DATA 604 – Solar PV System Simulation

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# Introduction:

As awareness of climate change increases, there is a growing trend to reduce reliance on fossil fuel. The two popular methods of slowing down (and possibly reversing) climate change are reliance on renewable energy and carbon footprint reduction. Renewable energy comes in many forms but we will focus our attention solar power in this project. We will simulate various aspects of power generation with Solar Photovoltaic system and consider system size, power usage, and cost of obtaining a solar PV system.

Tangentially, we would like to investigate carbon footprint reduction through the use of Battery Electric Vehicles (BEV). More specifically (and simply) we would like to investigate whether our solar PV system is large enough to support the electricity consumption of a BEV.

# Summary of journal papers:





Journal Article 1: Simulation and performance analysis of 110kWp grid-connected photovoltaic system for residential building in India: A comparative analysis of various PV technology

This paper has evaluated the technical performance of a 110 kWp grid connected roof top solar PV-system to supply electricity and energy for the Hostel building at Bhopal, India (Latitude: 23° 16′ N, Longitude: 77° 36′ E).

The following conclusions are drawn from the study:

• The performance ratio (PR) of the PV systems varies from 70% to 88% and their energy yields range from 2.67 kWh/kWp to 3.36 kWh/kWp.

• From the annual energy yield of the PV systems, it is observed that all the four technology perform satisfactory under the tropical weather conditions.

• The electricity generated by PV systems can be used to power the water pumps, lighting and other electrical appliances of the Hostel building.

Journal Article 2: Some Analytical Studies on the Performance of Grid Connected Solar Photovoltaic System with Different Parameters:

This paper discusses the analytical studies done on the performance of the grid connected solar photovoltaic system with various parameters in Rajasthan, India. The factors considered for this evaluation includes - solar irradiation, ambience, tilt angle, orientation and shading.

In addition to the cost analysis (capital cost, capacity utilization), the papers also present some interesting conclusions on how the ambient temperature, weather, humidity and dust content in the ambience influence the energy yield. It also indicates that sufficient pitch required in between the module's strings to minimize the shading loss, and provides an estimate of power output from the SPV plant.

# Problem Formulation and Statement of Objectives:

As noble the goal of climate change reduction is, a major factor in adopting solar PV system is monetary. The goal of this simulation is to ultimately answer one question. “Is it worth it to invest in a solar PV system?”

### High Level Description:

This simulation will be broken into two basic parts:

1. Solar power generation
2. Energy consumption

*Solar Power Generation*- This section will deal with the various aspects of generating solar electricity. We will simulate various weather conditions, taking into account variables such as geographic location, weather patterns, and time of the year.

### Assumptions:

* We will measure sunlight only in time. We will assume that solar intensity is constant throughout the day as well as the sun angle.
* The equipment and installation cost is fixed. There is only a one-time fee associated with purchase and installation of the solar PV system. It is assumed that there is no repair cost for the life of the system.
* Grid Energy cost is fixed.

*Energy Consumption-* This section will deal with various aspects of consuming electricity. We will simulate various usage patterns and conditions. These will include household size, household composition (# of adults, # of children), energy usage based on time of day, etc.

### Assumptions:

* Energy consumptions from electronics are constant. The device is either on or off. The devices will not consume different amounts of energy based on usage.
* We will not calculate carbon cost, rather we will simulate energy consumption and attribute a unit of electricity to a theoretical unit of Carbon Cost, CC.
* We will assume all appliances are electrical. We will assume electric heaters, electric stove, etc.