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Value-Based Reliability Planning for Grid Modernization Investments

November, 2014

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Agenda

- Utility industry dilemma: how to allocate scarce funds across diverse grid modernization options?
- Grid modernization investment decision framework
- Takeaway: 5 issues the industry needs to understand and quantify

Forces driving grid modernization -- limited funds mean investment in one area will take away from another

Economic growth	Grid security	Climate change

Outcome





Example: Benefits/Costs considered in Value of Solar proceedings

Value ranges for VOS components (cents / kWh)

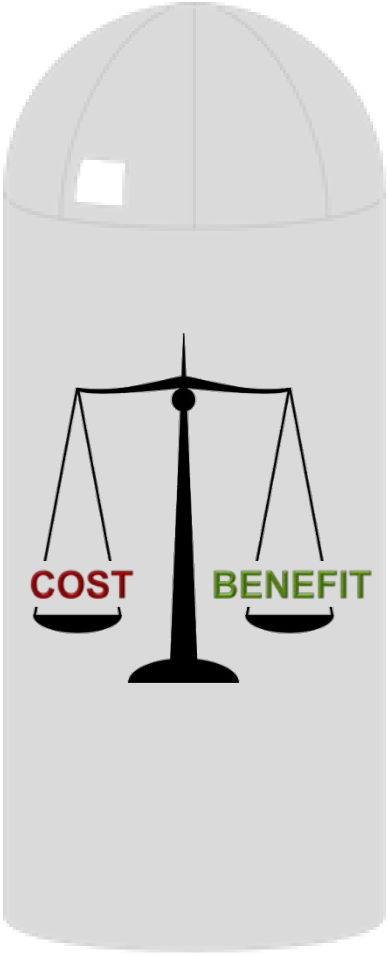
Category	Impact	RMI study	MN VOST	Consistent range (excluding outliers)
Energy	Fuel / gen cost	2.5 to 10.5	4.05	4 to 7 cents
	O&M costs (Fixed + variable)		0.28	
	Fuel price hedge	0.4 to 3.8	NA	inconsistent
	Market price response	0.8 to 4.5	NA	inconsistent
Capacity	Generation capacity	1 to 11	2.37	1 to 2 cents
	Ancillary services / costs	-0.4 to 1.5	0.17	inconsistent
	T&D capacity	0.1 to 8.5	2.46	0 to 1.5 cents
Environ-mental	Emissions (Carbon + Criteria pollutants	0.0365 to 3.9	2.87	1.5 to 2.5 cents
	Water	0.1	NA	inconsistent
Social	Resiliency	1 to 2.25	NA	inconsistent
	Economic development	1 to 4.5	NA	inconsistent

Example: Benefits/Costs considered in DER evaluation

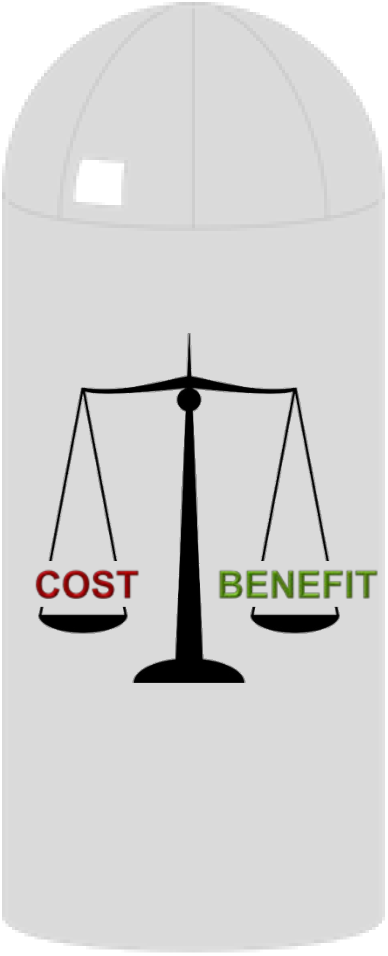
Criteria		Definition
Cost per Effective MW		Effective MW is the amount of peak load in MW's that can be carried by a specific resource after taking into account reliability, dispatch constraints, load shapes, etc. Cost per Effective MW is the component Effective MW divided by its total cost to ConEd, including project costs, incentives, and administrative costs.
Other Energy Benefits		Other energy benefits include avoided distribution costs (based on system wide average primary feeder, transformer, and secondary cable costs), avoided generation capacity costs (based on NYISO capacity demand curve), and avoided energy costs (based on NYISO projected LBMPs for NYC). Other known energy benefits can also be included.
Non Energy Benefits	*Resiliency benefits*	Accounts for expected outage costs from major weather events avoided by the resource over its lifetime.
	Avoided CO2 emissions	Benefit of emissions avoided over the lifetime of the resource.
	Health benefits	Benefit of SOx, NOx, and particulate emissions avoided over the lifetime of the resource.
	Economic benefits	GDP and employment impacts resulting from energy savings
	Other non-energy benefits	Other avoided resource costs, such as water conservation, over the lifetime of the resource.
Proposal viability		Estimation of likelihood of proposal success. Factors considered include execution details provided in the RFI, such as marketing plan, customer targets, etc.
Respondent qualifications		Estimation of demonstrated ability of the contractor to successfully execute the proposal. Factors considered include experience in similar past projects.
Reliability of load reduction		Estimation of likelihood the DER technology will deliver stated load reduction. Factors consider include newness of the technology and proven measurement of load reduction.
Flexibility of resource		Estimation of the ability of the resource to be dispatched at any time.
Availability of other funding sources		Degree to which additional funds are provided by outside initiatives (e.g., not utility or participant).

Grid modernization decisions currently siloed—different budgets, goals, success metrics

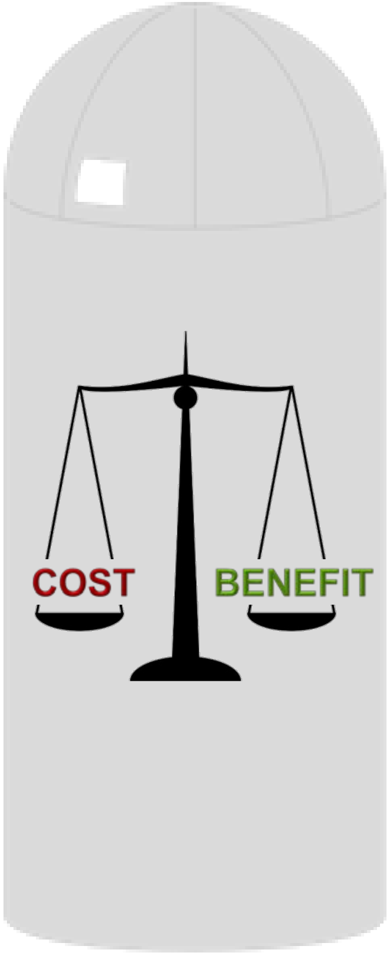
Grid Hardening



Smart Grid



Distributed Energy



Similar impacts apply to each type of investment, though size and magnitude differs

Illustrative example

Impacts (Benefits & Costs)	Magnitude, direction of grid modernization impacts: Grid Hardening	Smart Grid	DER
Capital investment	$$$$	$$$$	$$$$
GT&D Capacity	$$$	$	$$$
Energy generation		$	$$$
GT&D O&M	$$	$$$	Uncertain
Environmental			$
Power quality	$	$$	$$
Reliability: Utility restoration costs	$$$	$$$	$$
Reliability: Customer outage costs	Uncertain	$$$$$	Uncertain
Resiliency: Wide-scale blackouts	$$$$$		$$

$ Benefit $ Cost

Reliable, resilient energy is the <u>most fundamental benefit</u> the grid delivers: reliability impacts are substantial and cannot be ignored

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Grid investments <u>inconsistently consider</u> customer costs; DER <u>ignores</u> reliability; Resiliency methodology <u>lacking</u>

	Consideration of impacts in decision frameworks		
Impacts	**Grid Hardening**	**Smart Grid**	**DER**
Capital investment	●	●	●
GT&D Capacity	●	●	●
Energy generation	○	●	●
GT&D O&M	●	●	●
Environmental	○	○	●
Power quality	●	●	○
Reliability: Utility restoration costs	●	●	○
Reliability: Customer outage costs	◕	◕	○
Resiliency: Wide-scale blackouts	◔	○	◔

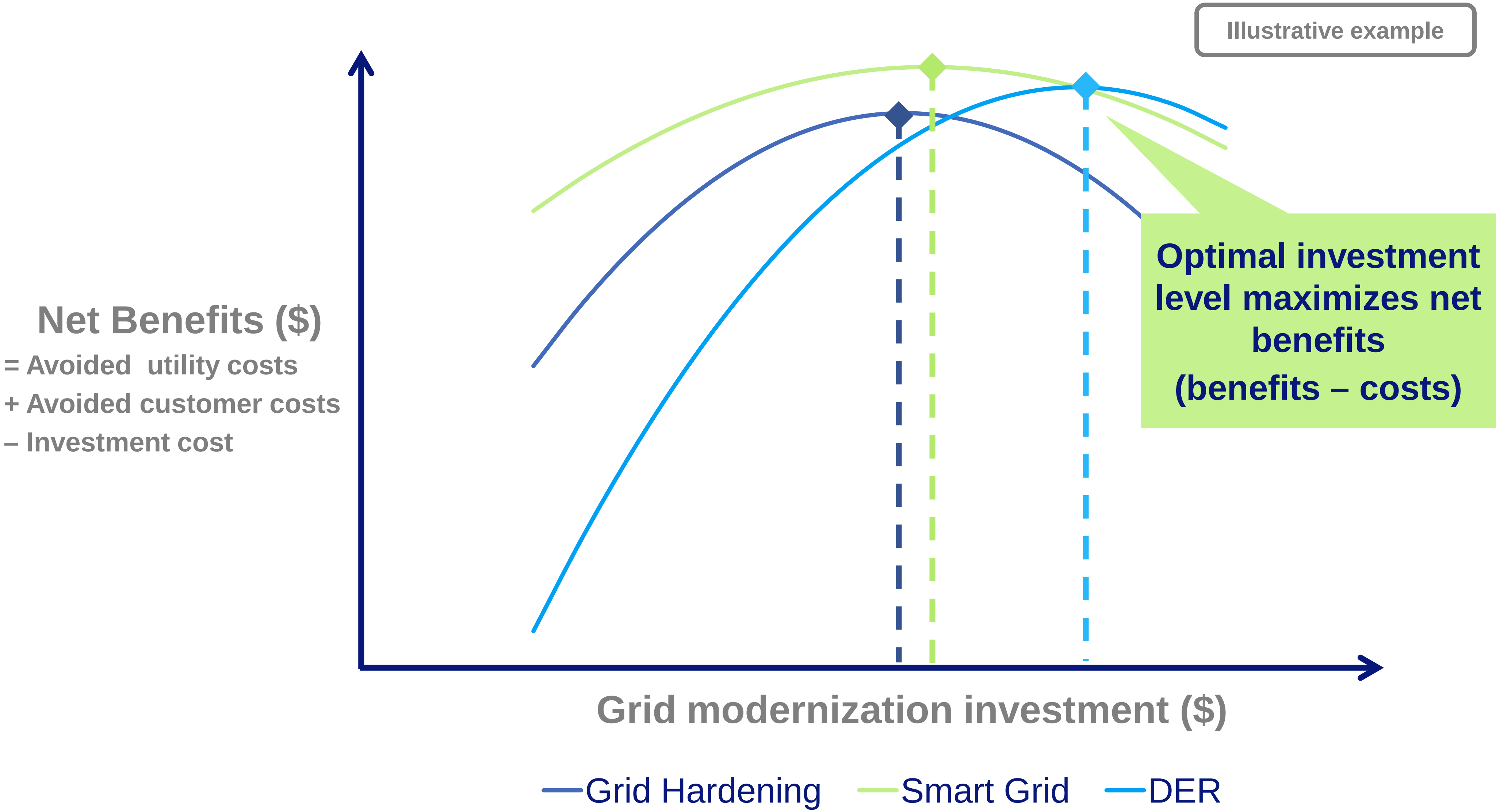
Customer cost inconsistency

DER ignores reliability

Resiliency lacking methodology

○ Not considered
◔ Recognized, methodology unknown
◕ Recognized, methodology not consistently applied
● Recognized, methodology consistently applied

Optimal (net benefit maximizing) investment level differs by investment category and specific investment



Grid investment evaluation best practice: Compare cost and benefits across options for an optimal portfolio

Conceptual

Portfolio Options	Grid Hardening Costs	Grid Hardening Benefits	Smart Grid Costs	Smart Grid Benefits	Distributed Energy Costs	Distributed Energy Benefits	Net Benefits (Benefit-Cost)
A	--	+++					+2
B			-	++			+1
C					---	++	-1
D	-	++	-	+++			+3
E			-	+++	--	++	+2
F	-	++	-	++++	-	++	+5

Investment portfolios can be optimized to achieve specified goals, e.g., X reliability, Y resiliency, Z carbon reduction

Goal of DOE Reliability / Resiliency collaboration: spread use of known methods and address unknowns

Known	Unknown
Customer surveys provide the best estimate of costs for momentary to multi-hour outages (reliability) Customer studies widely cited, e.g. in regulatory proceedings and cited by White House resiliency report* Outage costs far surpass $/kWh rates (by orders of magnitude) Outage costs vary widely by geography, segment, duration, time of day, day of week, time of year, weather, etc. Cost per event is the best methods for calculating reliability benefits *Avoided outage cost = change in reliability (SAIFI) * Cost per event*	Outage costs for many regions (only a handful of utility specific studies have been conducted) Multi-day outage costs (resiliency), few if any studies outside of the PG&E long-term cost study have been conducted Incremental resiliency impacts of individual grid modernization investments ➢ Detailed engineering modeling needed for each investment ➢ Difficulty estimating resiliency impacts due to high level of uncertainty for likelihood of extreme events, number / type of customers affected

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Three approaches to incorporating reliability & resiliency into grid modernization decisions

	Approaches for incorporating reliability & resiliency		
Impacts	**Ignore**	**Maintain**	**Measure & adjust**
Changes in reliability	↓ May inadvertently decrease	→ Keep current level	↓↑ May increase or decrease (aligned with customer value)
Net Benefit Optimization	Excludes reliability	Maintains current reliability as a constraint (assumed to be large but unknown)	Value-Reliability function is an input to optimization
Pro	Takes zero incremental effort	Simpler to implement (only need to model portfolio to maintain current reliability)	Allows more portfolio flexibility for arriving at net benefits due to aligning cost with value
Con	Could lead to unforeseen reliability issues and future costs	Constrains net benefit maximization, resulting in lower net benefits	Can be costly and time consuming to implement
Appropriate use	Never	When implementation resources are constrained	When implementation resources are available

5 issues the industry needs to understand and quantify

Key need: a common, standardized framework for evaluating grid modernization investments as a portfolio

	Issue	Understand	Quantify
1	**Siloed grid modernization** decisions have potentially resulted in sub-optimal investment	What is the most cost-effective grid modernization **investment portfolio** across Hardening, Smart Grid, DER?	**Comparison of impact across investment options** on utility cost AND customer value
2	**Reliability & resiliency benefits likely substantial** and may outweigh other benefits	How **can customer value be accurately measured** against other more traditional benefits?	**Region / utility specific outage costs** measured using standard survey best practices
3	**DER marginal reliability impacts** have only been considered at low penetration	Is there an **optimal level of DER** investment followed by diminishing returns?	**Influence of DER penetration** level on SAIFI / SAIDI
4	**Interactions / synergies between grid modernization investments** largely unstudied	Which options are **substitutes versus complements**? How do they interact with each other?	**Combined vs. individual impact** of options on SAIFI/SAIDI
5	**Lack of standardized, accepted resiliency benefit evaluation framework**, leading to exclusion from decisions	What is a standardized **economic framework for evaluating resiliency benefits**? What are the missing pieces?	**Likelihood of a catastrophic weather event** (e.g., 50 year storm = 2%) **Quantity and type of customers** likely to get affected

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