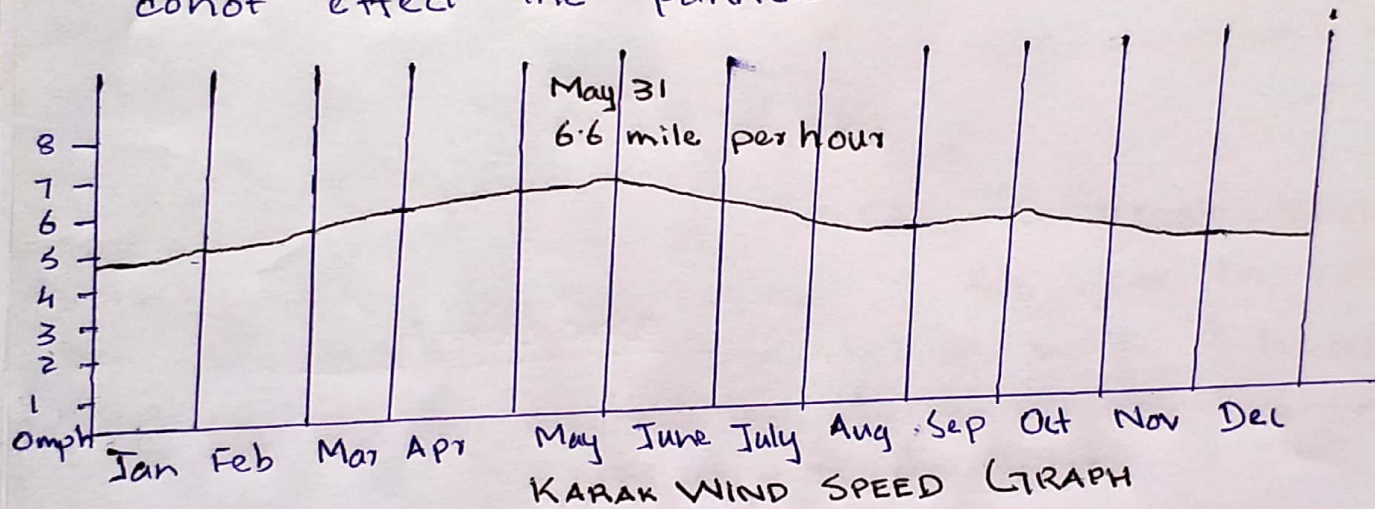
Hours of Daylight.
(Karak)

Wind

The highest wind speed in Karak is in the month of January with speed of 4.7 mile per hour.

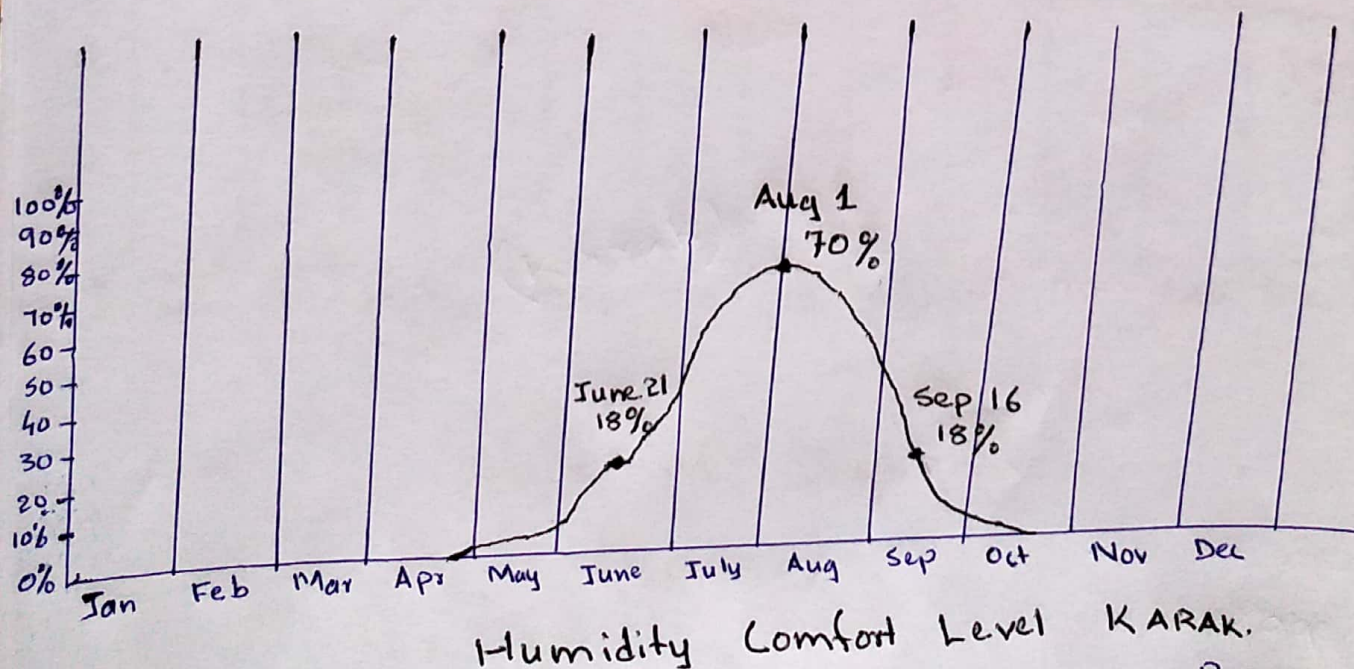
Most solar panels are certified to withstand winds of upto 140 mile per hour winds.

While the wind speed in our hometown donot effect the pannels.



Humidity

We base the humidity comfort level on the dew point, it determines whether perspiration will evaporate from the skin, thereby cooling the body. The average humidity graph of District Karak is given below.



Techniques Applied to Reduce Losses And Increase Efficiency

Following techniques applied to increase efficiency and reduce losses of solar panels.

⇒ It is ~~not~~ necessary that there is no shading on the panels all over the day.

⇒ While purchasing solar pannels it must be sure that your panels are made of monocrystalline cells.

⇒ During instalation the tilt angle and direction of panel towards south with angle of 180° .

⇒ Minimum distance between panels and inverter, to reduce line losses.

⇒ If the temperature exceeds the limit of 50°C use water to cool the pannel or if installed at power station then use mirror to divert the rays of sunlight from the Pannels.

⇒ If you sense that there is low rays of sunlight then you can use concentrator.

⇒ A concentrator is a mirror or lens system designed to capture more of sunlight onto the panels.

⇒ If we use moving structure for panels then we can use tracker that can move the panels towards sunlight radiations.

Q NO 3

ANSWER

Fuel cells are increasingly seen as a reliable green energy alternative to polluting process based on combustion from diesel and gasoline engines to coal burning power plant.

Fuel cell vendors shipped more than 650MW of fuel cells worldwide in 2017, a 100% increase in just two years.

Each fuel cell has two electrodes, an anode and cathode and an electrolyte between them. Fuel cell has different types of electrolytes and electrodes and their electrochemical process occurs at various temperature levels.

Each type of fuel cell has its own inherent strengths and weaknesses, that can make them more suitable for specific markets and application.

To power 680KW to INL

To power 680KW to INL located in Peshawar, the best option is to use Molten Carbonate fuel cell.

The power range that we require is only available in molten carbonate fuel cell.

However the efficiency of molten carbonate is 10% less than solid oxide but beside this the starting time of solid oxide is 60 minutes which is too greater.

Proton And Cons

Protons of Molten Carbonate

- ⇒ Efficiency greater than 50%.
- ⇒ Power range 10KW - 2MW
- ⇒ Require variety of fuel.
- ⇒ More efficient than others.
- ⇒ Used in distributed generations.
- ⇒ Not expensive and easily operate.

Cons of Molten Carbonate

- ⇒ Slow to respond
- ⇒ Highly corrosive
- ⇒ Starting time about 10 minutes.

Market

The molten carbonate fuel cell market is geographically segmented into key regions, with production, expenditure, income, market share reported in countries from 2017 to 2022.

On the basis of this product the Molten Carbonate Fuel Cell is primary categorized into coal fuel, Natural Gas Fuel and on the basis of the end users. Molten Carbonate Fuel Cell markets covers Household Thermo-electric system, Distributed generation power plant.