Presentation on Value of Solar to DG Working Group

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Outline

- Summary
- Survey of Key Studies & Analyses
- Utility Efforts
- Solar DG Case Study
- Recommendations
- References

Summary

- Majority of studies have shown that net metering actually undervalues solar DG at low market penetrations
  - Michigan has an extremely low market penetration of 0.02%
  - For simplicity, net metering should be retained in Michigan until solar DG penetration approaches 5% (currently limited to 1% by law)
- Utility companies have aggressively lobbied to weaken or eliminate net metering in Michigan and around the country
  - Utility recommendation for avoided energy cost of service outflow calculation takes a purposely limited view of the value of solar and is intended to undercut and stifle the DG market
  - MPSC should not use the Utility approach as a fair and reasonable solution
- An Inflow-Outflow scheme with the currently-estimated Staff outflow credit of ~$0.075/kWh does not accurately value solar DG, and would push payback periods beyond economic viability, effectively halting the DG industry in Michigan
- If switching to Inflow-Outflow instead of net metering, MPSC must conduct a true value of solar calculation for the outflow credit
  - Adopt a transparent, comprehensive standard valuation methodology such as the IREC model to fully account for the costs and benefits of solar DG
  - Inflow Rates & Outflow Credit should be Time-of-Use based

Survey of Key Studies & Analyses

- Lawrence Berkeley National Lab - Putting the Potential Rate Impacts of Distributed Solar into Context, G. Barbose, 2017
- Brookings Report – Rooftop Solar: Net metering is a net benefit, M. Muro, D. Saha, 2016
- Regulatory Assistance Project (RAP) – Designing Tariffs for DG Customers, J. Migden-Ostrander, J. Shenot, 2016
- NREL Report – The Value of Grid-Connected PV in MI, S. Ong, 2012
- Consumers Reports – How Utilities Are Fighting Back on Solar Power, J. Garskof, 2016
- Institute for Energy Innovation (IEI) Report – Rooftop Solar Systems Provide Economic Benefit to Michigan's Electric Grid, D. Scripps, 2017
- Univ. of Michigan / Dow Fellows – Valuing Solar DG in MI, A. Al-Heji, R. Chalat, J. Cornfield, S. Mostafa, 2014

Putting the Potential Rate Impacts of Distributed Solar into Context - Lawrence Berkeley National Lab

Current penetration levels for most utilities are quite low

Top-Ten Utilities for Net-Metered PV Penetration
(year-end 2015)

Penetration among all customers			*Penetration among residential customers only*		
Utility	State	% of Sales	Utility	State	% of Sales
Hawaii Electric Light	HI	12.4%	Maui Electric	HI	18.0%
Maui Electric	HI	12.1%	Hawaii Electric Light	HI	16.9%
Hawaiian Electric	HI	8.1%	Hawaiian Electric	HI	16.8%
Kauai Island Utility Cooperative	HI	7.9%	Kauai Island Utility Cooperative	HI	10.5%
Otero County Electric Cooperative	NM	5.6%	San Diego Gas & Electric	CA	7.7%
San Diego Gas & Electric	CA	5.5%	City of Moreno Valley	CA	6.5%
Washington Electric Cooperative	VT	5.3%	Pacific Gas & Electric	CA	5.3%
Town of Hardwick	VT	5.3%	Otero County Electric Cooperative	NM	5.2%
Trico Electric Cooperative	AZ	4.1%	Groton Dept. of Utilities	CT	4.5%
Pacific Gas & Electric	CA	3.6%	Southern California Edison	CA	3.9%
→	*Total U.S.*	*0.4%*		*Total U.S.*	*0.6%*

Notes: Based on data for NEM PV capacity and retail electricity sales reported through form EIA-861 (EIA 2016g). Net-metered PV generation is estimated using the PVWatts software with the program's default assumptions (NREL 2016).

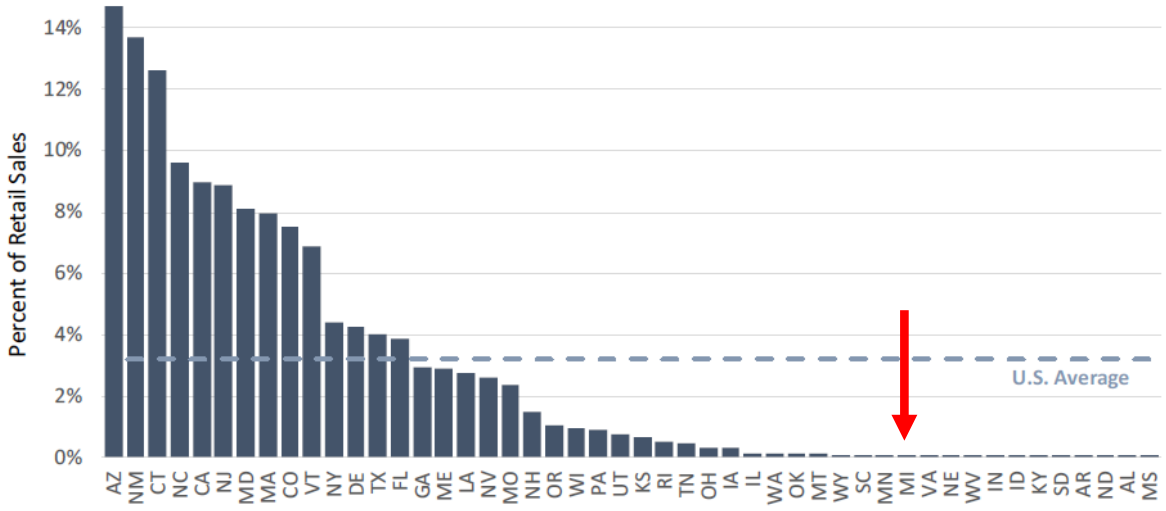
- A few utilities have net-metered solar penetration >5% of retail sales, and several (in HI) top 10%
- But most utilities have quite low penetration levels
  - U.S. average penetration was just 0.4% across all utilities
  - Most had yet to reach even one-tenth of that **Michigan is at 0.02%**
- Residential penetration rates somewhat higher

For the vast majority of utilities, current PV penetration levels are far too low for any discernible effect on retail electricity prices to have occurred

Putting the Potential Rate Impacts of Distributed Solar into Context - Lawrence Berkeley National Lab

High penetration levels are expected to remain concentrated within a small set of states

Projected rooftop solar penetration levels in 2030
(from NREL 2016 Standard Scenarios Report)



Notes: Based on central case scenario from Cole et al. (2016), which projects solar adoption in the contiguous United States (i.e., excludes Hawaii and Alaska). Penetration levels calculated from projected capacity based on estimated state-level capacity factors (NREL 2016) and retail sales projections developed by applying EMM-level growth rates from the Annual Energy Outlook 2016 reference case (EIA 2016a) to historical state-level retail sales data (EIA 2015c).

- Recent forecasts project total U.S. distributed solar generation grows to 2-4% of electricity sales by 2030
- High penetration levels remain concentrated within a relatively small set of states
- Latest NREL forecast projects that:
  - Three states in contiguous U.S. surpass 10% penetration by 2030
  - Seven others reach 5%
  - But most states remain below 1%
  - U.S. average = 3.2%

Putting the Potential Rate Impacts of Distributed Solar into Context - Lawrence Berkeley National Lab

"For the vast majority of states and utilities, the effects of distributed solar on retail electricity prices will likely remain negligible for the foreseeable future."

"For states or utilities with particularly high distributed solar penetration levels, retail electricity price effects may be more significant, but depend critically on the value of solar and underlying rate structure."

Summary of Recent VoS Studies

Region	Author (Year)	VoS (2015 cents/kWh)		VoS/CoS	
		Core	Core+	Core	Core+
Arizona (APS)	SAIC (2013)	3.7	n/a	31%	n/a
Arizona (APS)	Crossborder Energy (2013a)	24.6	n/a	204%	n/a
Arizona (APS)	Crossborder Energy (2016)	16.9	18.9	144%	161%
California	E3 (2013)	n/a	14.6	n/a	98%
California	Crossborder Energy (2013b)	11.0	20.2	74%	135%
Colorado (PSCo)	Xcel (2013)	7.2	8.4	71%	83%
Maine	Clean Power Research (2015)	13.8	24.3	106%	185%
Massachusetts	Acadia (2015)	15.9	23.2	93%	136%
Mississippi	Synapse (2014)	14.6	17.4	148%	176%
Nebraska	Lincoln Electric System (2014)	3.8	n/a	47%	n/a
Nevada	E3 (2014b)	n/a	13.1	n/a	134%
Nevada	SolarCity/NRDC (2016)	10.3	11.2	109%	118%
North Carolina	Crossborder Energy (2013c)	11.6	12.9	122%	136%
PJM Region	Clean Power Research (2012)	7.5	17.6	51%	121%
Tennessee Valley Authority	TVA (2015)	6.9	7.3	73%	77%
Texas (Austin Energy)	Clean Power Research (2013a)	9.1	11.2	90%	111%
Texas (San Antonio)	Clean Power Research (2013b)	13.3	16.0	143%	173%
Utah	Clean Power Research (2014)	8.3	11.9	97%	139%
Vermont	VT Public Service Dept. (2014)	n/a	24.4	n/a	163%

- Value of solar (VoS) study results vary considerably
  - Reflects differences in scope, methodology, and the characteristics of regions analyzed
- When counting a limited set of "core" costs and benefits (see notes below), most studies fall within 50-150% of the utility's average CoS
  - Lower end reflects low capacity value; mostly just avoided fuel and power purchase expenses
- "Core+" numbers include additional utility value categories (but not societal benefits); range shifted upward **to 90-174%**

Notes: "Core" VoS estimates consist of only avoided energy, RPS purchases, generation capacity, reserves, ancillary services, T&D capacity, and losses, and are net of any solar integration costs. "Core+" estimates include additional ratepayer benefits, which, depending on the study, may include items such as: reduced fuel price risk, reduced costs of future carbon regulations, and cost savings associated with reduced wholesale electricity and/or natural gas prices. Broader societal benefits are excluded from both VoS categories, as the present analysis is focused solely on ratepayer impacts. Cells are marked "n/a" if the VoS value was not estimated or identifiable. For studies that included multiple scenarios, we selected the reference case. For studies that presented ranges, we report the mid-point. The VoS/CoS percentages are calculated by dividing the VoS by the average retail electricity price for the corresponding state or utility, in the year in which the study was performed.

Putting the Potential Rate Impacts of Distributed Solar into Context - Lawrence Berkeley National Lab

Indicative ranges for potential effects on average retail electricity prices

Net-Metered PV: Impact at *current* penetration levels, across a range of VoS assumptions, with purely volumetric rates (U.S. average)

Net-Metered PV: Impact at *projected* 2030 penetration levels, across a range of VoS assumptions, with purely volumetric rates (U.S. average)

Net-Metered PV: Impact at *10% penetration*, across a range of VoS assumptions, with purely volumetric rates (high-pen. utility, U.S. avg. price)

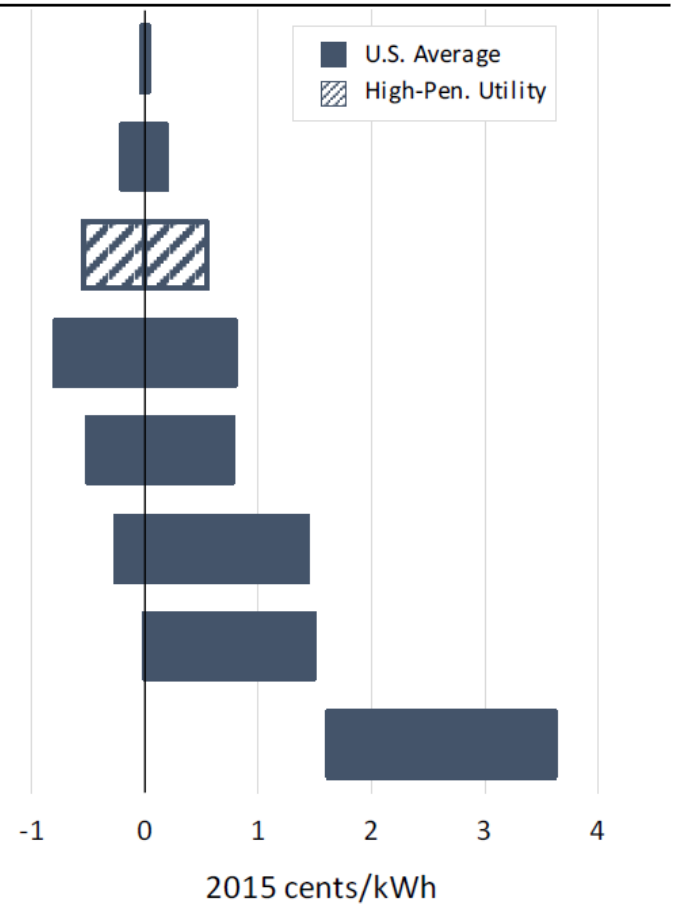
Energy Efficiency: Impact of projected 2015-2030 EE savings, if avoided costs are valued at the same rate as solar (U.S. average)

Natural Gas: Range in retail electricity price across 10th/90th percentile gas price confidence intervals for 2030 (U.S. average)

RPS: Impact in 2030 across low and high cost scenario assumptions (U.S. average, among RPS states)

Carbon: Impact of CPP in 2030 across multiple studies, each considering multiple implementation scenarios (U.S. average)

CapEx: *Gross* impact of electric-industry CapEx through 2030, across range of CapEx trajectories and WACC (U.S. average)



Notes: Current net-metered PV penetration equal to 0.4% of total U.S. retail electricity sales, as of year-end 2015. Projected 2030 net-metered PV penetration is 3.4%, based on Cole et al. (2016). VoS assumptions range from 50% to 150% of average cost-of-service. Please refer to the main body of the report for further details on how the ranges shown here were derived.

Rooftop Solar: Net Metering is a Net Benefit Brookings Report

- Recent Public Utility Commission studies:
  - In 2013 Vermont's Public Service Department conducted a study that concluded that "net-metered systems do not impose a significant net cost to ratepayers who are not net-metering participants."
  - In 2014 a study commissioned by the Nevada Public Utility Commission itself concluded that net metering provided $36 million in benefits to all NV Energy customers
  - A 2014 study commissioned by the Mississippi Public Services Commission concluded that the benefits of implementing net metering for solar PV in Mississippi outweigh the costs in all but one scenario. The study found that distributed solar can help avoid significant infrastructure investments, take pressure off the state's oil and gas generation at peak demand times, and lower rates. (However, the study also warned that increased penetrations of distributed solar could lead to lower revenues for utilities and suggested that the state investigate Value of Solar Tariffs, or VOST, and other alternative valuations to calculate the true cost of solar.)
  - In 2014 Minnesota's Public Utility Commission approved a first-ever statewide "value of solar" methodology which affirmed that distributed solar generation is worth more than its retail price and concluded that net metering undervalues rooftop solar.
  - Another study commissioned by the Maine Public Utility Commission in 2015 put a value of $0.33 per kWh on energy generated by distributed solar, compared to the average retail price of $0.13 per kWh. The study concludes that solar power provides a substantial public benefit because it reduces electricity prices due to the displacement of more expensive power sources, reduces air and climate pollution, reduces costs for the electric grid system, reduces the need to build more power plants to meet peak demand, stabilizes prices, and promotes energy security. These avoided costs represent a net benefit for non-solar ratepayers.

Rooftop Solar: Net Metering is a Net Benefit Brookings Report

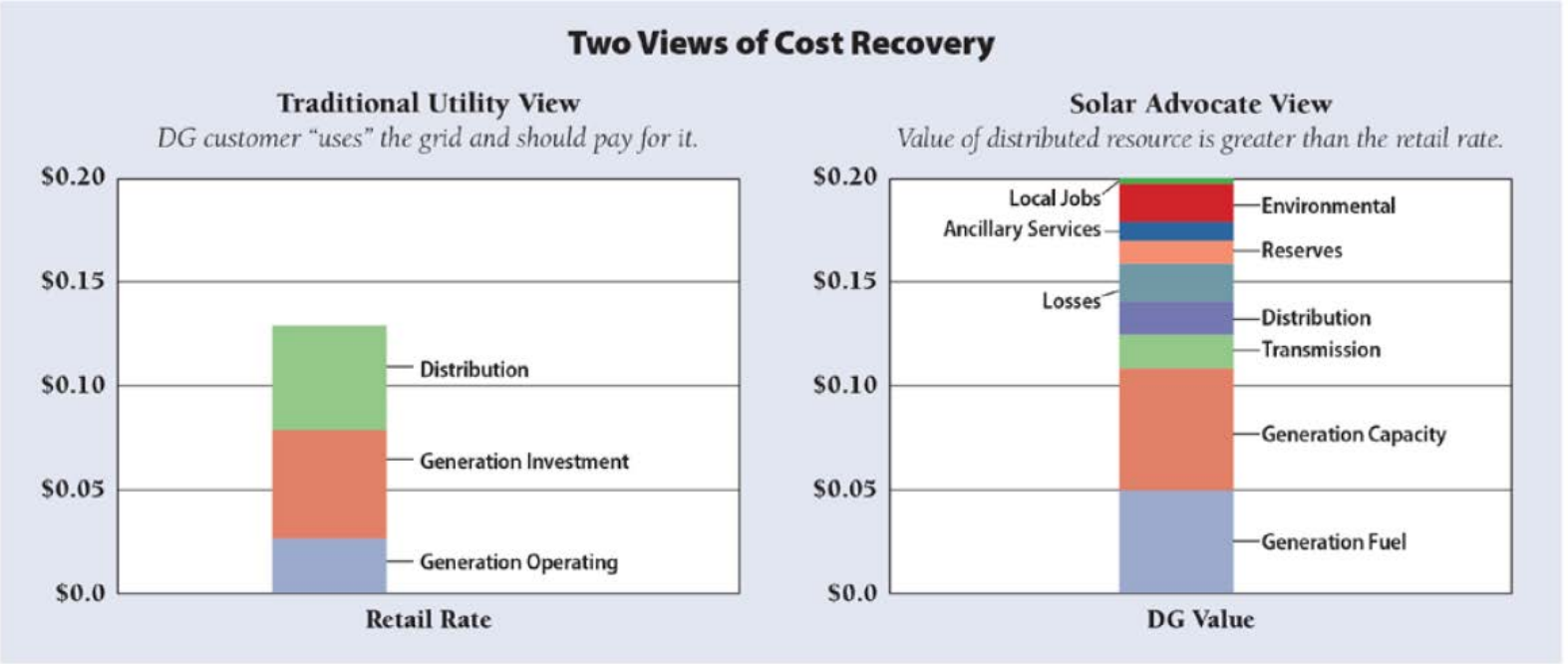
- Other Recent Studies:
  - A review of 11 net metering studies by Environment America Research and Policy Center has found that distributed solar offers net benefits to the entire electric grid through reduced capital investment costs, avoided energy costs, and reduced environmental compliance costs. Eight of the 11 studies found the value of solar energy to be higher than the average local residential retail electricity rate: The median value of solar power across all 11 studies was nearly 17 cents per unit, compared to the nation's average retail electricity rate of about 12 cents per unit.
  - A 2015 cost-benefit study of net metering in Missouri by the Missouri Energy Initiative found that even accounting for increased utility administrative costs and the shifting of some fixed expenses, net metering is a net benefit for all customers regardless of whether they have rooftop solar.
  - A study by Acadia Center found the value of solar to exceed 22 cents per kWh of value for Massachusetts ratepayers through reduced energy and infrastructure costs, lower fuel prices, and lowering the cost of compliance with the Commonwealth's greenhouse gas requirements. This value was estimated to exceed the retail rate provided through net metering.
  - Researchers at the University at Albany, George Washington University, and Clean Power Research have found that solar installations in New York deliver between 15 and 40 cents per kWh to ratepayers. The study noted that these numbers provide economic justification for the existence of incentives that transfer value from those who benefit from solar electric generation to those who invest in solar electric generation.

Conclusion:
"A significant body of cost-benefit research conducted by PUCs, consultants, and research organizations provides substantial evidence that net metering is more often than not a net benefit to the grid and all ratepayers."

Rooftop Solar: Net Metering is a Net Benefit Brookings Report

- Recommendations for PUCs:
  - **Adopt a rigorous and transparent methodology for identifying, assessing, and quantifying the full range of benefits and costs of distributed generation technologies**. In this regard, the Interstate Renewable Energy Council's "A Regulator's Guidebook: Calculating the Benefits and Costs of Distributed Solar Generation" and the National Renewable Energy Laboratory's "Methods for Analyzing the Benefits and Costs of Distributed Photovoltaic Generation to the U.S. Electric Utility System" represent helpful resources for identifying norms in the selection of categories, definitions, and methodologies to measure various benefits and costs.
  - **Undertake and implement a rigorous, transparent, and precise "value of solar" analytic and rate-setting approach that would compensate rooftop solar customers based on the benefit that they provide to the grid**. Seen as an alternative to 'traditional' net-metering rate design, a "value of solar" approach would credit solar owners for (1) avoiding the purchase of energy from other, polluting sources; (2) avoiding the need to build additional power plant capacity to meet peak energy needs; (3) providing energy for decades at a fixed prices; and (4) reducing wear and tear on the electric grid. While calculating the "value of solar" is very complex and highly location-dependent, ultimately PUCs may want to head toward an approach that accurately reflects all benefits and costs from all energy sources.
  - **Implement a well-designed decoupling mechanism that will encourage utilities to promote energy efficiency and distributed generation technologies like solar PV, without seeing them as an automatic threat to their revenues**.
  - **Move towards a rate design structure that can meet the needs of a distributed resource future**.
  - **Move towards a performance-based utility rate-making model for the modern era**.

Designing Tariffs for DG Customers
Regulatory Assistance Project (RAP)



"While net metering is being questioned in some jurisdictions, it nevertheless represents a rough justice premised on the assumption that the rate paid by the customer is equal to the value of the power being produced from the DG system. More precise quantification can occur through a VOS analysis. This analysis looks at all the value provided by a PV system, which may include a variety of externalities that may not typically be considered in an avoided cost calculation. A VOS analysis that includes externalities will more likely than not result in a rate that is higher than a net-metered rate."

How Utilities Are Fighting Back on Solar Power Consumers Reports

- Research shows that solar customers have a positive impact on utility finances because they reduce electricity demand and, therefore, the tremendous expense of adding capacity, says Sara Baldwin Auck, regulatory program director at the Interstate Renewable Energy Council. **“The vast majority of cost-benefit studies show a net benefit from solar,”** she says.
- A February 2016 study commissioned by Consumers Union, the policy and advocacy arm of Consumer Reports, echoed those findings and added that cost-benefit analyses done by utilities should be viewed with skepticism.
- “Solar penetration would have to reach more than 15 percent of the market before utilities would need to make investments to alter the grid,” says Joshua Pearce, a solar expert at the Michigan Tech Open Sustainability Technology Lab.

The Value of Grid-Connected PV in Michigan
National Renewable Energy Lab

- Major Finding:
  - Photovoltaic (PV) value is consistently higher than average electricity prices due to favorable correlation with peak prices.
  - PV in Michigan valued at $0.138/kWh vs. retail rate of $0.106/kWh
    - Study period 2006-2009

- PV Value Components:
  - Energy & Generation
  - Capacity
  - Transmission & Distribution
  - Loss Savings
  - Reactive Power Support
  - Environmental Benefits
  - Other – fuel hedge value, etc.

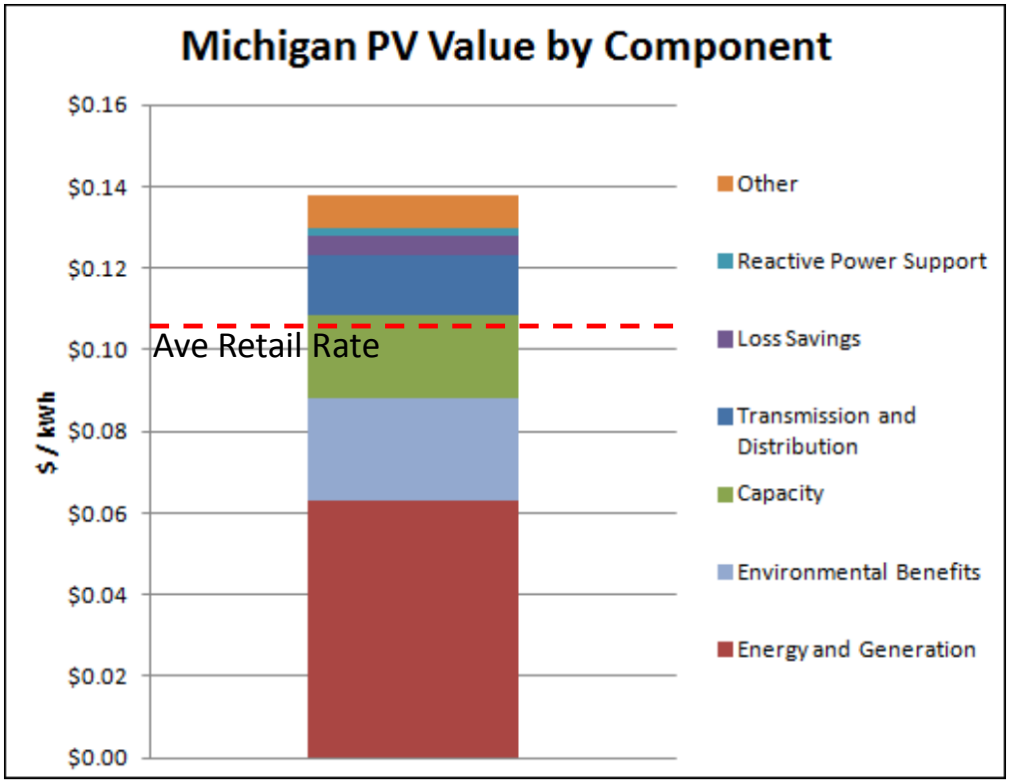


Figure 5. Estimated value of PV in Michigan

Rooftop Solar Systems Provide Economic Benefit to Michigan's Electric Grid – Institute for Energy Innovation (IEI)

- IEI conducted a meta-analysis of 49 studies on the value of solar from across the nation
- Key Findings:
  - The majority of studies conducted to date find that customers participating in net metering programs represent a net benefit to the grid.
  - While NEM customers receive credits that reduce or eliminate their monthly utility bills, solar DG provides measurable and monetizable benefits to the power system that should be considered when evaluating the true impact of solar DG and NEM on all ratepayers.
  - Solar DG both reduces demand for power from the utility and provides power to the grid when the systems generate more power than is used at a residential or commercial site. This surplus power is generated at or near peak times when the cost to the utility of procuring additional power is most expensive.
  - Net energy metering represents an attempt to balance the true costs and benefits of the energy being produced and that which is consumed in a way that is simple, fair, and convenient for both the utility and its customers.
  - Therefore, any tariff should fully compensate solar DG customers for the value their systems provide.
- Recommendation:
  - Establish a Uniform System of Valuation for Solar DG by using the IREC Value of Solar Methodology
  - Adopting a transparent, comprehensive standard valuation methodology such as the IREC model can help ensure full accounting of both the costs and benefits of solar DG

Valuing Solar DG in MI
University of Michigan / Dow Fellows

- Calculated the value of three solar externalities in Michigan:
  - Fuel Price Hedge
  - Environmental Benefit
  - Reactive Supply and Voltage Control
- Findings:
  - Value of Fuel Price Hedge + Environmental Benefit is $0.042/kWh
  - Value of Reactive Supply & Voltage Control is negligible
- Recommendations for the MPSC:
  - Include solar externalities in a value of solar tariff if the MPSC chooses to adopt this policy.
  - Conduct a complete value of solar analysis for Michigan that includes all of the solar externalities in order to determine the true value of DSG in Michigan

Utility Efforts Against DG

- Utilities lobbied hard in 2015-2016 for legislation ending or significantly weakening net metering in Michigan, mirroring efforts across the country[1,2,3,4,5,6,7,8]:
  - Original bill would have made DG customers purchase all electricity used at retail, and sell all electricity generated at wholesale
  - Second iteration left net metering in place, but would have required a TBD monthly grid usage charge for DG customers
  - Final bill required a new TBD tariff for DG customers
  - **"If someone wants to do solar just because they want to do it, if they're OK with an 18 or 20 year payback, they can do it." [2]**
    - Irene Dimitry, Vice President of Business Planning and Development for DTE Energy, in 2015
- Avoided Energy Cost of Service is the Outflow Credit Approach put forth by Utilities
  - Purposely limited view of the value of solar intended to undercut and stifle the DG market
  - Should we expect Utilities to propose something fair and reasonable?
    - Utilities are beholden to shareholders, not the ratepaying public
    - Utilities expect return on big lobbying investment
      - Utilities spent more than $1.6M in 2015, even more in 2016 [3] [6]
      - In 2016, DTE employed 26 lobbyists, Consumers Energy employed 15 lobbyists [7] [8]
- Instead of working to kill the solar DG market, Utilities should be working to harness the benefits of expanding solar DG and distributed energy storage

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(1) Lawler, E. (Dec 2016). *House Democrats prioritize solar net metering changes in energy debate*. Mlive.com. Available at: http://www.mlive.com/news/index.ssf/2016/12/house_democrats_prioritize_sol.html

(2) Lawler, E. (Aug 2015). *Solar owners who want to feed into grid may not be able to use their own energy under Senate proposal.* Mlive.com. Available at: http://www.mlive.com/lansing-news/index.ssf/2015/08/solar_owners_may_not_be_able_t.html

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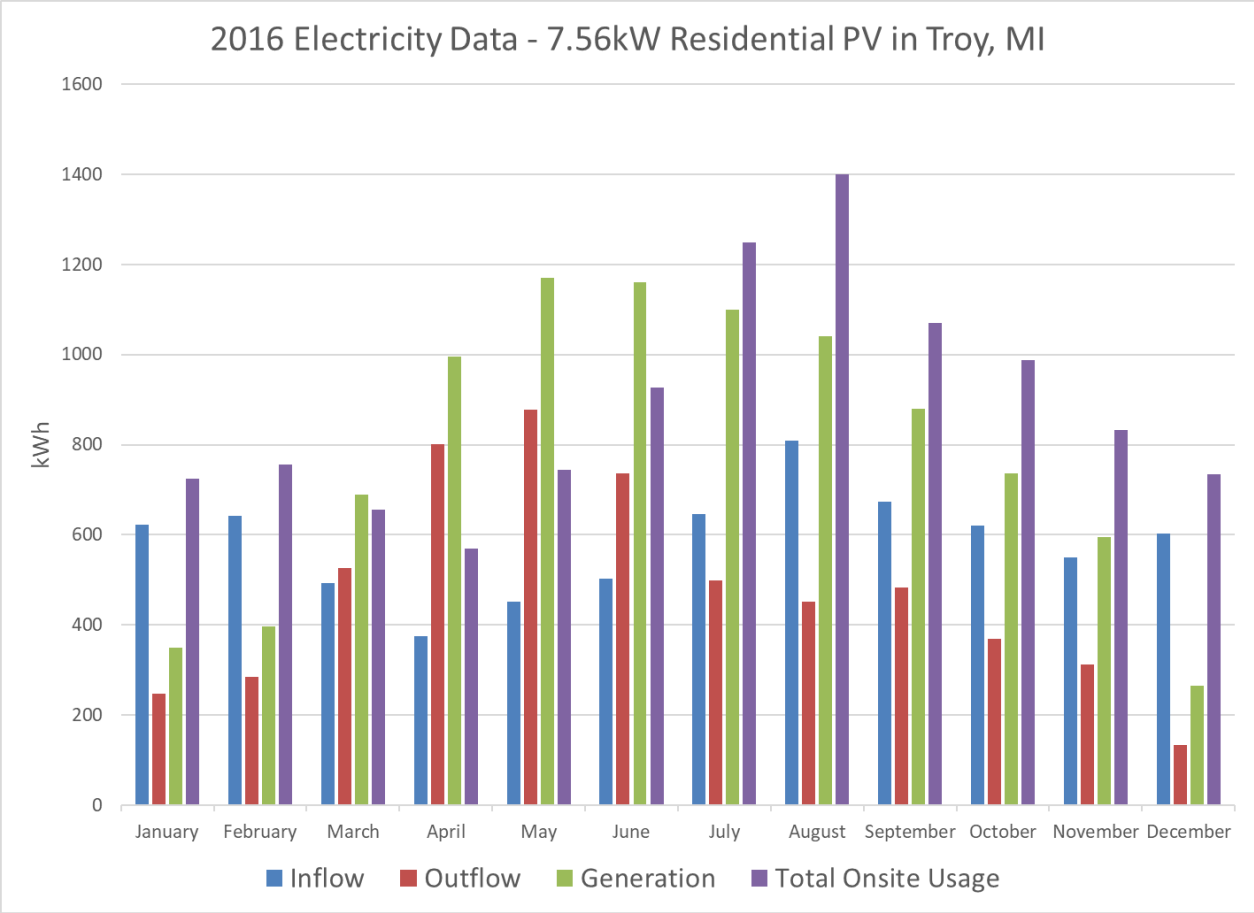
Solar DG Case Study

7.56kW Residential Solar Installation in Troy, MI

- 24 SolarWorld 315W Panels w/ SolarEdge Optimizers and 7.6kW SolarEdge Inverter
  - Panels facing south, nearly un-shaded, flush-mounted to roof at 18.4°
  - Installed Cost w/ 30% ITC = $16,100
  - Interconnected since July 2015
- PV generation supplies 86-88% of annual electrical consumption
  - Under current NEM, annual electric bills are reduced by 78-82%
    - Fixed service fees + charges
  - Simple Payback = 12 years
- If Inflow-Outflow is implemented with Staff outflow proposal of ~$0.075/kWh
  - Annual electric bill would increase by 242% vs NEM
  - Simple Payback would increase by 50% to 18 years
  - Not economically viable

Solar DG Case Study

7.56kW Residential Solar Installation in Troy, MI



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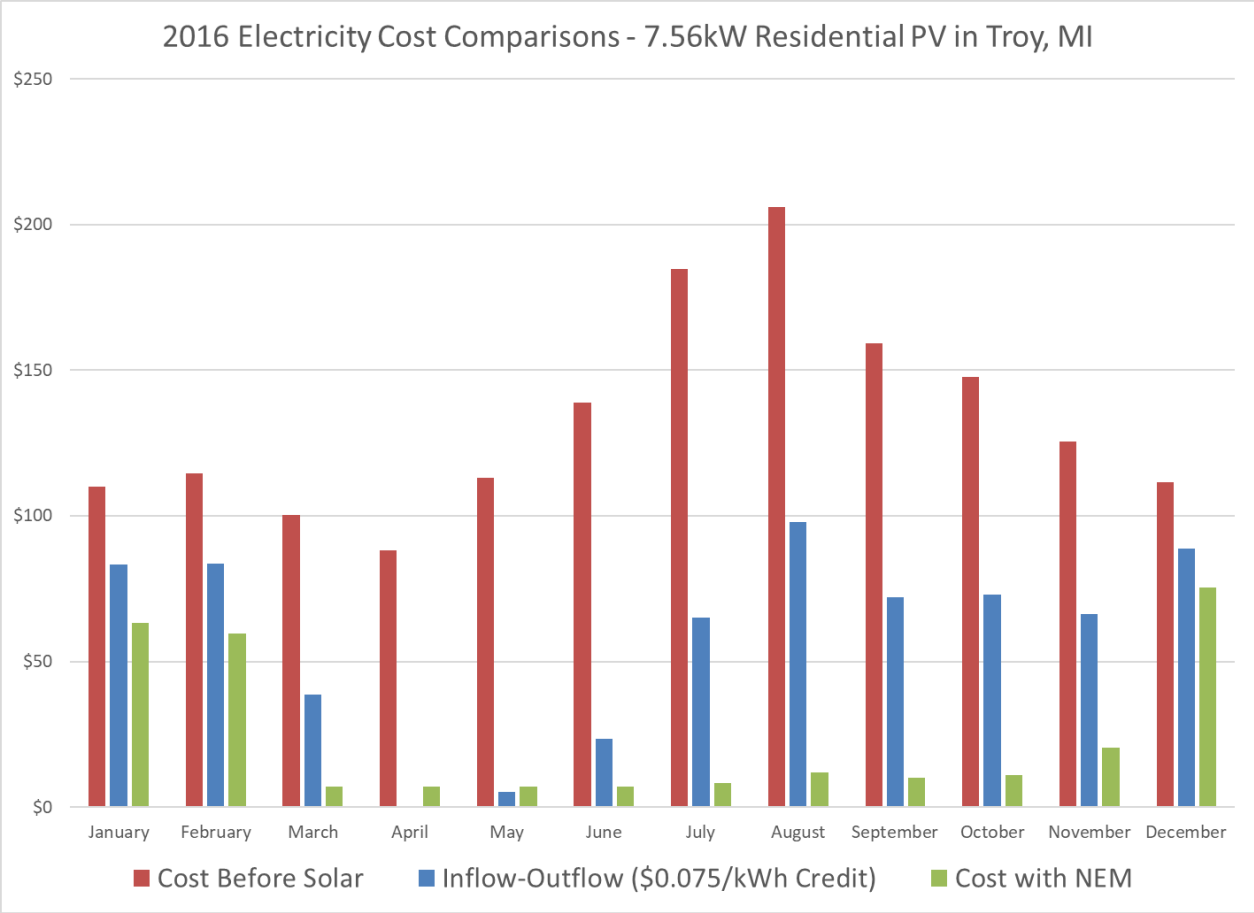

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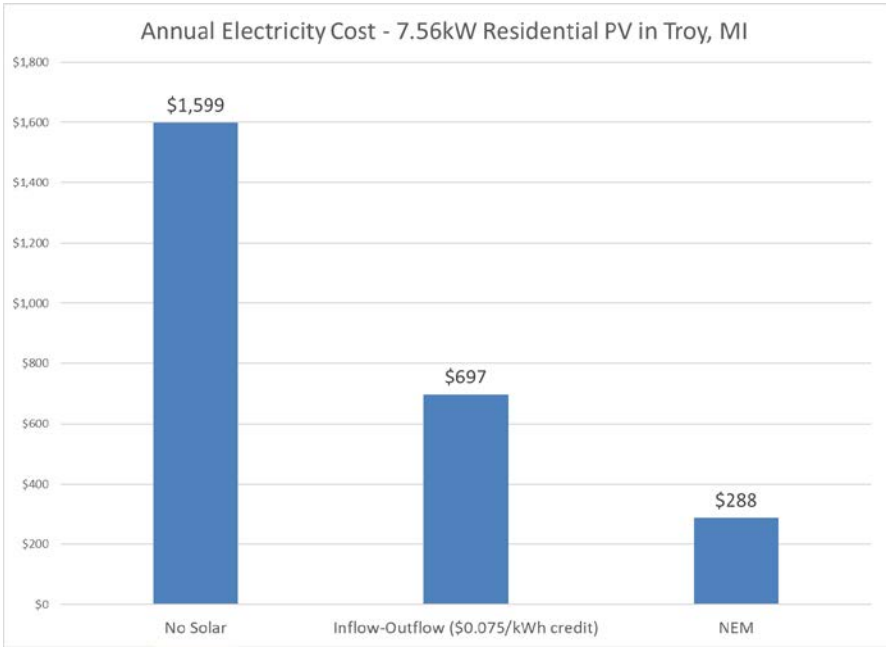

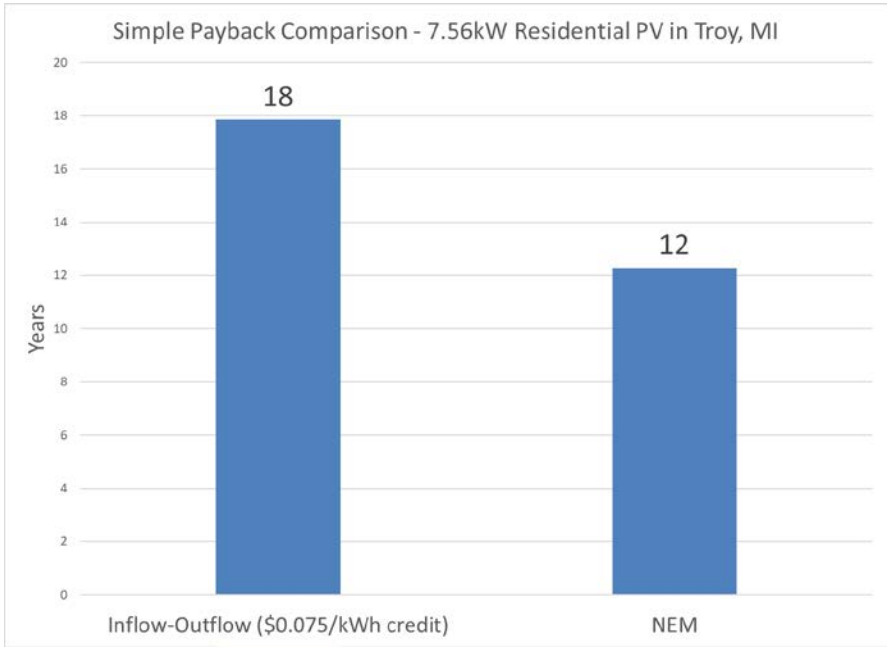

Recommendations

- **Option 1:** Consider leaving net metering in place with no changes until DG market penetration approaches 5%
  - At low market penetrations, NEM actually under-compensates DG customers and benefits the Utility and non-DG ratepayers, and provides a simple, stable, and easy-to-understand billing mechanism
  - Actual DG market penetration in MI is extremely low at 0.02%, and capped at 1%
  - 5% market penetration represents a 25,000% increase in solar DG in MI
- **Option 2:** If using Inflow-Outflow method, implement the following:
  - Inflow rate and Outflow credit should be Time-of-Use (TOU) based
  - Conduct a true value of solar calculation for the outflow credit, not the limited avoided energy cost of service calculation proposed by the Utilities
  - Adopt a transparent, comprehensive standard valuation methodology such as the IREC model to fully account for the costs and benefits of solar DG
  - As DG market penetration increases:
    - Incentives for distributed energy storage (residential batteries and V2G) should be enacted to mitigate the effects of excessive grid-wide outflow and swings in output due to weather
      - TOU rates naturally help to incentivize this
    - At high penetration rates, outflow credit will adjust downward to account for necessary grid upgrades and maintenance costs

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