Passive + Active: Batteries, Resilience, and the Duck Curve

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CONTINUING EDUCATION AIA

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Course Description

As more and more buildings are incorporating on-site renewable energy systems, it's becoming increasingly important to understand how those soon-to-be-ubiquitous systems affect the current grid structure, and to develop strategies for integrating the new with the old. At Nuthatch Hollow, a research station for Binghamton University which is pursuing Living Building Challenge (LBC) and Passive House Certification, the project team is tackling this issue from two directions.

Starting with the "Passive" approach, the building is designed to meet the aggressive heating, cooling, and energy limitations of PHIUS +2015. The effects of these limitations are that a smaller PV system is needed, so there is less variability between supply, or generation, and demand; also, the tight envelope means the building can thermally coast through power outages, thereby requiring less emergency backup energy. These strategies are the foundation of a resilient design.

On the "Active" side, the project incorporates a PV array on the roof, which will be sized to supply 105% of the project's net annual energy needs, a Living Building Challenge requirement, along with a battery storage system, all of which is designed to be a self-sufficient system, although is grid-tied for flexibility. Battery selection is important to the function of the system and is limited by the strict Red-List chemical compliance required by LBC. Two other critical considerations are the size of the battery itself: too small and the system fails, too large and it isn't cost effective, and the control system for the battery to optimize discharge to power the building. Calculations for sizing the battery derive from the size of the PV system along with the local demand. The control optimization is dictated by the development of an algorithm to take project specific operation into account. Variability in timing and quantity of peak energy supply to grid systems and peak demand from them can wreak havoc on utility grids, a phenomenon referred to as the "Duck Curve" by the California Independent System Operator. Because of this, some utilities offer minimal, if any, incentives for property owners to sell back excess energy, making battery storage a more attractive option, which helps to actually smooth out the generation/demand variability at the individual property. This smoothing reduces the utility fees related to peak demand, which will contribute to a shortened payback period. Also, batteries can make PV effective as an emergency power source during grid outages, where otherwise the instability of energy generated by PV makes it unusable in meeting the required loads effectively as a direct connection.

By designing the envelope and building systems to use very little energy from the beginning, and then applying a small on-site PV system, grid-tied and connected to appropriately sized battery storage, the project achieves increased resilience and decreased strain on the existing grid in a cost effective way, making this a replicable strategy for future projects looking to get to zero, or positive, without negative impacts to existing infrastructure.

Learning Objectives

At the end of the this course, participants will be able to:

1. Understand the compound benefits of building active energy production strategies over a passive energy use reduction foundation.

2. Understand the "Duck Curve" and the impact of grid-tied, site generated power across the utility grid.

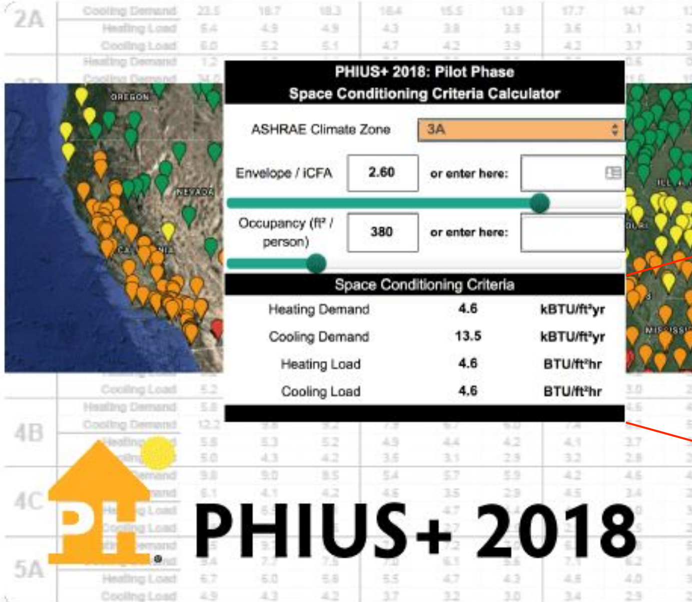
3. Understand the basics of PV battery systems, selection and sizing.

4. Understand how the battery control system can be optimized.

AGENDA

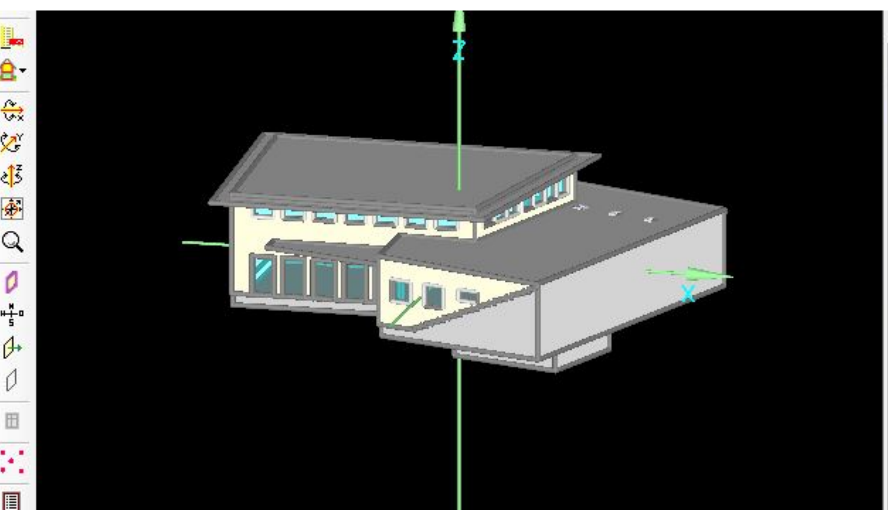
- Project
- Envelope Strategies
- MEP Strategies
- Energy Generation and Storage
- Questions

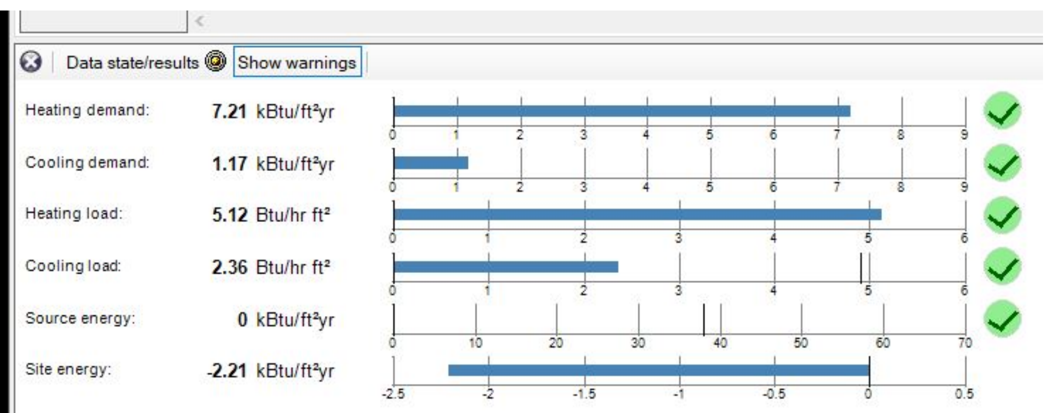

SUPPORT
MULTI-
PURPOSE
LAB
SUPPORT



Space Conditioning Criteria		
Heating Demand	9.5	kBTU/ft²yr
Cooling Demand	9.4	kBTU/ft²yr
Heating Load	6.7	BTU/ft²hr
Cooling Load	4.9	BTU/ft²hr

Source Energy: 34.8 KBTU/sf yr

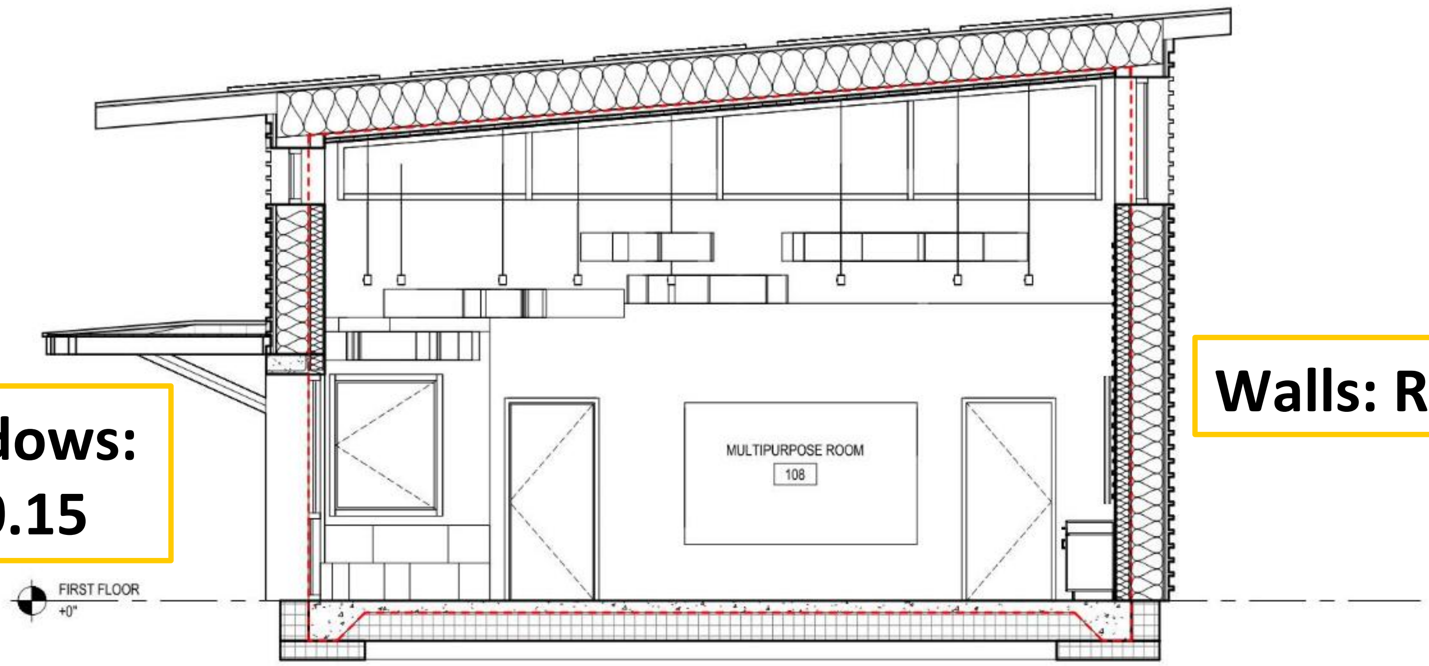




Roof: R-85/88

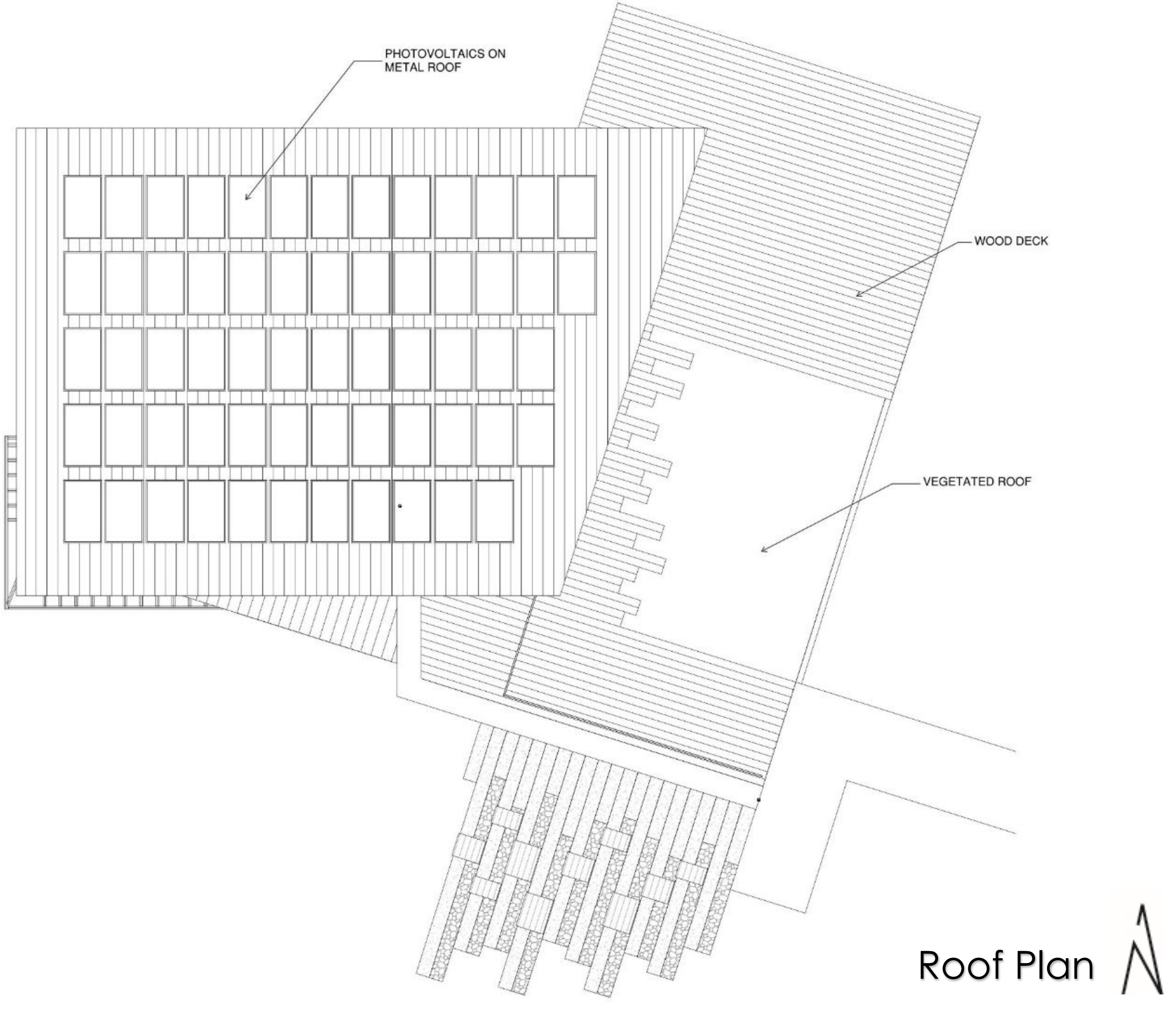
Windows: Uw 0.15

Walls: R-42/61



Slab: R-32

Below Grade Walls: R-34



Roof Plan

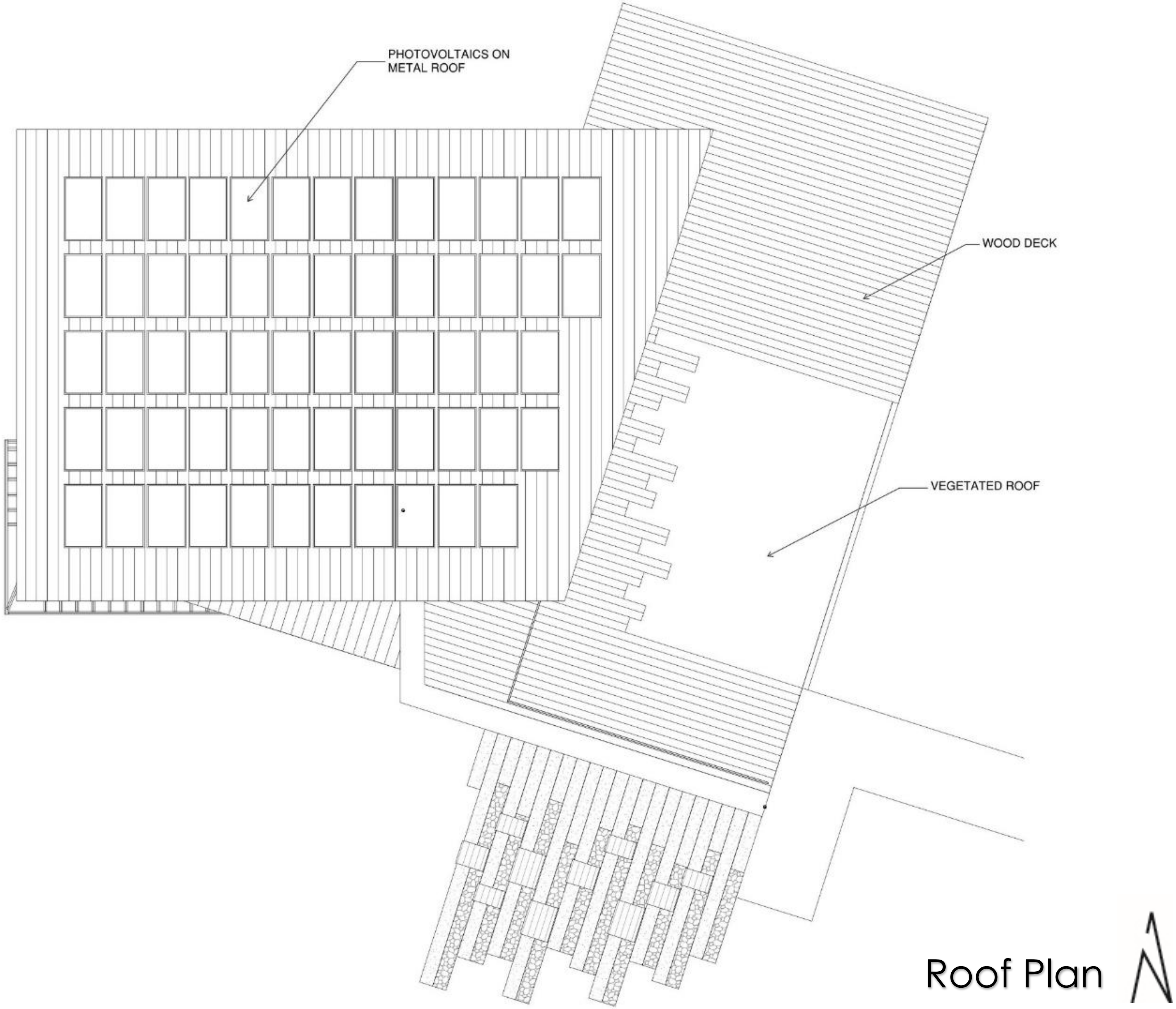
HVAC Systems

Minisplit – VRF

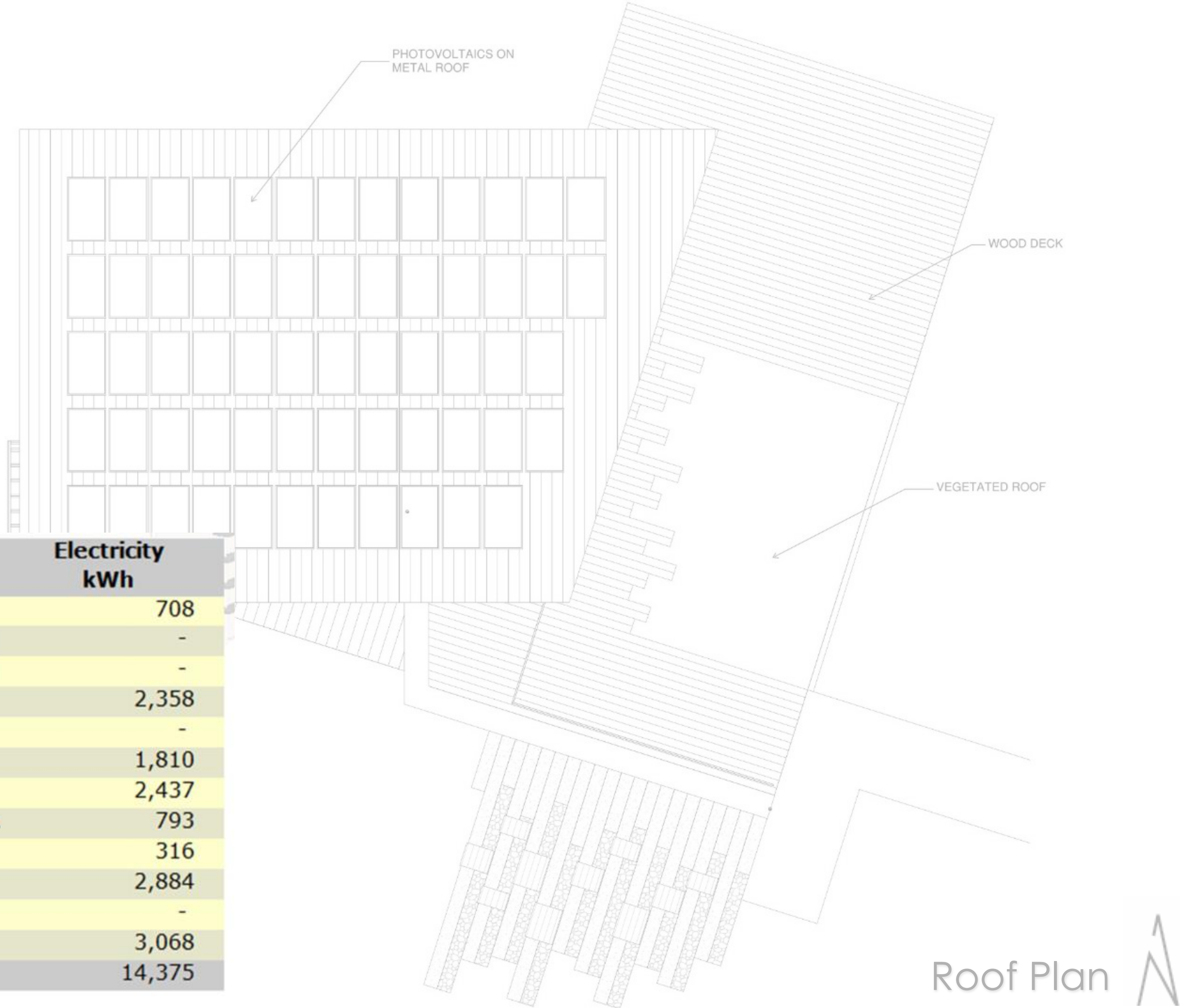
Ventilation with recovery – ERV

Composting toilets – HRV, need recovery, stop odors

Lighting reduction – daylighting

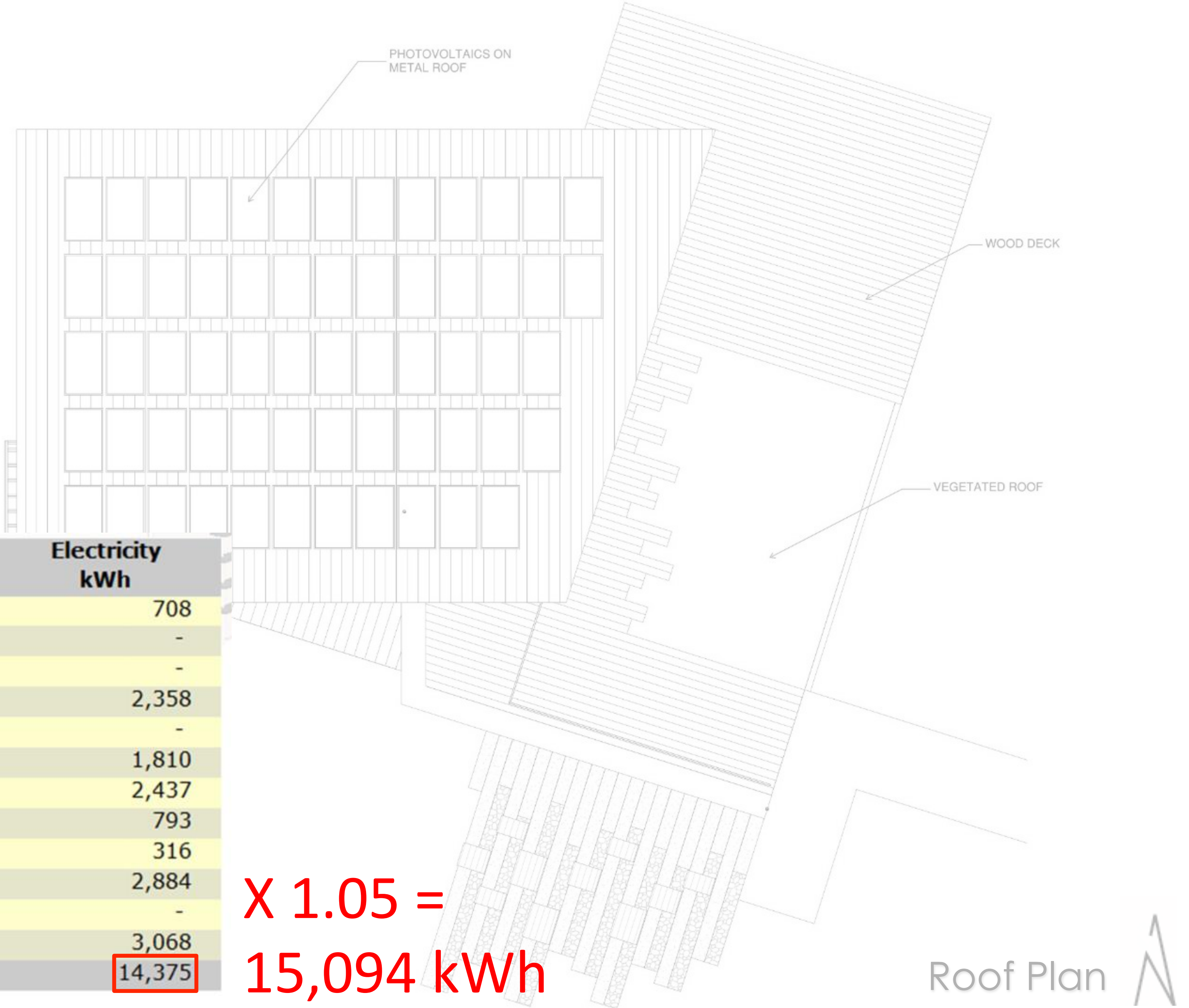


Roof Plan



	Electricity kWh
Space Cool	708
Heat Reject.	-
Refrigeration	-
Space Heat	2,358
HP Supp.	-
Hot Water	1,810
Vent. Fans	2,437
Pumps & Aux.	793
Ext. Usage	316
Misc. Equip.	2,884
Task Lights	-
Area Lights	3,068
Total	14,375

Roof Plan



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X 1.05 =

15,094 kWh

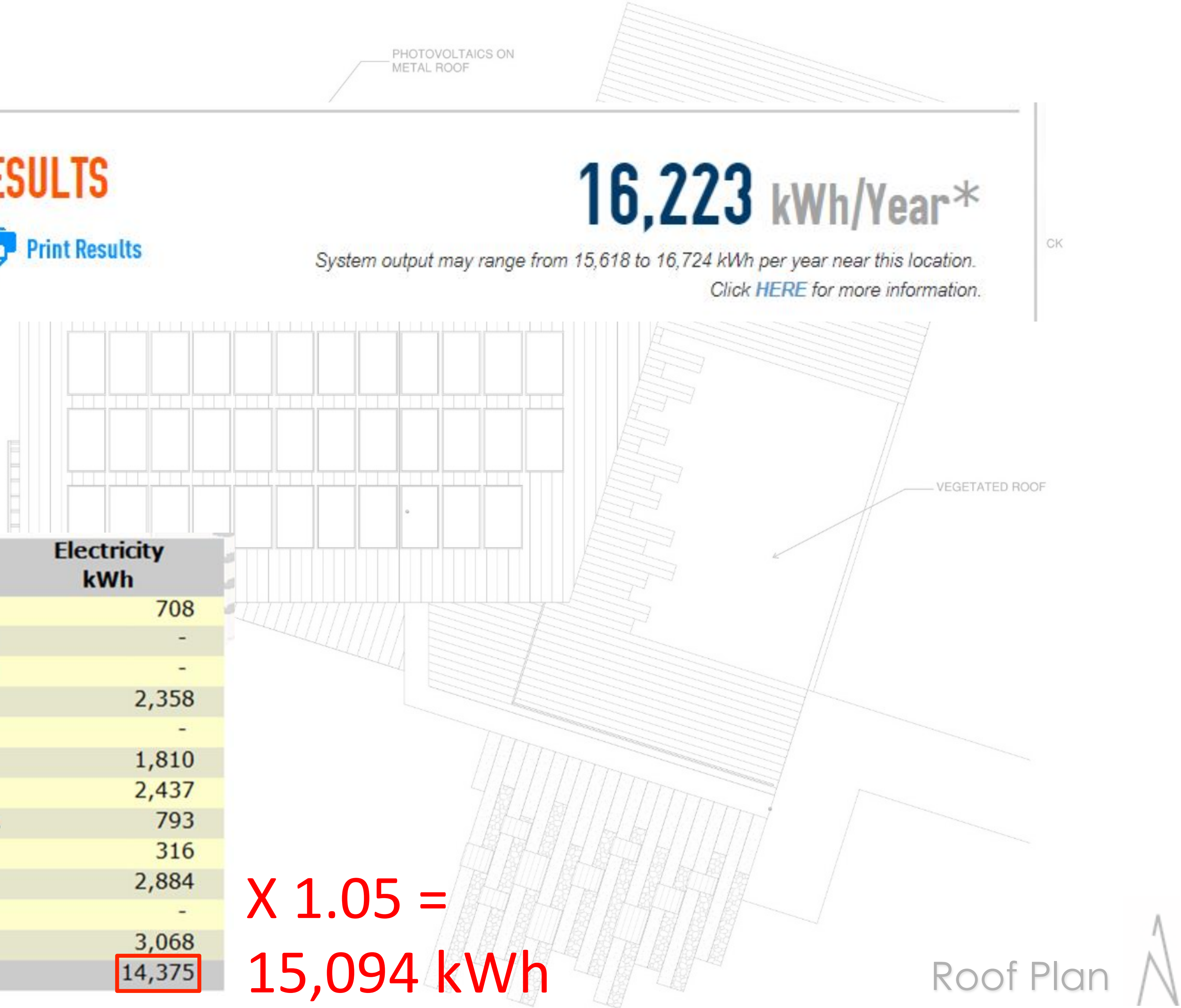
Roof Plan

RESULTS

Print Results

16,223 kWh/Year*

System output may range from 15,618 to 16,724 kWh per year near this location.
Click HERE for more information.



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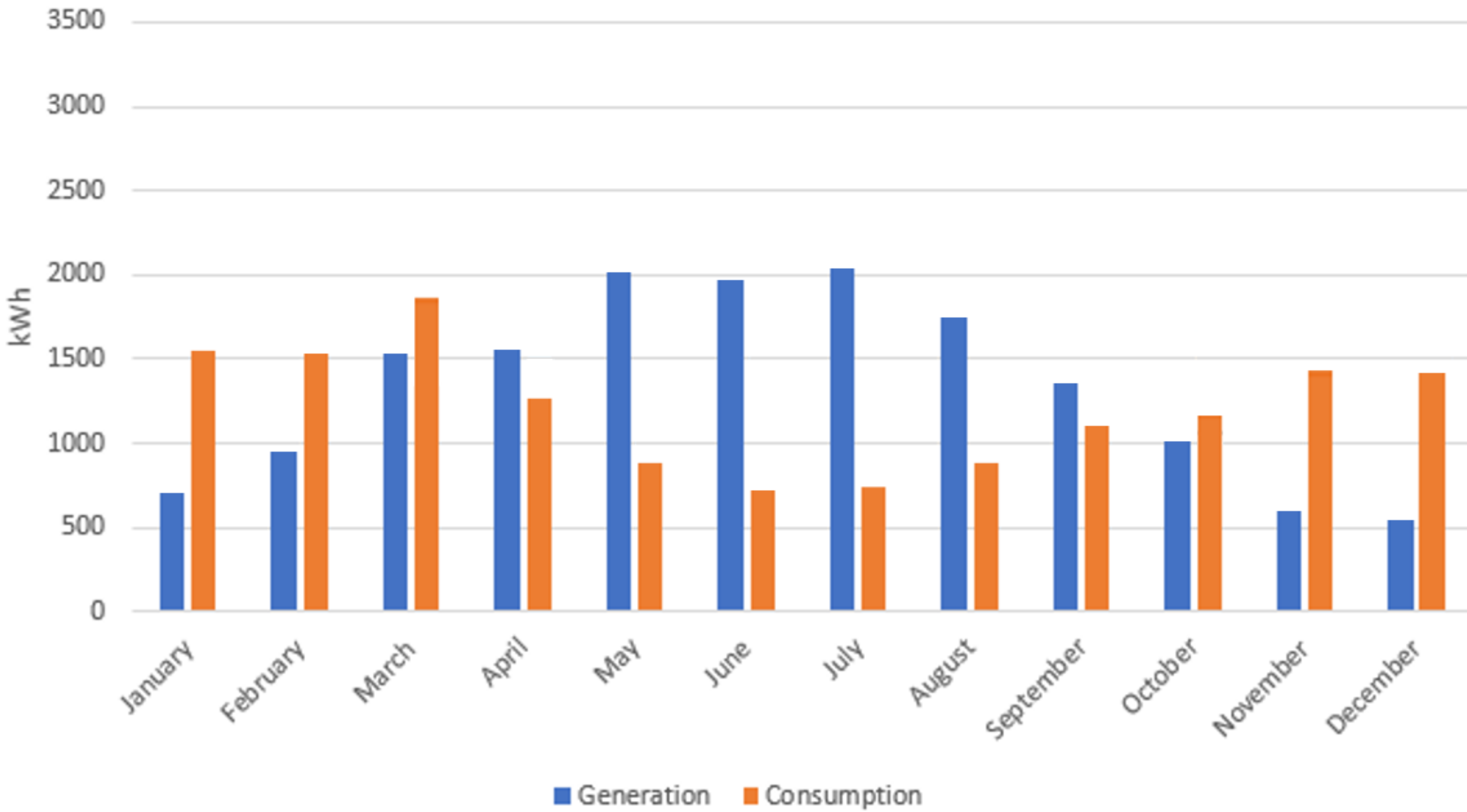

Source: PV Watts Calculator, 15kW array in Binghamton

Source: Equest Energy Model

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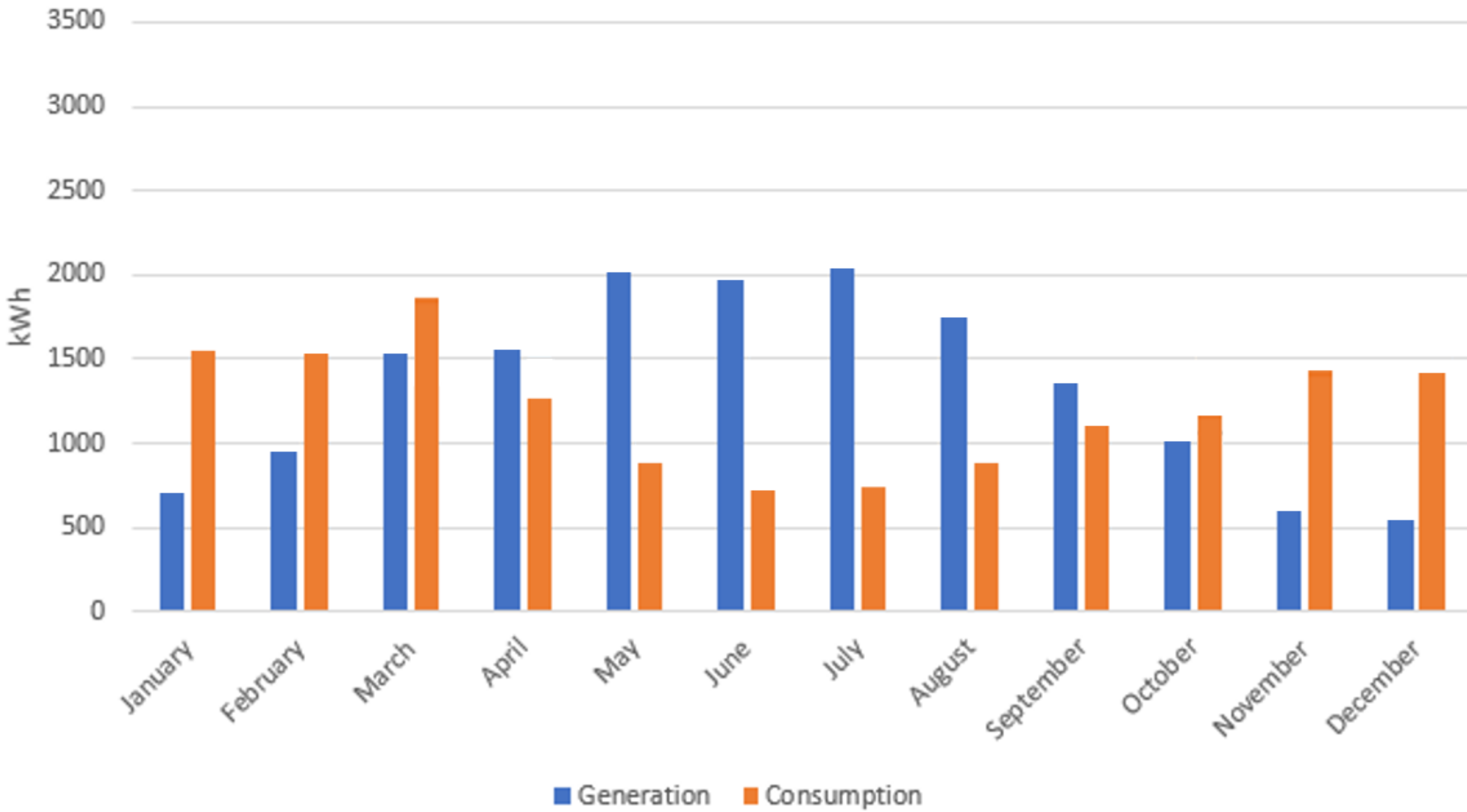
Average week =

Busy week = 90kWh

Battery = 10kW



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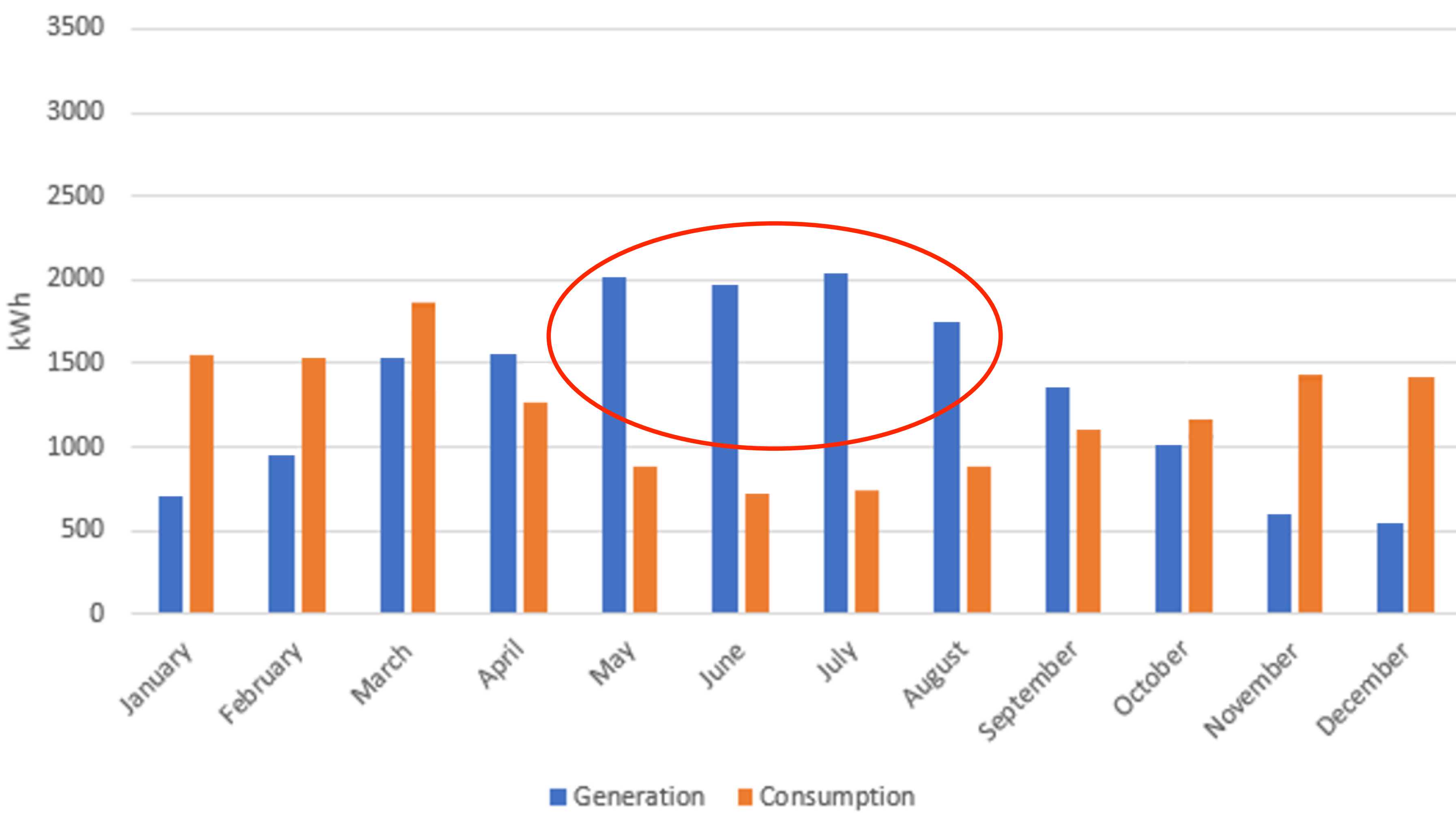

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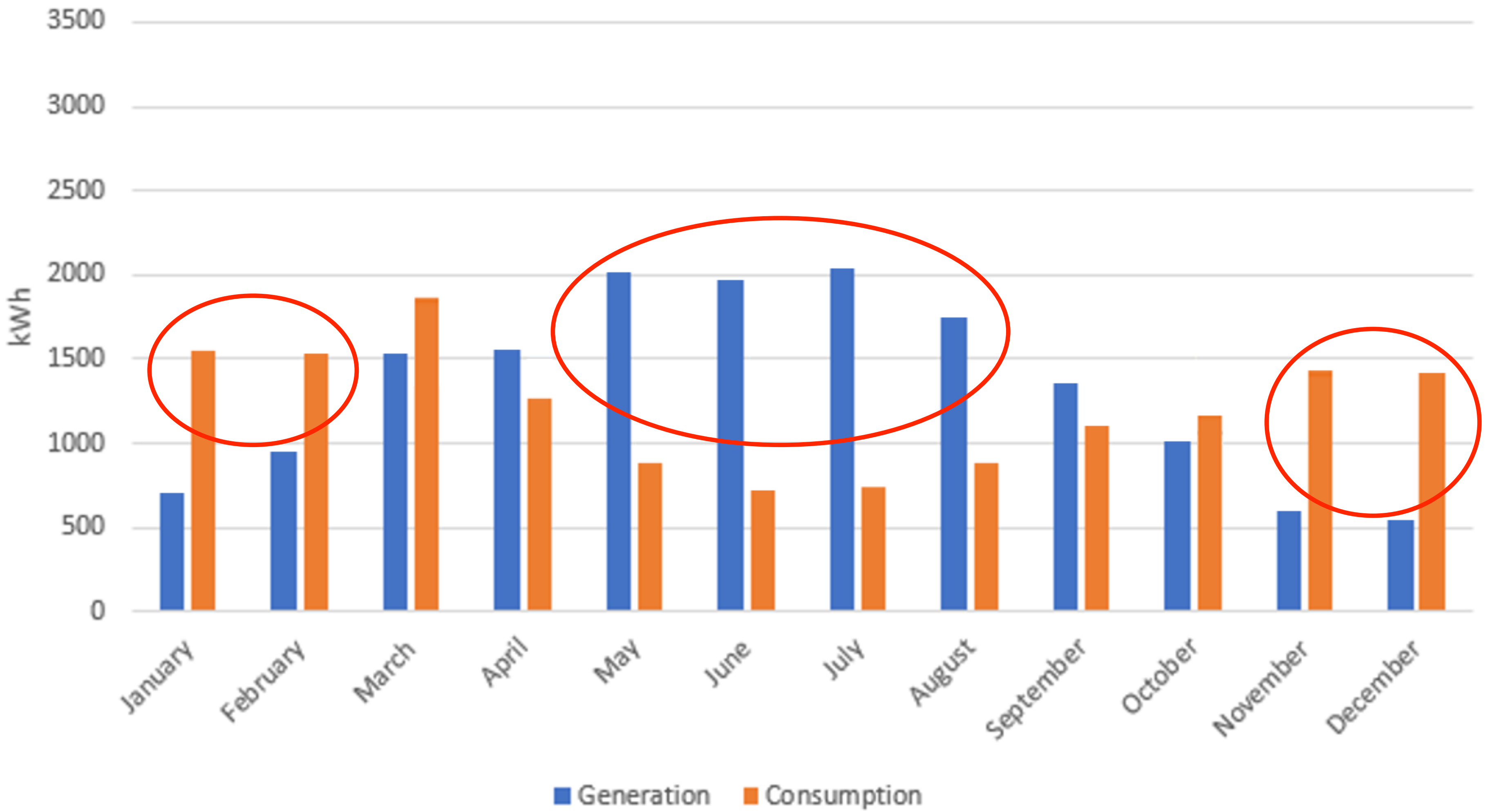

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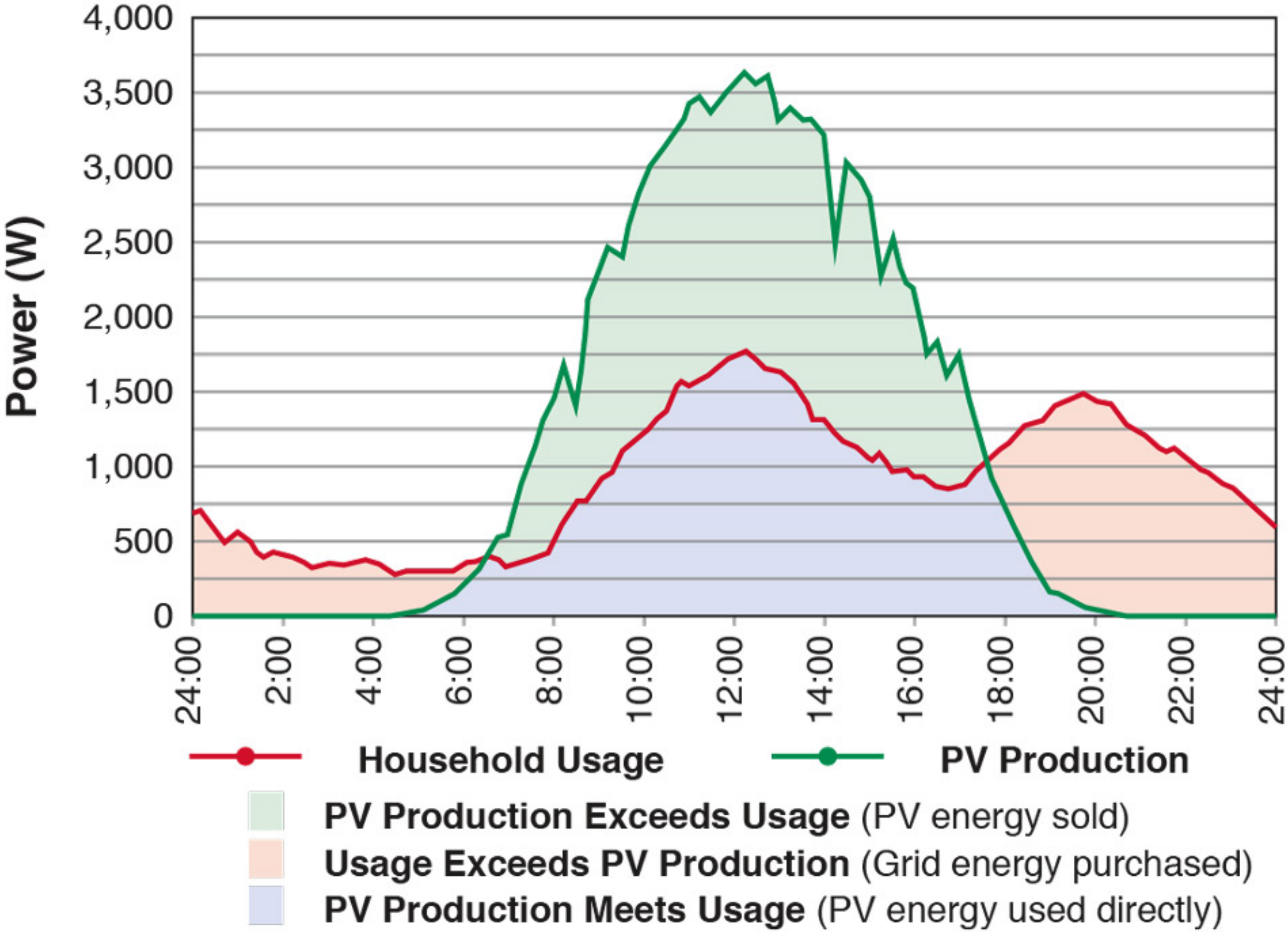
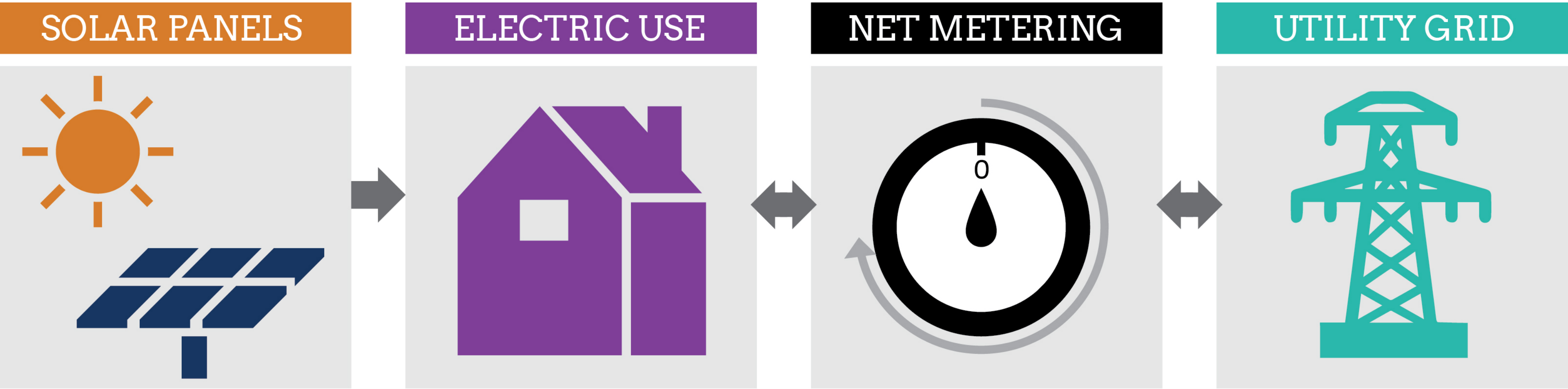
Example Daily PV Production vs. Loads




SOLAR PANELS
ELECTRIC USE
NET METERING
0
UTILITY GRID

QUESTIONS ?

This concludes The American Institute of Architects Continuing Education Systems Course