

Challenge exercise

Incorporate solar panels into a design and run a solar energy analysis in Forma Site Design

It is time to revisit our small boutique hotel and coffee shop that are in various locations across the planet again (see Module 1 Challenge Exercise, *Build an initial site layout in Forma Site Design with coasts, hotels, and coffee shops*). Or, if you are diving directly into this challenge exercise, then you will need to select one of the following locations for your site:

- **Busan** (South Korea): Coastal culture and cliffside temples and serious coffee culture throughout the local villages. The exact location is: 442C+GP Busan (latitude and longitude: 35.1011188, 129.1218062), South Korea (the bus stop will now be part of the coffee shop on the lower level. **Note** – use the latitude and longitude to set up this project, the address is a bit unreliable.
- **Muscat** (Oman): Close to Dubai, without the intensity of city, this location stays closer to the historic typology of the souq (markets) with authenticity creating a more intimate port city. The exact location is: JF98+8P Muscat, Oman (latitude and longitude: 23.6182818, 58.4667976). **Note** – use the latitude and longitude to set up this project, the address is a bit unreliable.
- **Whittier, Alaska** (United States): This is a location for cruise ship tourists heading to the Alaskan Railroad, but too often missed are the waterfalls, glaciers, and marine life of Prince William Sound. The exact location is: latitude and longitude: 60.7746516, -148.6893170.

The building will have a footprint of around 4,000 sq ft (375 M²) with 4-5 levels total, with an exterior park on the ground level and a viewing deck on any of the upper levels.

One common feature of each location is the type of tourist that is visiting these locations – the eco-tourist. This user type is willing to pay a premium for the knowledge that their explorations are as close to environmentally benign as possible. As such, one feature of each hotel and coffee shop is to operate with the lowest amount of energy possible. Design a solar panel system on one of the sites provided that will generate enough energy to power the entire facility given the following energy use estimates:

- 15 kWh per square foot for Whittier

- 20 kWh per square foot for Muscat
- 18.5 kWh per square foot for Busan

Complete the required activities:

1. Run the solar energy analysis simulation, and resolve the following questions:



Figure 1. Solar Energy Analysis - Whittier

- How many square feet of solar panels would be required to power:
 - The entire hotel?
 - 50% of the needed hotel power?
 - What is the percentage of power that can be generated by solar panels on the roof of your design proposal?
2. Design a site layout that expands your solar panels across the site to power at least 30% of the building. Note that you will need to rerun the solar energy analysis each time you create a design proposal. If a proposed area for solar panels is in the shade for half of the day, it will not create the same amount of energy as the solar panels on the roof. Propose a solution, then verify it with the simulation!

Hint: once you have your solar energy analysis completed, find the power created per square foot by the solar panels. Compare this with the overall annual kWh of your design proposal.

Key equations to understand:

Total annual building energy = kWh x square feet of design

Solar energy power per square foot of panel = Annual Electrical Output (kWh) / Panel Area (sf)

Area of panels needed = total annual building energy / kWh per square foot of panel

Grading Rubric:

	Advanced	Proficient	Basic	Emerging
Questions resolved	Well thought out response connecting design intent with data	Correct answers not implicitly tied to the design ideas.	Answers completed, but little to no application to the design	Answers are incomplete and/or incorrect
Is the data presented accurately	Accurate, applied, and presented with understanding	Completed, correct	Minor errors or missed interpretations	The data is either not completed, presented, nor available
Explanations provided with clarity (graphic and/or written)	Design ideas and design data are presented clearly and creatively	Clear responses and graphics	The information and graphics are presented, but not connected or composed	Incomplete or not legible
Creativity in the design solution	The site layout design is innovative, an appropriate response, and is informed by the data in Forma Site Design	The site layout is appropriate, but the connection to the simulation data is not clear	Quality design, but not connected to the simulation data created by Forma	The site layout design proposal does not meet the design criteria