Mechatronics Assignment

Group 14

1. Background

The increase in both local and international tourists in South Africa has given hotels and Inns a thriving chance in business [?]. However, some of the businesses are in areas that are heavily stricken with power shortages in addition to the current national loadshedding. This has a bearing effect on the survival of these businesses as some of the visitors may not be familiar nor comfortable with idea of being without power for prolonged periods. an Inn located remotely in Eastern Cape is picked to have an installation of solar panels, this Inn can have up to 4 guests and 2 staff members [?]. The Inn has been on grid for as long as it has existed, however due to the bearing effects of lack of power, the business has not been doing great compared to the previous years when power supply was not a problem.

To solve this problem for a specific business for this specific in, solar installation will be designed such that the solar installed can supply the Inn with enough power for up for 6 people living in the Inn regularly. The solar would be able to orientate itself such that it captures as much sunlight as possible during the day even during different seasons when the path of the sun is quite different from the summer path.

Assumptions made:

- There will be 6 people in the Inn on daily basis.
- Energy consumptions is the same in all seasons of the year.

1.1. Specifications

According to Ecoflow [?], an average household in South Africa with 3.4 people consumes 7kWh per day, this means the 6 people staying at an Inn would consume about 12.35 kWh per day.

With an 3kWh inverter, 2 ×425 W mono panels can supply the required energy per day [?]

Table 1: Living arrangements specifications [?]

Specification	Value
Number of residents	6
Occupancy duration	24 hours
Energy consumed per day	12.35 kWh

Table 2: Geographic location specification

Parameter	Value
Location	Den Hagen Guest Farm SUGGESTION FOR NOW
Latitude	-30.743507774746487
Longitude	27.956952851603862
Elevation above sea level	1935 m (USING https://www.dcode.fr/earth-elevation)
Average sun hours in Summer	1281.576 (USING http://fao.org/aquastat/en/geospatial-information/climate-information)
Average temperature in Summer	14.13 ºC
Average sun radiation in Summer	-----
Average sun hours in Winter	1703.472 (USING http://fao.org/aquastat/en/geospatial-information/climate-information)
Average temperature in Winter	5.07 ºC
Average sun radiation in Winter	-----

Assumption made for geographical location:

- No nearby topographical features that would cause shadow on the panels.
- No prevailing wind is considered.

Table 3: Solar panel specifications [?]

Parameter	Value
Number of mono solar panel modules	2
Peak power	425 W
Weight of the modules	43.6 kg
Dimensions (L W H)	1762 x 1134 x 30 mm
Operating temperature range	-40 ~ 85 ºC
Nominal operating cell temperature	43 ±2 °C
Module efficiency (η)	21.3 %
Maximum power voltage	39.5 V
Maximum power current	8.13 A
Temperature coefficient for peak power	-0.34 %/°C
Temperature coefficient for open circuit voltage	-0.25 %/°C
Temperature coefficient for short circuit current	0.04 %/°C
Number of inverters	1
Inverter energy rating	3 kW
Number of cells per module	144

Table 4: Inverter specifications [?]

Parameter	Value
Inverter type	High Frequency Hybrid Solar Inverter with pure sine wave output
Grid connection	Off-grid
Peak efficiency	93 %
Nominal AC voltage input	230 V
Rated power	3000 W
Surge power	6000 W
Nominal frequency range	50 Hz / 60 Hz (Auto sensing)
Mass	7.8 kg
Dimensions (L W H)	290 x 342 x 125 mm

Table 5: Battery specifications [?]

Parameter	Value
Nominal voltage	25.6 V
Nominal capacity	100 Ah
Nominal energy	2560 Wh
Maximum continuous current	100 A

Table 6: Electro-mechanical motor specifications

Parameter	Value
Motor type	
Number of motors used	
Rated power	
Rated current	
Rated voltage	
Maximum speed	
Maximum torque	
Gear ratio	
Operating temperature ranges	
Control interface	
Mounting type	
Position feedback	
Weight	
Dimensions (L W H)	

1.2. Objectives

- Develop a physical and mathematical model of the solar panel with sun tracking for a 6-person Inn.
- Simulate the control system and analyse the performance of the solar panel using MATHLAB or Simulink + Conduct stability analysis and need for control.
- Discuss and compare the results with published data.

Table 7: Variables and parameters used for analysis

Parameter	Variable
Solar panel module efficiency	η
