Transmission & Distribution Grid Impacts: Cost-Benefit Analysis

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Utah Public Service Commission - Docket No. 17-035-61
National Lab Technical Workshop on Distributed Solar Grid Impacts
July 11, 2019 1-5 PM

Agenda

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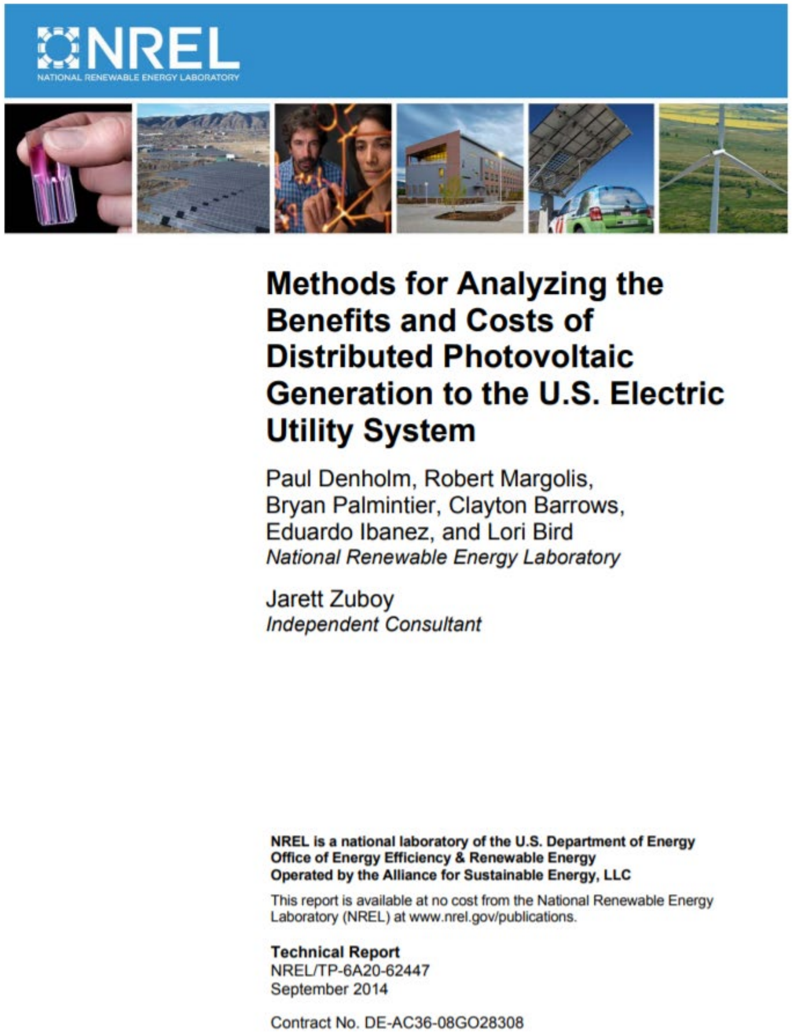
- Potential costs and benefits of distributed solar on transmission and distribution (T&D) system
- Methods and results from other cost-benefit analyses
- Relative significance of T&D costs and benefits compared to other utility system impacts
- Considerations and applicability to Utah
- Questions

Key Sources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Methods for Analyzing the Benefits and Costs of Distributed Photovoltaic Generation to the U.S. Electric Utility System

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Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Technical Report
NREL/TP-6A20-62447
September 2014

Contract No. DE-AC36-08GO28308

https://www.nrel.gov/docs/fy14osti/62447.pdf


ICF

Review of Recent Cost-Benefit Studies Related to Net Metering and Distributed Solar

May 2018

Prepared for:
The U.S. Department of Energy

Submitted by:
ICF

https://www.icf.com/blog/energy/value-solar-studies

Summary of Value Categories Used in ICF-Reviewed Studies

Table 4. Summary of value categories used in studies

	Value Category	Benefit (+) or Cost (-)	Number of Studies Addressing this Category
Utility System Impacts			
G	Avoided Energy Generation	+	15
	Avoided Generation Capacity	+	15
	Avoided Environmental Compliance	+	10
	Fuel Hedging	+	9
	Market Price Response	+	6
	Ancillary Services	+/-	8
T	Avoided Transmission Capacity	+	15
	Avoided Line Losses	+	11
D	Avoided Distribution Capacity	+	14
	Avoided Resiliency & Reliability	+	5
	Distribution O&M	+/-	4
	Distribution Voltage and Power Quality	+/-	6
C	Integration Costs	-	13
	Lost Utility Revenues	-	7
	Program and Administrative Costs	-	7
Societal Impacts			
S	Avoided Cost of Carbon	+	8
	Other Avoided Environmental Costs	+	9
	Local Economic Benefit	+	3

Source: ICF Review of Recent Cost-Benefit Studies Related to Net Metering and Distributed Solar May 2018

Takeaways From ICF Report

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- Value of distribution is an inherently location-specific activity.
- Decisions on value categories, quantification methods and input assumptions have a significant impact on findings.
- One of the most significant drivers for disparate results are choices about **which costs and benefits to include and monetize** in a study.
- Another major factor is the **perspective taken by the research** – whether to examine value categories from the customer, utility, grid or societal viewpoint.
- The only three elements included **in all studies** (all at the bulk level)
  - Avoided energy generation
  - Avoided generation capacity
  - Avoided transmission capacity
- Methodological approaches for calculating these are generally well established but regional factors and assumptions impact results.

Source: ICF Review of Recent Cost-Benefit Studies Related to Net Metering and Distributed Solar May 2018

Takeaways from ICF Report, cont'd

- **Distribution** related value components are challenging to standardize and were included in fewer studies.
  - Most studies took the first step looking at avoided distribution capacity because it is the most readily quantifiable distribution-level value, but it raises questions about rate differentiation amongst customers.
  - Avoided or deferred distribution capacity over a longer term planning horizon is relatively easier to quantify than less common value categories that are difficult to calculate or forecast based on data availability or lack of widely accepted quantification process.
- More challenging are values associated with resilience and reliability, voltage and power quality and avoided O&M costs – some studies identified but none quantified these.

Source: ICF Review of Recent Cost-Benefit Studies Related to Net Metering and Distributed Solar May 2018

Digging Into Some T&D Value Categories

- Distribution capacity
- Transmission capacity
- Generation capacity
- Losses
- Ancillary services
  - Voltage support
  - Operating reserves
- Reliability and resilience

Distribution Capacity Value

- Represents net change in distribution infrastructure requirements
  - DG can help meet rising demand locally, relieve capacity constraints and avoid upgrades (+$$)
  - DG can also lead to required investments(-$$)
    - Equipment may not be capable of bi-directional power flow
    - May require upgrade wires, transformers, voltage-regulating devices, control systems and/or protection equipment
  - Value varies greatly from one location to another
  - Smart inverters can regulate voltage, etc. and change the value proposition
- Distribution capacity value is a function of the following (corresponds to data needs):
  - Load growth
  - Distributed generation configuration and energy production
  - Peak coincidence
  - Effective capacity
  - Planned distribution upgrade replacement

Distribution Capacity Value, cont'd

- ► Options for calculating benefits of DG* (+$$):
  - Value DG contribution at peak hours at average or marginal distribution investment costs
  - Power-flow modeling – load growth triggers upgrades that DG defers
- ► Options for calculating costs*(-$$) :
  - Assume zero – assume DG limited to hosting capacity
  - Detailed interconnection study for a DG project - cost out a handful of workable mitigation options
- ► Beware: It is not easy to defer distribution capacity.
  - Is there a need for upgrades or new capacity? How much excess capacity is available now and in the planning horizon?
  - Does DG output match the stressed hours/seasons of the capacity need?
  - Is DG location able to defer capacity?
  - Can DG consistently/reliably provide power when needed? What if it's cloudy?
  - Will DG be available through deferral period?
  - Can utility monitor/control DG to meet distribution system needs?

*From Lew 2018 – *Emerging Distribution Planning Analyses*

Distribution Capacity Value, cont’d

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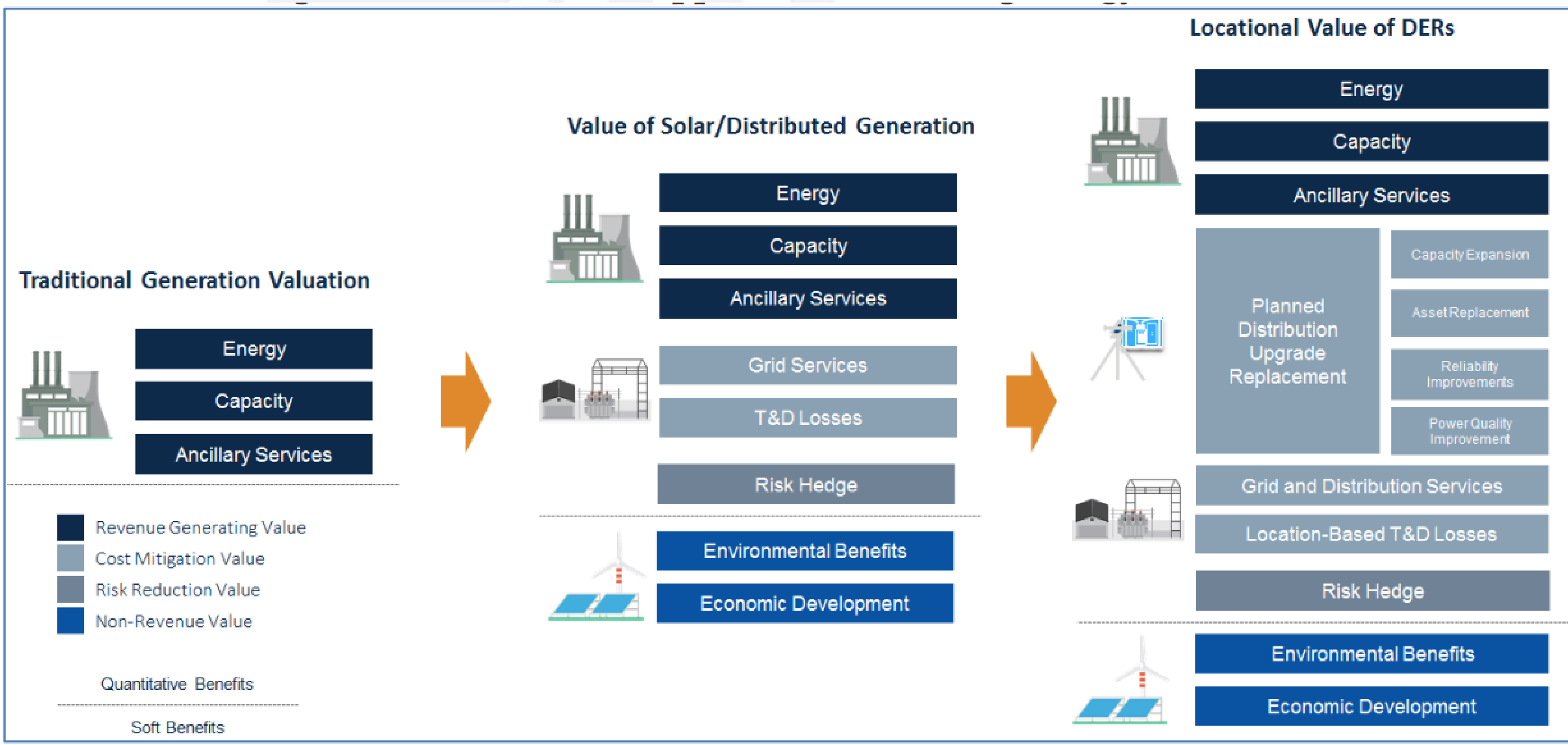
- Calculating value requires comparing expected capital investments <u>with</u> DG and <u>without</u> DG
  - Power-flow analysis is typically the basis for this analysis
- Projecting location and size of DG is challenging in itself
  - DG growth depends on rebates and incentives – circular question
- If you want detailed locational results, need detailed locational inputs
- Utilities can compile capital expenditure plans in each geographic area and assess what may be deferred or avoided due to DG in those areas
- The ultimate cost/value benchmark is the specific cost of a project
- Absent detailed geographic information, marginal cost of service (MCOS) studies can provide a reasonable basis for calculating avoided distribution capacity value
  - MCOS studies - quantify marginal cost of electricity service by calculating additional costs associated with changes in kilowatt-hours of energy, kilowatts of demand, and number of customers

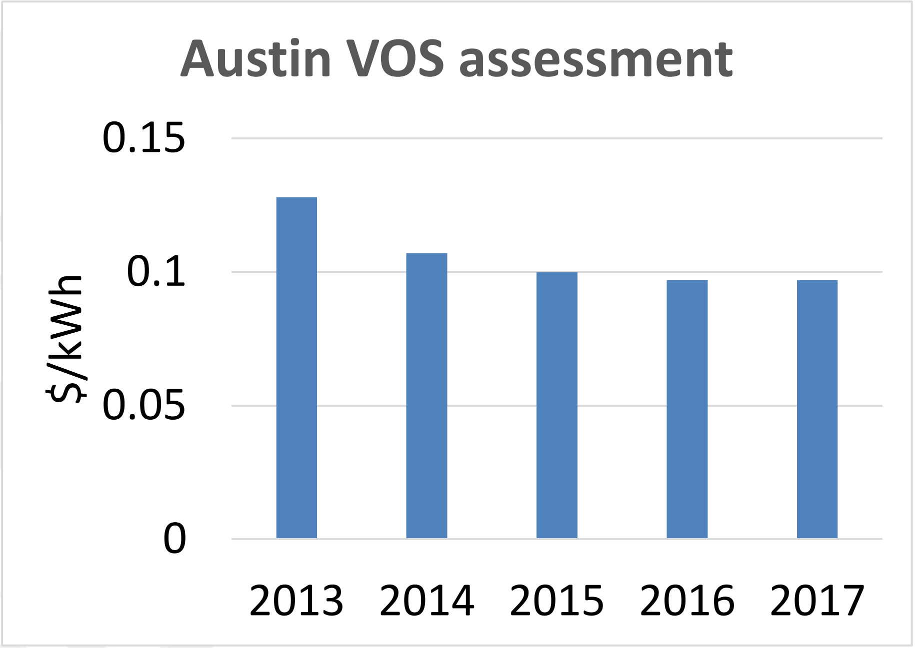
Locational value



Ben Kellison, "Unlocking the Locational Value of DER 2016: Technology Strategies, Opportunities, and Markets," January 2016,

Beware: Declining value of solar*

- As more MW of solar are added, the value of the energy and capacity decline.
- If a tariff is not locked in for long-term, this is risky for solar customers.
- Storage can mitigate the declining value of solar by producing at peak, even as peak shifts to later hours.
- Solar PV production degrades (0.5%/year) over time.



*From Lew 2018 – *Emerging Distribution Planning Analyses*

Transmission Capacity Value

- Distributed PV can affect congestion and reliability in the transmission system and can effectively reduce the need for additional transmission capacity.
  - Locational marginal prices can be used to capture the value of relieving transmission constraints
  - Scenario-based modeling can be used to assess transmission impacts of distributed PV – production cost modeling can simulate system operation with and without different combinations of distributed PV
  - Transmission expansion planning tool and a dedicated power flow model can be used to co-optimize transmission and generation expansion and evaluate proposed build-out plans

From Denholm et al., Methods for Analyzing the Benefits and Costs of Distributed Photovoltaic Generation to the U.S. Electric Utility System

Value of Reduction in Losses

- Because distributed generation is typically located near loads, it can result in avoided distribution losses
- However, at very high penetrations, where there is reverse power flow, DG can result in increased losses

Analysis approaches

- **Most basic** approach is to assume DG avoids an average distribution loss rate (but this can overestimates losses)
- More **detailed approaches** involve estimating marginal loss rates as a function of time, calculating loss rates at specific locations on the system and/or using power-flow models and detailed time series power-flow analysis
  - Computationally challenging
  - Where and how big are the DGs?
  - Should all feeders or representative feeders be modeled?

Ancillary Services

- Ancillary services (also referred to as grid support services) are services required for the grid to operate reliably.
  - Typically include:
    - operating reserves
    - reactive supply and voltage control
    - frequency regulation
    - energy imbalance
    - scheduling
- Two ancillary services most commonly associated with distributed generation are voltage control and operating reserves.
  - Without advanced inverters, large DG installations can contribute to overvoltage conditions
    - May require new voltage-regulating equipment or controllers.

Ancillary Services - Voltage Support

- Variable DG power production can lead to increased wear and tear on switches and voltage-control equipment
- DG with smart inverters can:
  - Actively support voltage regulation
  - Mitigate DG-produced voltage issues
  - Reduce the mechanical wear on transformer tap changers and capacitor switches
  - Conceivably replace traditional voltage-control equipment

Ancillary Services – Operating Reserves

- Operating reserves address short-term variability and plant outages.
- DG variability can increase the need for certain types of reserves.
- DG may also reduce load that must be served and reduce needed reserves.
- Where wholesale markets exist, value of ancillary services can be determined based on market prices.

Ancillary Services - Approaches

- Approaches for estimating impact of DG on ancillary services:*
  1. Assume no impact - Assume penetration is too small to have a quantifiable impact.
  2. Simple cost-based methods - Estimate changes in ancillary service requirement and apply cost estimates or market prices for corresponding services.
  3. Detailed cost-benefit analysis – Perform simulations with DG and calculate the impact of added reserve requirements; Requires tools for transmission and distribution simulations.

*From Denholm et al., Methods for Analyzing the Benefits and Costs of Distributed Photovoltaic Generation to the U.S. Electric Utility System

Reliability and Resilience

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- Reliability and resilience are not often quantified explicitly as a value associated with DG.
- DG can provide resilience and reliability benefits when incorporated into microgrids but these values accrue to system owners not ratepayers.
- In Oregon’s Resource Value of Solar (RVOS) Docket reliability and resilience were originally their own category but they were ultimately folded into grid services, which includes calculation of reserve benefits.

ICF Comparison of Value Categories Across Studies

		Arkansas - Crossborder Energy 2017	Nevada - E3 2016	Louisiana - Acadian Consulting Group 2015	South Carolina - E3 2015	Mississippi - Synapse 2014	Vermont - VT Public Service Dept 2014	Washington DC - Synapse 2017	Georgia - Southern Company 2017	Hawaii - Clean Power Research 2015	Maine - Clean Power Research 2015	Oregon - Clean Power Research 2015	Minnesota - Clean Power Research 2014	Utah - Clean Power Research 2014	New York - BCA Framework 2016 + VDER Phase One	California - LNBA Framework 2016	Total
Utility System Impacts																	
G	Avoided Energy Generation	●	●	●	●	●	●	●	○	○	●	○	○	●	○ (red)	○	15
G	Avoided Generation Capacity	●	●	●	●	●	●	●	○	○	●	○	○	●	○ (red)	○	15
G	Avoided Environmental Compliance	●	●			● (red)	●	●	○ (red)		● (red)	○		●		○ (red)	10
G	Fuel Hedging	●			●	●		●		○	●	○	● (red)	●			9
G	Market Price Response	●					●	●		○	●				○		6
G	Ancillary Services		●		●	○		○	○	○					○	○	8
T	Avoided Transmission Capacity	●	●	●	●	●	●	●	○	○	●	○	○	●	○ (red)	○	15
T	Avoided Line Losses	●	●		●	●	● (red)	●	○			○		● (red)	○ (red)	○	11
D	Avoided Distribution Capacity	●	●	● (red)	● (red)	● (red)	●	●		○	○	○	○	● (red)	○ (red)	○	14
D	Avoided Resiliency & Reliability	○				○		○							○	○	5
D	Distribution O&M			●					○						○	○	4
D	Distribution Voltage and Power Quality									○	○	○	○		○	○	6
C	Integration Costs	●	●	●	●	○		●	○	○	●	○	○		○	○	13
C	Lost Utility Revenues	●	●	●	●	●	●								○		7
C	Program and Administrative Costs		●	●	●	●	●	○							○		7
Societal Impacts																	
S	Avoided Cost of Carbon	●					●	●		○	●		○		○ (red)	○	8
S	Other Avoided Environmental Costs	●	●			○		○		○	●		○		○	○	9
S	Local Economic Benefit	●				○		○									3

Included	●
Included/represented in another category	● (red)
Discussed but not monetized/quantified	○
For NY, included in VDER Phase One	○ (red)

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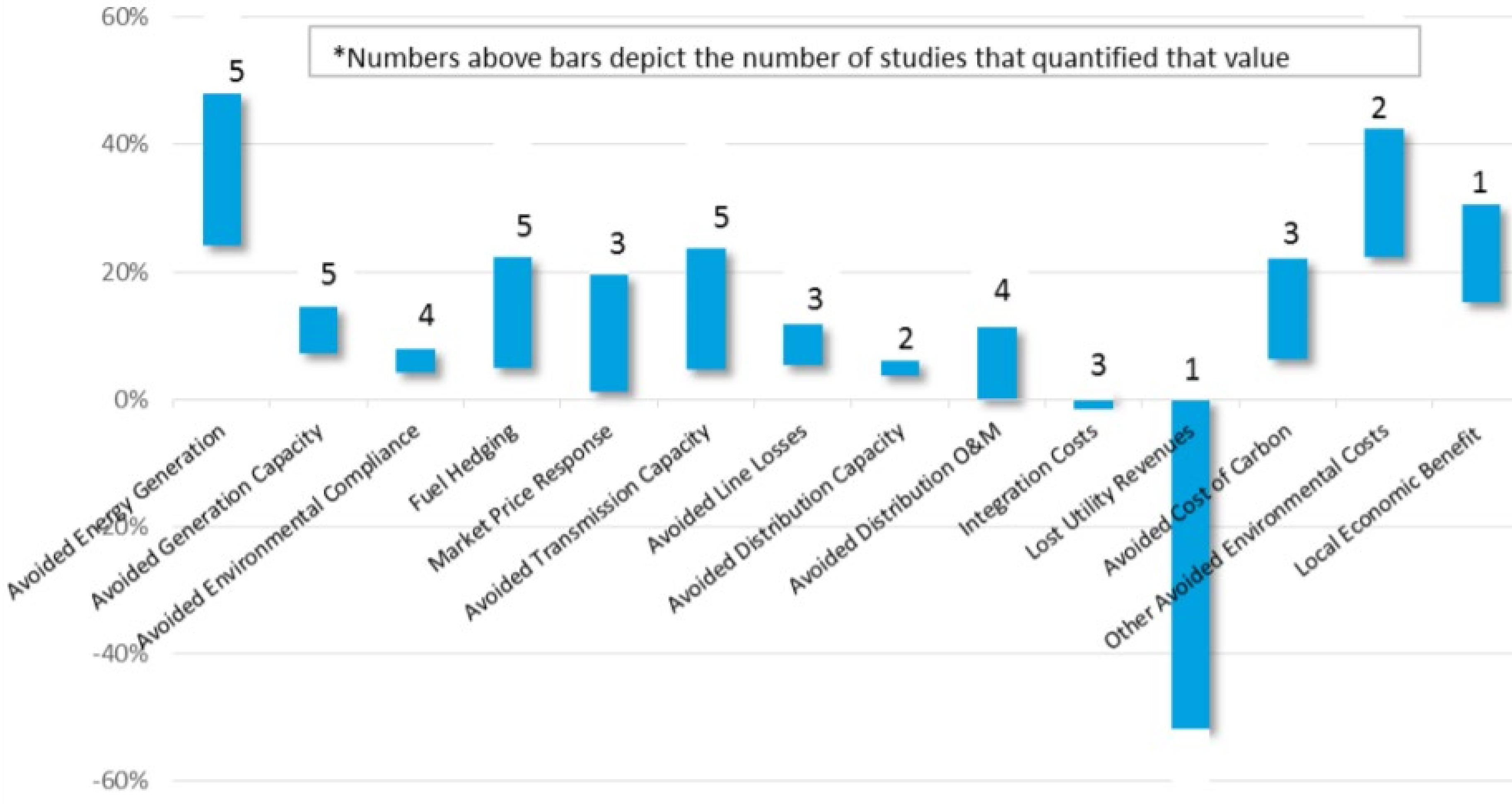
Range of Magnitude of Value Categories as a Percentage of Net Impact



Example Components and Magnitudes of Resource Value of Solar Calculations in Oregon

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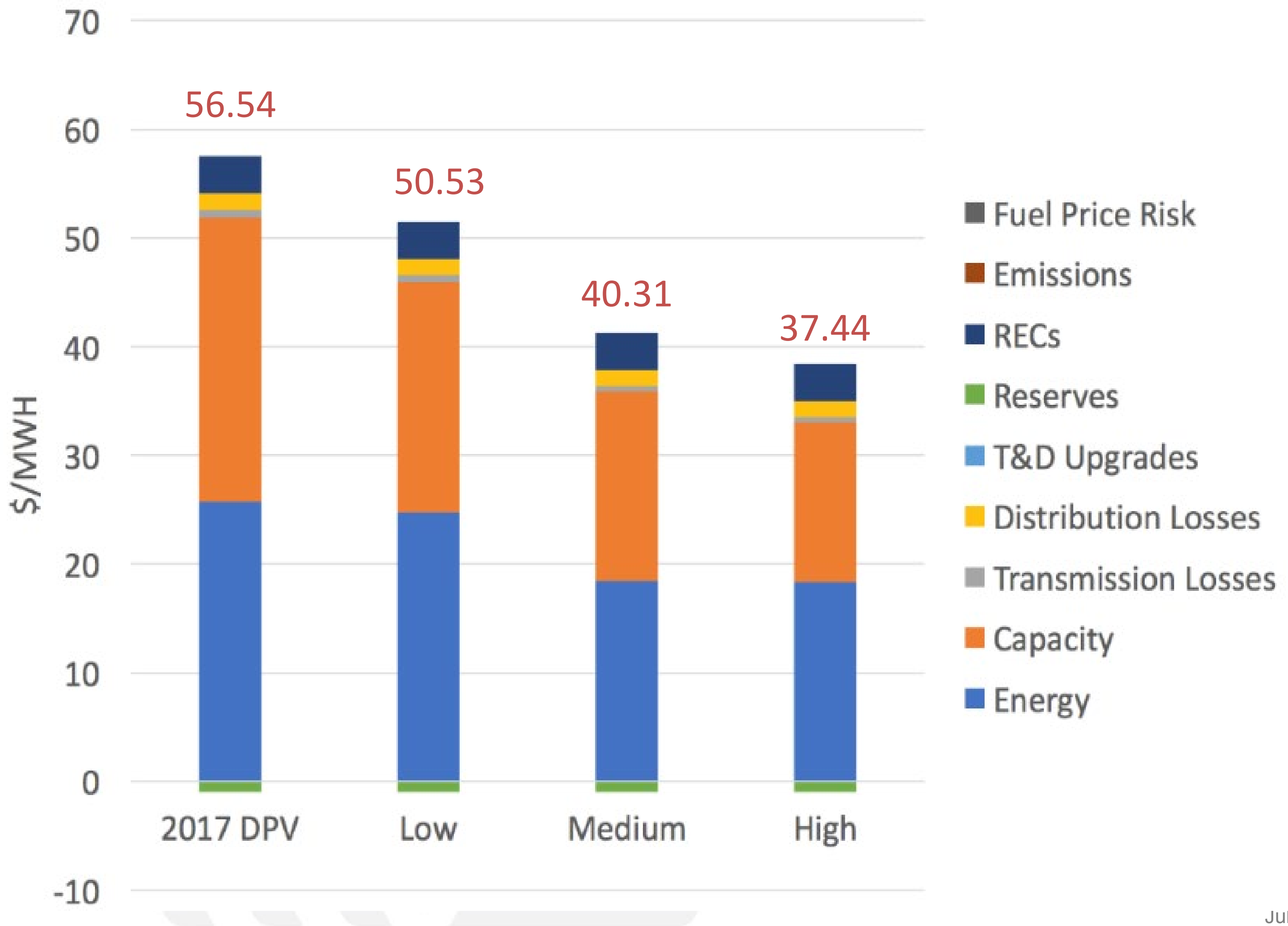
Impact of March 18, 2019 Updates on PGE's Initial RVOS Compliance:

RVOS Element	December 2017 $/MWh, real levelized value	March 2019 $/MWh real levelized value
Energy	24.98	25.33
Generation Capacity	7.30	7.19
T&D Capacity	8.08	7.91
Line Loss	1.48	1.50
Administration	(5.58)	(5.58)
Market Price Response	1.81	1.81
Integration	(0.83)	(0.83)
Hedge Value	1.25	1.27
Environmental Compliance	11.41	11.57
RPS Compliance	0	0
Grid Services	0	0
RVOS Total	**49.88**	**50.16**

Stacked value streams of distributed PV



GE *Solar Program Design Study*, 2017 https://ge-energy.postclickmarketing.com/Global/FileLib/PDFs/Final-Executive-Summary-GE-CSU-7-24-17.pdf

Locational Benefits

- Locational value analysis can be used to understand locational benefits and costs of solar PV on the distribution system.
  - Benefits and costs vary by technology, time of day and year, and location.
  - DERs may reduce or delay the need for:
    1. energy and associated fuel, operations, and maintenance costs;
    2. additional generating capacity, due to capacity value plus avoided losses and avoided planning reserve margin; and
    3. avoided or deferred distribution capacity upgrades.
  - DERs may cause additional costs if equipment is not capable of bi-directional power flow; and may reduce the life of equipment like load tap changers and other voltage regulation devices.
  - Tools used to assess locational value include utility marginal cost of service studies, spreadsheet calculators used to track marginal costs and avoidable projects, detailed power flow analysis simulations with in-depth load and DER projections, and detailed DER performance information.
  - Complete data sets needed for detailed locational value assessments are not often available.

California – Locational Net Benefits Analysis (LNBA)

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- California Distribution System Planning
  - Original legislation required:
    - "Evaluate locational benefits and costs of distributed resources on the distribution system"
  - The Commission directed utilities to use a two part methodology
    - System-level avoided costs which estimates the system-level avoided costs given a user-defined DER solution calculated through E3's DER Avoided Cost Calculator
    - Project deferral benefits which calculates the values of deferring a specific capital project

Project deferral benefit module

Input
Universal inputs
Project-specific inputs
DER inputs
Output
Lifecycle DER avoided costs

+

System-level avoided cost module

Input
DER data
Resource Adequacy multiplier
Output
System-level avoided cost

=

Total achievable avoidable cost of a given DER solution at a specific location

CA LNBA Tool – cont'd

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- Project Deferral Benefit Module – DERs are considered able to defer distribution upgrades by reducing loads
  - Inputs include:
    - Universal inputs – discount rate, revenue requirement multiplier, equipment inflation rate, O&M inflation rate
    - Project specific inputs - book life, O&M factor, project identifiers, equipment type, project cost, project install/commitment year, project flow factors, loss factors, load provide/need profile, overloading threshold magnitude and hours
    - DER inputs – DER type and location, DER useful life, DER install year, defer T&D to this year, hourly DER profile, dependability in local area
  - Four T&D services were identified and analyzed that may be provided by DER and result in avoided costs
    - T&D capacity deferral – based on DER reducing thermal loading
    - Voltage support – injecting or absorbing reactive power through inverters or reducing net load
    - Back-tie – DER may defer an upgrade to a back-tie switch if installed downstream of constrained tie switch
    - Microgrid – DER may contribute to a local microgrid service

CA LNBA Tool – cont'd

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- System-Level Avoided Cost Module
  - Calculated using a tool called DERAC – developed by E3 for use in demand-side cost-effectiveness proceedings at the CPUC
  - Tool can produce an hourly set of values over a 30-year time horizon representing the costs the utility would avoid with power supply from DER

Component	Description
Generation Energy	Estimate of hourly wholesale value of energy
Generation Capacity	The costs of building new generation capacity to meet system peak loads
Ancillary Services	The marginal costs of providing system operations and reserves for electricity grid reliability
T&D Capacity	The costs of expanding transmission and distribution capacity to meet peak loads
Environment	The cost of carbon dioxide emissions associated with the marginal generating resource
Avoided RPS	The reduced purchases of renewable generation at above-market prices required to meet an RPS standard due to a reduction in retail loads

Considerations – 1
Data

- ► Granularity of results depends on granularity in data and analysis
- ► To understand value of DG, need to understand system needs and impacts without DG and then with DG
- ► Data needed to characterize locational and temporal value:
  - Load growth projections
  - System capacity planning studies – from distribution transformer to bulk system sub-transmission
  - Existing and projected distributed generation deployment and production by location
  - Line loss studies
  - System reliability studies (including voltages, protection, phase balancing)
  - System-wide and location-specific cost information
  - System-wide and location-specific peak demand growth rates
  - Marginal cost of service studies
- ► Establishing actual needs and specific distribution projects that can be deferred or avoided is the most direct way to come up with avoided costs

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Considerations – 2
Technical and Modeling Challenges

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- Garbage in = Garbage out
- Important to validate and calibrate models and use the correct tools
- Real world example (from Emma Stewart at LLNL):
  - Study 1: "during the system impact study, we found the 1 MW PV site would cause flicker at a number of large customers, mitigation solutions presented cost $1Million plus"
  - Study 2: redid original study and investigated data sources fully (distribution model, source impedance representing transmission, modeling technique used) and found original data was unvalidated, no data or best guess estimates.
    - Less costly solution proposed to mitigate risk and use full range of inverter capability
    - Site was approved and interconnected with less expensive option. No flicker issues were reported.
- Key point: Good data and accurate system models are important to avoid bad outcomes including unnecessary capital expenditures

Thanks and Questions

Extra Slides

15 Studies analyzed in ICF Report

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Table 1. Selection of studies analyzed

State	Year	Study Sponsor	Prepared by
Arkansas	2017	Sierra Club	Crossborder Energy
District of Columbia	2017	Office of the People's Counsel	Synapse Energy Economics
Georgia	2017	Southern Company	Southern Company
California	2016	California Public Utility Commission (CPUC)	CPUC/Energy and Environmental Economics (E3)
Nevada	2016	State of Nevada Public Utilities Commission	E3
New York	2016	New York Public Service Commission (PSC)	NY Department of Public Service (DPS) Staff
Hawaii	2015	Interstate Renewable Energy Council	Clean Power Research
Louisiana	2015	Louisiana Public Service Commission	Acadian Consulting Group
Maine	2015	Maine Public Utility Commission	Clean Power Research
Oregon	2015	Portland General Electric	Clean Power Research
South Carolina	2015	South Carolina Office of Regulatory Staff	E3
Minnesota	2014	Minnesota Department of Commerce	Clean Power Research
Mississippi	2014	Public Service Commission of Mississippi	Synapse Energy Economics
Utah	2014	Utah Clean Energy	Clean Power Research
Vermont	2014	Public Service Department (PSD) Staff	VT PSD

Source: ICF Review of Recent Cost-Benefit Studies Related to Net Metering and Distributed Solar May 2018

Calculating Generation Capacity Value

- Production simulations only calculate the operational (variable) costs of an electricity system. The ability of distributed PV to reduce fixed costs is based on its capacity value – ability to replace or defer capital investments.
- Estimating the generation capacity value of DGPV requires calculating the actual fraction of a DGPV system's capacity that could reliably be used to offset conventional capacity and also applying an adjustment factor to account for T&D losses.
- Four methods for estimating generation capacity value:
  - 1. Capacity factor approximation using net load—examines PV output during periods of highest net demand
  - 2. Capacity factor approximation using loss of load probability (LOLP)—examines PV output during periods of highest LOLP
  - 3. Effective load-carrying capacity (ELCC) approximation (Garver's Method)—calculates an approximate ELCC using LOLPs in each period
  - 4. Full ELCC—performs full ELCC calculation using iterative LOLPs in each period.

From Denholm et al., Methods for Analyzing the Benefits and Costs of Distributed Photovoltaic Generation to the U.S. Electric Utility System

Specific benefit categories – from ICF study

- ► Fuel price hedging
  - Forecasted price of fuel for the displaced marginal resource is the primary driver of this component. Can be assessed as:
    - Benefit to utility – reduced risk in fuel price volatility
    - Benefit to society – benefit that all customers may experience from reduced utility rate fluctuations
- ► Market price response – Change in wholesale energy or capacity market prices due to increased penetration of renewable generation
  - As PV increases, demand for generation and capacity resources may be reduced which could have the effect of lowering energy prices
- ► Ancillary services – increase or decrease in need for generation reserves to provide grid support such as reactive supply, voltage control, frequency regulation, spinning reserve, energy imbalance and scheduling
  - Where formal markets exist for ancillary services, it is easier to include and quantify this category
    - In South Carolina, E3 uses 1 percent of avoided energy
    - New York uses 2-year average of ancillary service costs

Specific benefit categories – from ICF study

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- Avoided transmission – avoided cost of transmission constraints
  - Impacted by characteristics of bulk system and DER penetration levels
  - Most common methodology was assessing the utility's marginal cost of load-related transmission capacity as opposed to specific line cost analysis. Inputs to the calculation include historical transmission capacity expenditures and load-carrying contribution made by solar PV
- Avoided line losses – value of energy that would otherwise be lost due to inefficiencies in transmitting and distributing energy
  - Generally calculated by developing an average loss factor and they vary based on time of day and the characteristics of the utility system.
  - May be reflected in other categories through use of a loss savings factor instead of a separate line losses category.
- Avoided distribution capacity – reflects DERs ability to reduce load and defer or avoid planned distribution infrastructure upgrades. Sensitive to:
  - Load growth rate at distribution feeder or substation level
  - Locational load shape characteristics
  - Penetration of PV and their coincidence with load on that substation or feeder

Specific benefit categories – from ICF study

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- Avoided reliability and resilience costs – reflects avoided costs due to frequency and duration of outages and provision of back-up services
  - Challenging to quantify
  - None of the 15 studies reviewed by ICF include a specific value
  - Mississippi study: not "sufficient evidence to estimate the extent to which solar NEM would improve reliability" at this time
  - DC: mentions potential impact to outage frequency, duration and breadth but indicates that it is difficult to "credibly forecast" when smart inverters will be deployed and how they will help reduce outages and lower costs.
- Distribution O&M – increase or decrease in O&M costs associated with utility investment as a result of deploying distributed solar. Tied to the integration costs category.
- Distribution voltage and power quality – either cost or benefit – reflects any increase or decrease in the costs of maintaining distribution system voltage and frequency within acceptable ranges and potentially improving power quality
  - 6 of 15 studies ICF reviewed identify this but none quantify it

Specific cost categories – from ICF study

- Integration costs – utility costs to integrate and manage distributed solar on the grid
  - Investments may include: support voltage regulation, upgrade transformers, increase available fault duty, provide anti-islanding protection.
  - Costs may include: scheduling, forecasting and controlling DERs, as well as procurement of additional ancillary services such as reserves, regulation, and fast-ramping resources.
  - Most studies don't specify what specific investments are assumed to be included in integration costs.
- Lost utility revenues – loss of utility revenues due to reduced customer loads
  - Result of residential PV owners paying smaller electric bills
  - Some studies used rate impact measure (RIM) test to gauge impact on utility rates
  - Some argue lost revenues are not a new cost created by customer solar PV systems

Specific cost categories – from ICF study

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- Program and Administrative Costs – costs incurred by the utility to administer various DER incentive programs. Can include:
  - Cost of State incentive payments and cost of administering them
  - Compliance and reporting activities
  - Personnel, billing costs and other administrative costs
- Societal impacts
  - Avoided cost of carbon – avoided cost to society from reduced carbon emissions, outside avoided costs to the utility
    - Some use the Social Cost of Carbon developed by U.S. EPA
    - Some use netting process to ensure avoided utility costs aren't double counted
  - Other avoided environmental costs – societal impacts related to public health improvements from criteria air pollutants, methane leakage and impacts on land and water
  - Economic development – reflects economic growth benefits such as:
    - Jobs in the solar industry, local tax revenues or other indirect benefits to local communities
    - Challenging to quantify and heavily influenced by assumptions

More about reliability and resilience

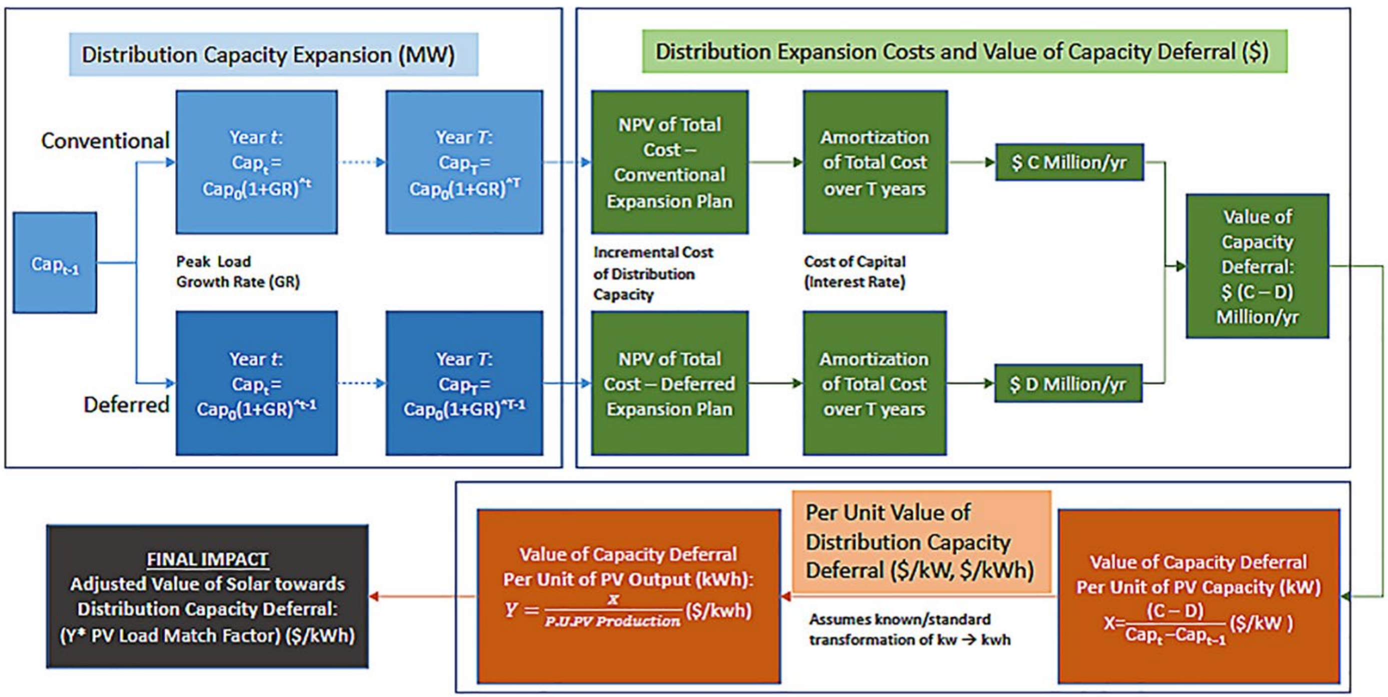
- California Locational Net Benefits Assessment (LNBA)
  - Measures reliability/resilience by monitoring SAIDI, SAIFI and MAIFI
  - Includes a reliability value when DER can avoid an otherwise necessary investment to bring reliability up to an acceptable level
  - Consensus has not yet been reached on whether non-capacity benefits of increased reliability associated with the frequency, duration, or magnitude of customer outages should be factored in.
- New York benefit-cost analysis framework includes net avoided restoration costs and net avoided outages.
  - Net avoided restoration costs – calculated by comparing number of outages and speed and costs of restoration before and after a project
  - Avoided outage costs are calculated by determining how a project affects the number and length of an outage and multiplying by the estimated outage cost; estimated cost determined by customer class and geographic region.

Example approaches – Minnesota

- Data needed for calculating distribution capacity costs = system-wide costs and peak load data for historical 10 year period
- Distribution capacity expansion calculated for two cases:
  - Conventional plan, where traditional development occurs, and
  - Deferred plan, where the conventional plan is delayed for a year because of introduction of solar PV
  - Difference is used to calculate value of capacity deferral per unit of PV capacity
- Distribution Cost per unit growth ($/kW)
  - First year value is determined from historical data – using total distribution plan additional dollars from summing relevant FERC accounts
  - Total deferrable cost value is divided by the kW increase in peak annual load during that 10 year period
  - For subsequent 25 years of analysis, initial cost per unit growth is escalated by a utility-provided distribution capital cost escalation rate discounted by the utility's weighted average cost of capital and then amortized for each year.
- Same process if followed for the deferred case

Example Approaches – Minnesota, cont'd

- Utilities can take a system-wide or location-specific approach to calculating avoided distribution capacity costs.
- For location-specific approach, same basic methodology but with location-specific technical and cost data



Approaches

- Seven of the 15 studies used one or more of the cost-effectiveness tests traditionally applied to energy efficiency programs.

Figure 7. Summary of cost-effectiveness test used in studies

			Cost-Effectiveness Test				
State	Year	Prepared by	PCT	UCT	RIM	TRC	SCT
Arkansas	2017	Crossborder	√	√	√	√	√
District of Columbia	2017	Synapse		√			√
Georgia	2017	Southern Company					
California	2016	CPUC	√		√		
Nevada	2016	E3	√	√	√	√	√
New York	2016	NY DPS		√	√		√
Hawaii	2015	CPR					
Louisiana	2015	Acadian					
Maine	2015	CPR					
Oregon	2015	CPR					
South Carolina	2015	E3			√		
Minnesota	2014	CPR					
Mississippi	2014	Synapse	√			√	
Utah	2014	CPR					
Vermont	2014	PSD					

Beyond traditional energy efficiency cost tests – Utility Cost Test, Total Resource Cost Test, etc.

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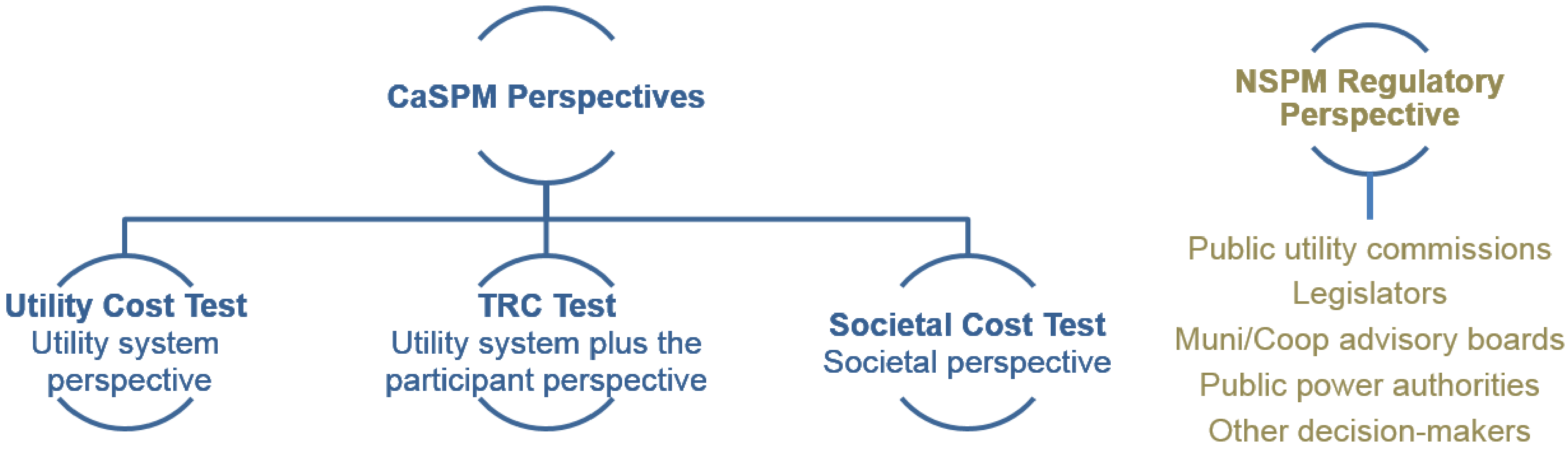
► National Standard Practice Manual – proposes a new Resource Value Test guided by a jurisdiction's energy and other applicable policy goals

Step 1	Identify and articulate the jurisdiction's applicable policy goals.
Step 2	Include all utility system costs and benefits.
Step 3	Decide which additional *non-utility* system costs and benefits to include in the test, based on applicable policy goals.
Step 4	Ensure the test is symmetrical in considering both costs and benefits.
Step 5	Ensure the analysis is forward-looking, incremental, and long-term.
Step 6	Develop methodologies and inputs to account for all impacts, including hard-to-quantify impacts.
Step 7	Ensure transparency in presenting the analysis and the results.

https://nationalefficiencyscreening.org/wp-content/uploads/2019/04/NSPM-Standard-Overview-slide-deck-April-2019.pptx

Cost-Effectiveness Perspectives



- California Standard Practice Manual (CaSPM) – test perspectives are used to define the scope of impacts to include in the ‘traditional’ cost-effectiveness tests
- NPSM introduces the ‘regulatory’ perspective, which is guided by the jurisdiction’s energy and other applicable policy goals

From Daymark BCA study for Maryland Sept 2019

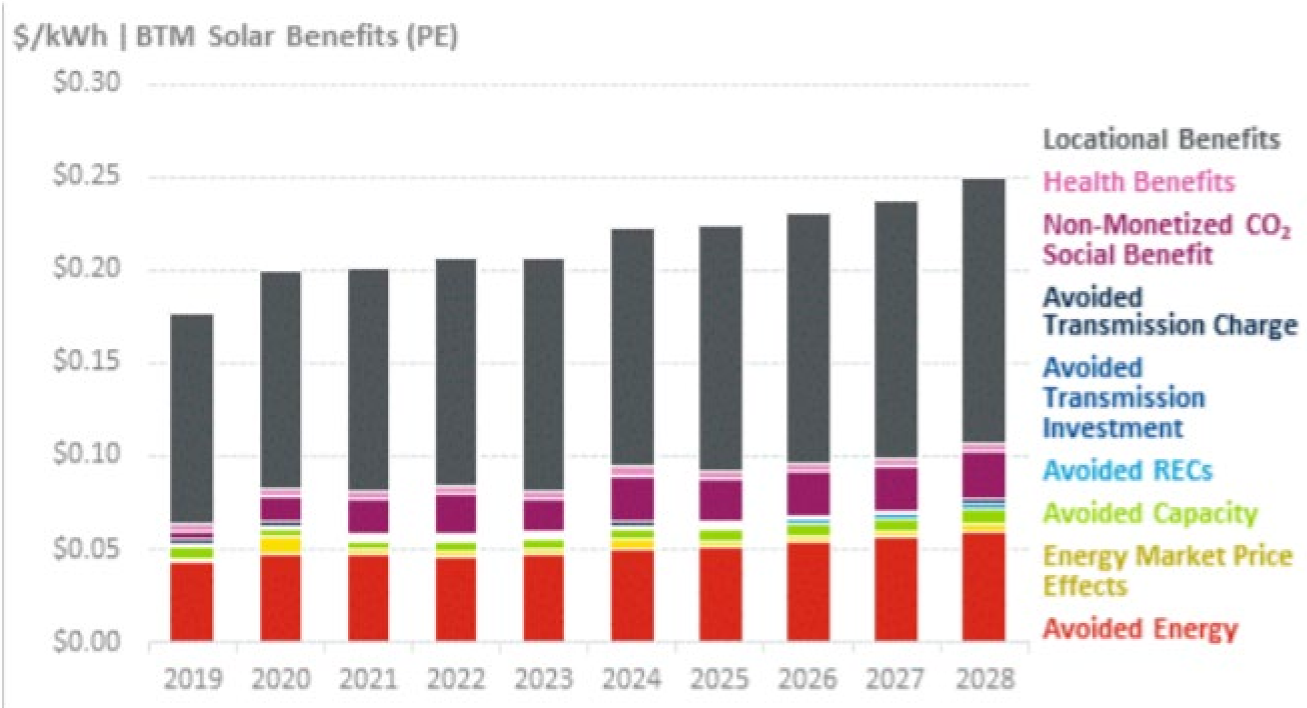


Figure 9: BTM Value of Solar with Distribution Benefits Included: Potomac Edison

Location-specific benefits include potentially avoidable infrastructure investments