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Technology & Economic Impact of Solar Rooftops on Pennsylvania Warehouses

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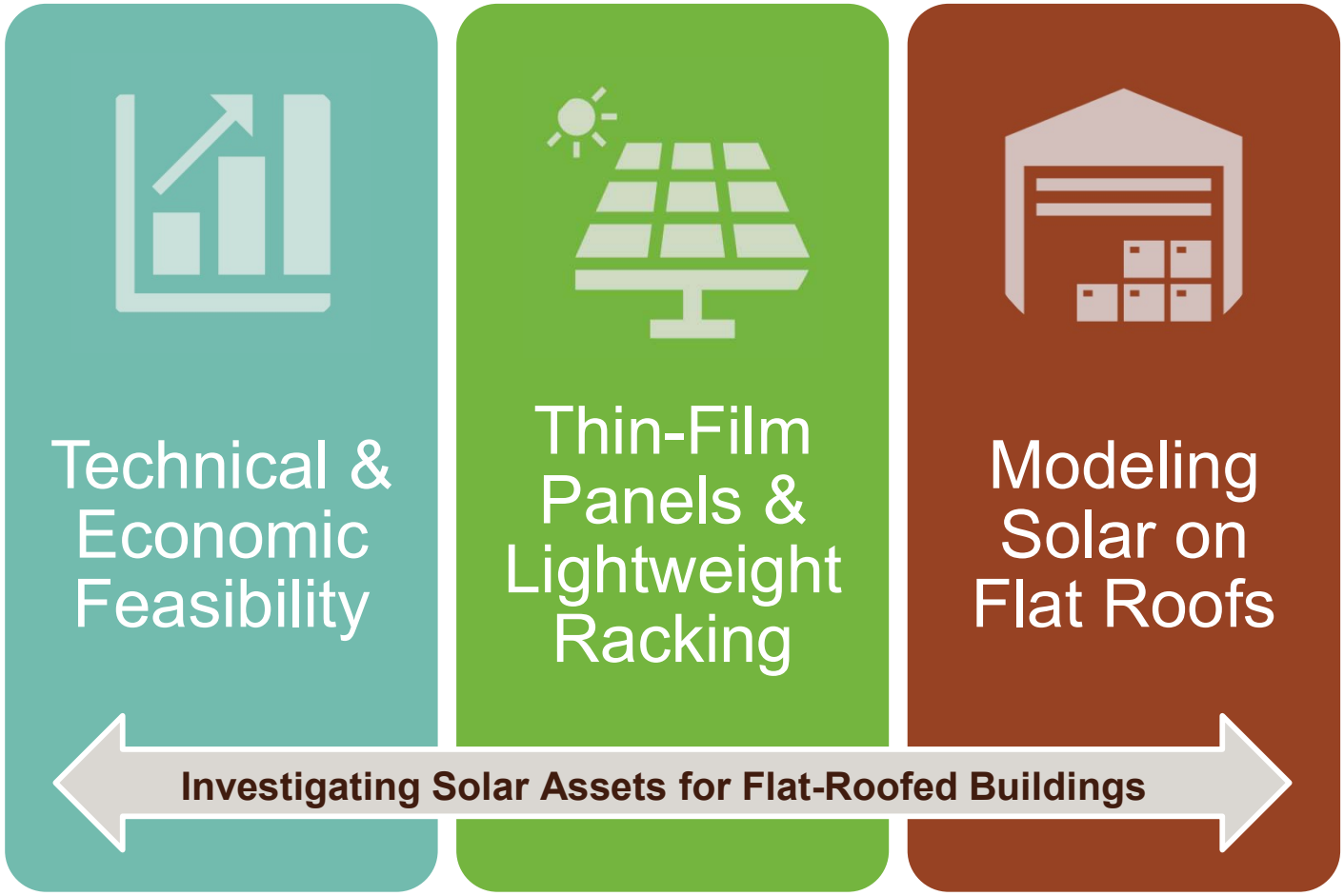

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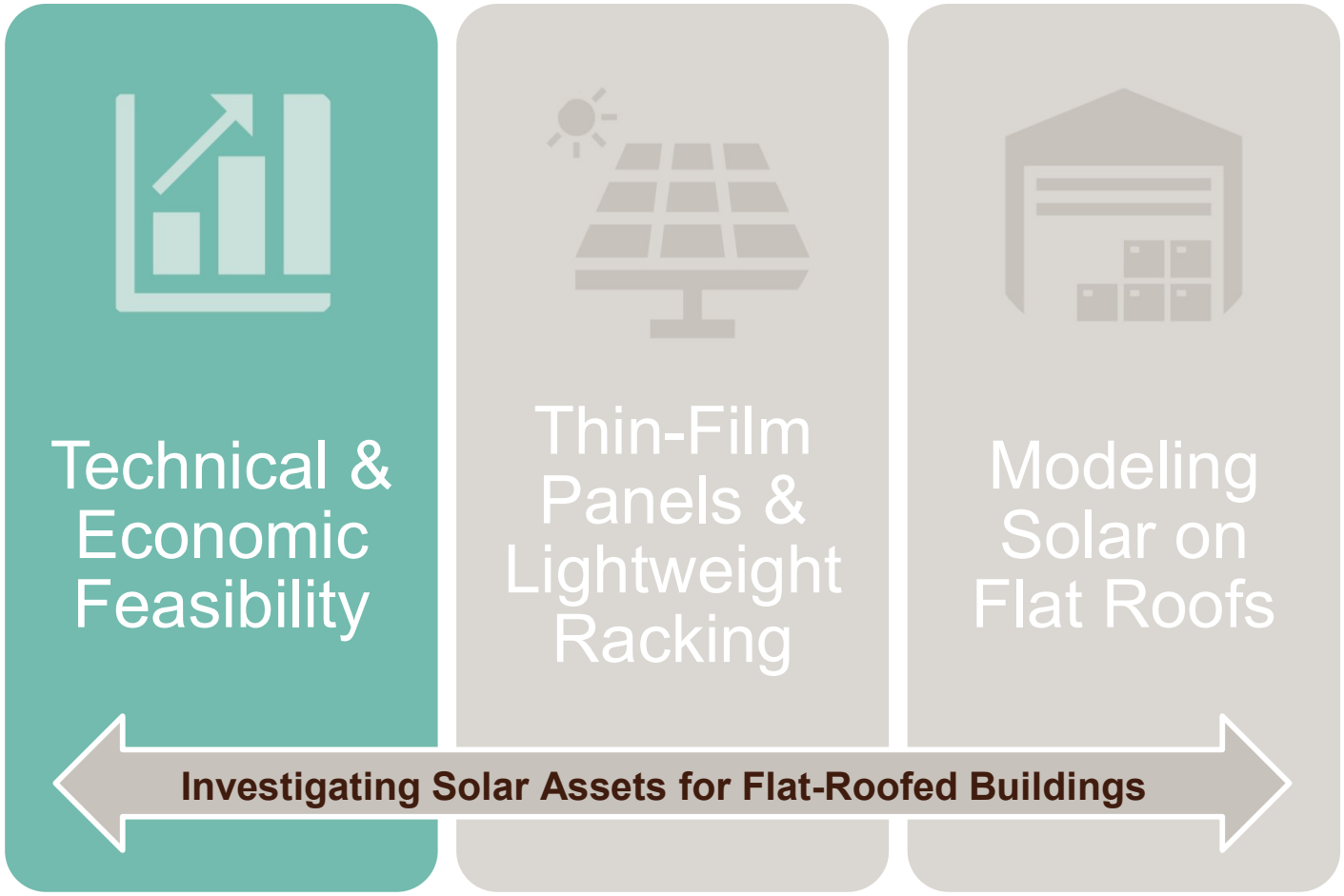

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Warehouse Facts

- 450,000 warehouses; 16.4 Billion ft^2
- POTENTIAL
- ~ 175 TWH annual solar generation
- 20 million homes ➔ New York/Newark/Jersey City

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The goal of this project is to summarize information essential for warehouse owners to evaluate the feasibility of adding a rooftop solar array.

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The project scope focuses on four key research areas.

Warehouse Inventory

Structural Analysis

Policy Research

Economic Analysis

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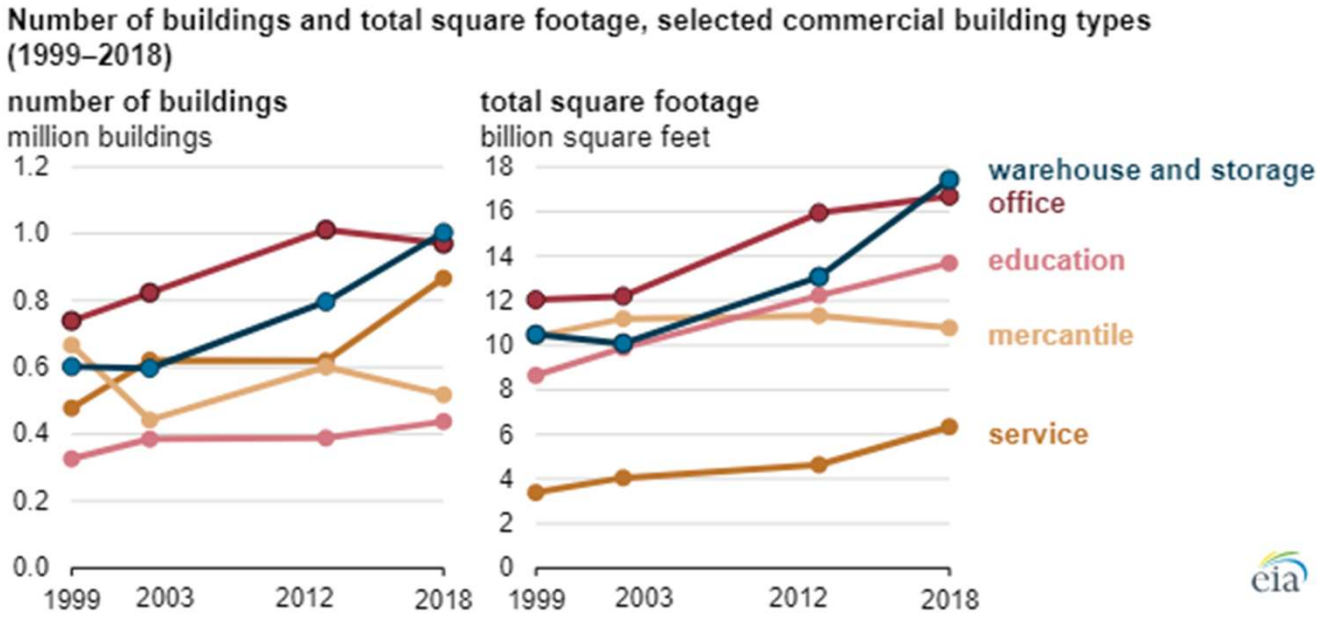
Warehouses were the most common type of commercial building in the U.S. as of 2018.



Source: U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey* (CBECS)

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Warehouses, abundant in Pennsylvania, are well-suited for rooftop solar panels.

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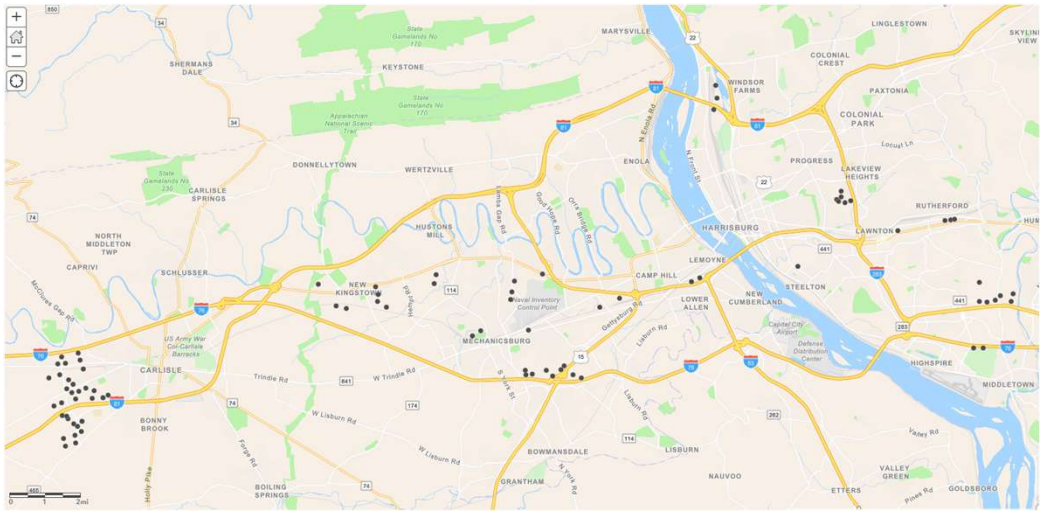
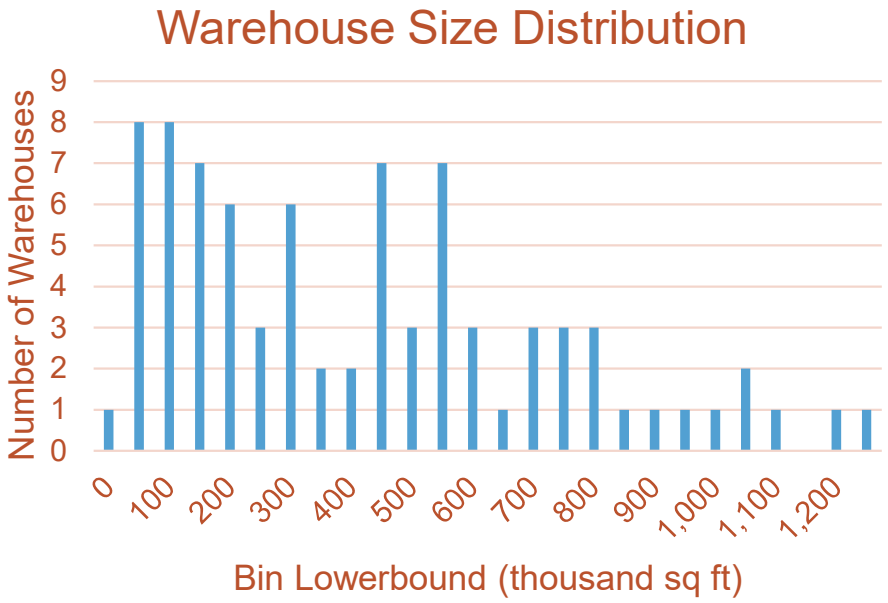
Data for 96 warehouses in Dauphin and Cumberland Counties was analyzed.





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Average yearly energy consumption for warehouses ranges from **7-24 GWh** depending on primary use.

Warehouse Primary Function	EUI (kBtu/ft^2)	Area (ft^2)	Energy Consumption (MWh)
Non-Refrigerated Warehouse	52.9	455,601	7,063
Refrigerated Warehouse	235.6	348,779	24,083

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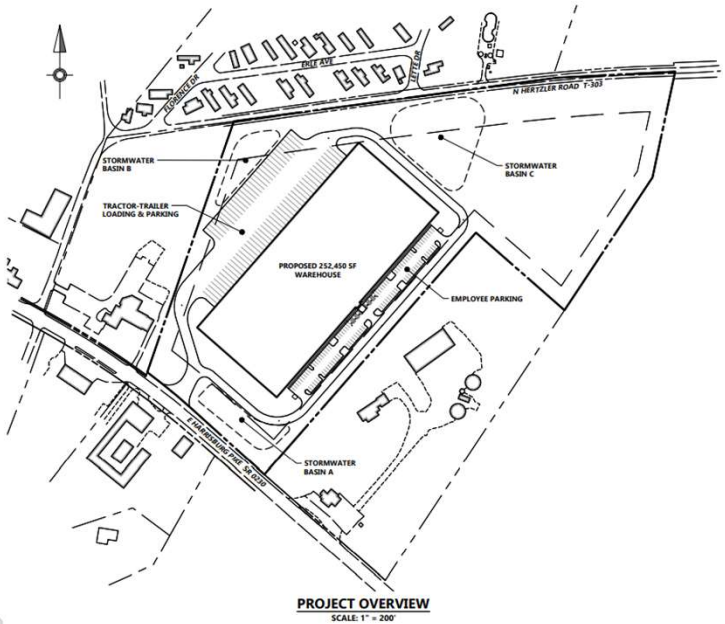
The load of the panels and racking system is estimated to be **3-6 lb/ft²** with an added wind load of **50 lb/ft²**.



Parameters for Wind Load Calculation		
Panel Length	Lp (ft)	6.5
Panel Width	Wp (ft)	3.25
Parapet Height	hp (ft)	2.5
Roof Height	h (ft)	40
Roof Width	Ws (ft)	330
Roof Length	WL (ft)	765
Tilt Angle	ω	20
Wind Load	**p (lb/ft²)**	**49.59**

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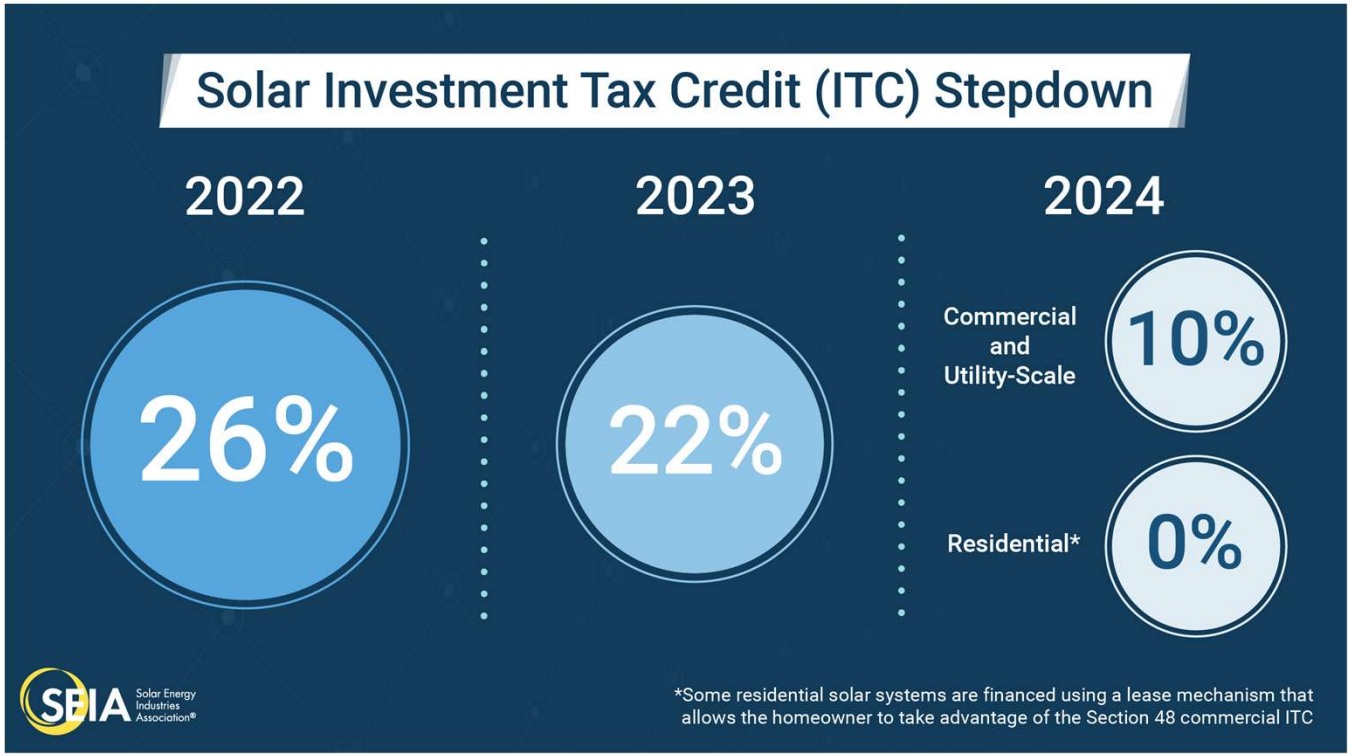
Pennsylvania does not have any tax exemptions for solar, so all financial incentives will be federal.



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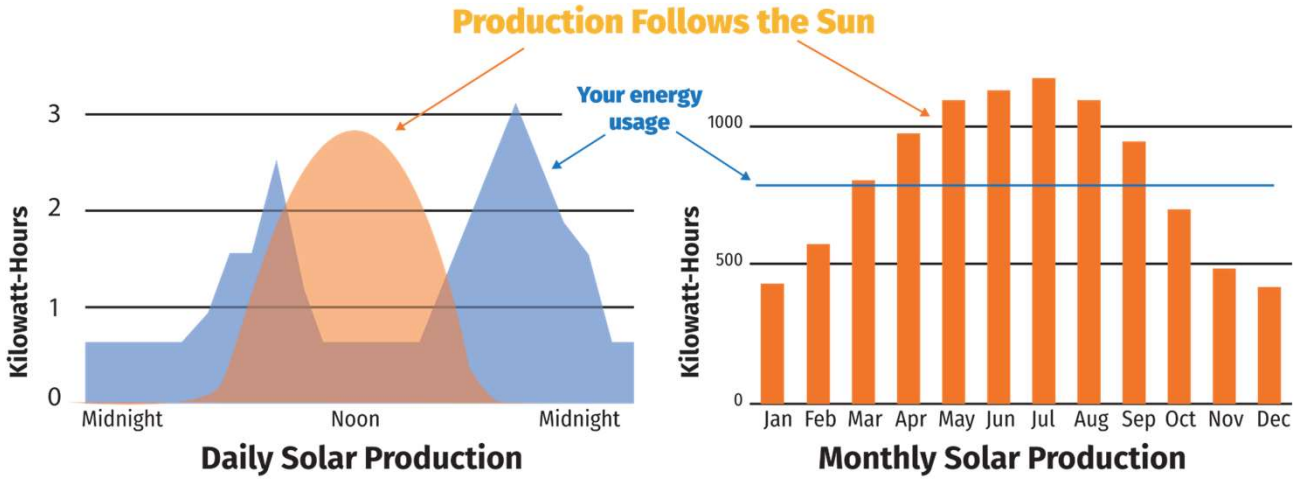
Net metering policy across Pennsylvania dictates size limitations for distributed generation assets.



Your Message Center

- **Net Metering kWh Summary**

kWh Delivered (to Customer)	0
kWh Received (from Customer)	160
kWh Net for this bill	-160
Previous Banked Balance	500
Added to Bank	160
New Banked Balance	660
You are being billed for this kWh	0

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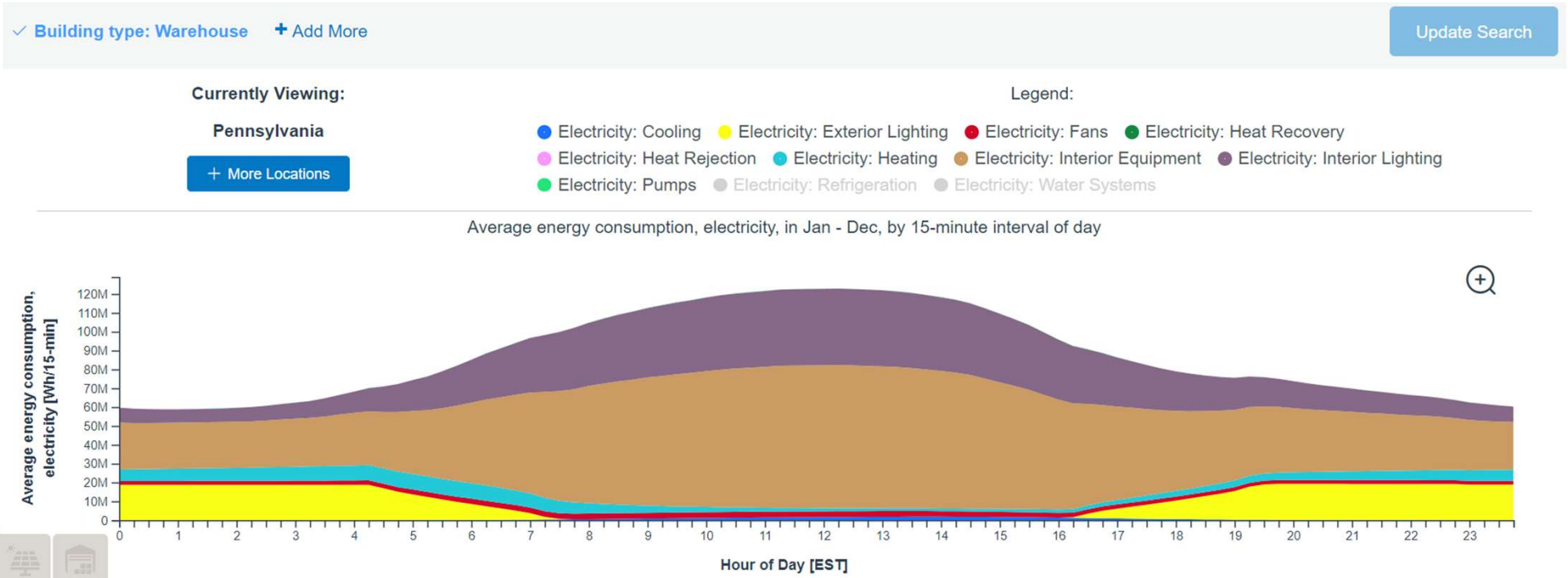
More granular electric load data from an NREL database allows for more accurate modeling in SAM.



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More granular electric load data revealed average annual electric load for PA warehouses to be **450 MWh**.

Number of Warehouses	Total Electricity Consumption	Average Annual Electricity Consumption
6,780	3,070 GWh/yr	453 MWh

The System Advisor Model (SAM) is free software from NREL which can be used to model renewable energy projects.

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

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SAM is being used to analyze the economic feasibility of rooftop solar systems.

INPUTS	OUTPUTS
Array Size	LCOE
Electric Load	Electricity Bill Savings
Rate Schedule	NPV
System Costs	Production Profile
Financial Parameters	Cash Flows

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A majority of the variables were held constant when conducting cost analyses to focus on system size.

Location	Module	Inverter	Grid Limits	Lifetime & Degradation	Incentives	Electricity Rates	Electric Load
Harrisburg, PA	SunPower SPR-X22-360-COM	SMA America STP 62-US-41	3,000 kWac	0.7%/yr	26% Federal ITC	PPL GS-3	453 MWh/year

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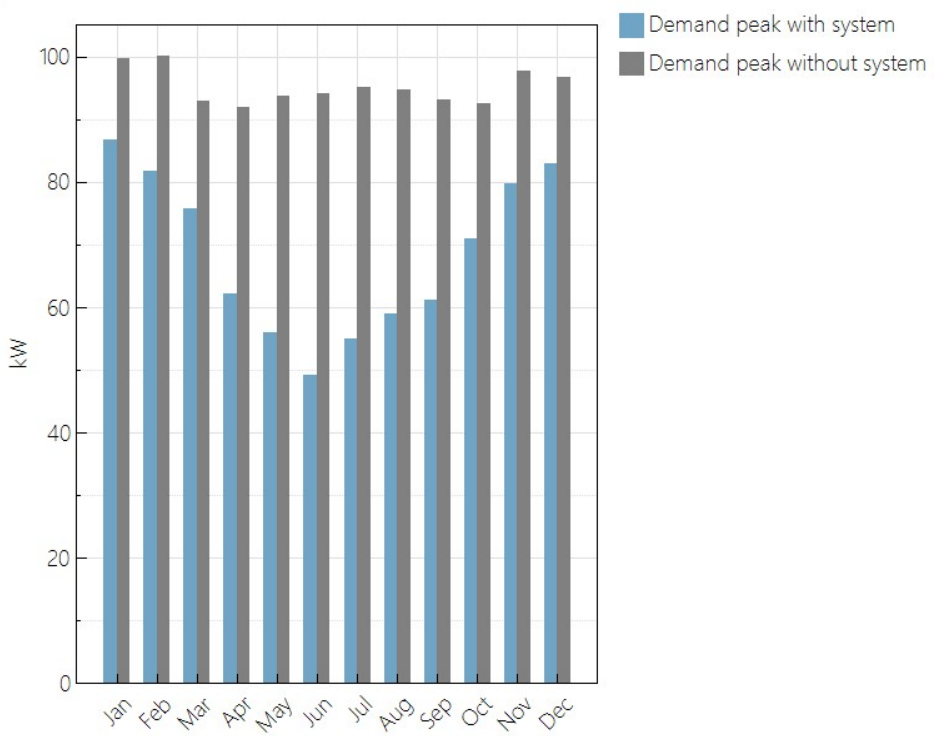
A 3 MW system was modeled to demonstrate meeting the interconnection limit.

Metric	Value
Annual energy (year 1)	4,168,000 kWh
Capacity factor (year 1)	15.9%
Energy yield (year 1)	1,389 kWh/kW
Performance ratio (year 1)	0.81
Levelized COE (nominal)	3.06 ¢/kWh
Levelized COE (real)	2.56 ¢/kWh
Electricity bill without system (year 1)	$15,891
Electricity bill with system (year 1)	$3,991
Net savings with system (year 1)	$11,900
Net present value	$-1,110,621
Simple payback period	NaN
Discounted payback period	NaN
Net capital cost	$4,104,946
Equity	$0
Debt	$4,104,946



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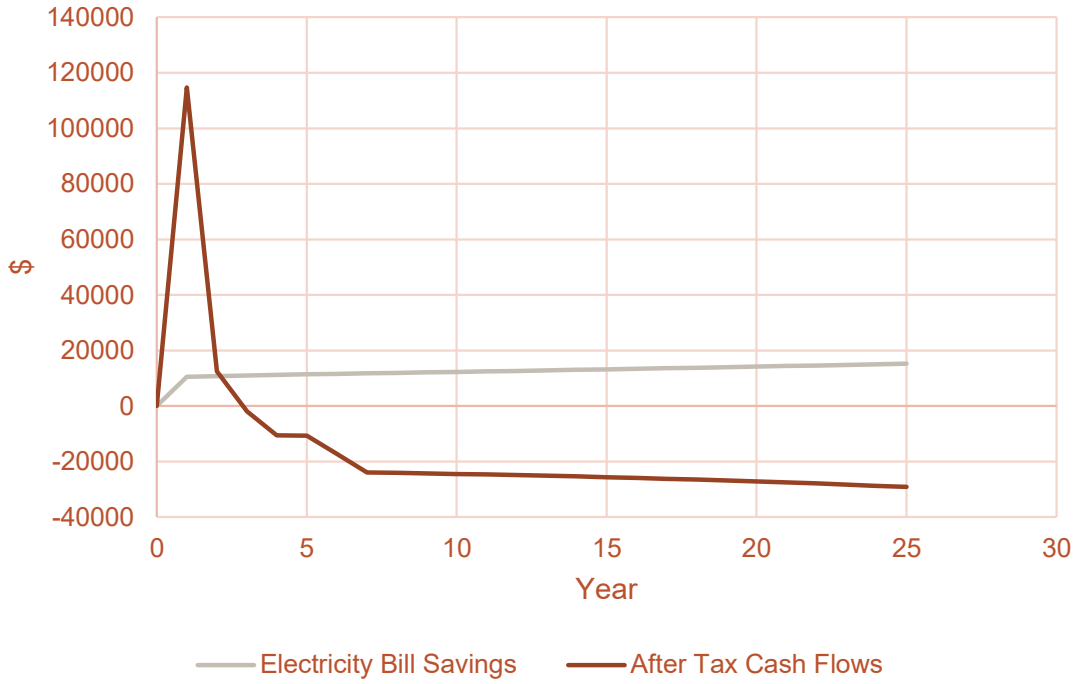
Using the estimated specific production of 1,389 kWh/kW, the system should be appropriately sized at 326 kW.



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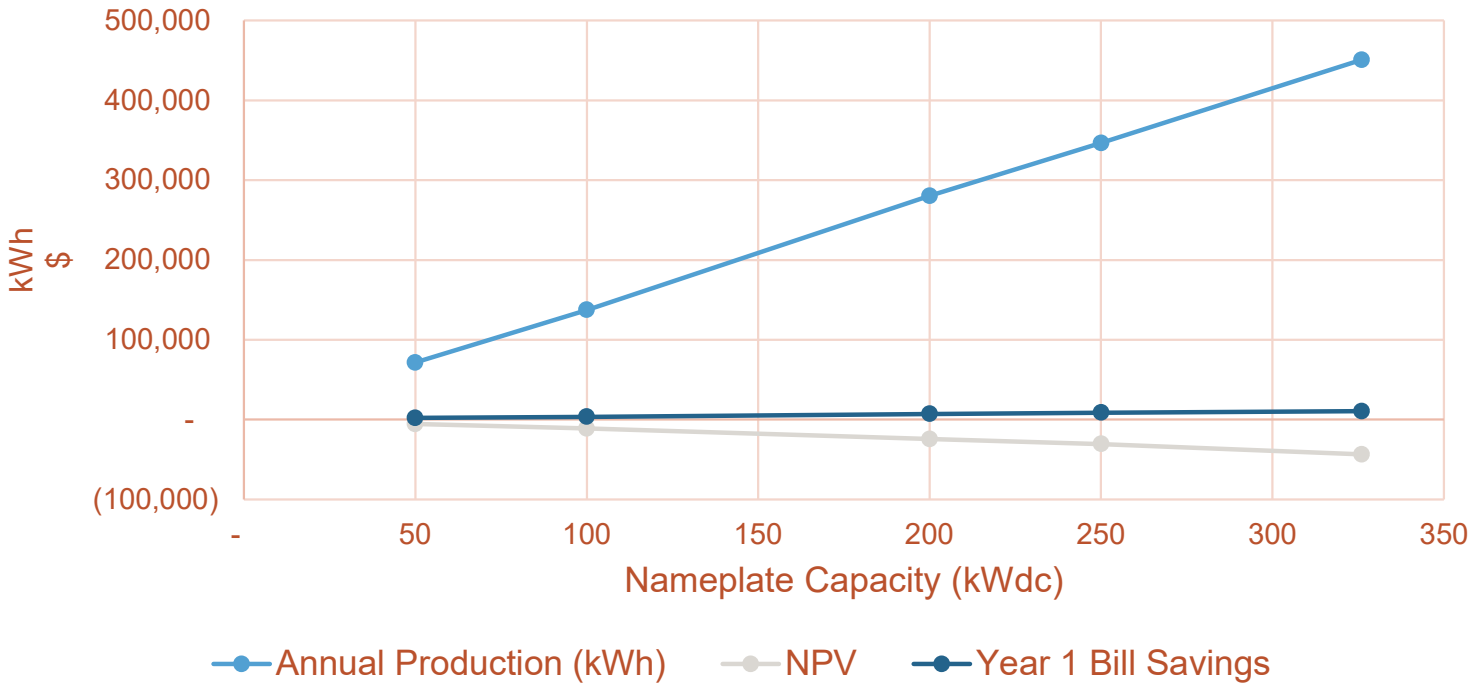
Varying system size revealed that project costs are too high to outweigh electricity bill savings.



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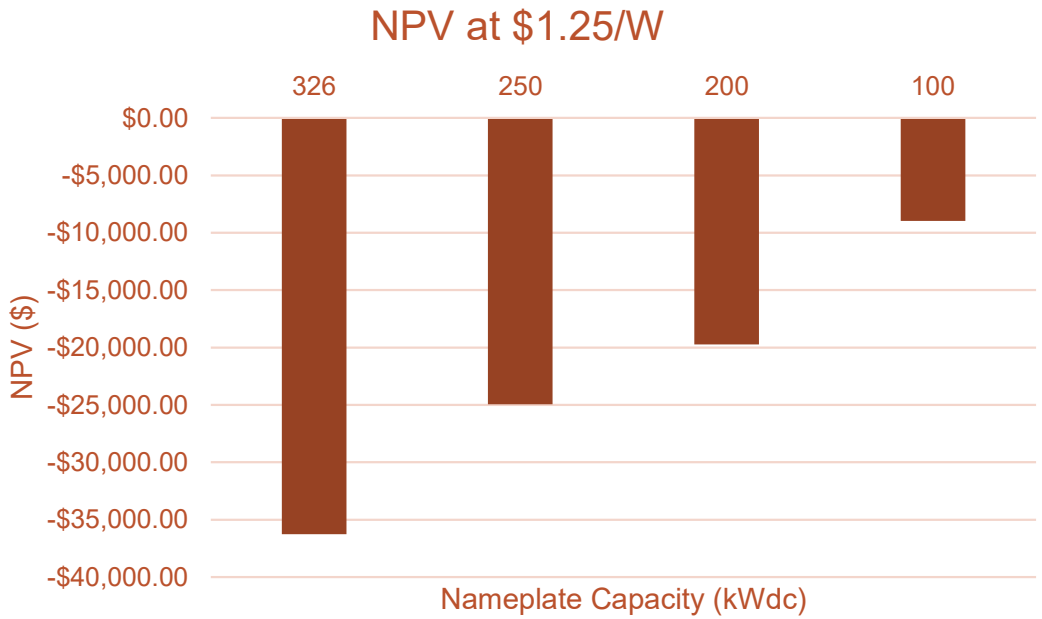
Even with a lower $/W cost, these projects are still not financially viable.



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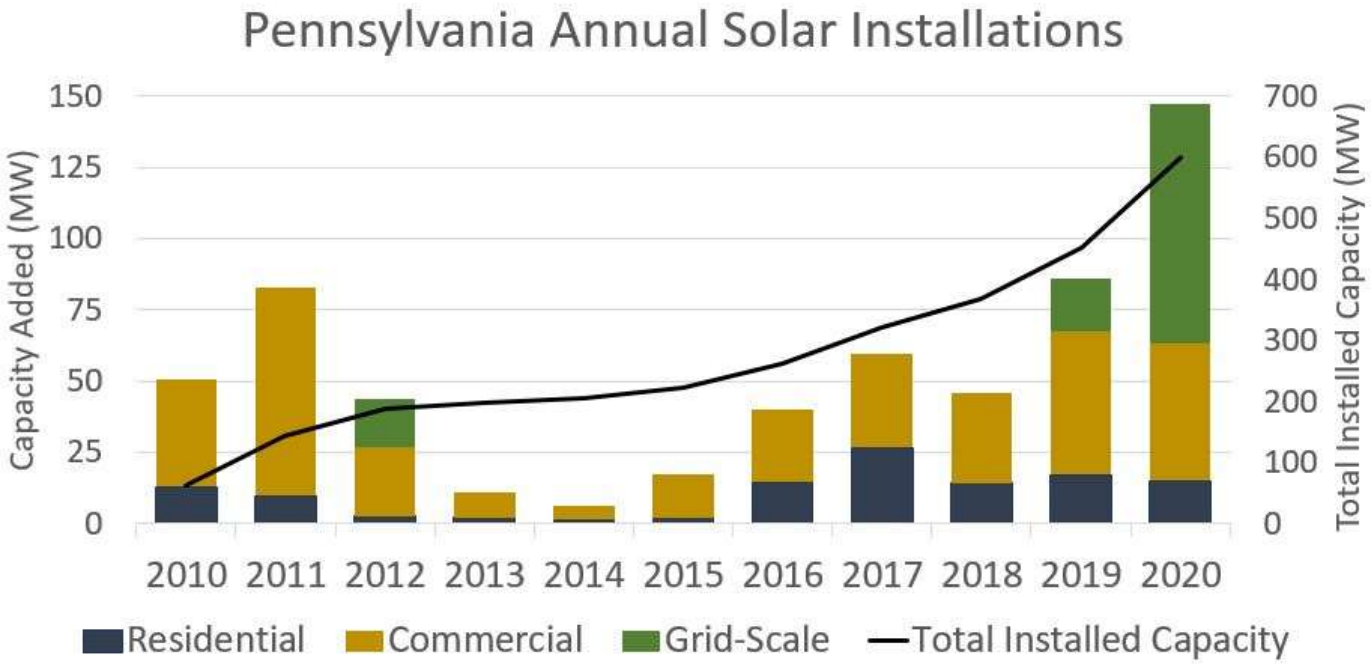
Low electricity rates in Pennsylvania and lack of incentives impact the financial viability of rooftop solar.



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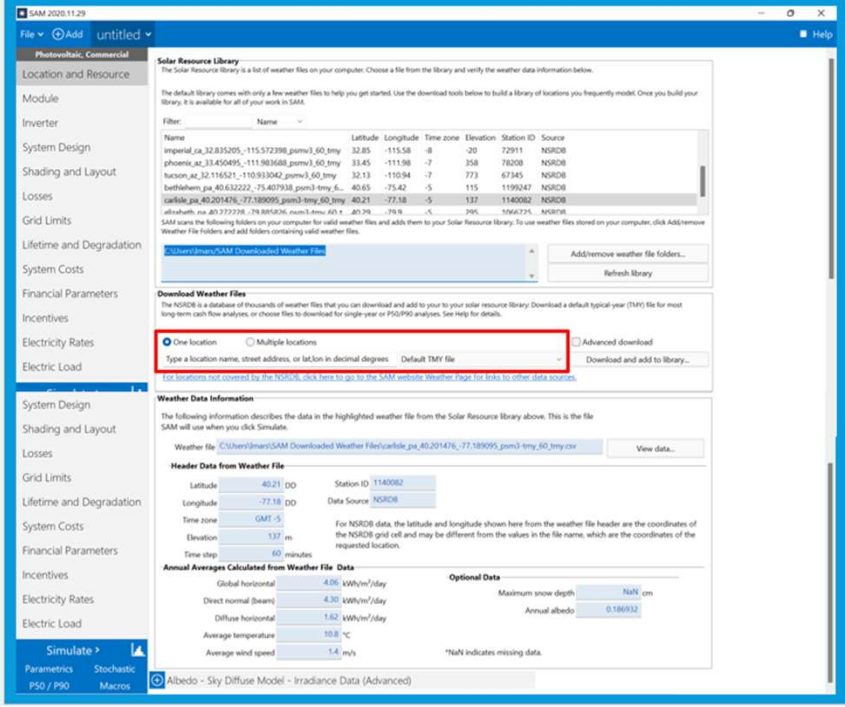
The users' guide will outline PA- and building-specific information necessary to complete an analysis.

Location and Resource



STEP 1:
Choose "One location" under Download Weather Files and type in the address of your facility. Choose "Default" TMY file from the drop-down menu.

This will add a weather file for that location in a typical meteorological year to your library and auto-populate the remainder of the information.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Thank you!