4.401/4.464 Environmental Technologies in Buildings – Assignment 4

Instructor:	Christoph Reinhart
Due Date:	Friday of week 5
Type:	This is an individual assignment.

Designing a PV System

During assignment 1 you determined how much electricity you have used at some point in your life living in an apartment or house. In this assignment you are going to design a PV system that yields the same amount of electricity over the course of a year and calculate the simple payback time required to get your investment back. The assignment is broken into three parts.

1. Use annual radiation maps of your building and its surroundings to place and orient 1x1.5m^2 panels on the roof, façades or in the garden of your building. Overall system yield should approximate your annual electricity use from assignment 1.
2. Once the PV panels are in place, use DIVA4 (GH tutorial #07) to calculate the actual monthly electricity yield of your system.
3. Calculate total costs and payback for the PV system.

Task 1 PV system placement and preliminary electricity yield calculation

Using radiation maps in DIVA4, visualize the annual solar radiation falling onto your panels (Fig 1) and verify that no partial shading occurs on Dec 21st at noon (Fig 2). An example radiation map in Anchorage is shown below. Estimate the annual AC electricity gain assuming a panel efficiency of 18% and an inverter efficiency of 96%.

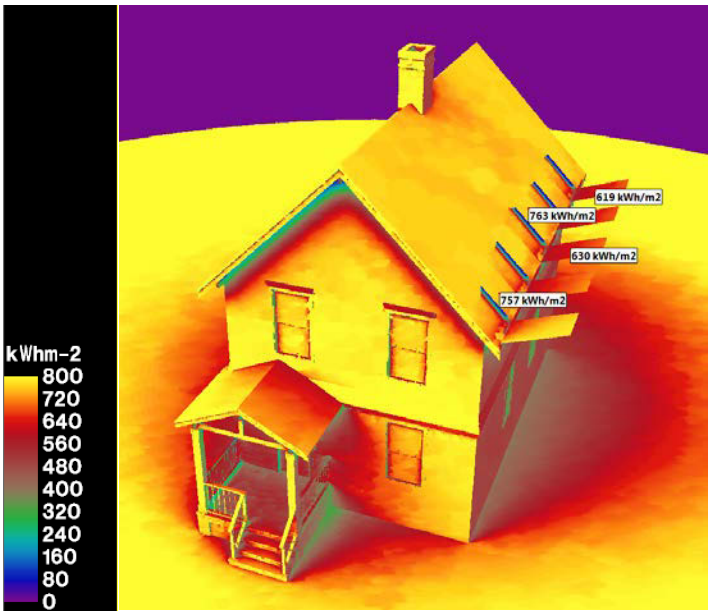

Fig 1 DIVA/Radiance radiation map of the "design albatross" with 10 PV panels

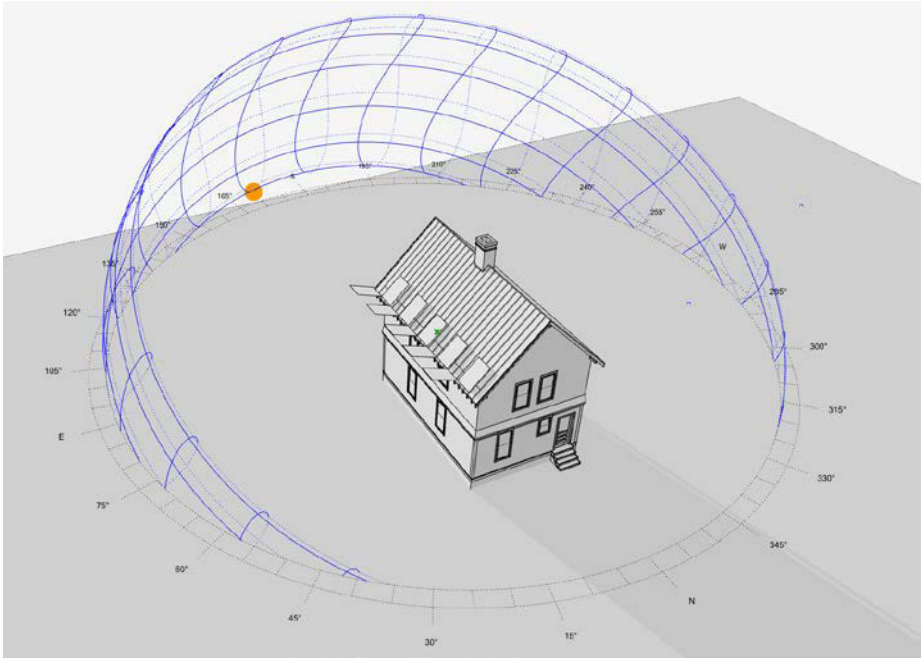

Fig 2 DIVA Visualization of direct shading on Dec. 21, 12pm, in Anchorage

Task 2 DIVA4/Archsim Simulation

Once you are satisfied with your PV system design, model the monthly electricity gain in DIVA4/Archsim and report the results in a figure similarly to Fig 3. Comment on your

findings. (Remember, 1J = 1/3600000 kWh). Please pay attention to the orientation of the surfaces in Rhino. (You can identify the surface orientation in Rhino using the "dir" command. "flip" changes the orientation.)

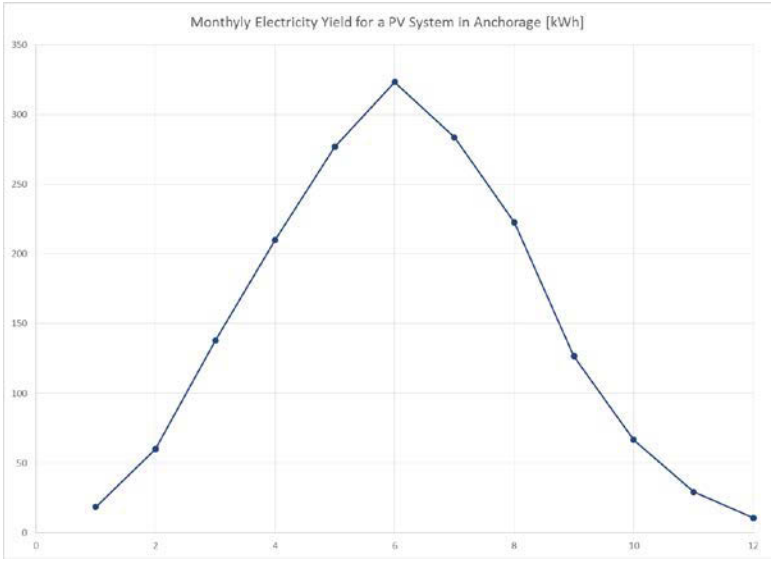

Fig 3 Monthly electricity yield of the PV system based on DIVA4/Archsim

Task 3 Financial Analysis

Calculate the simple payback time for your PV system. Each panel has a peak efficiency of 294W_p. Installed system costs are \$US 3.50/W_p. Massachusetts provides you with a onetime State Tax Break of \$1000 for the overall system. The Federal government further offers a tax break over 30% of the total system price. You are welcome to either use the above incentives for Massachusetts, even if your building is located in a different jurisdiction, or you research the actual incentives for your particular situation.

In terms of payback, you simply save \$0.18 for every kWh that you generate and feed back into the grid (as long as you are not surpassing your own energy use). You will further receive a Solar Renewable Energy Certificate (SREC) of \$0.285 for every kWh that you feed back into the grid. Can you reduce your electricity bill to zero? How long will it take for your PV system to pay for itself?

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