



Worcester Polytechnic Institute Solar Canopy Solutions Catalog

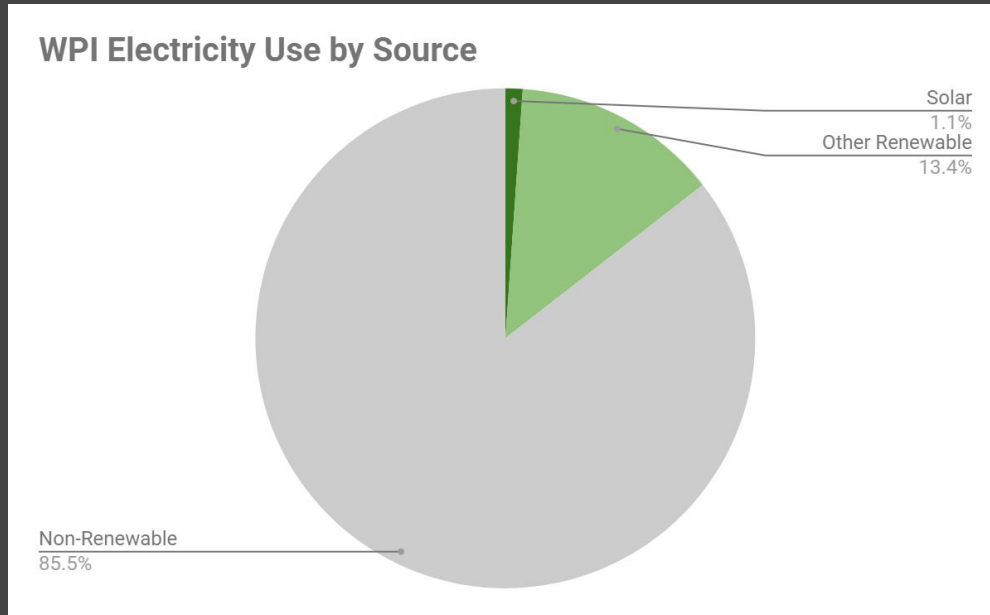
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Background



* Data sourced from 2017 STARS report

Renewable Energy

Currently, the state of Massachusetts is a leader in solar technology, generating 72% of New England's solar energy. In 2018, 11.4% of the state's electricity was generated from solar power.

In a 2017 STARS report, WPI scored only .01/4 in their renewable energy scoring system. WPI could stand to benefit by improving its renewable energy use through the installation of a solar canopy system that would provide clean, renewable energy to the university. There are many additional benefits to installing a canopy system, discussed further in the catalog.

Incentive Programs

- Federal Tax Credit (ITC) - WPI must partner with a for-profit corporation to be eligible for a tax credit worth 30% of the cost of installing the system.
- SMART Program - WPI can apply to the SMART program, and receive an incentive paid from the utility. This includes an additional \$0.05 / kWh generated
- MACRS - Accelerated depreciation program, WPI would be eligible for a 5 year cost recovery period with an 85% deduction from the owner's tax basis

Solar Panel Canopy Benefits

Solar energy:

- Reduce Impact of climate change
- Reduce non-renewable energy sources
- Decrease reliance on grid
- Well-suited for urban environments



Visibility:

- Promotes image of sustainability
- Increase interest within the sustainability department

Potential Applications:

- Electric Vehicle charging stations
- Water conservation



Education:

- Opportunities for research and study
- Appeal to prospective students interested in sustainability

Parking Areas:

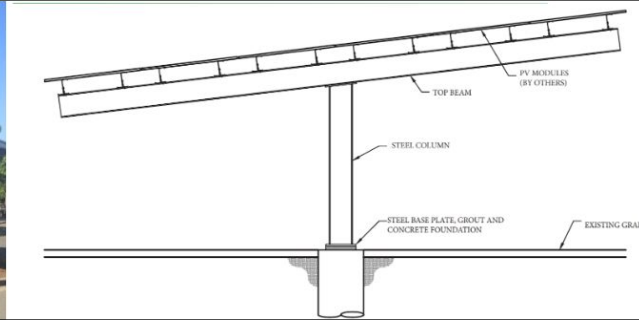
- Reduce need to plow
- Decrease re-paving frequency
- Protects vehicles and pedestrians



Canopy Design Options

T Support:

- Typically cover parking spaces, not aisles
- 3 - 10 degrees tilt to increase energy production
- Roughly \$3.50 / watt installation cost (average)
- Typically lowest total installation cost



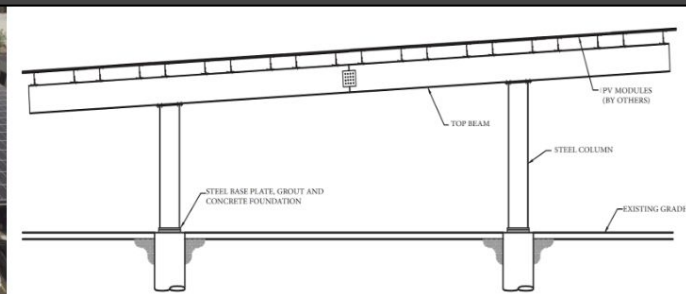
Inverted:

- Typically cover parking spaces, not aisles
- Two separate degrees of tilt (1- 10 degrees) to increase energy production
- Roughly \$3.75 / watt installation cost (most expensive)
- Rain and snow melt collects in center trough and can be easily drained



Long Spanning:

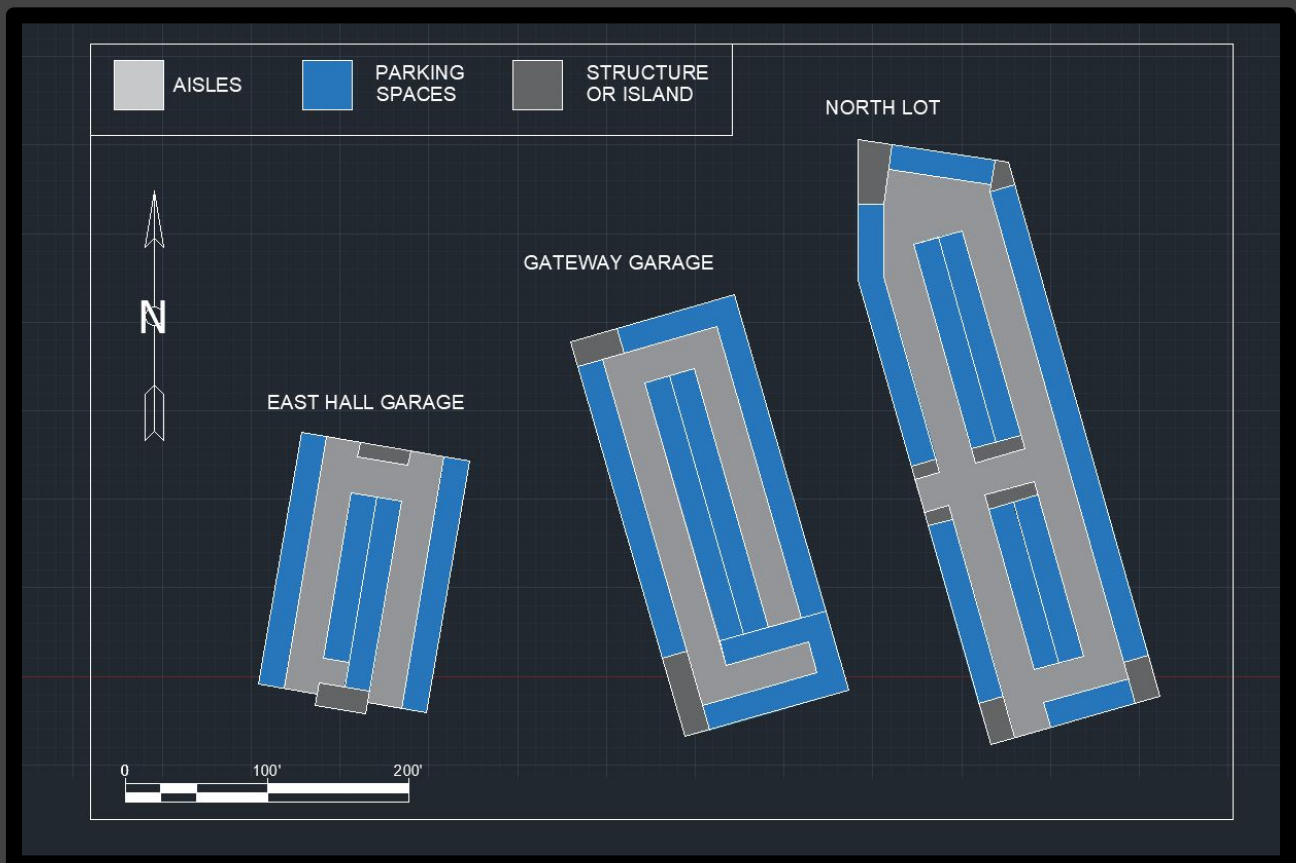
- Typically cover parking spaces and aisles (clearance may be an issue)
- Less than 5 degrees tilt (often no tilt) as structure is very large
- Roughly \$3.25 / watt installation cost (least expensive)
- Less efficient, but produces more energy due to area covered



Parking Areas

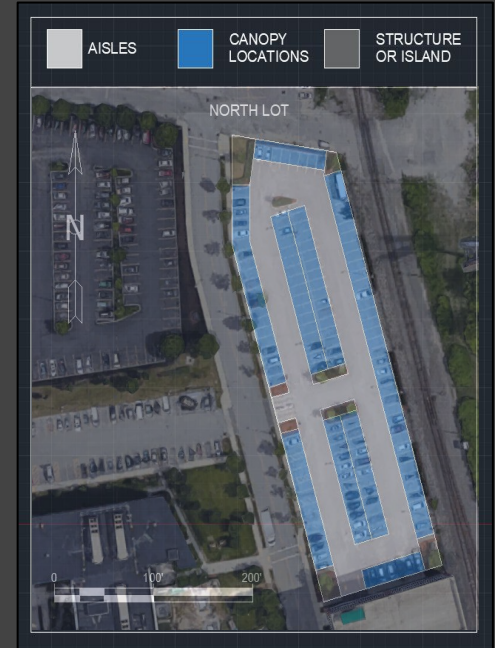
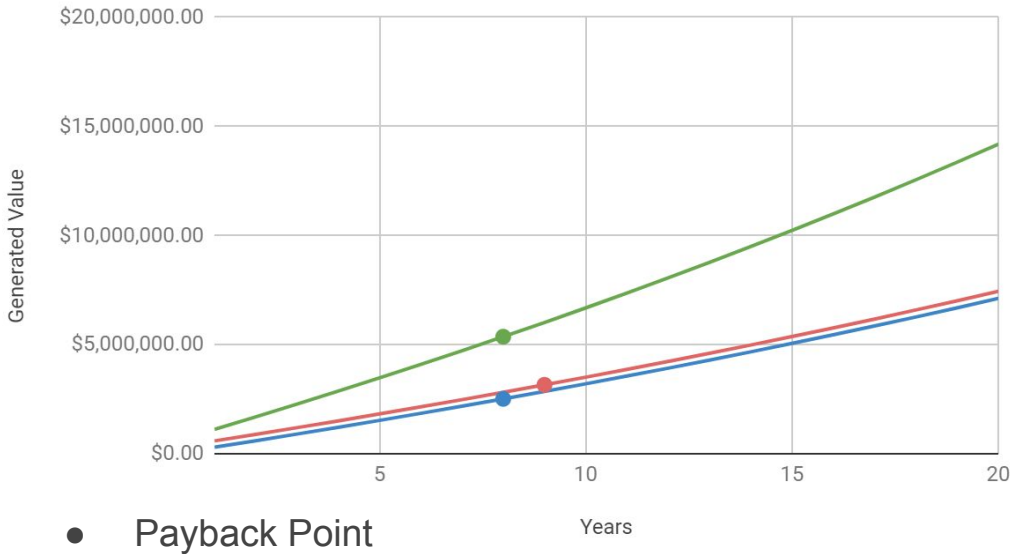


The East Hall Garage, Gateway Garage, and North Lot were considered the most feasible for a solar canopy on campus. This is due to their excellent solar radiation exposure, large areas, and large number of parking spaces. The North Lot and Gateway Garage are also highly visible from interstate 290.



North Lot (Recommended)

North Lot Generated Value Over Time (Ownership)



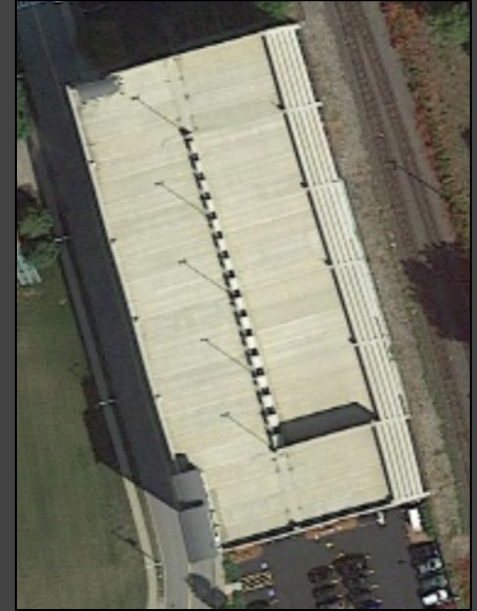
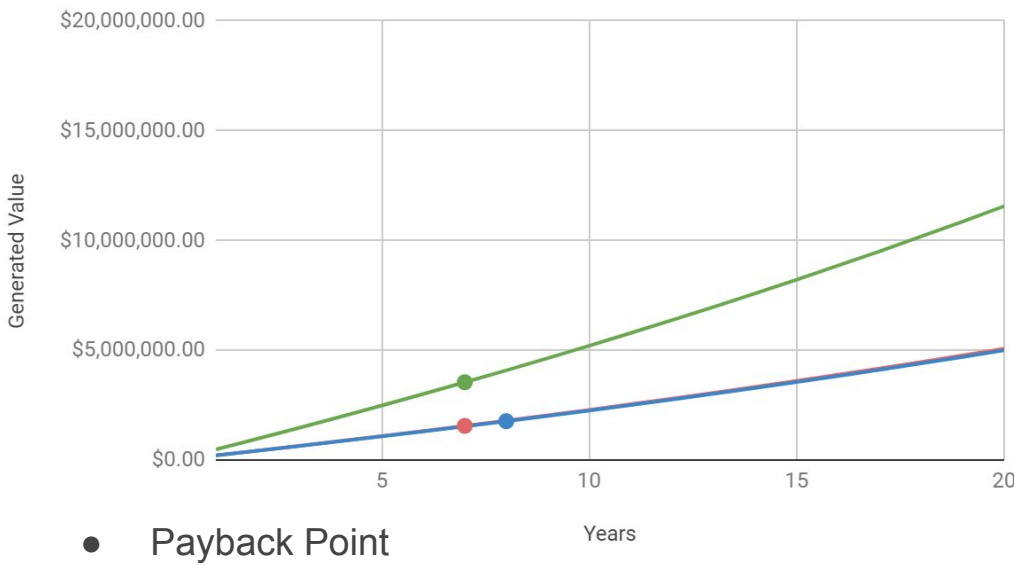
136 Parking Spaces	T Support	Long-Spanning	Inverted
System Size (kW)	816	1570	816
Total Cost (\$) (with SMART & MACRS)	\$2,427,600	\$4,337,100	\$2,601,000
Payback Period (Yrs) (with SMART and MACRS)	7.75	7.5	8.5
20 Year Savings (\$)	\$4,685,500	\$9,020,200	\$4,407,000

Our recommendation for a solar canopy system at WPI is a T Support system installed at the North Lot located at Gateway Park. This is WPI’s largest parking area at over 50,000 square feet, and also has excellent solar radiation exposure at 94.3%. In addition, the parking lot is highly visible from the heavily trafficked 290 Interstate, which would advertise WPI’s renewable practices to the broader Worcester community.

The T Support Canopy option was deemed most feasible, mostly due to its low relative cost. This \$2.4 million figure and 7.75 year repayment period takes into account both the SMART and MACRS incentive benefits. After the standard 20 Year period in which these incentives last, WPI is expected to save \$4.7 million in energy costs. This could be nearly doubled with the Long Spanning option, however the upfront cost would be much higher.

Gateway Garage

Gateway Garage Generated Value Over Time (Ownership)



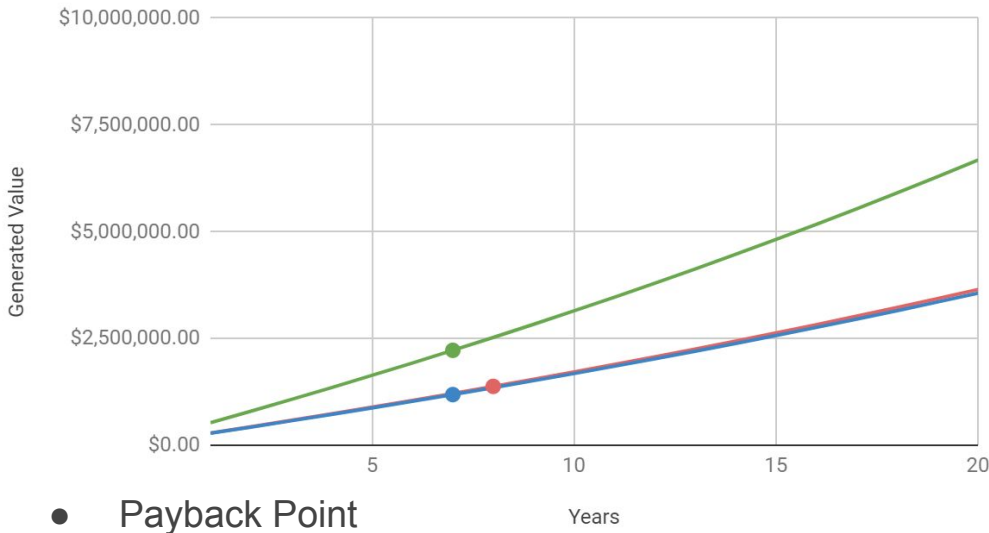
92 Parking Spaces	T Support	Long-Spanning	Inverted
System Size (kW)	552	1289	552
Total Cost (\$) (with SMART & MACRS)	\$1,642,200	\$3,560,900	\$1,759,500
Payback Period (Yrs) (with SMART and MACRS)	7.5	7	8
20 Year Savings (\$)	\$3,429,800	\$7,998,800	\$3,237,635

Gateway Garage was also considered and can be thought of as a number 2 option. The garage is the third largest parking structure on campus in terms of surface area, and also scores the highest of all in terms of solar radiation exposure at 99.4%. It is also equally visible from Interstate 290, perhaps even more so due to its elevation 5 stories above ground level.

The main issue with the Gateway Garage lies in potential increases in construction costs. Since the canopy system would be installed 5 stories up, this would increase costs to \$4 or \$5 per watt installed, or increase the total cost shown above by 60% (as per solar installation companies). Due to this, a Long Spanning Canopy option is recommended here as the 20 year savings are more substantial. The upfront cost is likely to be greater than that of the North Lot, despite the Garage's smaller footprint.

East Hall Garage

East Hall Garage Generated Value Over Time (Ownership)



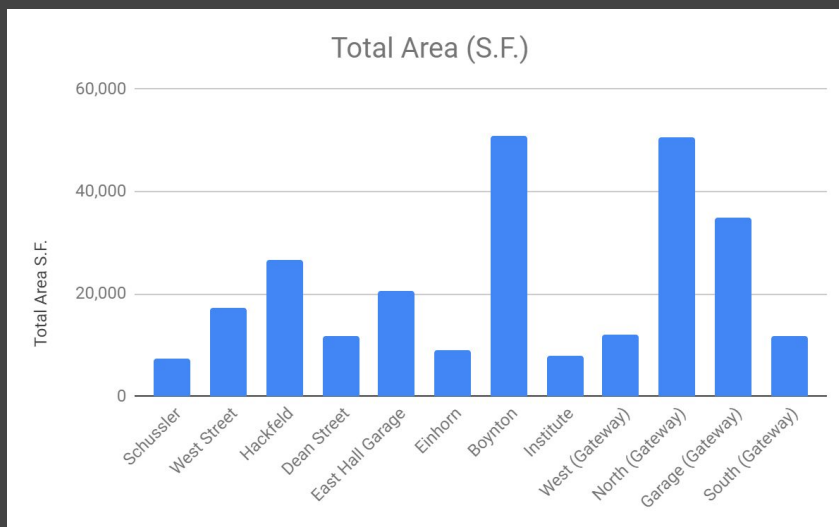
67 Parking Spaces	T Support	Long-Spanning	Inverted
System Size (kW)	402	747	402
Total Cost (\$) (with SMART and MACRS)	\$1,196,000	\$2,063,600	\$1,281,400
Payback Period (Yrs) (with SMART and MACRS)	7.5	7.25	8.25
20 Year Savings (\$)	\$2,235,900	\$4,224,400	\$2,072,100

East Hall Garage was also considered for its relatively large area (5th out of 12 measured) and good solar exposure at 93.3%. It is overall a good option when compared to WPI's other parking areas, but is not as desirable as the North Lot or Gateway Garage. Unlike these two areas, the parking structure is only visible from Dean Street or from East Hall itself. Although it can be advertised in other ways, the canopy system would not be viewed as easily by the general public.

In addition, the Garage also faces the same challenges that the Gateway Garage would face. In reality, its total cost would likely climb higher than the estimates given above due to construction complications, although this 2 story garage may be more accessible by construction workers than Gateway's 5 stories. A Long Spanning Canopy is again recommended here to maximize savings.

Other Options

While there are 9 additional parking lot options where a solar panel canopy could be implemented at WPI, many were determined to not be feasible for the reasons outlined in the following table. Per solar installation companies, smaller lots are generally less feasible as they produce less energy and therefore have an extended payback period. The graph below compares relative areas of each lot.



Schussler	Insufficient area
West Street	Insufficient area, poor sunlight exposure
Hackfeld	Not level - will increase and complicate costs
Dean Street	Insufficient area, poor sunlight exposure
Einhorn	Insufficient area, poor sunlight exposure
Institute	Insufficient area, poor sunlight exposure
Gateway West	Insufficient area, poor sunlight exposure
Gateway South	Insufficient area
Boynton	Plans for New Building, poor sunlight exposure

Funding Options

Ownership	Ownership with Partner	PPA
<p>WPI pays ~\$2,427,600 net cost</p> <p><u>WPI Qualifies for...</u> SMART \$0.14 / Kwh for 20 years MACRS pays 15% of installation cost</p> <p>\$4,700,000 estimated savings over 20 years</p> <p>Estimated payback 7 - 8 year</p> <p>WPI fully owns system, and deals with all potential benefits and risks on its own</p>	<p>WPI & Partner pay ~\$1,400,800 net cost</p> <p><u>WPI & Partner Qualify for...</u> Federal ITC pays 30% of installation cost via tax credit SMART \$0.14 / kWh for 20 years MACRS pays 15% of installation cost</p> <p>\$2,800,000-\$3,200,000 estimated savings over 20 years</p> <p>Estimated payback 5 - 6 years</p> <p>Many fine details are a largely gray area and would be worked out in a specific contract agreement</p>	<p>Third party pays ~\$1,400,800 net cost</p> <p><u>Partner Qualifies for...</u> Federal ITC pays 30% of installation cost via tax credit SMART \$0.14 / kWh for 20 years MACRS pays 15% of installation cost</p> <p>\$1,350,000-\$2,600,000 estimated savings over 20 years</p> <p>Payback not applicable as WPI has no upfront cost</p> <p>WPI buys back energy from the system at reduced rates. Typically system is turned over after 20 years of third party ownership</p>



*Leasing options and PPA's vary greatly by solar installer and specific contract agreements

Next Steps



- **Reach out to Installation Companies:**
 - Get quotes
 - Estimate construction timeline
- **Utilize tax services:**
 - Maximize savings and lower costs
 - Eligibility to receive incentives benefits
- **Plan for additional features:**
 - Number of EV Charging stations needed
 - Water conservation technology
- **Consider other factors:**
 - Determine temporary parking plan
 - Traffic management during construction
- **Reach out to community:**
 - Sustainability events for renewable energy
 - Research opportunities
 - Future IQPs/MQPs