Resource Value of Solar (RVOS) Methodologies

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for

Renewable Northwest

Who is looking into RVOS?

States Considered

- Maine
- Minnesota
- Nebraska
- Texas
- Tennessee

Fun Facts

- The Minnesota PUC created the first statewide VOS methodology.[1]
- To this day, the only utility to adopt a VOS methodology is Austin Energy.[2]

1)A New "Sunshine State"? Evaluating Minnesota's Value of Solar Tariff Methodology. Miller, Addison O. Spring, 2016. George Washington Journal of Energy and Environmental Law. Retrieved from https://gwujeel.files.wordpress.com/2016/05/addison-o-miller-note-a-new-22sunshine-state22-evaluating-minnesotas-value-of-solar-tariff-methodology-7-geo-wash-j-energy-envtl-l-177-2016.pdf

2)Rate Design for Distributed Generation: Net Metering Alternatives. Zummo, Paul. American Public Power Association (APPA). June, 2015. Retrieved from http://www.publicpower.org/files/PDFs/Rate_Design_for_DG-_Net_Metering_final.pdf

Austin Energy (Texas)

About the Utility

- Publically Owned Utility regulated by the Austin City Council
- Future Approach to NEM:
  - Austin Energy uses a Value-of-Solar Rate which is a tariff rider set annually through the AE budget approval process.[3]
    - Reassessed each year using calculations for value components.

Methodology Details

- Prepared by CPR
- CPR helped AE use a multi-factor VOS energy calculator which uses an avoided cost calculation and simplified net metering charge and credit approach.[4]
- **Value Components:**
  - Loss savings
  - Energy savings
  - Generation Capacity savings
  - Fuel Price Hedge Value
  - T&D Capacity Savings
  - Environmental Benefits
- Resulted in a VOS of $0.128/kWh

3) City of Austin Electric Tariff: Value-of-Solar Rider. 2015. Retrieved from http://my.austinenergy.com/wps/wcm/connect/c6c8ad20-ee8f-4d89-be36-2d6f7433edbd/ResidentialSolar.pdf?MOD=AJPERES

4) Designing Austin Energy's Solar Tariff Using a Distributed PV Calculator. Rabago, Karl R. March, 2011. Retrieved from https://www.cleanpower.com/wp-content/uploads/090_DesigningAustinEnergysSolarTariff.pdf

Where the Data Comes From

- Energy Value is inferred from the Electric Reliability Council of Texas (ERCOT) wholesale market price data and future natural gas prices come from the New York Mercantile Exchange (NYMEX)[4]
- Plant O&M Value[4]
- Generation Capacity Value is inferred from ERCOT market price data[4]
- T&D Value[4]
- Environmental Compliance Value is set at $0.015/kWh based on the societal cost of carbon estimates[4]

4) 2018 Value of Solar (VOS) Update. Electric Utility Commission. May, 2017. Retrieved from http://www.austintexas.gov/edims/document.cfm?id=276970

Assumptions

- **Generating Overnight Capacity Cost:** $676/kW
- **Generation Life:** 30 years
- **Reserve Planning Margin:** 13.75%
- **Heat Rate:** 8024 BTU/kWh
- **Heat Rate Degradation:** 0% per year
- **O&M Cost (first year)-Fixed:** $7.04/kW-yr.
- **Discount Rate:** Various/yr.
- **General Escalation Rate:** 2.10% per year
- **Avoided Environmental Cost:** $0.015/kWh
- **Environmental Value Escalation Rate:** 2.60% per year
- **Capacity-Related Capital Cost (Transmission):** $28.0/kW-yr.
- **Years until new capacity is needed (Transmission):** 0
- **Capacity-Related Capital Cost (Distribution):** $0/kWh
- **PV Degradation:** 0.5% per year
- **PV Life:** 25 years

5) Value of Solar Methodology. Chakka, Babu. May, 2014. Retrieved from http://www.austintexas.gov/edims/document.cfm?id=210805

AE Calculations

Equations[5]

1) $GFV = EV * (1+LF)$

2) $EV = (\Sigma HR*GP*RFDF)/(\Sigma PVP*RFDF)$

3) $PlantO\&MValue = ((\Sigma O\&M_{cost}*(1+i)^{y}*PVC*RFDF)/(\Sigma PVP*RFDF))*(1+LF)$

4) $GCV=((\Sigma ACCC*PVC*RFDF)/(\Sigma PVP*RFDF))*LM*(1+LF)$

5) $ATC=((\Sigma TC*PVC*RFDF)/(\Sigma(PVP*RFDF))*LM*(1+LF)$

Key

- Guaranteed Fuel Value = GFV
- Energy Value = EV
- Load Factor = LF
- Heat Rate = HR
- Gas Price = GP
- Risk Free Discount Factor = RFDF
- PV Capacity = PVC
- PV Production = PVP
- Avoided Transmission Cost = ATC
- TransmissionCost (TC) = AE contribution to ERCOT transmission cost.[5]
- LoadMatch (LM) = Average of percentage of solar generation with respect to its capacity for top 10 peak hours of each summer month.[6]

5) Value of Solar Methodology. Chakka, Babu. May, 2014. Retrieved from http://www.austintexas.gov/edims/document.cfm?id=210805
6) 2018 Value of Solar (VOS) Update. Electric Utility Commission. May, 2017. Retrieved from http://www.austintexas.gov/edims/document.cfm?id=276970

Successes and Downfalls

What Worked

- Customers currently benefit from AE's incentive program.[7]
  - Incentive is received for every kWh the system produces for the first 10 years.
  - The 10 year time frame incentivizes customers with large systems to properly maintain the system.

What Didn't Work

- Updating VOS rate annually.[7]
  - AE has proposed to its committee to change the update time frame to every 4-5 yrs.

7) Austin Energy Proposed Value of Solar for Commercial Properties. Brugal, Sommer. April, 2017. Retrieved from https://www.austinmonitor.com/stories/2017/04/austin-energy-proposes-value-solar-commercial-properties/

Minnesota

About the State

- Public Utility Commission
- Future Approach to NEM:
  - Voluntary Value of Solar Tariff.[8]

Methodology Details

- Prepared by CPR
- Value Components
  - Avoided fuel cost
  - Avoided plant O&M cost
  - Avoided generation capacity cost
  - Avoided reserve capacity cost
  - Avoided transmission capacity cost
  - Avoided distribution capacity cost
  - Avoided environmental cost
  - Voltage control
  - Integration cost
- Methodology leads to an output of a VOS data table containing utility-specific input assumptions and a VOS calculation table of utility-specific total value of solar values to calculate a 25-year levelized value.[9]
- Load analysis period of at least one year allows the utility to gather time-series data[9]
  - Hourly generation load, hourly distribution load, and hourly PV fleet production
- A rating convention used for PV capacity based on AC delivery energy[9]
- Last step of the methodology involves converting the 25-year levelized value to an equivalent inflation-adjusted credit[9]
  - Utility uses the first year credit for solar customers, other years are adjusted using the latest Consumer Price Index (CPI)

8) Minnesota's 2025 Energy Action Plan. pg. 30 Rocky Mountain Institute. August, 2016. Retrieved from http://mn.gov/commerce-stat/pdfs/mn-e2025-finalreport.pdf.
9) Minnesota Value of Solar: Methodology. Minnesota Department of Commerce, Division of Energy Resources. January, 2014. Retrieved from https://www.cleanpower.com/wp-content/uploads/MN-VOS-Methodology-2014-01-30-FINAL.pdf

Where the Data Comes From

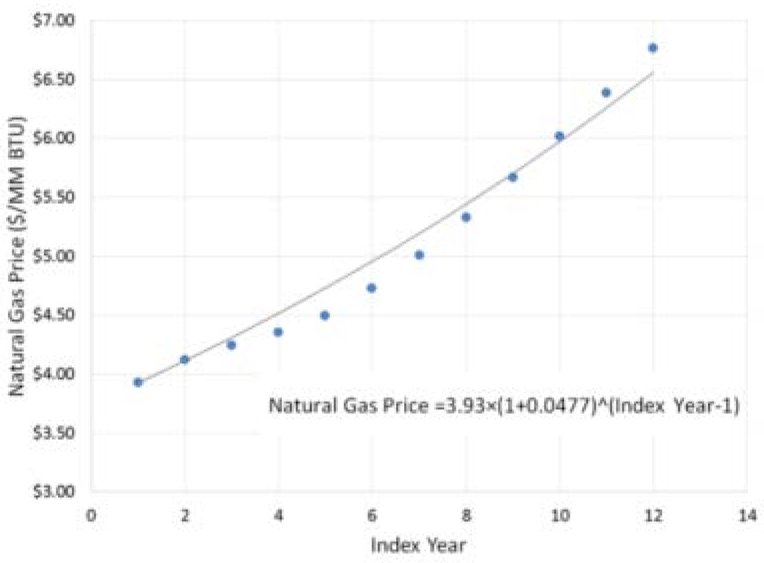
- **Utility fleet data** comes from metered production or simulated production.
- **Expected fleet data** comes from simulated production.
- **Hourly Generation Load:** sum of utility generation and import power needed to meet all customer load.
- **Hourly Distribution Load:** the power entering the distribution system from the transmission system (i.e. generation load minus transmission losses).
- **Hourly PV Fleet Production:** PV fleet production is the aggregate generation of all the PV systems in the PV fleet.

9) Minnesota Value of Solar: Methodology. Minnesota Department of Commerce, Division of Energy Resources. January, 2014. Retrieved from https://www.cleanpower.com/wp-content/uploads/MN-VOS-Methodology-2014-01-30-FINAL.pdf

Assumptions

- An expected general escalation rate is created by calculating an average annual inflation rate over the last 25 years using published values for the Urban Consumer Price Index (UCPI) (ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt): 2.53%.
- The "Guaranteed NG Fuel Price Escallation" is calculated to be 4.77% by using a best fit of the listed NYMEX future prices (shown in Figure 1).
- PV degradation rate = 0.5/yr.
- PV life = 25 years.
- UTILITY SPECIFIC ASSUMPTIONS: Economic assumptions (i.e. discount rate) and technical calculations (i.e. ELCC)

Figure 1: Fit to NYMEX NG future prices



9) Minnesota Value of Solar: Methodology. Minnesota Department of Commerce, Division of Energy Resources. January, 2014. Retrieved from https://www.cleanpower.com/wp-content/uploads/MN-VOS-Methodology-2014-01-30-FINAL.pdf

Minnesota VOST Calculations

Equations

1) $25YearAverageAnnualInflation = ((Nov2013UCPI/Nov1988UCPI)^{((1/(2013-1988)))}-1 = (224.939/120.300)^{(1/25)}-1 = 2.53\%$
2) $Rating (kW\text{-}AC) = MQ * MPTCR * IER * LF$
3) $AAE = (\Sigma HPVFP_h)/(Y)$
4) $AAE_{withlosses} = AAE_{withoutlosses} *(1+LS_{Energy})$
5) $LS_{Energy}=(AAE_{withlosses}/AAE_{withoutlosses})-1$
6) $LS_{PLR}=(PLRwith_{losses}/PLR_{withoutlosses})-1$
7) $LS_{ELCC}=(ELCC_{withlosses}/ELCC_{withoutlosses})-1$
8) $DF=1/(1+DR)^I$
9) $RFDF_i=1/(1+RFDR)^i$
10) $EDF_i=1/(1+EDR)^I$
11) $NDR=(1+RDR)*(1+GER)-1$
12) $PVP_i=PVP_0*(1-PVDR)^I$
13) $PVC_i=(1-PVDR)^i$
14) $SWHR_0=(\Sigma HR_j)*(FP_j))/(\Sigma FP_j)$
15) $UP_j=(BFP_j*SWHR_j)/10^6$
16) $UCost=(O\&M_{fixed}*PVC)/(UCap)$
17) $UP=(UCost)/(PVP)$
18) $Cost = Cost_{CCGT} + (HR_{PV} - HR_{CCGT}) * ((Cost_{CT}-Cost_{CCGT})/(HR_{CT} - HR_{CCGT})$

9) Minnesota Value of Solar: Methodology. Minnesota Department of Commerce, Division of Energy Resources. January, 2014. Retrieved from https://www.cleanpower.com/wp-content/uploads/MN-VOS-Methodology-2014-01-30-FINAL.pdf

Calculation Table

Figure ES-1. VOS Calculation Table: economic value, load match, loss savings and distributed PV value.

25 Year Levelized Value	Gross Value ($/kWh)	×	Load Match Factor (%)	× (1 +	Loss Savings Factor (%)	)	=	Distributed PV Value ($/kWh)
Avoided Fuel Cost	GV1				LSF-Energy			V1
Avoided Plant O&M - Fixed	GV2				LSF-Energy			V2
Avoided Plant O&M - Variable	GV3				LSF-Energy			V3
Avoided Gen Capacity Cost	GV4		ELCC		LSF-ELCC			V4
Avoided Reserve Capacity Cost	GV5		ELCC		LSF-ELCC			V5
Avoided Trans. Capacity Cost	GV6		ELCC		LSF-ELCC			V6
Avoided Dist. Capacity Cost	GV7		PLR		LSF-PLR			V7
Avoided Environmental Cost	GV8				LSF-Energy			V8
Avoided Voltage Control Cost								
Solar Integration Cost								
								Value of Solar

9) Minnesota Value of Solar: Methodology. Minnesota Department of Commerce, Division of Energy Resources. January, 2014. Retrieved from https://www.cleanpower.com/wp-content/uploads/MN-VOS-Methodology-2014-01-30-FINAL.pdf

Minnesota VOST Equation Key

- Module Quantity = MQ
- Module PTC Rating (kW) = MPTCR
- Inverter Efficiency Rating = IER
- Loss Factor = LF
- Annual Avoided Energy (kWh) = AAE
- Hourly PV Fleet Production = HPVFP
- Number of years in load analysis period = Y
- Loss Savings = LS
- Peak Load Reduction = PLR
- Effective Load Carrying Capability = ELCC
- Discount Factor = DF
- Discount Rate (DR) = Utility weighted average cost of capital
- Risk Free Discount Factor = RFDF
- Risk Free Discount Rate (RFDR) = based on yields of current Treasury Securities of 1,2,3,5,7,10,20,&30 year maturation dates
- Environmental Discount Factor = EDF
- Environmental Discount Rate (EDR) = based on 3% real discount rate determined to be appropriate societal discount rate for future environmental benefits. Equivalent to 5.61% NDR.
- Nominal Discount Rate = NDR
- Real Discount Rate = RDR
- General Escalation Rate = GER
- PV Production (PVP_0) = annual avoided energy for marginal PV resource
- PV Degradation Rate (PVDR) = annual rate of PV degradation assumed to be 0.5% per year.
- Initial Solar-Weighted Heat Rate = $SWHR_0$
- Heat Rate (HR) = units of Btu/kWh, actual HR of plant on margin
- Solar-Weighted Heat Rate = HR_{PV}
- Fleet Production (FP) = fleet production shape time series
- Utility Price = UP
- Burnertip Fuel Price = BFP
- Utility Cost = UCost
- PV Capacity = PVC
- Utility Capacity = UCap
- i=year
- j=hour

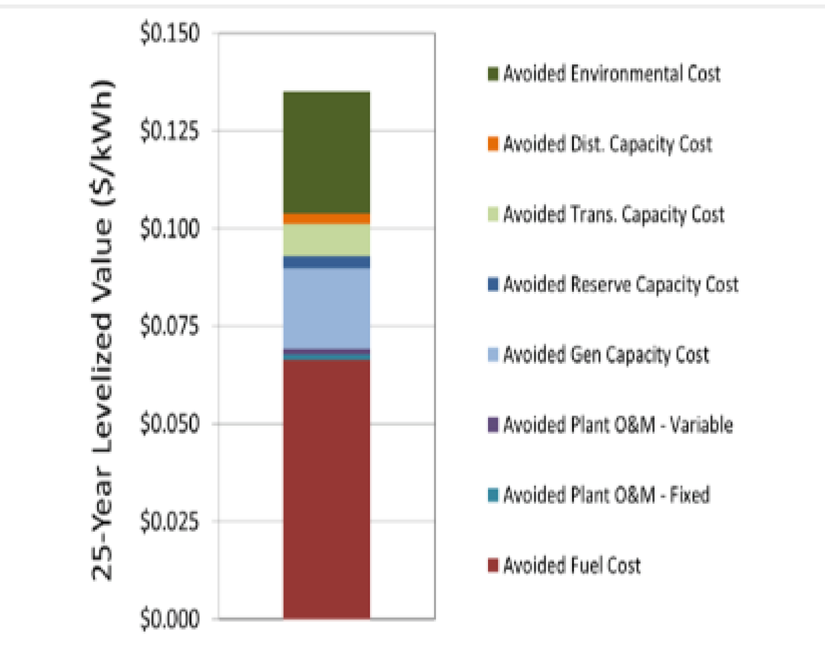
9) Minnesota Value of Solar: Methodology. Minnesota Department of Commerce, Division of Energy Resources. January, 2014. Retrieved from https://www.cleanpower.com/wp-content/uploads/MN-VOS-Methodology-2014-01-30-FINAL.pdf

Example of Final Values

Figure 3. (EXAMPLE) VOS Levelized Calculation Chart (Required).

25 Year Levelized Value	Gross Starting Value ($/kWh)	x	Load Match Factor (%)	x (1 +	Loss Savings Factor (%)	) =	Distributed PV Value ($/kWh)
Avoided Fuel Cost	$0.061				8%		$0.066
Avoided Plant O&M - Fixed	$0.003		40%		9%		$0.001
Avoided Plant O&M - Variable	$0.001				8%		$0.001
Avoided Gen Capacity Cost	$0.048		40%		9%		$0.021
Avoided Reserve Capacity Cost	$0.007		40%		9%		$0.003
Avoided Trans. Capacity Cost	$0.018		40%		9%		$0.008
Avoided Dist. Capacity Cost	$0.008		30%		5%		$0.003
Avoided Environmental Cost	$0.029				8%		$0.031
Avoided Voltage Control Cost							
Solar Integration Cost							
							$0.135

Figure 4. (EXAMPLE) Levelized value components.



9) Minnesota Value of Solar: Methodology. Minnesota Department of Commerce, Division of Energy Resources. January, 2014. Retrieved from https://www.cleanpower.com/wp-content/uploads/MN-VOS-Methodology-2014-01-30-FINAL.pdf

Successes and Downfalls

What Worked

- Separating usage (charges) from production (credits)[9]
  - This simplifies the rate process since PV systems do not offset usage before calculating charges
  - Ensures utility infrastructure costs are recovered by the utility
  - Rates for usage can be adjusted in future ratemaking

What Didn't Work

- Allowing VOST to be voluntary for the utility[10]
  - No utility has adopted VOST in place of NEM
- Not ensuring VOST is financially attractive to utilities
- Placing a 3-year restriction on charging below the retail rate
- Having a 25 year long contract term

9) Minnesota Value of Solar: Methodology. Minnesota Department of Commerce, Division of Energy Resources. January, 2014. Retrieved from https://www.cleanpower.com/wp-content/uploads/MN-VOS-Methodology-2014-01-30-FINAL.pdf

10) A New "Sunshine State"? Evaluating Minnesota's Value of Solar Tariff Methodology. Miller, Addison O. Spring, 2016. George Washington Journal of Energy and Environmental Law. Retrieved from https://gwujeel.files.wordpress.com/2016/05/addison-o-miller-note-a-new-22sunshine-state22-evaluating-minnesotas-value-of-solar-tariff-methodology-7-geo-wash-j-energy-envtl-l-177-2016.pdf

Lincoln Electric System (Nebraska)

About the Utility

- Municipal Utility regulated by Nebraska Power Review Board (NPRB)
- Future approach to net metering:
  - VOS Study used to improve current net metering structure
    1. Identify true value of distributed solar in order to develop a reference for measuring incentives.
    2. Revisit current net-metering rate, determine how to improve support for customer-owned generation.
    3. Develop a way for customers "without a roof" to contribute to a solar program

Methodology Details

- Prepared by Lincoln Electric System (LES)
- **Value Components:**
  - Energy
  - Generation Capacity
  - Transmission Capacity & Losses
  - Distribution Capacity & Losses
  - Environmental

11) LES Solar Program Portfolio: Understanding Rate Implications. Benson, Scott. November, 2016. Retrieved from http://www.neo.ne.gov/renew/wind-working-group/2016conference/scott-benson.pdf

Where the Data Comes From

- **Base Case Load Profile:** from LES 2013 Long-Range Forecast
- **Solar Modeling:** Solar output for each orientation is modeled using NREL PVWatts tool, output is shifted one week to coincidize solar output peak in July with LES's peak load in July
- **Power Costs Analysis:** analysis captures any direct benefits/costs represented by a componenet of the LES load's Locational Marginal Price (LMP): energy, transmission congestion (representing transmission capacity), and marginal transmission losses, resulting change in market LMP leads to indirect benefits/costs due to changes in LES unit production levels
- **Generation Capacity Benefit:** reflects net-present value (NPV) savings of moving construction costs back one year, "Base Case" includes new 126 MW GE LM6000 2x1 combined cycle in 2030 and "Solar Case" moves to 2031 with costs escalated 2.2%
- **Environmental Benefits:** based on leveraging the value of RECs
- **Distribution System Benefits (Capacity Losses):** Energy Delivery (ED) showed LES how to calculate "loss factor", or average energy losses incurred over a distribution network, where calculated losses are assigned a value based on LES's Large Light and Power (LLP) rate.

12) LES Value of Distributed Photovoltaic Solar Study. Benson, Scott. March, 2014. Retrieved from https://www.les.com/pdf/solar-study-presentation.pdf

Assumptions

- **Solar Modeling:** 50 MW-DC Solar installed "overnight" in 2014 and mixed solar orientation: South 60%, Southwest 25%, West 25%
- **Power Costs Analysis:** 20 yr. feed-in-tariff type solar contract (2014-2033), all solar in "solar case" in service on 1/1/2014, solar is operated at zero cost to LES meaning difference in power costs reflects savings to serve reduced load from solar power plant (SPP)
- **Generation Capacity Benefit:** LES does not offer an upfront capacity payment meaning capacity benefit is captured as part of the energy payment.
- **Environmental Benefits:** LES retains rights to REC's, selling them at market value, annual REC price escalatin was reduced evenly after 2016 until hitting inflation rate (2.2%) in year ten and remained fixed at that level through the remainder of the study.

12) LES Value of Distributed Photovoltaic Solar Study. Benson, Scott. March, 2014. Retrieved from https://www.les.com/pdf/solar-study-presentation.pdf

Successes and Downfalls

What Worked

- VOS program would "essentially have no net impacts on rates over 20 years."

What Didn't Work

- Study shows that net metering is more attractive than VOS for LES customers.

12) LES Value of Distributed Photovoltaic Solar Study. Benson, Scott. March, 2014. Retrieved from https://www.les.com/pdf/solar-study-presentation.pdf

Maine

About the State

- Public Utility Commission
- Future approach to NEM:
  - Value of Solar
    - Determine value of distributed solar generation in state
    - Evaluate implementation options
    - Deliver report to legislature

Methodology Details

- Prepared by CPR
- Value Components
  - Avoided Energy Costs
  - Avoided NG Pipeline Cost (future placeholder)
  - Solar Integration Costs
  - Avoided Transmission Capacity Costs
  - Avoided Distribution Capacity Costs
  - Voltage Regulation(future placeholder)
  - Net Social Cost of Carbon, SO_2, and No_x
  - Market Price Response
  - Avoided Fuel Price Uncertainty
- Load Analysis Period
  - The methodology requires that technical parameters such as PV energy production, ELCC, PLR load match factors, and electricity loss factors be calculated over a fixed period of time to account for solar radiation changes.
- Calculates the value of a group (fleet) of PV systems
  - i.e. all systems in a common utility service territory
- By statute (The Main Solar Energy Act), the methodology must at least account for the following:
  - Value of the energy
  - Market price effects for energy production
  - Value of energy delivery
  - Value of generation capacity
  - Value of transmission capacity
  - T&D line losses
  - Societal value of reduced environmental impacts of the energy
- PV capacity is determined by a rating convention based on AC delivery and is weighted by zip code population

13) Maine Distributed Solar Valuation Study. Norris, B.L. and Gruenhagen P.M. Clean Power Research. April, 2015. Retrieved from http://www.maine.gov/mpuc/electricity/elect_generation/documents/MainePUCVOS-ExecutiveSummary.pdf
14) Maine Distributed Solar Valuation Study. Norris, B.L. and Gruenhagen P.M. Clean Power Research. April, 2015. Retrieved from http://www.maine.gov/mpuc/electricity/elect_generation/documents/MainePUCVOS-FullRevisedReport_4_15_15.pdf

Where the Data Comes From

- **Avoided Energy Cost:** Hourly avoided wholesale market procurements, based on ISO New England Inc. (ISO-NE) day ahead locational marginal prices for the Maine Load Zone.

- **Avoided Generation Capacity and Reserve Capacity Costs:**
  - **Avoided Generation:** ISO-NE Forward Capacity Market (FCM) auction clearing prices, followed by forecasted capacity prices by the ISO's consultant.
  - **Reserve Capacity:** ISO's reserve planning margin is applied.

- **Solar Integration Costs:** Operating reserves required to handle fluctuations in solar output, based on the New England Wind Integration Study (NEWIS) results.

- **Avoided Transmission Capacity Cost:** ISO-NE Regional Network Service (RNS) cost reductions caused by coincident solar peak load reduction.

- **Net Social Cost (Carbon, SO_2, No_x):** EPA estimates of social costs, reduced by compliance costs embedded in wholesale electricity prices.

- **Market Price Response:** Temporary reduction in electricity and capacity prices resulting from reduced demand, based on the Avoided Energy Supply Costs in New England (AESC) study.

- **Avoided Fuel Price Uncertainty:** The cost to eliminate long term price uncertainty in NG fuel displaced by solar.

14) Maine Distributed Solar Valuation Study. Norris, B.L. and Gruenhagen P.M. Clean Power Research. April, 2015. Retrieved from http://www.maine.gov/mpuc/electricity/elect_generation/documents/MainePUCVOS-FullRevisedReport_4_15_15.pdf

Assumptions

- **AC Rating:** 77% of DC rating at standard test conditions
- **PV Life:** 25 years
- **Marginal Fuel:** PV displaces natural gas
- **Solar Profile:** Assumed to be the same state-wide

14) Maine Distributed Solar Valuation Study. Norris, B.L. and Gruenhagen P.M. Clean Power Research. April, 2015. Retrieved from http://www.maine.gov/mpuc/electricity/elect_generation/documents/MainePUCVOS-FullRevisedReport_4_15_15.pdf

Maine VOS Calculations

1) $AAE = (\Sigma HPVFP_h)/(Y)$
2) $AAE_{withlosses} = AAE_{withoutlosses} * (1+LS_{Energy})$
3) $LS_{Energy} = (AAE_{withlosses} / AAE_{withoutlosses}) - 1$
4) $LS_{PLR} = (PLRwith_{losses} / PLR_{withoutlosses}) - 1$
5) $LS_{ELCC} = (ELCC_{withlosses} / ELCC_{withoutlosses}) - 1$
6) $DF = 1/(1+DR)^I$
7) $RFDF_i = 1/(1+RFDR)^i$
8) $EDF_i = 1/(1+EDR)^I$
9) $NDR = (1+RDR)*(1+GER) - 1$
10) $PVP_i = PVP_0 * (1 - PVDR)^I$
11) $PVC_i = (1 - PVDR)^i$
12) $AEC_0 = \Sigma(LMP_h * HPVFP_h)$

Maine VOS Equation Key

GrossValue	Value of a centrally located, dispatchable resource
Load Match Factor (LMF)	Factor required for capacity-related components used to take into account the effective capacity of solar as a non-dispatchable resource.
Loss Savings Factor (LSF)	Incorporates the added benefit associated with avoided losses from distributed resources as compared to centrally located resources.
Distributed PV Value (DPVV)	Represents the benefit or cost of a distributed, non-dispatchble resource, summed to give the total value.
PV Fleet Production (PVFP)	kWh, hourly production of a Margina PV Resource having a rating of 1 kW-AC
Margina PV Resource (MPVR)	1 kW-AC, however, this resource does not exist in practice since there is no PV system having the output shape of the blended fleet
Avoided Annual Energy (AAE)	kwh/kW-AC/year, does not include effects of loss savings
ELCC	median of the PVFP Profile found in the peak 100 hrs. in the ISO-NE control area.
Avoided Energy Cost (AEC)	Hourly avoided wholesale market procurements, based on ISO-NE day ahead locational marginal prices for the Maine Load Zone

Successes and Downfalls

What Worked

- The methodology demonstrates a comprehensive and objectively verifiable approach.[15]
- LD 1649 is based on the VOS study findings.[16]
  - A proposed law to establish a marketplace for solar and its benefits
    - 20-year contract
    - Solar owner can keep any RECs

What Didn't Work

- This future approach to net metering has the potential to increase non-solar customers' bills.[16]
- It is hard to say what the price of solar will be in 20 years.[16]

15) Docket No. 4600-Investigation into the Changing Electric Distribution System. Pace Energy and Climate Center. August, 2016. Retrieved from http://www.ripuc.org/eventsactions/docket/4600-PaceComments_8-5-16.pdf
16) Maine is exploring a sensible alternative to net metering. Zientara, Ben. March, 2016. Retrieved from https://solarpowerrocks.com/net-metering/maine-is-exploring-a-sensible-alternative-to-net-metering/

Tennessee Valley Authority (TVA)

About the Company

- Largest public power company in the nation
- Nine appointed board directors

Methodology Details

- Distributed Generation-Integrated Value (DG-IV) Study:
  1. Transparency
  2. Fairness
  3. Adaptability
  4. Versatility
- Prepared by Solar Electric Power Association (SEPA) and Electric Power Research Institute (EPRI)
- **Value Components:**
  - Avoided Energy
  - Generation Capacity Deferral
  - Generation O&M
  - System Losses
  - Transmission System Impact
  - Distribution System Impact
  - Reserves
  - Environmental Impact
  - System Integration/Ancillary Services
  - Economic Development Impact
  - Security Enhancement Disaster Recovery
- **3 Categories**
  1. Value Streams included in DG-IV methodology
  2. Program design considerations
  3. Placeholder topics

17) Distributed Generation-Integrated Value (DG-IV): A Methodology to Value DG on the Grid. Tenessee Value Authority. October, 2015. https://www.tva.gov/file_source/TVA/Site%20Content/Energy/Renewables/dgiv_document_october_2015-2.pdf

Where the Data Comes From

- **Solar Data:** provided by members of a stakeholder group who commissioned CPR to provide TVA with solar energy profiles for 26 sites across the Tennessee Valley (SolarAnywhere data for 15 plus years of time-series irradiance measurements).
- **Environmental market value:** based on voluntary REC market data (requires periodic updating).

17) Distributed Generation-Integrated Value (DG-IV): A Methodology to Value DG on the Grid. Tenessee Value Authority. October, 2015.
https://www.tva.gov/file_source/TVA/Site%20Content/Energy/Renewables/dgiv_document_october_2015-2.pdf

Assumptions

- **REC Value:** $1/MWh with 1.9% escalation (2015-2021) after 2021, it is assumed that the REC would need to be retired to meet compliance obligations.
- **PV System for transmission impact and loss analysis:** 1 MW AC.
- **Average transmission loss value:** 2.6%.
- **Solar PV Projects:** projects approved by TVA are done so in a manner that is increasingly favorable towards enhancing the existing grid infrastructure.
- **Utility Tracking Unit:** 68% capacity credit.
- **Fixed axis options:** 50% capacity credit.

17) Distributed Generation-Integrated Value (DG-IV): A Methodology to Value DG on the Grid. Tenessee Value Authority. October, 2015. https://www.tva.gov/file_source/TVA/Site%20Content/Energy/Renewables/dgiv_document_october_2015-2.pdf