Valuing Distributed Solar

Presentation for Regulatory MOSEIA Stakeholders

31 January 2014

Karl R. Rábago, Rábago Energy LLC, RabagoEnergy.com

Utility Transformation

On the Road to a New Business Model

- From "Ratepayers" to Empowered Customers
- From dumb 1-way electron flow to 3-way dynamic interactions: utility to customer, customer to utility, customer to customer
- From "throughput" model where assets equal wealth and utilities sell a commodity, to an "integrated services" model where the utility creates value for customers and shareholders by delivering services
- From customer control as a threat to distributed energy services as a revenue center

The Core Objective for Value of Solar

- Provide rates and services in the public interest that support:
    - Economic efficiency
    - Societal equity
    - Technological innovation
- Comprehensively assess benefits and costs to the utility, utility customers, and society
- Establish the economic indifference price at which the utility can compensate the customer or make and deliver the service themselves

Beyond Value of Solar

- Value of Storage - Stationary, and soon, the electric vehicle kind, operating in V-to-Grid settings
- Value of Smarts - smart inverters, home, local grids, substations and feeders
- Value of Security - smart, self-healing, storm-resistant, secure grids and micro grids
- Value of Savings - customer or utility controlled curtail-able and shape-able loads interacting in dynamic curtailment markets

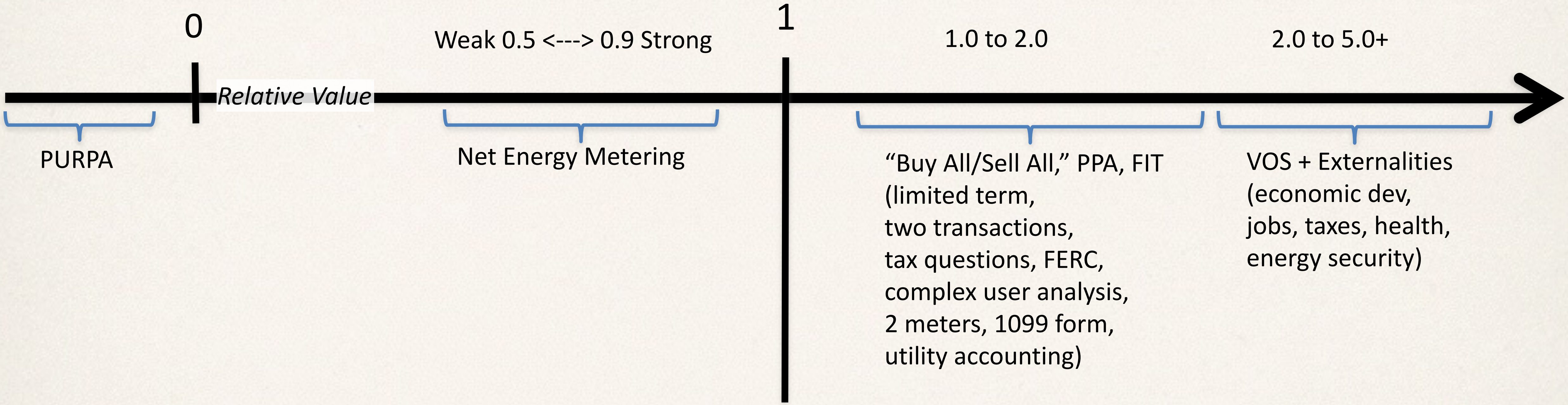
Brief History of DSG Valuation

- 1990s - Numerous experiments (e.g. Kerman substation study)
- 2002 - Rocky Mountain Institute publishes "Small Is Profitable"
- 2005-2006 - Vote Solar (Smeloff) and Austin Energy (CPR) conduct first "Value of Solar" studies
- 2007-2013 - Miscellaneous VOS studies, cost-benefit analyses, reports
- 2012-2013 - Austin Energy VOS rate, Minnesota law, California Solar Initiative cost effectiveness studies, APS solar study

Kinds of DSG Studies

- Establishing DSG *value*
- Establishing DSG and DSG program *cost effectiveness*
- *Issue-specific* studies and reports, e.g.:
  - PURPA avoided cost
  - High penetration impacts
  - Utility resource planning processes

Where Things Fit



Value of Solar Rate

annually adjusted, present value of 30-yr stream of benefits / costs,
net on bill, 2 meters, avoids cross-subsidy,
recovers cost of service, encourages efficiency

Solar Value: Analytically

- Customer and community investment in solar provides valuable, privately-funded, clean electricity at or very near the point of use.
- If the utility had to provide that same electricity, what would it be worth? What is the fair value?
- Calculate direct benefits & costs (energy, capacity, T&D energy & capacity, line losses, hedging, environmental, risk, water, integration, net lost sales, etc.)
- Other studies show additional societal value, often >2X utility value, for jobs, economic development, local tax revenues, etc.

Categories of Benefits Studied

- Energy & Generation Capacity
- Transmission & Distribution Capacity
- Line Losses
- Ancillary Services
- Environmental Benefits
- Hedge & Fuel Price Benefits
- RPS Compliance Benefits
- Other - Security, recovery, jobs and economic development

Categories of Costs Studied

- Customer Costs - Hardware, installation, insurance, maintenance, etc.
- Utility Costs - Integration, metering & billing, ancillary services, administrative, rebates and incentives, etc.
- Declines in Value due to Increased Penetration - reduction in capacity value for incremental installations, reduction in peak energy prices and resulting value

Distinctive Differences in the Studies

- Models used
- Penetration rates & system sizes
- Timescale
- Geography
- System Boundaries
- Valuation Perspective (utility, customers, society, etc.)
- Assumptions (solar performance, system mix, etc.)
- Original vs. Secondary Data

Key and Recurrent Issues

- Actual Mileage May Vary!
- Value vs. Cost, Cost vs. Price
- Annualized vs. Levelized
- Dealing with Valuation Uncertainty
- Compensation vs. Incentive
- Cost-Benefit Tests Sensitive to Rates
- Evolution in Analysis Techniques

Noteworthy Example Studies

- "The Value of Distributed PV to Austin Energy and the City of Austin," and "Designing Austin Energy's Solar Tariff," Clean Power Research/Austin Energy (2006 & 2012) - "Original" utility-specific VOS study of 5 key benefits (energy, capacity, T&D, line losses, environmental); later updated with ERCOT nodal pricing and used as compensation basis for residential solar tariff. Established that value is higher than retail rates on a levelized basis.

- "The Benefits and Costs of Solar Distributed Generation for Arizona Public Service," Beach/Vote Solar Initiative (2013) - Cost-benefit study of distributed solar using RIM (ratepayer impact measure) test. Included benefits of energy, capacity, T&D, ancillary services, and avoided RPS. Also included costs for lost revenues, incentives, and integration costs. Found benefits outweighed costs on levelized basis.

- "Unlocking DG Value," Keyes, Fox/IREC (2013) - White paper laying out PURPA-based tools for improving DG valuation. Cites PURPA authority to consider: energy and capacity, reduced line losses, modularity benefits, avoided T&D, dispatchability, energy security benefits, environmental benefits, and contracting benefits. No explicit analytical findings.

- DG Valuation Meta-Analysis, Rocky Mountain Institute/eLab (forthcoming ~ July 2013) - Quantitative and qualitative meta-analysis of DG valuation studies. Characterizes studies according to RMI's "distribution edge" framework and identifies areas of future research and analysis.

Using Valuation in a Rate

The Austin Energy Value of Solar Rate

- Drivers - Opportunities to improve net metering
- Credit solar customers for gross production at calculated Value of Solar Rate
- Charge solar customers for gross consumption at applicable retail rate

Net Billing

Customer Charge (per customer)	$
Energy Charge (per total kWh use)	$
Fuel Charge (per total kWh use)	$
Other Charges	$
Total Charges	$
Value of Solar Credit (per solar kWh)	($)
Total (net) Bill	**$**

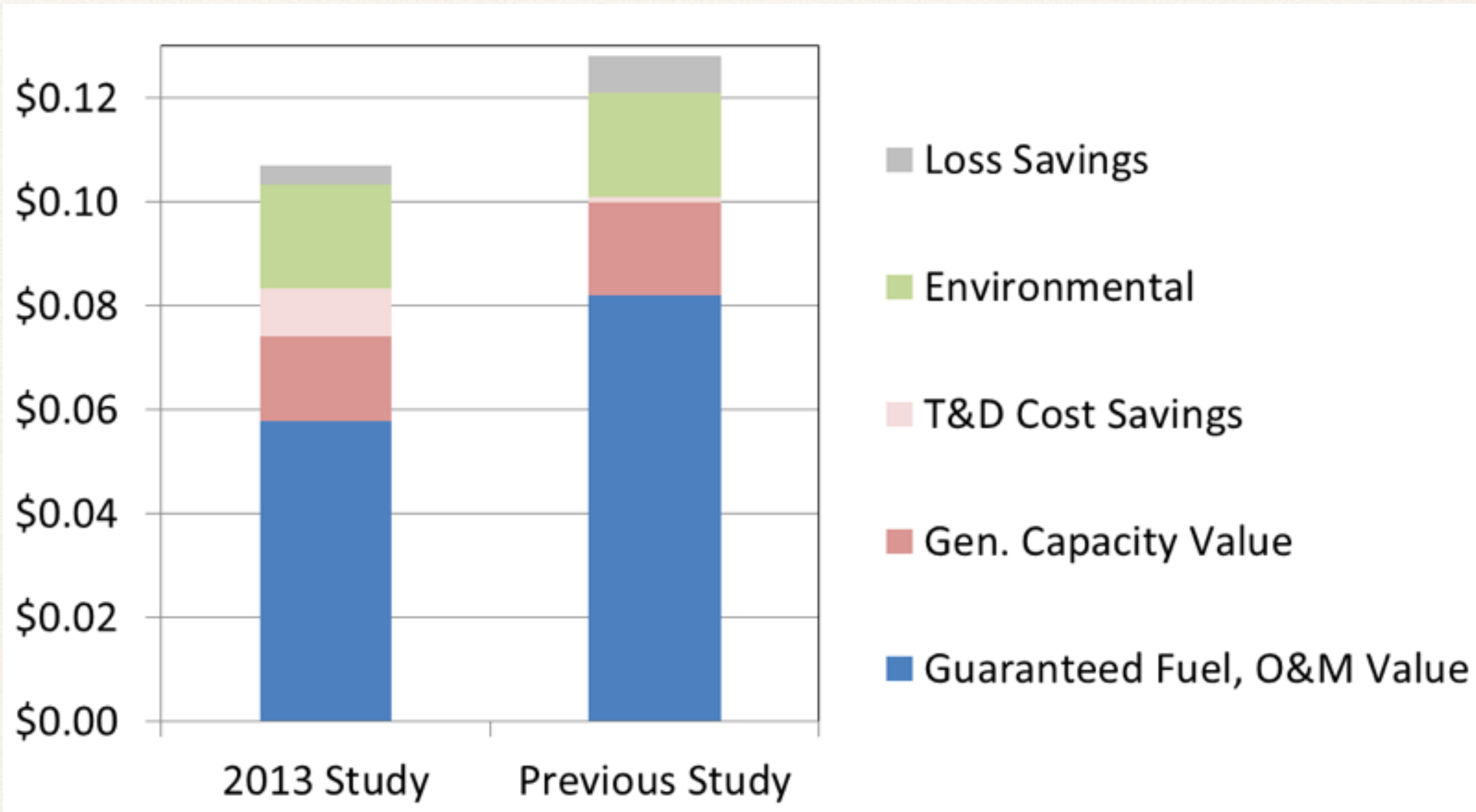
- The solar customer is credited for all solar generation at the annually adjusted VOS rate, empirically derived, based on actual values.
- The solar customer is charged for all energy consumption as if the customer did not have a solar system. This ensures that utility cost of service is always covered, regardless of solar system performance.
- Customer pays net charges, carries/uses credit value until end of year.
- Utility accounts for cumulative difference and collects balance through fuel factor

Drivers of CPR Value of Solar Changes for Austin

- Natural gas prices have declined
- Assumed life of 25 rather than 30 years
- Loss savings slightly lower
- Transmission savings results increased
- Methodology refined for ERCOT market

CPR 2013 Update of Austin VOS

http://www.cleanpower.com/resources/2014-value-solar-austin-energy/



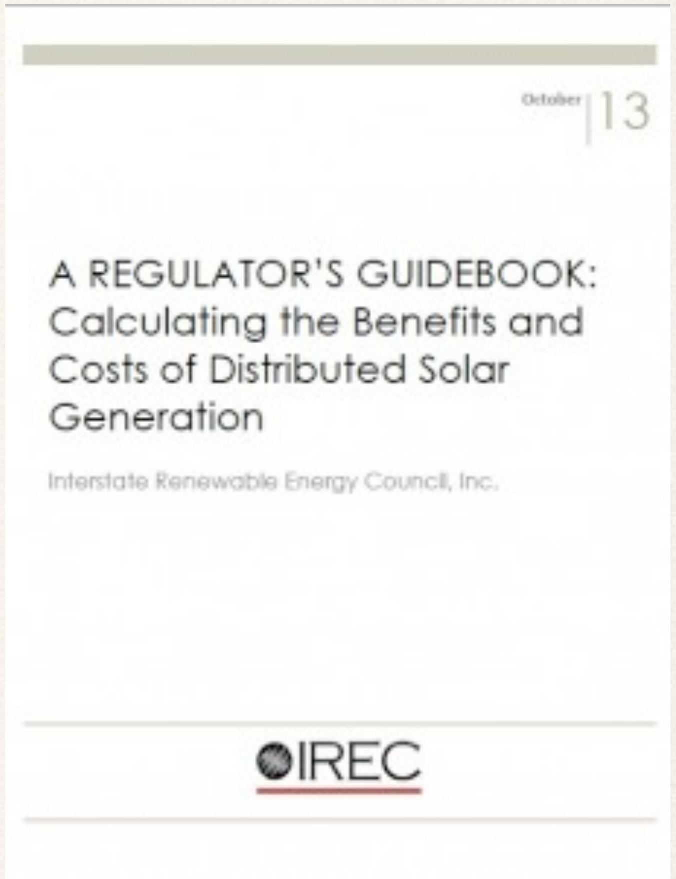
Highlights from New IREC/Rábago Energy LLC Paper

A Regulator's Guidebook: Calculating the Benefits and Costs of Distributed Solar Generation

IREC - Jason Keyes

Rábago Energy LLC - Karl R. Rábago

Available at: www.irecusa.org


October | 13

A REGULATOR'S GUIDEBOOK: Calculating the Benefits and Costs of Distributed Solar Generation

Interstate Renewable Energy Council, Inc.

IREC

Key Questions To Ask At The Onset of a Study

Q1: WHAT DISCOUNT RATE WILL BE USED?

- Recommendation: We recommend using a lower discount rate for DSG than a typical utility discount rate to account for differences in DSG economics.

Q2: WHAT IS BEING CONSIDERED – ALL GENERATION OR EXPORTS ONLY?

- Recommendation: We recommend assessing only DSG exports to the grid.

Q3: OVER WHAT TIMEFRAME WILL THE STUDY EXAMINE THE BENEFITS AND COSTS OF DSG?

- Recommendation: Expect DSG to last for thirty years, as that matches the life span of the technology given historical performance and product warranties. Interpolate between current market prices (or knowledge) and the most forward market price available or data that can accurately be estimated, just as planners do for fossil-fired generators that are expected to last for decades.

Key Questions To Ask At The Onset of a Study (2)

Q4: WHAT DOES UTILITY LOAD LOOK LIKE IN THE FUTURE?

- Recommendation: Given that NEM resources are interconnected behind customer meters, and result in lower utility loads, the utility can plan for lower loads than it otherwise would have. In contrast, other DSG rate or program options involving sale of all output to the utility do not reduce utility loads, but rather the customer facilities contribute to the available capacity of utility resources.

Q5: WHAT LEVEL OF MARKET PENETRATION FOR DSG IS ASSUMED IN THE FUTURE?

- Recommendation: The most important penetration level to consider for policy purposes is the next increment: what is likely to happen in the next three to five years. If a utility currently has 0.1% of its needs met by DSG, consideration of whether growth to 1% or even 5% is cost-effective is relevant, but consideration of whether higher penetrations are cost-effective can be considered at a future date.

Q6: WHAT MODELS ARE USED TO PROVIDE ANALYTICAL INPUTS?

- Recommendation: Transparent input models that all stakeholders can access will establish a foundation for greater confidence in the results of the DSG studies. When needed, the use of non-disclosure agreements can be used to overcome data sharing sensitivities.

Q7: WHAT GEOGRAPHIC BOUNDARIES ARE ASSUMED IN THE ANALYSIS?

- Recommendation: It is important to account for the range in local values that characterize the broader geographical area selected for the study. In some cases, quantification according to similar geographical sub-regions may be appropriate.

Key Questions To Ask At The Onset of a Study (3)

Q8: WHAT SYSTEM BOUNDARIES ARE ASSUMED?

- Recommendation: It may also be appropriate to consider impacts associated with adjacent utility systems, especially at higher (above 10%) penetration levels of DSG.

Q9: FROM WHOSE PERSPECTIVE ARE BENEFITS AND COSTS MEASURED?

- Recommendation: We recommend that ratepayer and societal benefits and costs should be assessed.

Q10: ARE BENEFITS AND COSTS ESTIMATED ON AN ANNUALIZED OR LEVELIZED BASIS?

- Recommendation: We recommend use of a levelized approach to estimating benefits and costs over the full assumed DSG life of 30 years. Levelization involves calculating the stream of benefits and costs over an extended period and discounting to a single present value. Such levelized estimates are routinely used by utilities in evaluating alternative and competing resource options.

Data Sets Needed

- The five or ten-year forward price of natural gas, the most likely fuel for marginal generation, along with longer-term projections in line with the life of the DSG
- Hourly load shapes, broken down by customer class to analyze the intra-class and inter-class impacts of NEM policy
- Hourly production profiles for NEM generators, including south-facing and westfacing arrays
- Line losses based on hourly load data, so that marginal avoided line losses due to DSG can be calculated
- Both the initial capital cost and the fixed and variable O&M costs for the utility's marginal generation unit
- Distribution planning costs that identify the capital and O&M cost (fixed and variable) of constructing and operating distribution upgrades that are necessary to meet load growth
- Hourly load data for individual distribution circuits, particularly those with current or expected higher than average penetrations of DSG, in order to capture the potential for avoiding or deferring circuit upgrades

Note: Where a utility or jurisdiction does not regularly collect some portion of this data, there may be methods to estimate a reasonable value to assign to DSG.

Assessing Benefits

The following benefits should be assessed:

- Energy
- System Losses
- Generation Capacity
- Transmission and Distribution Capacity
- Grid Support Services
- Financial: Fuel Price Hedge
- Financial: Market Price Response
- Security: Reliability and Resiliency
- Environment: Carbon& Other Factors
- Social: Economic Development

Assessing Benefits (2)

- Energy benefits should be based on the utility not running a CT or a CCGT. It is highly unlikely that DSG will offset coal or nuclear generation. Some combination of intermediate and peaking natural gas generation, with widely accepted natural gas price forecasts, should establish the energy value.
- Line losses should be based on marginal losses. Losses are related to load and DSG lowers circuit loads, which in turn lowers losses for utility service to other customers. Average line losses do not capture all of the loss savings; any study needs to capture both the losses related to the energy not delivered to the customer and the reduced losses to serve customers who do not have DSG.
- Generation capacity benefits should be evaluated from day one. DSG should be credited for capacity based on its Effective Load Carrying Capacity ("ELCC") from the day it is installed. If the utility has adequate capacity already, it may not have taken into account DSG penetration in its planning and overbuilt other generation; the DSG units that are actually operating during utility peaks should be credited with capacity value rather than a plant that is never deployed.
- T&D capacity benefits should be assessed. If the utility has any transmission plans, then DSG is helping to defer a major expense and should be included. On distribution circuits, watch for a focus on circuits serving residential customers, which tend to peak in the early evening when solar energy is minimal. Circuits serving commercial customers tend to peak during the early afternoon on sunny days, and a capacity value should be recognized for them in the form of avoided or deferred investment costs.

Assessing Benefits (3)

- Ancillary services should be evaluated. Inverters that can provide grid support are being mass-produced, and utility CEOs in the United States are calling for their use; ancillary services will almost certainly be available in the near future. Modeling the benefits and costs of ancillary services can also inform policy decisions like those related to interconnection technology requirements.

- A fuel price hedge value should be included. In the past, utilities regularly bought natural gas futures contracts or secured long-term contracts to avoid price volatility. The fact that this is rarely done now and that the customer is bearing the price volatility risk does not diminish the fact that adding solar generation reduces the reliance on fuels and provides a hedging benefit.

- A market price response should be included. DSG reduces the utility's demand for energy and capacity from the marketplace, and reducing demand lowers market prices. That means that the utility can purchase these services for less, saving money.

Assessing Benefits (4)

- Grid reliability and resiliency benefits should be assessed. Blackouts cause widespread economic losses that can be reduced or avoided in some situations with DSG. As well, customers who need more reliable service than average can be served with a combination of DSG, storage and generation that is less expensive than the otherwise necessary standby generator.

- The utility's avoided environmental compliance and residual environmental costs should be evaluated. DSG leads to less utility generation, and lower emissions of NOx, SOx and particulates, lowering the utilities costs to capture or control those pollutants.

- Societal benefits should be assessed. DSG policies were implemented on the basis of environmental, health and economic benefits, which should not be ignored and should be quantified.

Assessing Costs

- Determine whether lost revenue or utility costs are the basis of the study. For NEM studies, lost revenue is the standard (what the DSG customer would have otherwise paid the utility). For other studies and even some NEM studies, the cost to serve the DSG customer is addressed instead, which should lead to an inquiry in particular regarding allocation of capacity costs.

- Assumptions about administrative costs should reflect an industry-wide move towards automation. With higher penetration, costs per DSG customer tend to decline, so administrative costs should assume automation of processes.

- Interconnection costs should not be included. If the DSG customer pays for the interconnection, this should not be included as a cost to the utility. As well, the utility's interconnection costs should be compared to national averages to determine whether they are reasonable.

- Integration costs should not be based on unrealistic future penetration levels. Studies tend to find minimal grid upgrade requirements at DSG penetrations below a few percent. Looking ahead to what the grid might need to accommodate 50% penetration unnecessarily adds costs that are not actually being incurred.

Questions?

Thanks!

Karl R. Rábago

karl@rabagoenergy.com

www.rabagoenergy.com

512.968.7543