A Study on Association between Tilt Angle, Solar Insolation Exposure and Output of Solar PV Panel using BIM 3D Modelling

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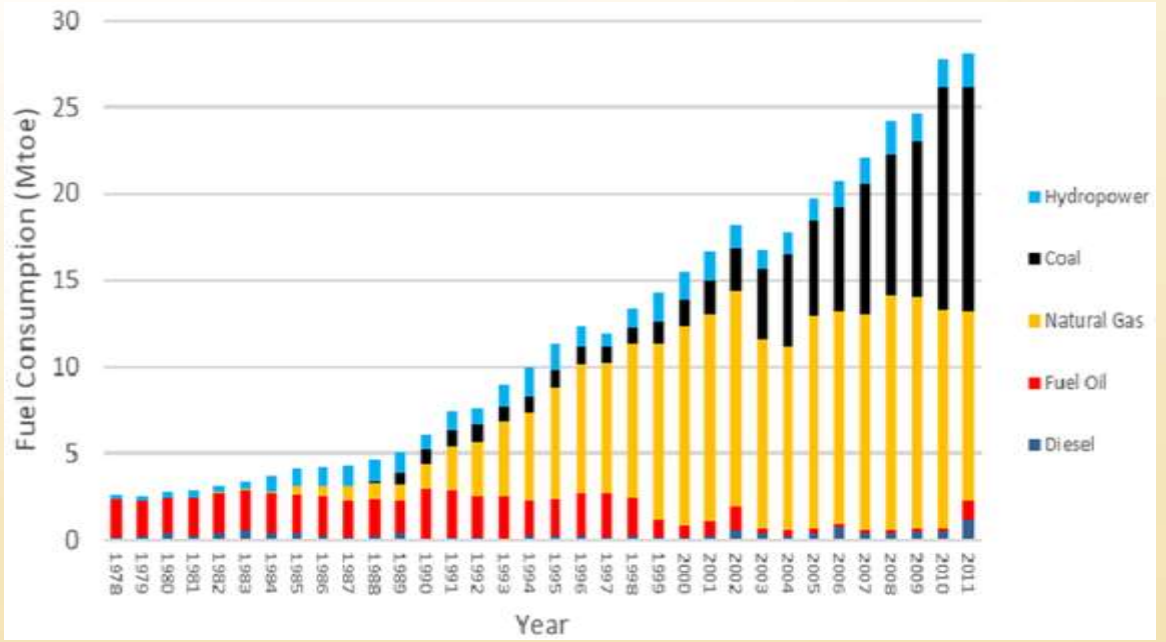
Problem Statement

- Malaysia still rely on the conventional method in electricity generation.

Coal-fired power plant
in Perak state.

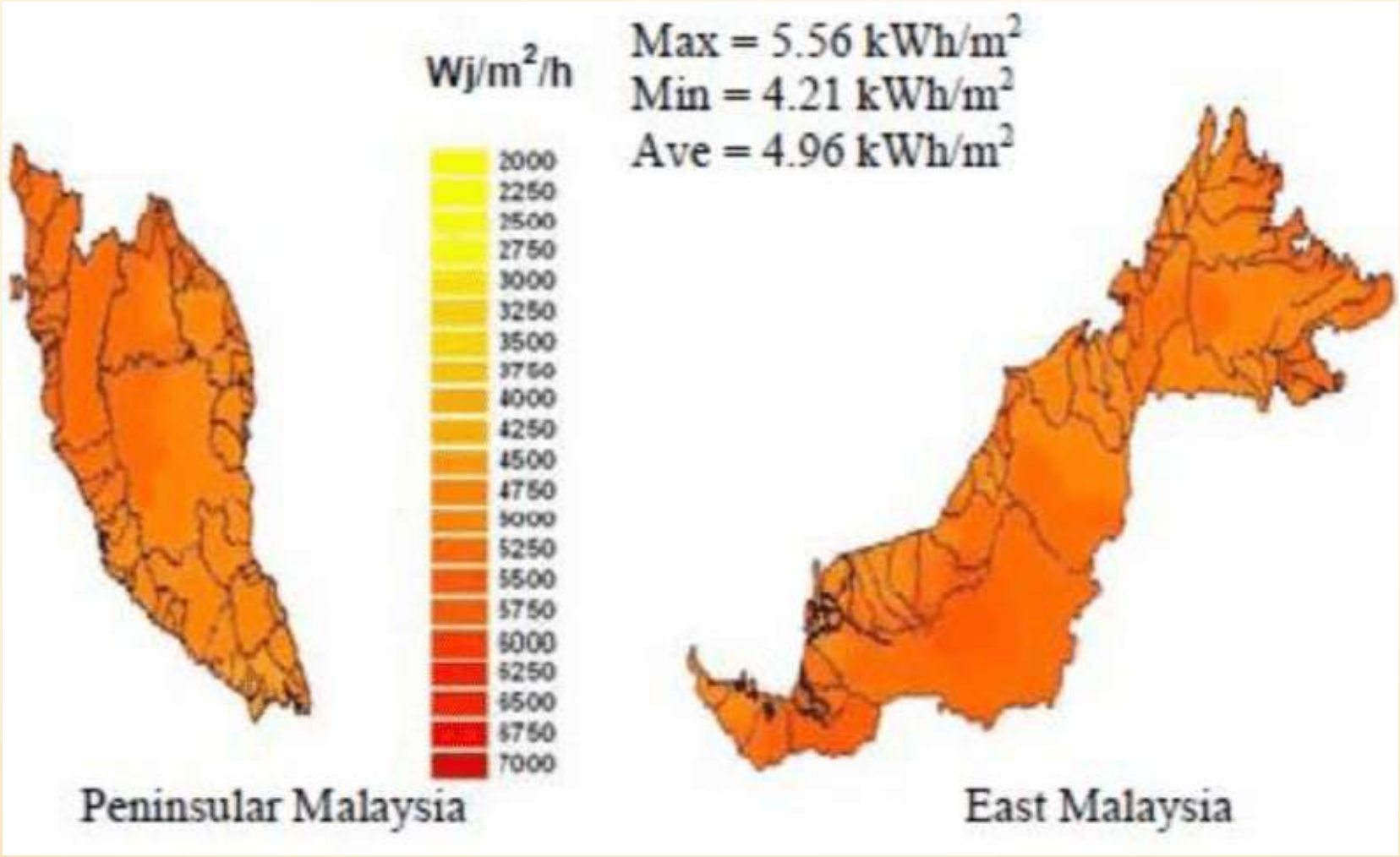


Problem Statement

- Lack of information for the installation of the solar panel at research location such as tilt angle and orientation.
- Lack of application of BIM software for solar analysis in Malaysia.

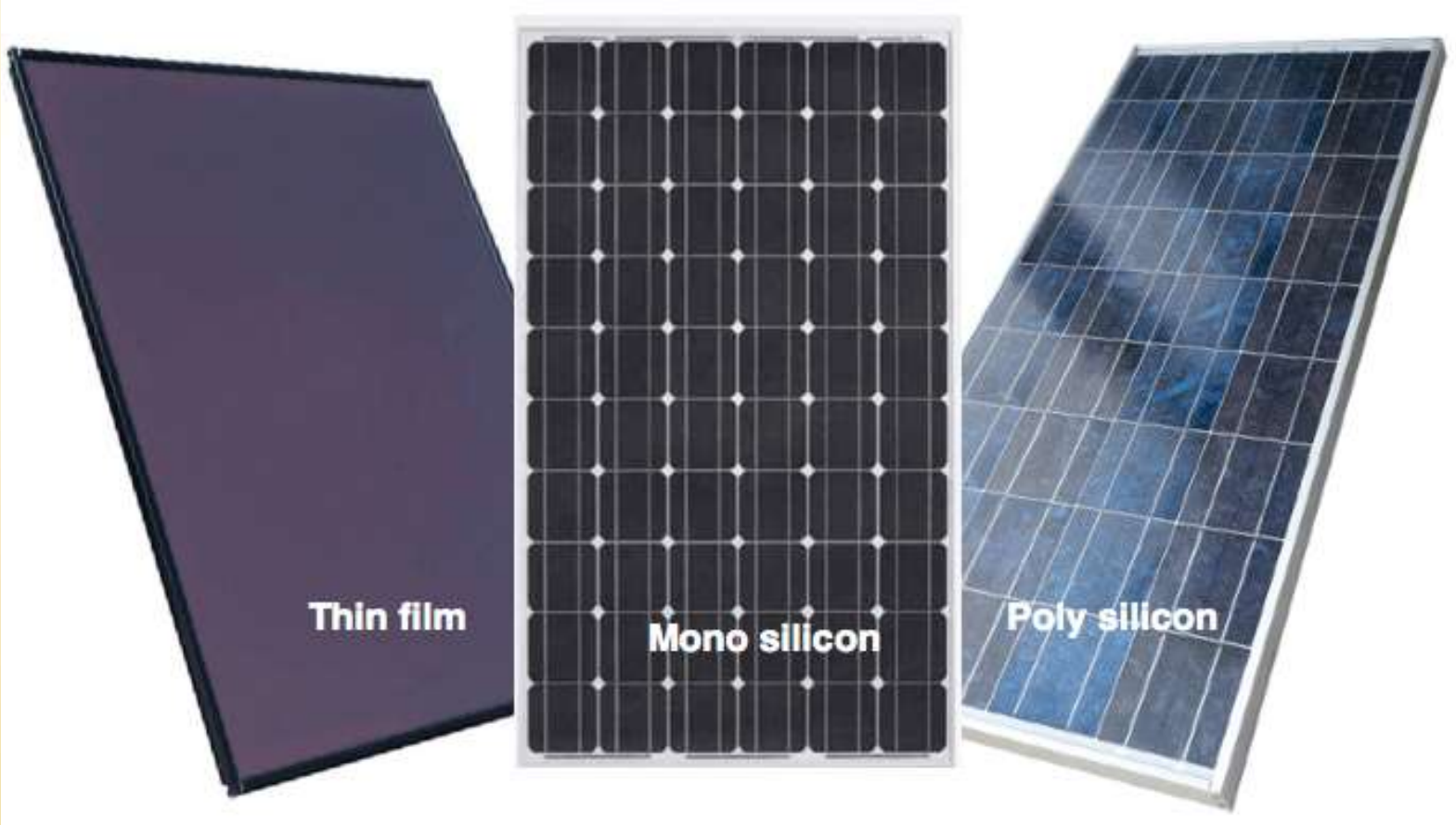
Introduction

- Solar photovoltaic (PV) is one of the alternative ways to reduce environmental problems due to non-renewable energy such as coal, natural gas, fuel oil and diesel.
- Malaysia's location, which lies near the equator, from 1° to 7° North is strategic to harvest solar energy through the PV panels.
- Field testing for each PV installation important to improve functionality and cost effectiveness .



Source:Md. Khairuk,Islam (2017). Performance Analysis of Parabolic Trough Concentrated System.

- Solar irradiance is the amount of light energy which reaches the surface of the receiver measured in square meter per second.
- Mainly three types of solar panels such as mono-crystalline silicon Photovoltaic Cell, polycrystalline silicon Photovoltaic Cell and thin film amorphous silicon Photovoltaic Cell.



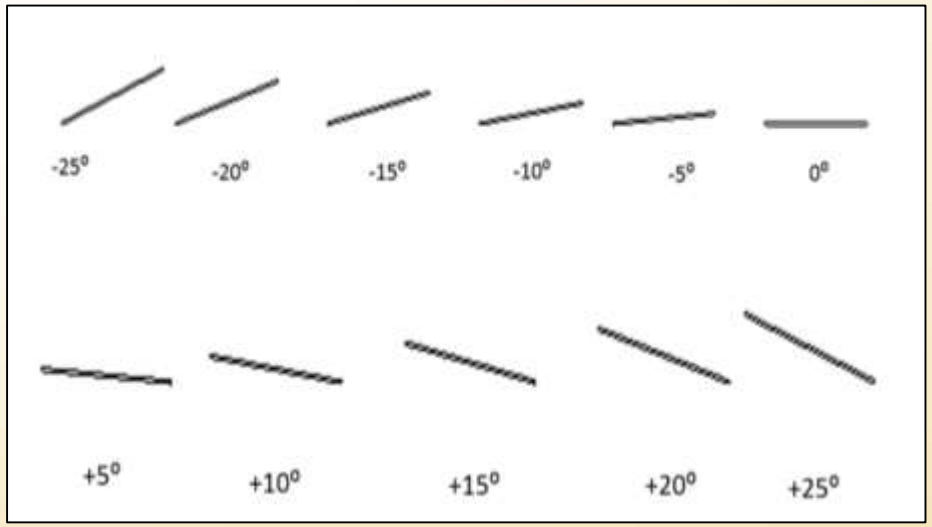
Researchers	System description and location
Zeinab Abdallah M. Elhassan, Mohammad Fauzi Moh. Zain, Kamaruzzaman Sopian, & Arafa Awadalla, (2011)	Five modules with four facing direction (North, East, South and West) with 15°, 20° and 30° of tilt angle at University Kebangsaan Malaysia
B. Kamanga, J. S. P. Mlatho, C. Mikeka, & C. Kamunda, (2014)	PV module is set to be North-facing with tilt at angles of 0°, 15°, 20°, and 25° at Zomba district.
K.R. Ajao, R.M. Ambali, & M.O. Mahmoud, (2013)	PV module set to be 0° to 30° with a succession of 2° facing south at Ilorin, Nigeria.
T. Pavlović, Z. Pavlović, L. Pantić, & Lj. Kostić, (2010)	PV modules set to be 0°, 30°, 45°, 60° and 90° in east, south and west orientation at Nis, Serbia.

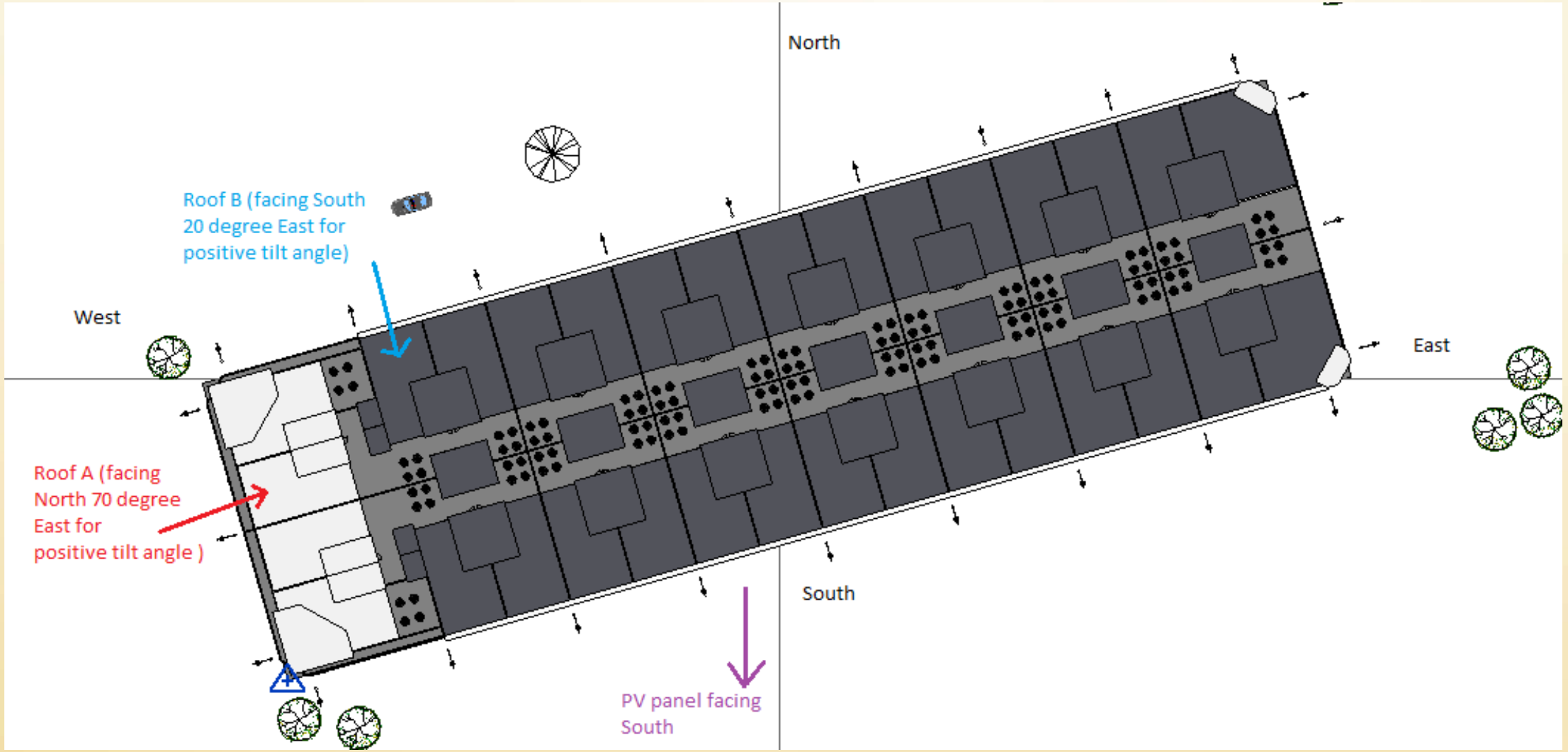
Research Location

- Coordinates of building studied is 6.6495° N, 100.2566° E.
- UniCITI ALAM, Kampung Baharu, 02100 Padang Besar, Perlis.

Research Methodology

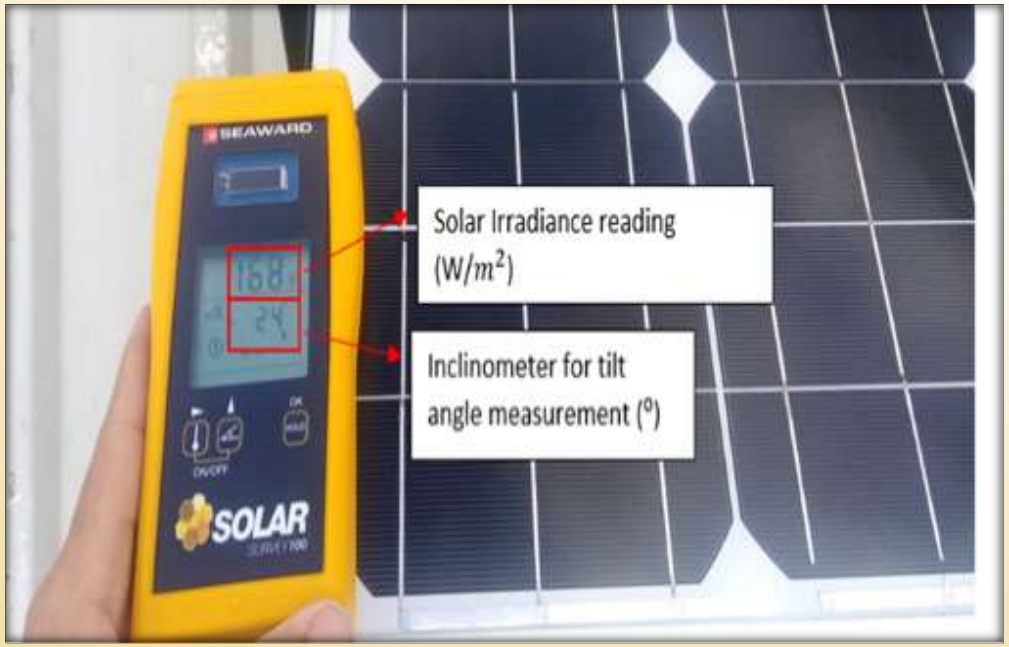
- Irradiance meter and PV panels are set up with three different orientations and eleven types of tilt angles for each solar panel to collect data for solar irradiance and power output of PV panel.




North
West
East
South
Roof B (facing South 20 degree East for positive tilt angle)
Roof A (facing North 70 degree East for positive tilt angle)
PV panel facing South

Site Measurement (Solar Irradiance)

- SEAWARD irradiance meter which covers the solar irradiance readings and tilt angle for the set-up of PV panels.
- Data is then tabulated to observe the changes for each hour and averaged for the comparison between the three orientations to determine the best tilt angle for the testing duration.

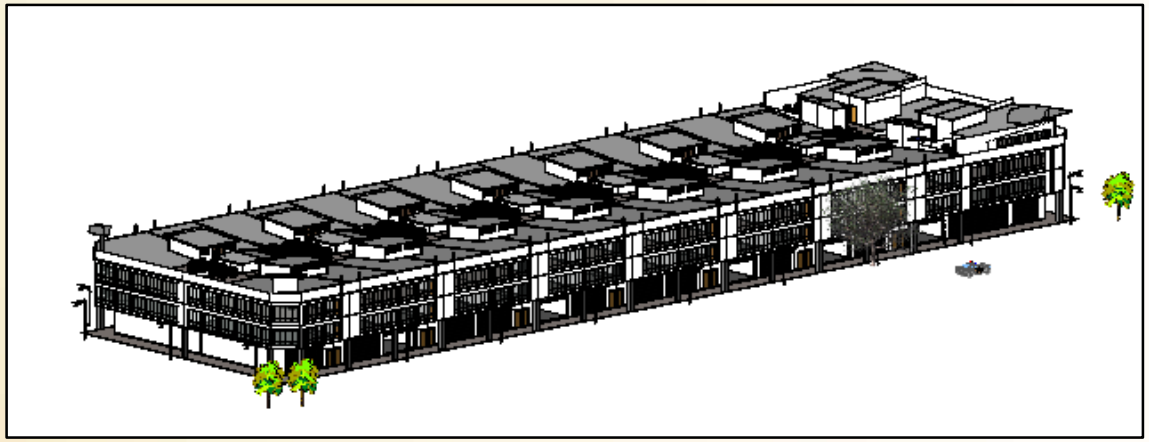


Site Measurement (Power Generated by Solar PV)

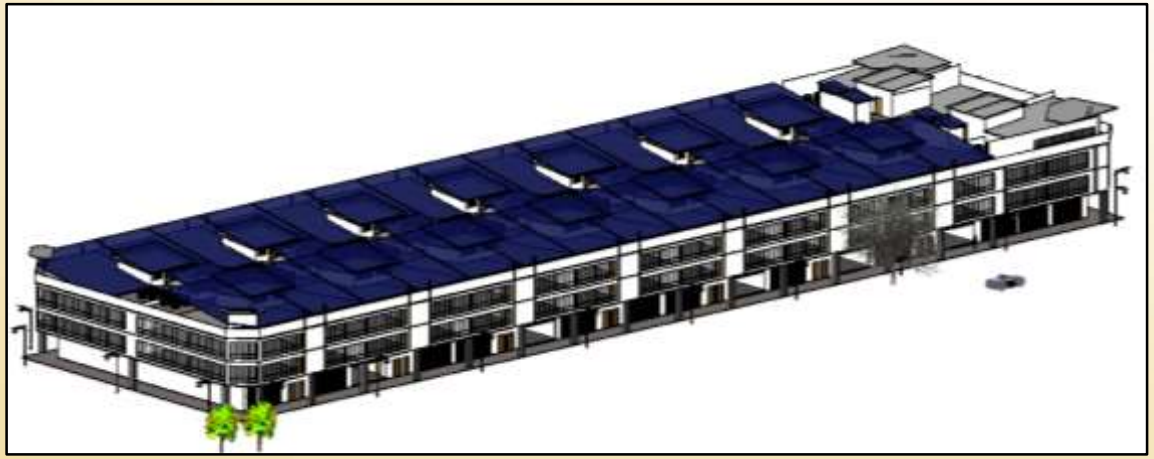
- In order to increase the accuracy of the data obtained, field testing was conducted where six solar panels were located at Padang Besar with the research duration of ten selected days within July 2017.

- Research location is at Padang Besar which lies within the latitude of 6°38′58″ N and longitude of 100°15′23″ E. The building studied is a 3 storeys commercial building at UniCITI ALAM, Padang Besar, Perlis.

Solar Insolation Analysis by using BIM Software

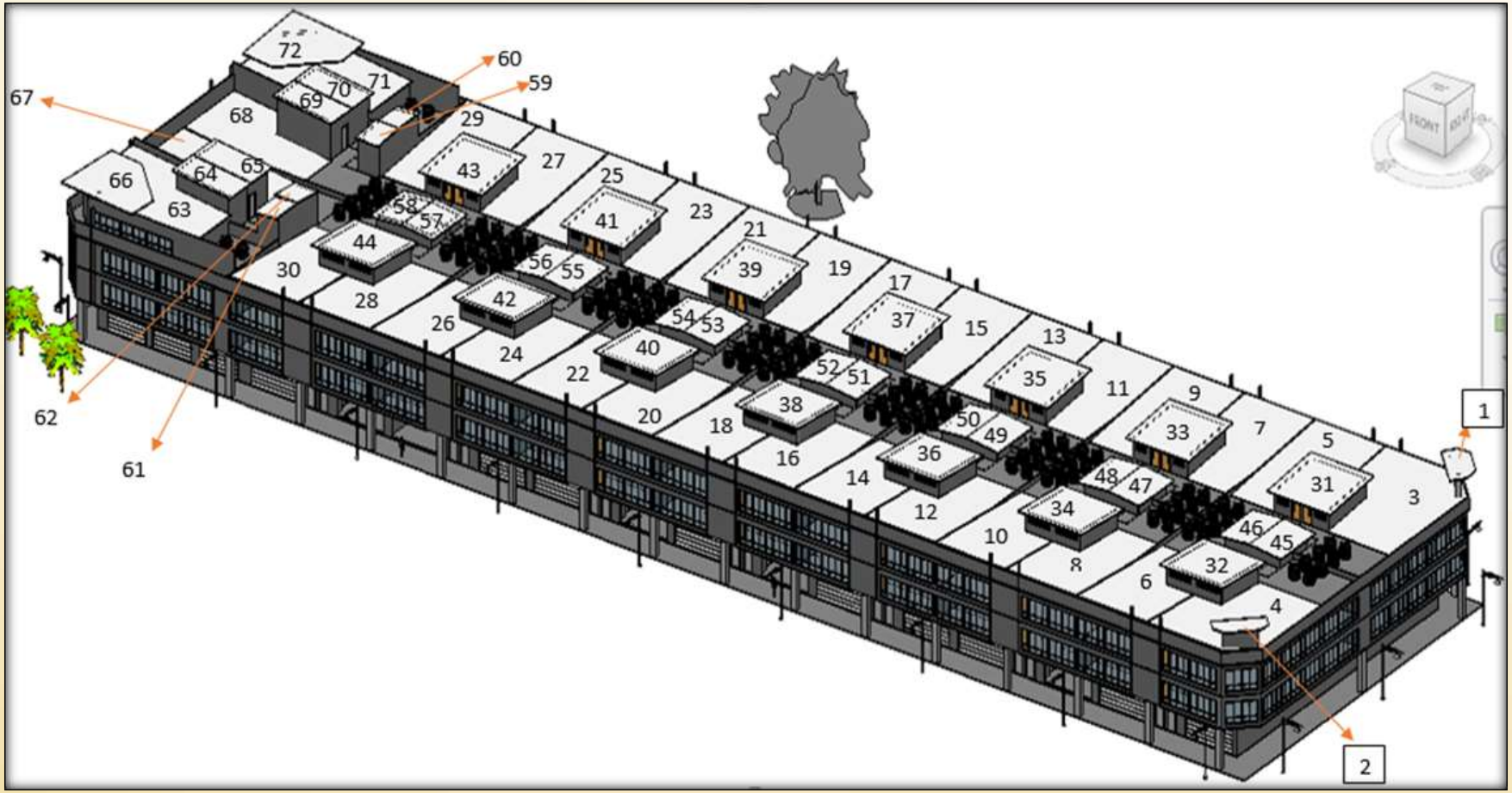


First model: Existing roof design of the building studied.



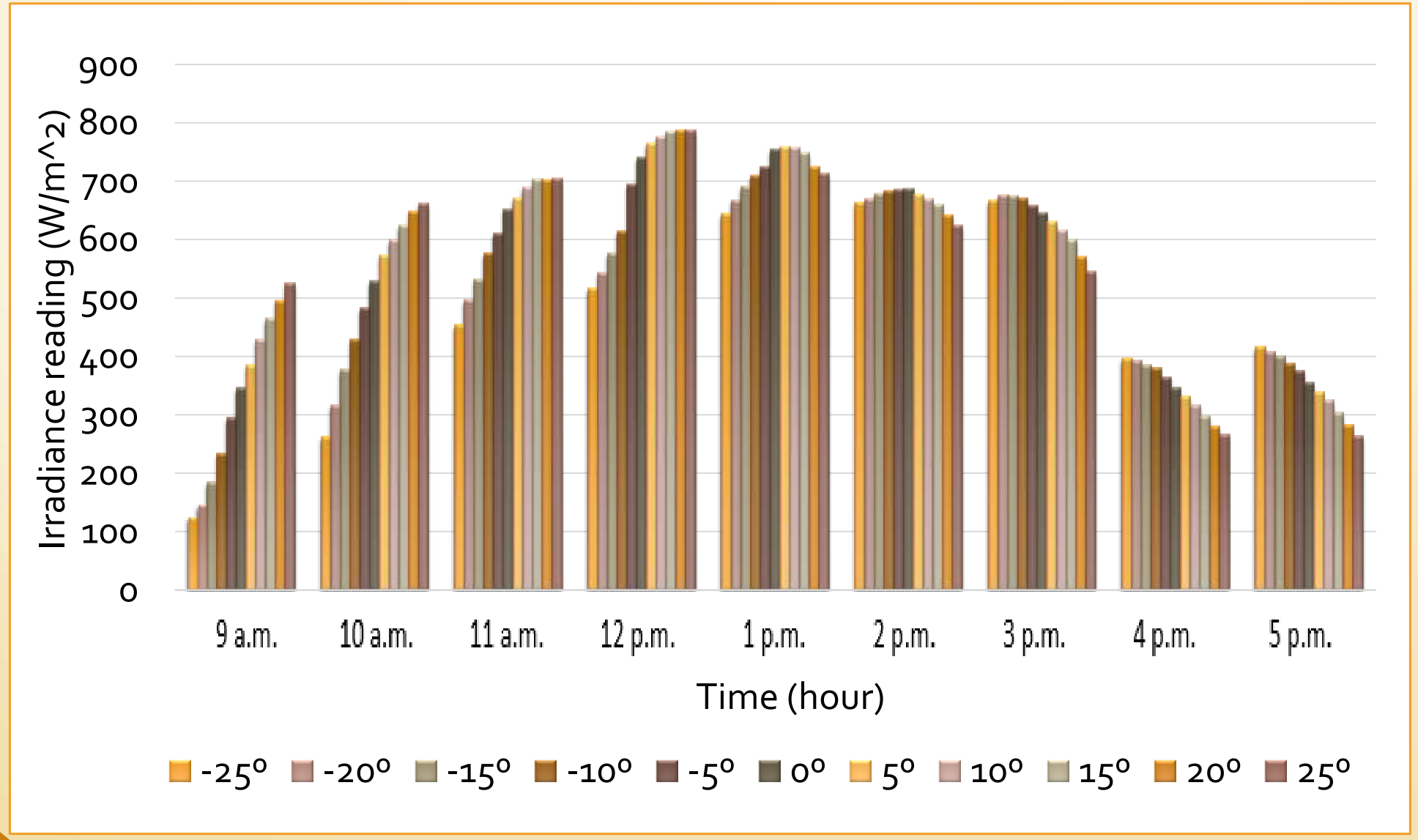
Second model: Roof design based on the best tilt angle and orientation of PV panel obtained from field testing.

Solar Insolation Analysis by using BIM Software

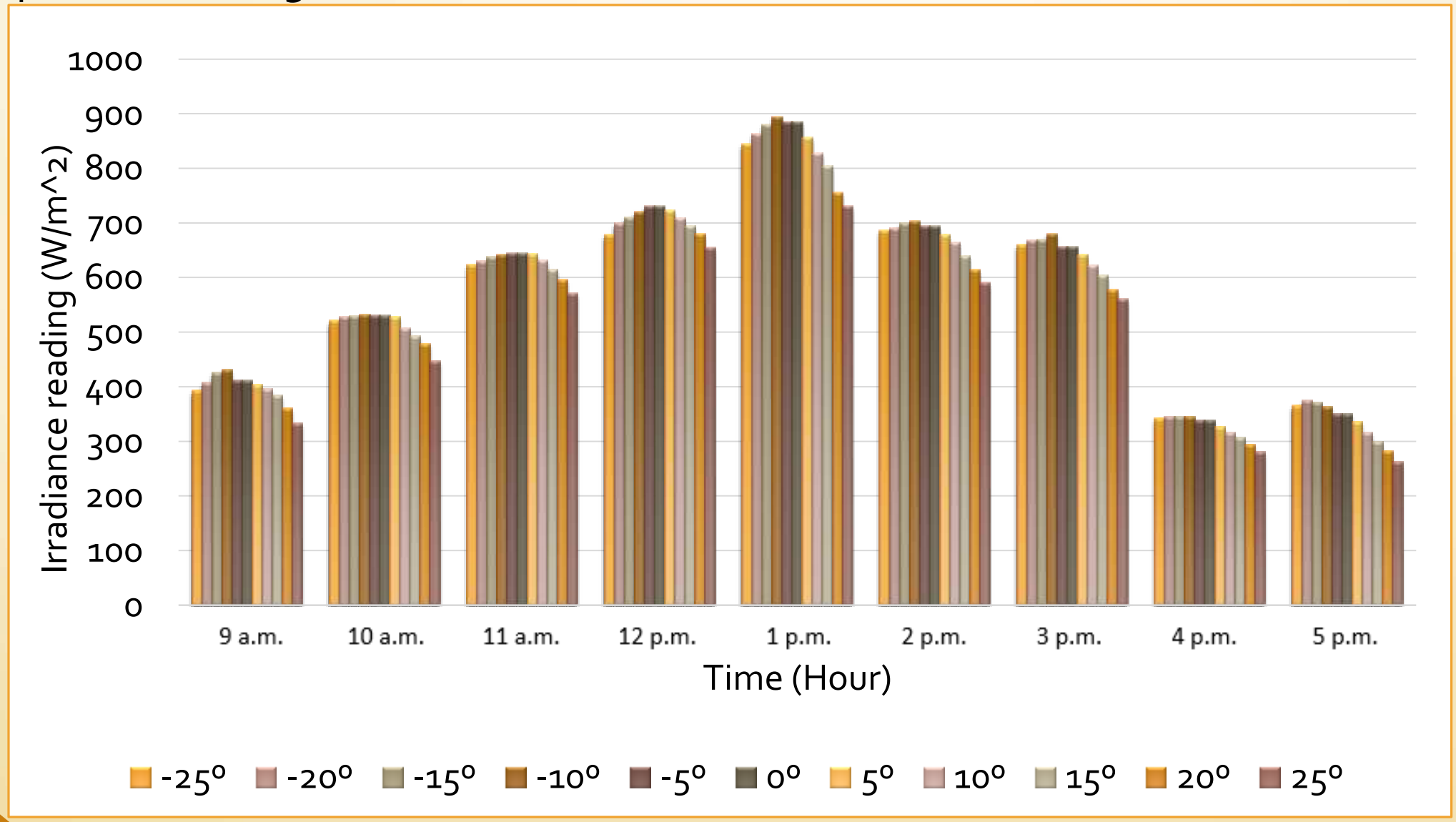


Results and Discussion

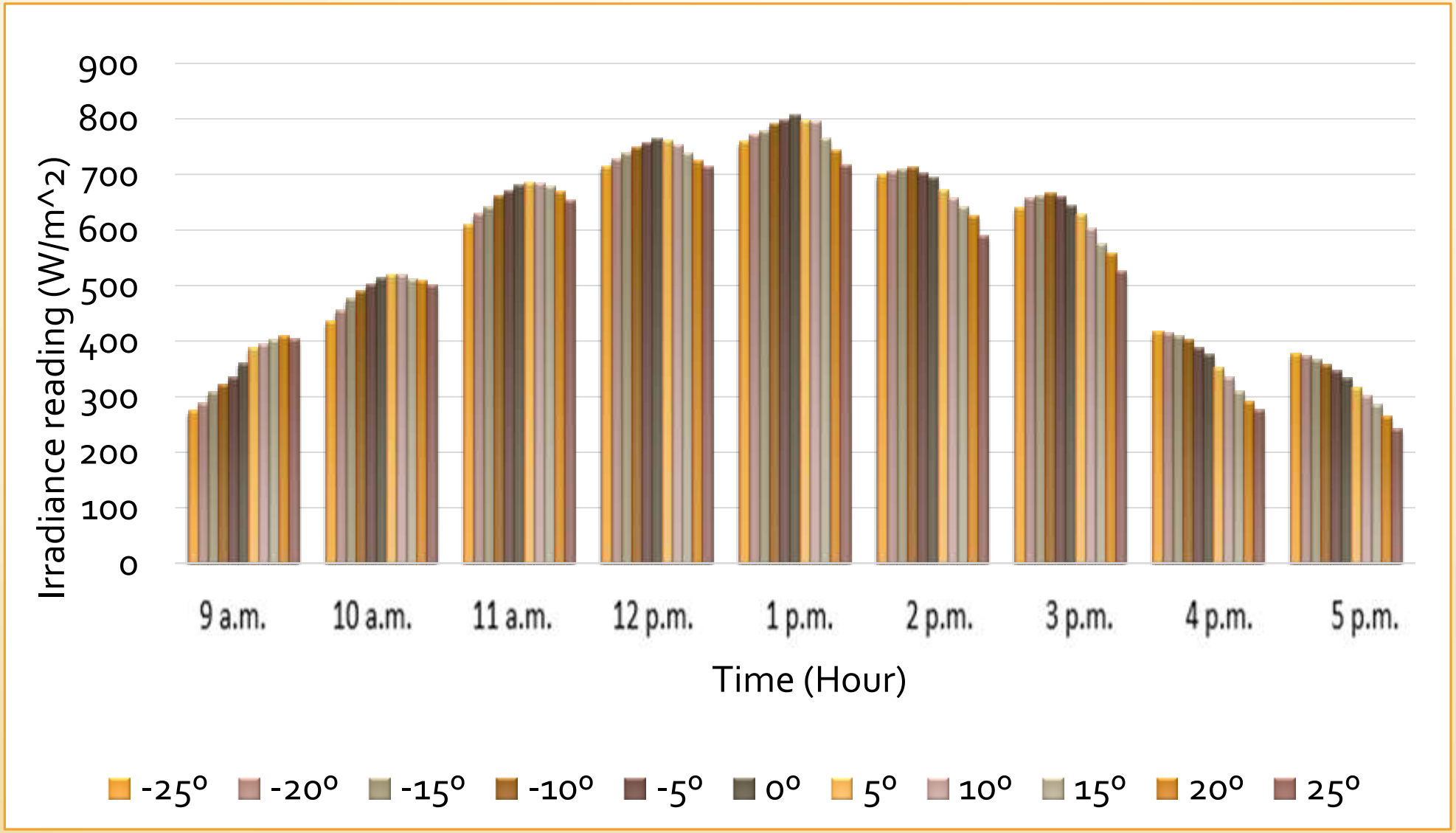
The average readings of solar irradiance (W/m^2) with different tilt angle, ove the field testing period with the orientation of North 70° East for positive tilt angle.



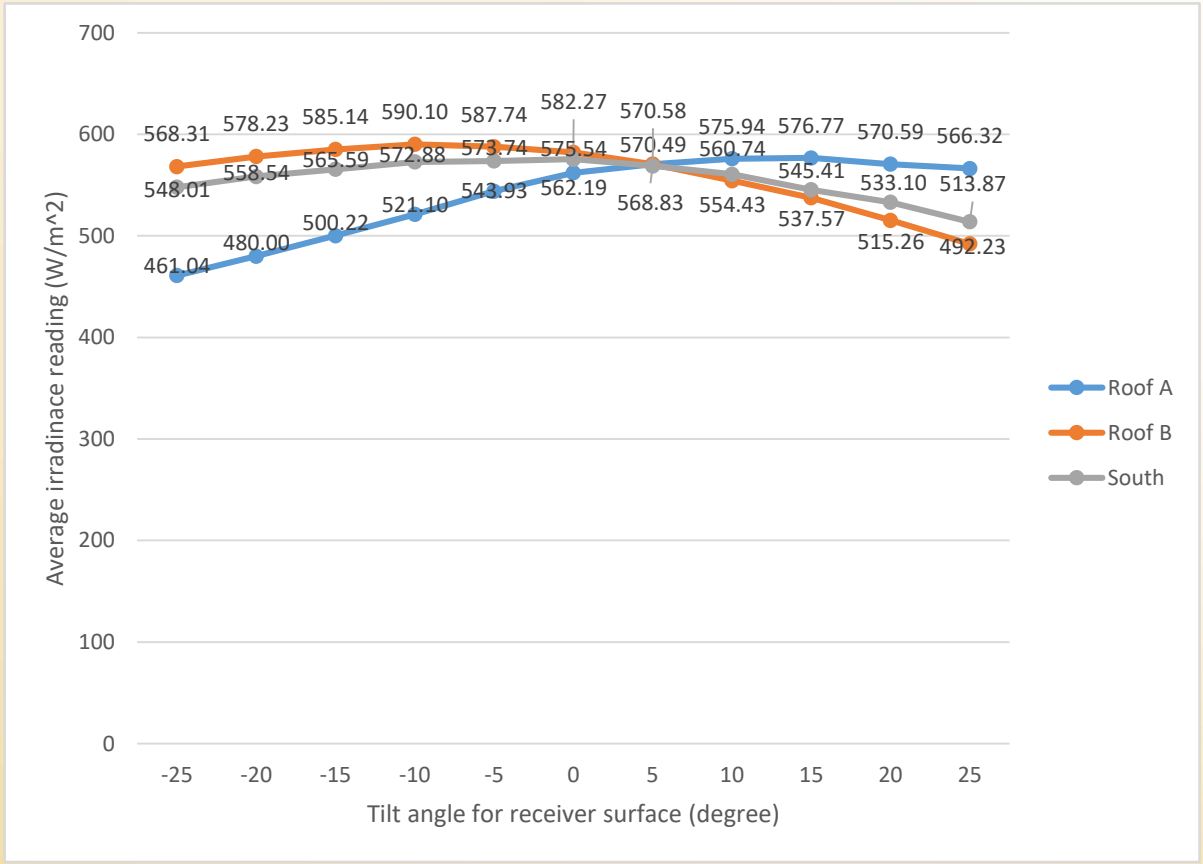
The average readings of solar irradiance (W/m^2) with different tilt angle, over the field testing period with the orientation of South 20° East for positive tilt angle.



The average readings of solar irradiance (W/m^2) with different tilt angle, over the field testing period with the orientation of South.

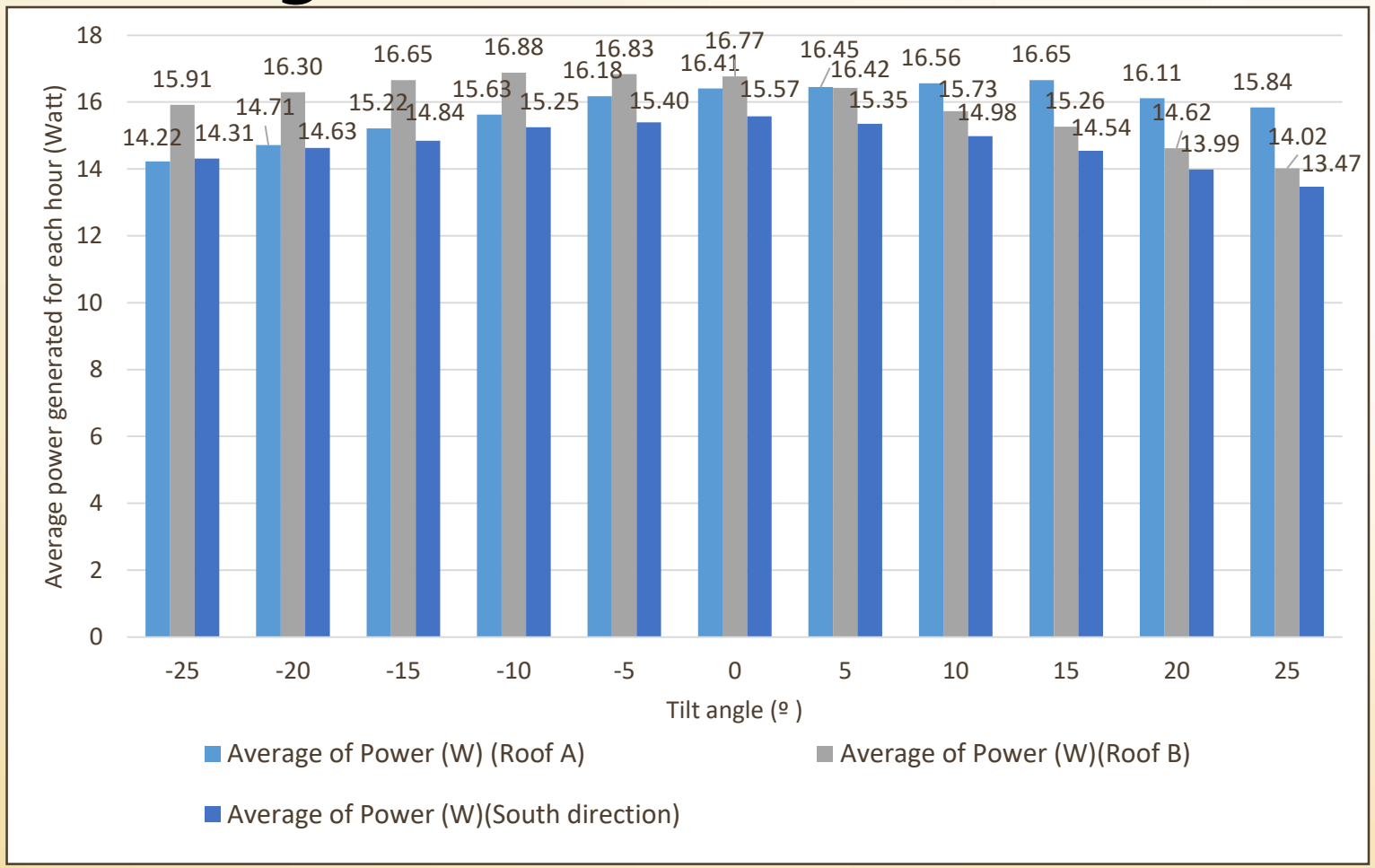


Comparison of average solar irradiance for each tilt angle and orientation.



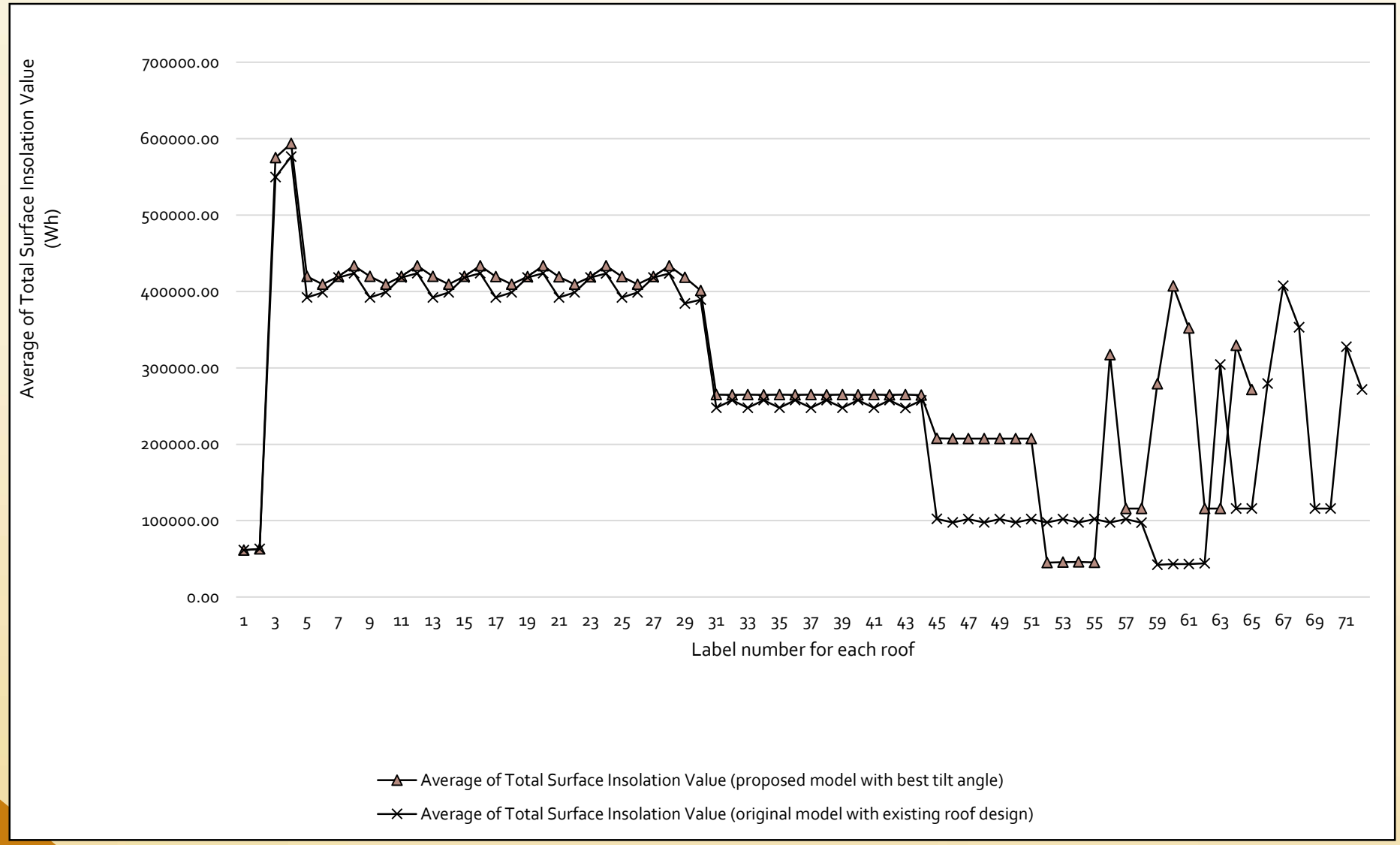
- Highest solar irradiance amount received
  - -10degree for Roof B facing
  - 0 degree for South facing
  - +15 degree for Roof A facing
- Maximum amount of solar irradiance
  - -10 degree of solar panel with facing
  - of Roof B

Comparison of average output power for each tilt angle and orientation.



- Different tilt angle of PV panel enable different amount of solar radiation to hit perpendicular on PV panel's surface.
- Highest amount of power generated is 16.88 Watt by -10 degree tilt angle of Roof B facing.

Comparison of total surface insolation amount among original model with proposed roof model



Conclusion

- Tilt angle and orientation of solar panels plays an important role in contributing variation in term of solar irradiance exposure and followed by the power generated by a PV panel.
- Best tilt angle of PV panel to be installed is -10° with orientation, facing South 20° East for positive tilt angle on July 2017 at the building studied.
- Maximum amount of solar irradiance is attained at 1 p.m. at research location and reduction of solar irradiance received increased as the differences between tilt angle and best tilt angle increased.
- Proposed model generated with the aid of BIM software indicates that, solar insolation exposure on the roof, increased 14.4% compared to the existing roof design.


THANKYOU