# Solar Energy Integration Project: Efficient Load Analysis and PV Array Sizing

**Question-1:** Describe your site and its usage, being sure to include relevant details needed to design a PV system for a specific situation. These details include whether the building is residential or commercial, patterns of usage (single family home, multiple family home, 24/7 manufacturing plant, office park building that generally is only open during weekdays from 7 AM to 6 PM, shopping mall open for business daily from 8 AM to 9:30 PM), overall size (how many floors, rooms, overall square footage), and footprint of the building. Use one of the linked resources (U.S. only, international) to calculate your average annual sunlight hours and provide a direct link to the actual map you used.

Answer: PV System Site Description For my Home

Site area = 220 m^2

Residential Building

Single Family Home

One floor (Ground floor)

Daily full sun hours=4.4

Average annual sunlight hours=1606 hours / year

https://solargis.com/maps-and-gis-data/download/india

**Question-2:** In a spreadsheet or a table, quantify all of the major electrical devices in the building, either based on the actual appliances (if known), or estimates for such appliances (wholesalesolar.com, lbl.gov, energy.gov). Include the power consumption for the appliance, the number of each appliance, an estimate of hours used each day, and days used per year. Describe any assumptions being used in your calculations. For example, an electric space heater is used 6 hours daily, but only during 4 months of the year; a window AC unit is used only on days above 27 °C (90 °F), which on average is 13 days per year at this location. Calculate the average daily electrical energy usage for each item and the total annual energy usage for each item in kWh. Based on these values, calculate the total average daily electrical usage for the building and total annual energy usage. Next, identify any areas where efficiencies could be introduced to reduce the total load (for example: changing all incandescent bulbs to LED bulbs, replacing a washing machine with a high efficiency unit, replacing 2 bulb fluorescent overhead lighting with single bulbs). Copy the first table and create a new table in the same document labeled “efficiency improvements.” For the areas where you've identified efficiency improvements, input the new power consumption for any new efficient appliances within the existing rows, along with any changes in the quantity of items, and/or new estimated usage times. Calculate the new daily and annual electrical usage for those rows, and then recalculate the building’s new potential average daily electrical energy usage and total annual electrical usage in kWh. Cost savings/input is not needed for this assignment. Submit both tables in single PDF document.

Answer:

| Appliances | No.s | Power(W) | Hrs/day | Days/yr | Daily Electrical Usage (kWh) | Annual Electrical Usage (kWh) |
|---|---|---|---|---|---|---|
| Washing machine | 1 | 500 | 1 | 300 | 0.5 | 150 |
| Tubelights | 5 | 40 | 19 | 350 | 3.8 | 1330 |
| Television | 1 | 200 | 1 | 200 | 0.2 | 40 |
| Personal Computer | 1 | 200 | 6 | 260 | 1.2 | 312 |
| AC | 2 | 1000 | 10 | 120 | 20 | 2400 |
| Fans | 5 | 35 | 22 | 310 | 3.85 | 1193.5 |
| Water Heater | 1 | 1500 | 1 | 90 | 1.5 | 135 |
| CFL Bulbs | 3 | 15 | 3 | 355 | 0.135 | 47.92 |
| Refrigerator | 1 | 225 | 24 | 360 | 5.4 | 1944 |

**Total Daily Electrical Usage For Building (KWh) = 36.585**
**Total annual electrical usage(KWh) = 7552.425**

# Efficiency Improvements

| Appliances | No.s | Power(W) | Hrs/day | Days/yr | Daily Electrical Usage (kWh) | Annual Electrical Usage (kWh) |
|---|---|---|---|---|---|---|
| Washing machine | 1 | 225 | 1 | 300 | 0.26 | 67.5 |
| LED Tubelights | 5 | 16 | 19 | 350 | 1.52 | 532 |
| Television | 1 | 200 | 1 | 200 | 0.2 | 40 |
| Personal Computer | 1 | 200 | 6 | 260 | 1.2 | 312 |
| AC | 2 | 1000 | 10 | 120 | 20 | 2400 |
| Fans | 5 | 35 | 22 | 310 | 3.85 | 1193.5 |
| Water Heater | 1 | 1500 | 1 | 90 | 1.5 | 135 |
| LED Bulbs | 3 | 10 | 3 | 355 | 0.09 | 31.95 |
| Refrigerator | 1 | 225 | 24 | 360 | 5.4 | 1944 |

**Total Daily Electrical Usage For Building (KWh) = 34.02**
**Total annual electrical usage (KWh) = 6655.95**

**Question-3:** Based on your site description and your calculated building energy needs after efficiency improvements, calculate the power of a PV array capable of meeting your building's energy needs. Use the total annual solar irradiance for your specific location and assume a 25% loss during PV generation and conversion. Then, select a commercially available module to use that can be used to create the array. Post a link to module's specification sheet and summarize the key specifications of the module you used in the selection process. Calculate the number of modules required to produce the calculated system power. Calculate the voltage and current output of the system at maximum power based on series wiring.

## Answer:

Loss=25%

Average annual sunlight hours=1606 hours / year

Total annual electrical usage (KWh) = 6655.95 (after Efficiency improvement)

Power of a PV array = 6655.95/ (1606*0.75) =5.5259 KW

Link of Module specification- https://lsin.panasonic.com/media/brouchers/2021/6/polycrystaline.pdf

Specification:-

Wattage Wp- 330 W

Voltage at Max Power, Vmax 36.80 V

Current at Max Power, Imax 8.97 Amp

Number of modules= 5525.9/330=16.74  =17 (Approx)

voltage output of the system at maximum power based on series wiring = 625.6 V

current output of the system at maximum power based on series wiring =8.97 Amp