Economic Analysis of Solar Panel Installation: A Case Study at Derrickson Agriculture Complex

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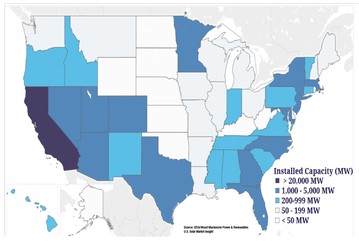
Introduction

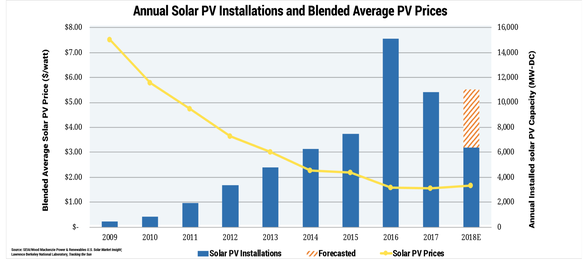
Increasing electricity cost and desire for renewable energy sources, Morehead State University (MSU) is looking for alternative energy sources. This research will analyze potential use for solar energy for part of the Derrickson Agricultural Complex (DAC). Objective of this study is to analyze economic and financial feasibilities of solar panel installation at DAC.

Installed Capacity of Solar Panels by State



Top 10 States	
California	23,186 MW
North Carolina	4,671 MW
Arizona	3,664 MW
Nevada	2,707 MW
New Jersey	2,647 MW
Texas	2,466 MW
Massachusetts	2,319 MW
Florida	2,159 MW
Utah	1,636 MW
New York	1,570 MW

Annual Solar PV Installations and Blended Average PV Prices



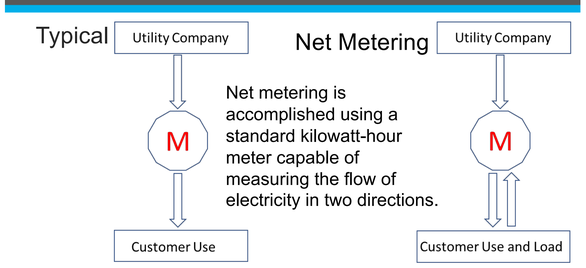
Major Factors That Contribute to Solar Panel Installations

- High electricity prices
- Net metering/Feed-in tariff
- Interconnection policies
- Solar Tax Credits
- Performance payment
- Property Tax exemptions
- Sales Tax exemptions

States and Policy Classes Respect to Solar Panel Installation

Grade A	Grade B	Grade C	Grade D	Grade F	Unknown
Connecticut	California	Alaska	Nebraska	Alabama	Texas
Maryland	Colorado	Arizona	Tennesse	Arkansas	
Massachusetts	Delaware	Florida	Virginia	Georgia	
New Jersey	Hawaii	Indiana	West Virginia	Idaho	
New Mexico	Illinois	Iowa	Wyoming	Kentucky	
New York	Minnesota	Kansas		Louisana	
Oregon	Nevada	Maine		Mississippi	
Rhode Island	New Hampshire	Michigan		North Dakota	
Washington D.C.	Vermont	Missouri		Oklahoma	
		Montana		South Dakota	
		North Carolina			
		Ohio			
		Pennsylvania			
		South Carolina			
		Utah			
		Washington			
		Wisconsin			

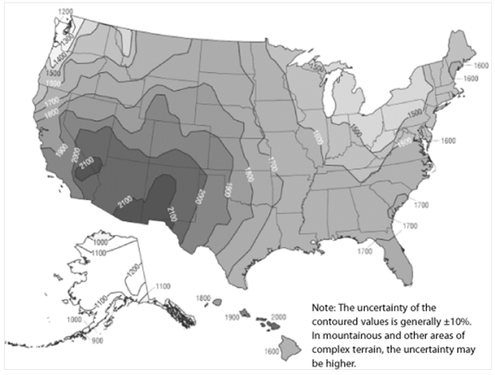
Typical Vs. Net Metering Billing System



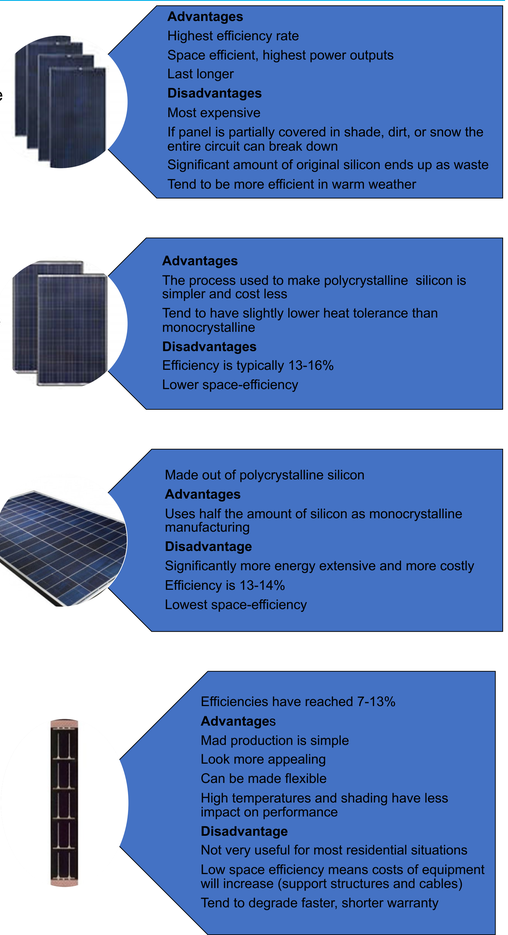
Incentives/ Polices in Kentucky

Grade A	Grade F	Definitions
Ranks better in RPS. Renewable Portfolio Standard.	Low grades or low ranking in all or most categories	-state legislature mandates that a certain percentage of all energy generation comes form renewable sources by a certain date
Ranks better in Interconnection policies		Determines solar owners can "plug in" the grid and send power to utility companies
Net Metering/Feed-in Tariff		Net metering: get full-price credit for all energy solar panels generate. Feed-in Tariff: payment for solar energy in non-net metering states
Solar Rebates		
Solar Tax Credit		
Performance Payment		Reward homeowners for electricity their panels produce on an ongoing basis
Tax exemptions, Property and sales		

United States Solar Radiations Map



Types of Solar Panels



Economic and Financial Analysis

Building: Vet-Tech Building at DAC
Current electricity use: 183,160 kWh/year
Cost per year: 17,513

Identifying Solar Panel Capacity

Required electricity: 183,160 kWh/year

Required solar energy adjusted to the efficiency:

$$183{,}160 = x * 0.78$$
$$x = 234{,}821\ kW$$

Required solar panel capacity in kWh:

$$\frac{234{,}821kW}{1600} = 147\ kWh$$

Required roof space: $1333\ sq.ft\ * 8 = 10{,}664$

Cost before tax credit: $49{,}160\ * 8\ = 393{,}280$
Cost after tax credit: $34{,}412\ * 8 = 275{,}296$

Calculation of Required Annual Benefits to Justify Solar Panel Adoption

Assumptions:
Discount rate: 5%; Life of solar panels: 25 years

Scenario 1: Purchasing Solar Panels Without Tax Credit:

$$Required\ Annual\ Benefits = \frac{Investment}{USPV_{.05,25}}$$

$$= \frac{393{,}280}{14.0939}$$

$$= \$27{,}904/year$$

Scenario 2: Purchasing Solar Panels With Tax Credit:

$$Required\ Annual\ Benefits = \frac{Investment}{USPV_{.05,25}}$$

$$= \frac{275{,}296}{14.0939}$$

$$= \$19{,}352/year$$

Scenario 3: Using Traditional Electricity without any increase in electricity cost

Present value of next 25 years of payments:

$$V_0 = A\left[USPV_{0.05,25}\right]$$

$$= 17{,}513 \text{ x } 14.0939$$

$$= \$246{,}826$$

Scenario 4: **Using Traditional Electricity with 3% annual increase in cost**

$r = \frac{1+i}{1+g} - 1$ where i= discount rate g= growth rate

$r = \frac{1.05}{1.03} - 1$ r = 0.0194 = 1.94%

Present value of next 25 years of payments:

$$V_0 = A\ * \left[USPV_{0.0194,25}\right]$$

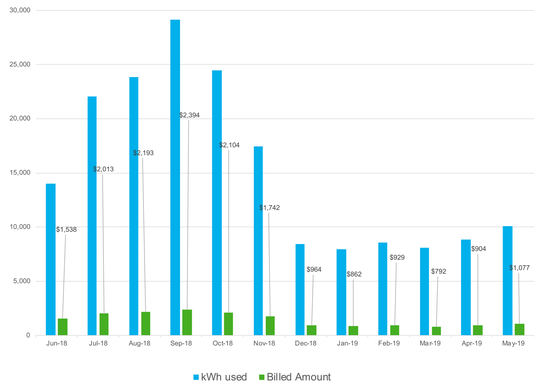
$$= 17{,}513\ * 19.6734$$

$$= \$344{,}540$$

Varying Types of Solar Panels and Prices

Type	Price	Wattage
Monocrystalline Silicon	$342.99	180
Polycrystalline Silicon	$223.51	45
String Ribbon	$444.60	195
Thin Film	$37.50	1.44

Electric Bill for the Vet-Tech building



Conclusion

Our study shows that the Vet-Tech building uses 183,160 kWh per year and it costs about $17,500 year to MSU. We need 8 pieces of 20 kW solar panels which can produce 160,000 kWh (16 kW more than currently used in this building). Required roof space is 10,664 sq.ft but we are not sure if the roof is strong enough to handle that much weight. If not we need to consider ground based installation. Purchasing solar panels without government tax credit will not be profitable as the required benefits are $27,904 a year. Government tax credit reduces the required benefits to $19,352/ year but it is still greater than our current bill. At the same time, we are not sure how the tax credit will help our university since we do not pay federal tax. We assume that our electricity bill may increase at least 3% per year (including inflation), and the expected total payment for the next 25 years is $344,540, which is much higher than the money we need to pay for the solar panels. In this case, solar panels can be a good investment (assume we can benefit from the federal tax credit). It is possible that the cost of solar panels may decrease significantly in the near future. As a result, leasing solar panels can be a better option. Therefore, it is necessary to conduct a proper benefit cost analysis for both leasing and purchasing options before we make a final decision.

References

- Llorens, Dave. "2019 Guide to Connecticut Home Solar Incentives, Rebates, and Tax Credits." *Solar Power Rocks*, Solar Power Rocks, 31 Dec. 2018, www.solarpowerrocks.com/connecticut/.
- Llorens, Dave. "2019 Guide to Kentucky Home Solar Incentives, Rebates, and Tax Credits." *Solar Power Rocks*, Solar Power Rocks, 31 Dec. 2018, www.solarpowerrocks.com/kentucky/.
- "Solar Industry Research Data." *SEIA*, www.seia.org/solar-industry-research-data.
- "Which Solar Panel Type Is Best? Mono-, Polycrystalline or Thin Film?" *Energy Informative,* energyinformative.org/best-solar-panel-monocrystalline-polycrystalline-thin-film/.
- Zientara, Ben. "How to Calculate the Amount of Kilowatt Hours (KWh) Your Solar Panel System Will Produce." *Solar Power Rocks*, Solar Power Rocks, 14 Dec. 2018, www.solarpowerrocks.com/buying-solar/how-to-calculate-the-amount-of-kilowatt-hours-kwh-your-solar-panel-system-will-produce/.