Benefit-Cost Analysis for New York Energy Investments

Training Session for Earthjustice

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Tim Woolf
Synapse Energy Economics

Outline

- General overview of Benefit-Cost Analysis (BCA)
- BCA experience in electric and gas utility regulation
  - Prudent, used, and useful
  - Integrated resource planning
  - Energy efficiency
    - California Standard Practice Manual
    - National Standard Practice Manual
- New York REV BCA Order
- NY BCA Handbooks for Electric Utilities
- NY BCA Handbook for Non-Pipeline Solutions
- BCA example: NiMo BCA for DERs in recent rate case

Please ask questions throughout the presentation.

Benefit Cost Analysis

BCA is simply a way to compare multiple costs with multiple benefits over the long term.

- Identify a reference case.
- Identify a counterfactual case.
- Define costs and benefits.
- Determine appropriate time frame.
- Determine discount rates.
- Present results.
  - Cumulative net benefits
  - Benefit-cost ratio
  - Break-even date
  - Annual and cumulative net benefits each year

BCAs For Utilities

Prudency Reviews

Integrated Resource Planning

Energy Efficiency

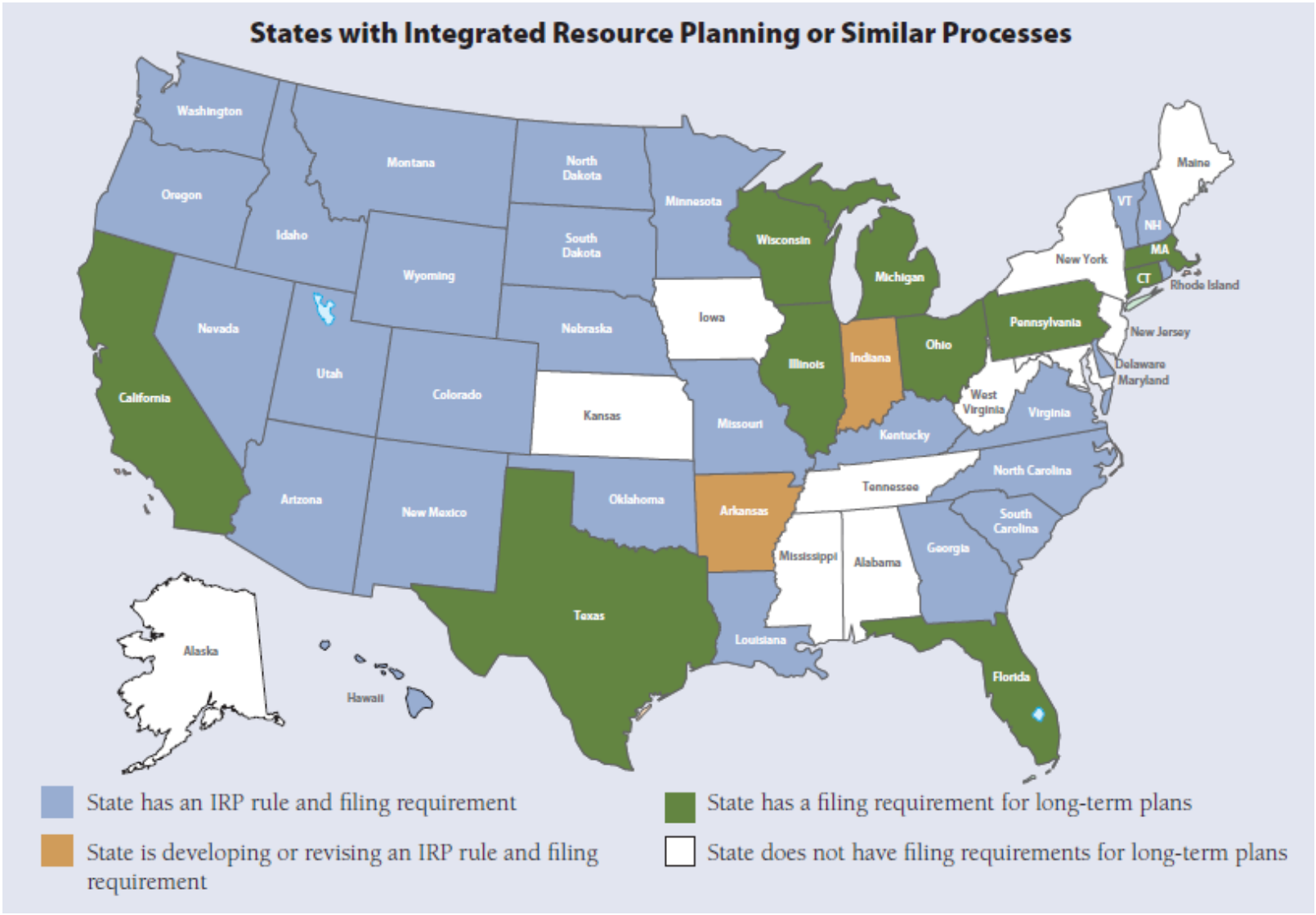
BCAs for Utilities: Prudency Reviews

- BCAs have been used for many years to determine whether it is prudent to invest in power plants.
- BCAs have been conducted:
  - Prior to plant construction -- Should construction commence?
  - During plant construction -- Should construction continue?
  - After plant construction -- Should the utility recover costs and/or profits?
- Many BCAs were project-specific
  - Nuclear plants with large cost over-runs
  - Coal plants with large cost over-runs
- Often they were performed too late
  - Commissions and stakeholders seeking to engage in decision before investment
  - This led to the concept of integrated resource planning

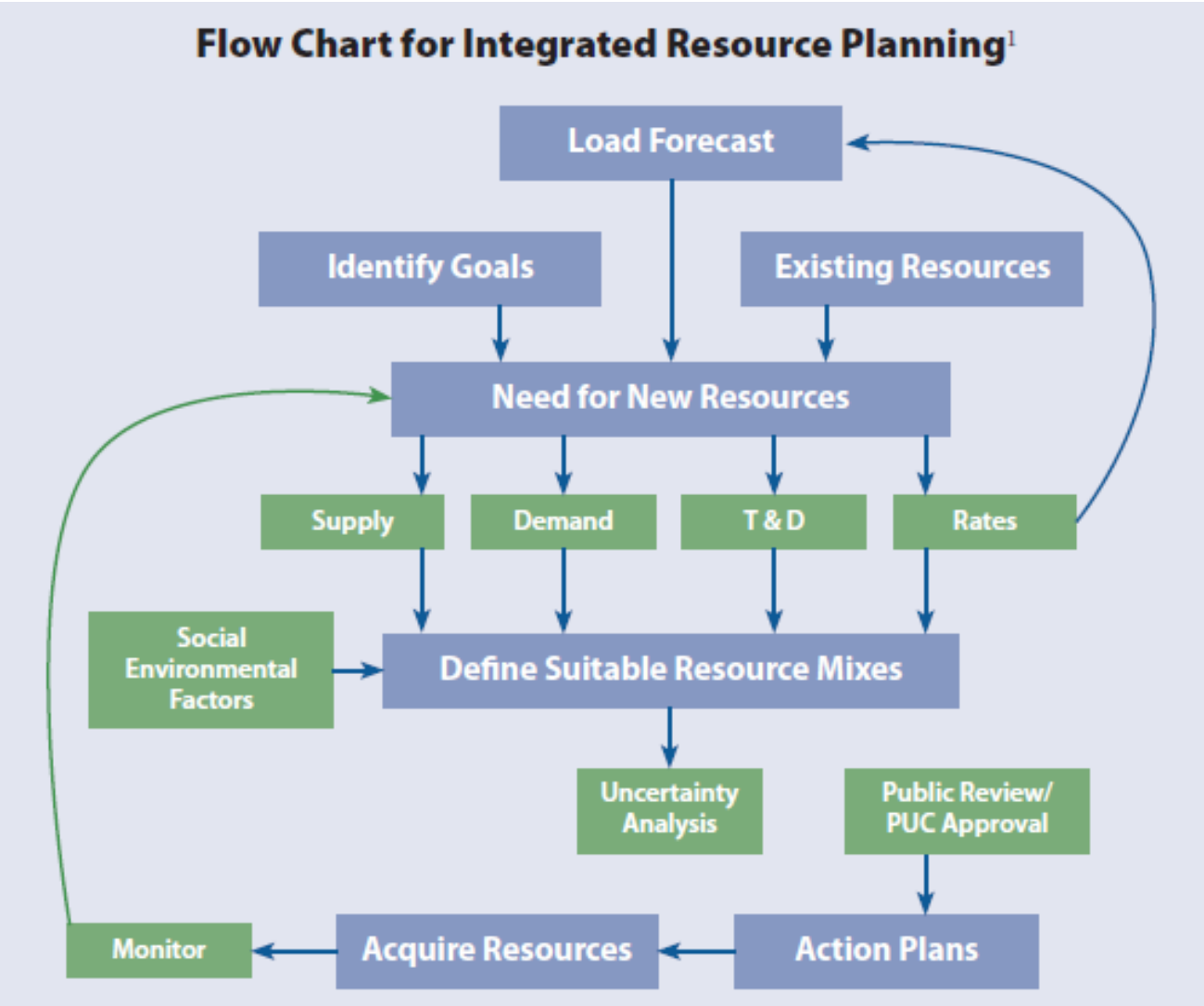
BCAs for Utilities: Integrated Resource Planning

- Integrated resource planning is essentially a big BCA.
- Impetus behind IRP
  - Regulatory and stakeholders review utility plans (and BCAs) before expenditures
  - Utilities required to optimize their resource portfolios
  - Utilities required to seriously consider (and integrate) demand-side resources
- The majority of states require some form of IRP
- Experience with IRP has been mixed
  - Has made some utility planning practices more transparent
  - Has had a modest impact on promotion of demand-side resources
  - Outcomes are often manipulated and controlled by utilities
  - Stakeholders and Commissions often do not have sufficient resources to review
  - It can collapse from its own weight
- IRP experience is a cautionary tale:
  - A good NWA or NPS should be a comprehensive IRP at the distribution level
  - With more resource options and more complexity

IRP Widely Used in the US



IRP Overview



IRP Best Practices: The Process

- Resource plan development
  - IRPs prepared on a regular basis (e.g., every two or three years)
  - Guided by comprehensive IRP rules
  - Allow for stakeholder input early on in the development
- Resource plan review
  - Clear regulatory oversight
    - Commission has the ability to approve, modify, or reject plan
    - Implications of Commission approval, modification, or rejection of plan
  - Allow for stakeholder review and input

IRP Best Practices: The Plan

- Load forecasts
  - Based on realistic assumptions and fully documented
- Existing resources
  - Comprehensive assessment of repowering, retirement, or replacement
- New demand-side resources
  - Comprehensive evaluation of all opportunities
- New supply-side resources
  - Comprehensive evaluation of all opportunities
- Fuel prices
  - Based on realistic assumptions and fully documented
- Environmental costs and constraints
  - Sound projection of future costs of environmental compliance

IRP Best Practices: The Plan

- Integrated analysis
  - Meaningful integration of demand-side resources
- Time frame
  - Study period should be long enough to account for all costs and benefits
- Uncertainty
  - Scenario, sensitivity, and risk mitigation analyses
- Valuing and selecting plans
  - Identify the proper criteria for selecting plans: PVRR, environmental, financial, etc.
- Action plan
  - Clearly defined steps to implement the preferred resource plan
- Documentation
  - Transparent inputs, methodologies, and outputs

California Standard Practice Manual

- Describes five standard cost-effectiveness tests:
  - **Utility Cost test**
  - **Total Resource Cost test**
  - **Societal Cost test**
  - **Rate Impact Measure (RIM) test**
  - **Participant test**
- The CA SPM has been widely used in the U.S. and Canada for EE.
- These tests are increasingly being used for DERs.
- The CA SPM suffers from several limitations:
  - Does not address some important issues (e.g., policy goals)
  - Does not address rate impact issues well
  - Has been misunderstood and misused in many applications
  - Is out of date with current needs.

CA SPM Traditional Tests

Test	Perspective	Key Question Answered	Summary Approach
Utility Cost	The utility system	Will utility system costs be reduced?	Includes the costs and benefits experienced by the utility system
Total Resource Cost	The utility system plus participating customers	Will utility system costs plus program participants' costs be reduced?	Includes the costs and benefits experienced by the utility system, plus costs and benefits to program participants
Societal Cost	Society as a whole	Will total costs to society be reduced?	Includes the costs and benefits experienced by society as a whole
Participant Cost	Customers who participate in an efficiency program	Will program participants' costs be reduced?	Includes the costs and benefits experienced by the customers who participate in the program
Rate Impact Measure	Impact on rates paid by all customers	Will utility rates be reduced?	Includes the costs and benefits that will affect utility rates, including utility system costs and benefits plus lost revenues

National Standard Practice Manual

- Designed to update, improve, and replace the CA SPM
- Includes a set of fundamental BCA principles
- Acknowledges the importance of policy goals in BCAs
- Provides an framework for determining a state BCA test
- Distinguishes between primary and secondary tests
- Provides guidance on whether and how to include participant impacts
- Provides guidance on key BCA inputs:
  - Discount rates
  - Avoided costs
  - Study period
  - End effects

NSPM: Principles

Efficiency as a Resource	EE is one of many resources that can be deployed to meet customers' needs and therefore should be compared with other energy resources (both supply-side and demand-side) in a consistent and comprehensive manner.
Policy Goals	A jurisdiction's primary cost-effectiveness test should account for its energy and other applicable policy goals and objectives. These goals and objectives may be articulated in legislation, commission orders, regulations, advisory board decisions, guidelines, etc., and are often dynamic and evolving.
Hard-to-Quantify Impacts	Cost-effectiveness practices should account for all relevant, substantive impacts (as identified based on policy goals,) even those that are difficult to quantify and monetize. Using best-available information, proxies, alternative thresholds, or qualitative considerations to approximate hard-to-monetize impacts is preferable to assuming those costs and benefits do not exist or have no value.
Symmetry	Cost-effectiveness practices should be symmetrical, where both costs and benefits are included for each relevant type of impact.
Forward-Looking Analysis	Analysis of the impacts of resource investments should be forward-looking, capturing the difference between costs and benefits that would occur over the life of the subject resources as compared to the costs and benefits that would occur absent the resource investments.
Transparency	Cost-effectiveness practices should be completely transparent and should fully document all relevant inputs, assumptions, methodologies, and results.

NSPM: Resource Value Framework

STEP 1 Identify and articulate the jurisdiction's applicable policy goals.

STEP 2 Include all the utility system costs and benefits.

STEP 3 Decide which non-utility impacts to include in the test, based on applicable policy goals.

STEP 4 Ensure that the test is symmetrical in considering both costs and benefits.

STEP 5 Ensure the analysis is forward looking and incremental.

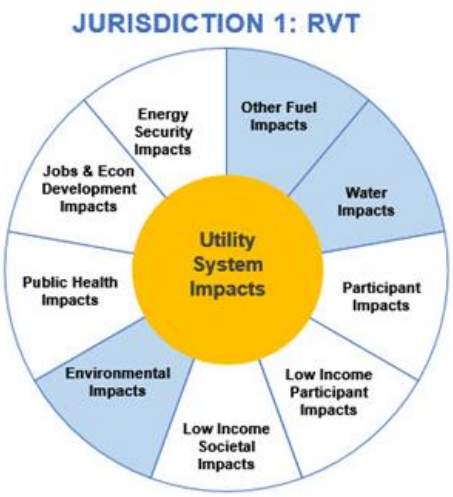
STEP 6 Develop methodologies to account for all relevant impacts, including hard to quantify impacts.

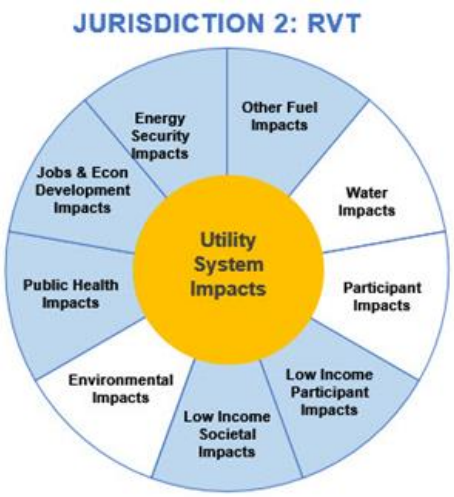
STEP 7 Ensure transparency in presenting the inputs and results of the cost-effectiveness test.

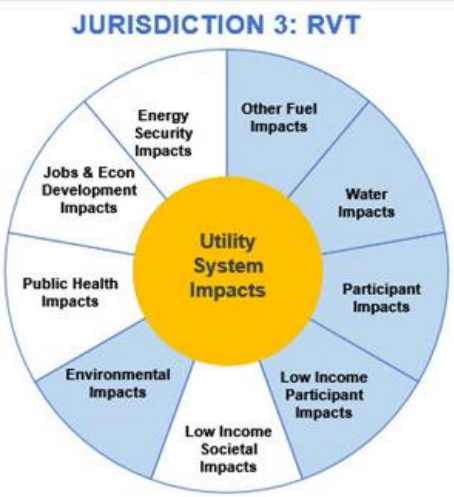
NSPM: Participant Non-Energy Benefits

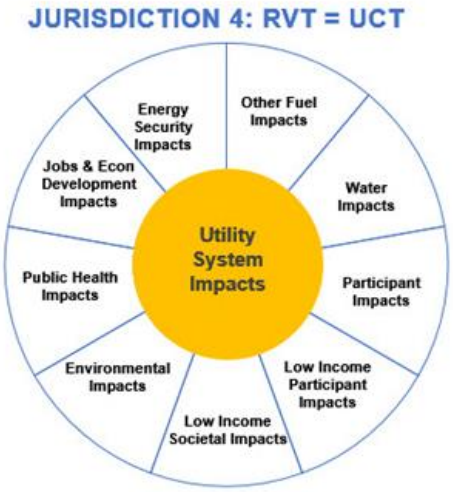
Category	Examples
Asset value	• Equipment functionality/performance improvement • Equipment life extension • Increased building value • Increased ease of selling building
Productivity	• Reduced labor costs • Improved labor productivity • Reduced waste streams • Reduced spoilage/defects • Impact of improved aesthetics, comfort, etc. on product sales
Economic well-being	• Fewer bill-related calls to utility • Fewer utility intrusions & related transactions costs (e.g., shut-offs, reconnects) • Reduced foreclosures • Fewer moves • Sense of greater "control" over economic situation • Other manifestations of improved economic stability
Comfort	• Thermal comfort • Noise reduction • Improved light quality
Health & safety	• Improved "well-being" due to reduced incidence of illness—chronic (e.g., asthma) or episodic (e.g., hypothermia or hyperthermia) • Reduced medical costs (emergency room visits, drug prescriptions) • Fewer sick days (work and school) • Reduced deaths • Reduced insurance costs (e.g., for reduced fire, other risks)
Satisfaction/pride	• Improved sense of self-sufficiency • Contribution to addressing environmental/other societal concerns

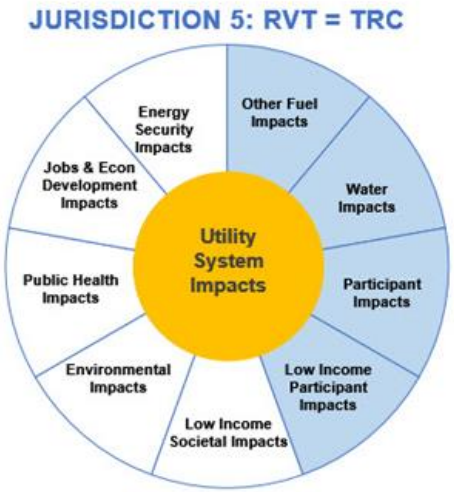
NSPM: Relationship Of Different Tests

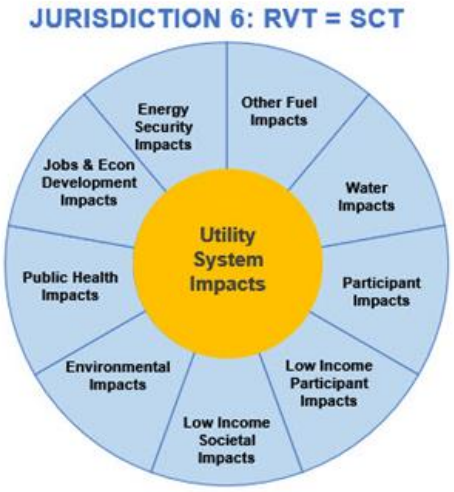






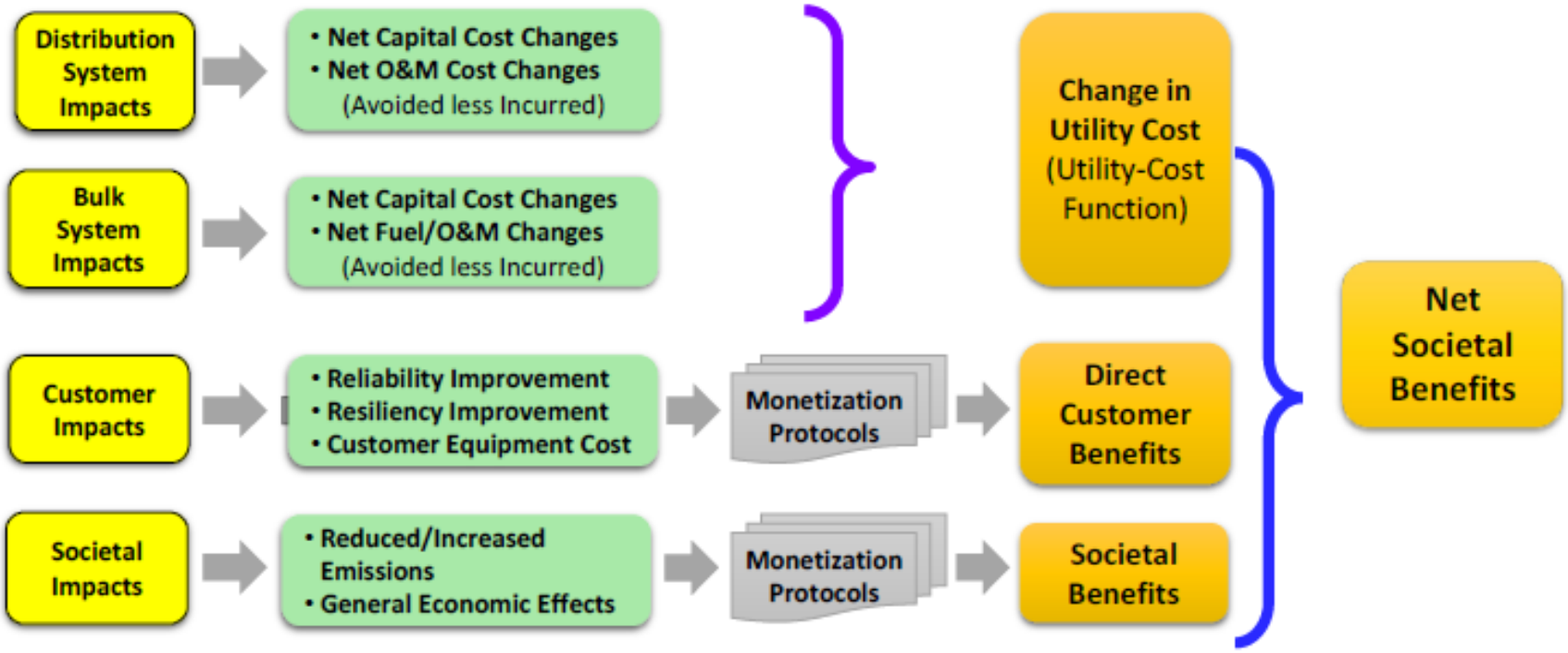






Recent Trends on BCAs for Grid Modernization

EPRI: Benefit-Cost Framework for the Integrated Grid



Source: Electric Power Research Institute, The Integrated Grid: A Benefit-Cost Framework, February 2015, page 9-3.

EPRI report explains the rationale for the utility and societal perspectives.
No mention of a Total Resource Cost test.
No mention of lost revenues or a RIM test.

U.S. Department of Energy: Modern Distribution Grid

DOE divides modern grid expenditures into four types:

1. Expenditures to replace aging infrastructure
   - Apply the **Utility Cost test**
2. Expenditures to maintain reliable operations
   - Apply the **Utility Cost test**
3. Expenditures to enable public policy or societal benefits
   - Apply the **Societal Cost test**
4. Expenditures that will be paid for by customers
   - No need to analyze because they do not require regulatory approval

Source: US Department of Energy, Modern Distributed Grid, Decision Guide, Volume III, June 8, 2017, pages 39-44.

No mention of a Total Resource Cost test.
No mention of lost revenues or a RIM test.

New York BCA Policies

New York BCA Order: Highlights

- The Societal Cost test should be the primary test
- The Utility Cost test should play a subsidiary role
- The RIM test should play a subsidiary role
  - But a more sophisticated rate and bill impact analysis is needed
- The Societal Cost test should include environmental externalities
  - Based on the EPA Social Cost of Carbon
- Non-energy benefits
  - Should be monetized on a location-specific or project-specific basis, where possible
  - NEBs that cannot be monetized should be considered on a qualitative basis
- The utility WACC should be used as the discount rate

NY BCA Order: Cost-Effectiveness Tests

Cost Test	Perspective	Key Question Answered	Calculation Approach
SCT	Society	Is the State of New York better off as a whole?	Compares the costs incurred to design and deliver projects, and customer costs with avoided electricity and other supply-side resource costs (e.g., generation, transmission, and natural gas); also includes the cost of externalities (e.g., carbon emissions and other net non-energy benefits)
UCT	Utility	How will utility costs be affected?	Compares the costs incurred to design, deliver, and manage projects by the utility with avoided electricity supply-side resource costs
RIM	Ratepayer	How will utility rates be affected?	Compares utility costs and utility bill reductions with avoided electricity and other supply-side resource costs

New York BCA Order: Principles

1. Be based on transparent assumptions and methodologies; list all benefits and costs including those that are more localized and granular.
2. Avoid combining or conflating different benefits and costs.
3. Assess portfolios rather than individual measures or investments.
4. Address the full lifetime of the assumption while reflecting sensitivities on key assumptions.
5. Compare benefits and costs to traditional alternatives instead of valuing them in isolation.

Source: NY PSC, Order Establishing the Benefit-Cost Analysis Framework, Case 14-M-0101, January 21, 2016, page 2.

New York BCA Order: Disappointments

- Maintains the use of the RIM test. However:
  - The order makes the RIM test subsidiary to the Societal Cost test.
  - The order requires more sophisticated analyses of rate and bill impacts.
  - The order states that a project or investment that passes the Societal Cost test cannot be rejected on the grounds of the RIM test, without first demonstrating that the impact on customer bills is unacceptable.
  - There are some limited situations where the RIM test is useful.
- Maintains the use of the utility weighted average cost of capital for the discount rate.
  - Not consistent with the Societal Cost test.
  - Will undermine resources with long operating lives.
- Discounts non-energy benefits.
  - "Nor will a generalized adder be adopted to accommodate operational or societal NEBs on other costs that cannot be monetized at this time. Such an adder would increase the price of electricity without necessarily resulting in value to ratepayers." *BCA Order, page 22.*

BCA Handbooks for Electric Utilities

- Generally follow the directives from the PSC Order.
- Define the relevant costs.
  - Program administration
  - Utility costs
  - Participant costs
  - Societal
- Define the relevant benefits.
  - Bulk system
  - Distribution system
  - Reliability/resilience
  - Societal
- Provide methodologies and assumptions.
  - State-wide and utility-specific
- Explain how to determine the profiles of DERs.
- Propose applying reliability/resilience benefits in only limited circumstances.

BCA Handbooks for Electric Utilities: Costs & Benefits

Section #	Benefit/Cost	SCT	UCT	RIM
Benefit				
4.1.1	Avoided Generation Capacity Costs†	✓	✓	✓
4.1.2	Avoided LBMP‡	✓	✓	✓
4.1.3	Avoided Transmission Capacity Infrastructure†‡	✓	✓	✓
4.1.4	Avoided Transmission Losses†‡	✓	✓	✓
4.1.5	Avoided Ancillary Services*	✓	✓	✓
4.1.6	Wholesale Market Price Impacts**		✓	✓
4.2.1	Avoided Distribution Capacity Infrastructure	✓	✓	✓
4.2.2	Avoided O&M	✓	✓	✓
4.2.3	Avoided Distribution Losses†‡	✓	✓	✓
4.3.1	Net Avoided Restoration Costs	✓	✓	✓
4.3.2	Net Avoided Outage Costs	✓		
4.4.1	Net Avoided CO_2‡	✓		
4.4.2	Net Avoided SO_2 and NO_x‡	✓		
4.4.3	Avoided Water Impacts	✓		
4.4.4	Avoided Land Impacts	✓		
4.4.5	Net Non-Energy Benefits***	✓	✓	✓
Cost				
4.5.1	Program Administration Costs	✓	✓	✓
4.5.2	Added Ancillary Service Costs*		✓	✓
4.5.3	Incremental T&D and DSP Costs	✓	✓	✓
4.5.4	Participant DER Cost	✓		
4.5.5	Lost Utility Revenue			✓
4.5.6	Shareholder Incentives		✓	✓
4.5.7	Net Non-Energy Costs**	✓	✓	✓

BCA Handbook for Non-Pipeline Solutions

Based on an initial review...

- This seems like a reasonable description of the issues and assumptions, and is consistent with the NY REV BCA order.
- Some issues that are likely to warrant attention:
  - Gas price forecasts
  - Estimates of avoided costs
    - Derating factors
    - Avoided distribution costs
  - Estimates of reliability/resilience benefits
  - Sensitivity analyses
  - Estimates of non-energy benefits: health & safety to participants and society
  - Estimates of participant costs

BCA Handbook for Non-Pipeline Solutions

Main Benefit Categories

- Fixed and variable avoided upstream supply
- Avoided distribution expense
- Reliability/resilience
- Societal benefits

Main Cost Categories

- Program administration
- Incremental distribution
- Lost utility revenue
- Participant cost
- Alternative fuel cost
- Societal cost

BCA Handbook for Non-Pipeline Solutions

Table 4 - 2 Components Applicable to BCA Tests

Benefit/Cost	Section #	SCT	UCT	RIM
Benefits				
Fixed Costs of Avoided Upstream Supply	3.3.1.3	✓	✓	✓
Commodity Costs of Avoided Upstream Supply	3.3.1.4	✓	✓	✓
Avoided Distribution System Capacity Infrastructure	3.3.2.1	✓	✓	✓
Avoided Distribution O&M	3.3.2.2	✓	✓	✓
Reliability/Resiliency	3.3.3	✓	✓	✓
Avoided CO_2	3.3.4.1	✓		
Avoided Other Emissions	3.3.4.2	✓		
Other Non-Energy Benefits	3.3.4.3	✓	✓	✓
Other External Benefits	3.3.4.4	✓		
Costs				
Program Administration Costs	3.4.1	✓	✓	✓
Incremental Distribution System Costs	3.4.2	✓	✓	✓
Lost Utility Revenue	3.4.3			✓
Participant NPS Cost	3.4.4	✓	✓	✓
Alt. Fuel Costs (Electric) *	3.4.6	✓	✓	✓
Alt. Fuel CO_2 Emissions	3.4.7.1	✓		
Alt. Fuel Other Emissions	3.4.7.2	✓		
Other Net Non-Energy Costs	3.4.7.3	✓	✓	✓
Other External Costs	3.4.7.4	✓		

BCA Handbook for Non-Pipeline Solutions

Five case studies:

1. Renewable natural gas
   - An incremental, baseload, on-system supply project
2. Storage – compressed natural gas
   - An incremental, dispatchable, on-system storage project
3. Energy efficiency
   - Reduced demand through an EE program that also saves energy
4. Demand response
   - Reduced demand through a dispatchable DR program
5. Gas to electricity conversions
   - Replace peak demand through different technology, not dispatchable

BCA Handbook for NPS: Case Studies

Benefit/Cost	Section	RNG	CNG	EE	DR	G2E
Benefits						
Avoided Upstream Costs -- Fixed Costs	3.3.1.3	●	●	●	●	●
Avoided Upstream Costs -- Variable Costs	3.3.1.4	●	●	●	●	●
Avoided Distribution Costs -- Capital Related	3.3.2.1	○	○	◒	◒	◒
Avoided Distribution Costs -- O&M	3.3.2.2	○	○	◒	◒	◒
Reliability / Resiliency	3.3.3	◒	◒	◒	◒	◒
Avoided CO2	3.3.4.1	●	○	●	●	●
Avoided PM, NOX, SOX	3.3.4.2	◒	○	◒	◒	●
Other Net Non-Energy Benefits	3.3.4.3	◒	◒	◒	◒	◒
Costs						
Program Administration	3.4.1	●	●	●	●	●
Incremental Distribution System Investments/Costs	3.4.2	●	●	◒	◒	◒
Lost Utility Revenue	3.4.3	○	○	●	◒	●
Participant NPS Costs	3.4.4	●	●	●	●	●
Alternative Fuel Costs (Electric)	3.4.6	◒	◒	○	◒	●
CO2 Impacts	3.4.7.1	◒	◒	○	◒	●
PM, NOX, SOX Impacts	3.4.7.2	◒	◒	○	◒	●
Other Net Non-Energy Costs	3.4.7.3	◒	◒	◒	◒	◒

● Generally Applicable ◒ Maybe Applicable ○ Limited or No Applicability

New York BCA Examples

Niagara Mohawk BCA for DERs: Projects Accepted

Category	Item	Total (NPV $MM)	VVO/CVR	Solar Portal	E-Commerce Portal	DRMS	Energy Storage
Benefits	Total	$62.6	$45.6	$3.0	$0.2	$7.1	$6.6
	SCT	$59.8	$45.6	$3.0	$0.2	$7.1	$3.8
	UCT	$49.2	$35.0	$3.0	$0.2	$7.1	$3.8
	RIM	$52.0	$35.0	$3.0	$0.2	$7.1	$6.6
Costs	Total	$37.0	$26.9	$1.0	$0.1	$4.3	$4.6
	CapEx split	$25.8	$17.1	$0.05	$0.1	$3.9	$4.6
	O&M split	$11.2	$9.8	$0.98	$0.09	$0.4	$0.0
	SCT	$37.0	$26.9	$1.0	$0.1	$4.3	$4.6
	UCT	$37.0	$26.9	$1.0	$0.1	$4.3	$4.6
	RIM	$37.0	$26.9	$1.0	$0.1	$4.3	$4.6
Cost-Effectiveness Tests	SCT Ratio	1.6	1.7	2.9	1.5	1.7	0.8
	UCT Ratio	1.3	1.3	2.9	1.5	1.7	0.8
	RIM Ratio	1.4	1.3	2.9	1.5	1.7	1.4

Niagara Mohawk BCA for DERs: Projects Rejected

Category	Item	Total (NPV $MM)	VVO/CVR	Solar Portal	E-Commerce Portal	DRMS	Energy Storage	Electric Vehicles	Heat Pumps
Benefits	Total	$116.9	$45.6	$3.0	$0.2	$7.1	$6.6	$39.3	$15.0
	SCT	$93.6	$45.6	$3.0	$0.2	$7.1	$3.8	$23.8	$10.0
	UCT	$49.6	$35.0	$3.0	$0.2	$7.1	$3.8	$0.0	$0.4
	RIM	$72.9	$35.0	$3.0	$0.2	$7.1	$6.6	$15.5	$5.4
Costs	Total	$74.1	$26.9	$1.0	$0.1	$4.3	$4.6	$28.0	$9.0
	CapEx split	$39.2	$17.1	$0.1	$0.1	$3.9	$4.6	$13.4	$0.0
	O&M split	$21.5	$9.8	$1.0	$0.1	$0.4	$0.0	$7.5	$2.8
	SCT	$74.1	$26.9	$1.0	$0.1	$4.3	$4.6	$28.0	$9.0
	UCT	$70.3	$26.9	$1.0	$0.1	$4.3	$4.6	$28.0	$5.3
	RIM	$70.3	$26.9	$1.0	$0.1	$4.3	$4.6	$28.0	$5.3
Cost-Effectiveness Tests	SCT Ratio	1.3	1.7	2.9	1.5	1.7	0.8	0.85	1.1
	UCT Ratio	0.7	1.3	2.9	1.5	1.7	0.8	0.0	0.1
	RIM Ratio	1.0	1.3	2.9	1.5	1.7	1.4	0.6	1.0

NiMo BCA for DERs: Heat Pumps

Category	Item	Value
Benefits	**Total**	$15.0
	SCT	$10.0
	UCT	$0.4
	RIM	$5.4

Costs	**Total**	$9.0
	CapEx split	$0.0
	O&M split	$2.8
	SCT	$9.0
	UCT	$5.3
	RIM	$5.3

Cost-Effectiveness Tests	SCT Ratio	1.1
	UCT Ratio	0.1
	RIM Ratio	1.0

Category	Benefit / Cost	SCT	UCT	RIM	NPV ($MM)	% out of total		
Benefit	Avoided Generation Capacity Costs	Y	Y	Y	$0.38	3%		
	Net Avoided CO2	Y			$1.17	8%		
	Net Avoided SO2 and NOx	Y			$0.00	0%		
	Increased Utility Revenue			Y	$4.99	33%		
	Avoided Non-Electric Fuel Cost	Y			$8.44	56%		
	TOTAL BENEFITS	**$10.0**	**$0.4**	**$5.4**	**$15.00**			
							CapEx split	O&M split
Cost	Program Administration Costs	Y	Y	Y	$2.82	31%		$2.82
	Increased LBMP	Y	Y	Y	$2.43	27%		
	Participant DER Cost	Y			$3.77	42%		
	TOTAL COSTS	**$9.0**	**$5.3**	**$5.3**	**$9.02**		**$0.0**	**$2.8**

NiMo BCA for DERs: VVO/CVR

Category	Item	NPV ($MM)
Benefits	Total	$45.6
	SCT	$45.6
	UCT	$35.0
	RIM	$35.0

Costs	Total	$26.9
	CapEx split	$17.1
	O&M split	$9.8
	SCT	$26.9
	UCT	$26.9
	RIM	$26.9

Cost-Effectiveness Tests	SCT Ratio	1.7
	UCT Ratio	1.3
	RIM Ratio	1.3

Category	Benefit / Cost	SCT	UCT	RIM	NPV ($MM)	% of total	CapEx (NPV)	O&M (NPV)
Benefit	Avoided Generation Capacity Costs	Y	Y	Y	$10.91	24%		
	Avoided LBMP	Y	Y	Y	$24.11	53%		
	Net Avoided CO2	Y			$10.58	23%		
	TOTAL BENEFITS	$45.6	$35.0	$35.0	$45.6			
Cost	Program Administration Costs	Y	Y	Y	$9.77	36%	$0.00	$9.77
	Incremental T&D and DSP Costs	Y	Y	Y	$17.13	64%	$17.13	$0.00
	TOTAL COSTS	$26.9	$26.9	$26.9	$26.9		$17.1	$9.8

NiMo BCA for DERs: Residential Solar Portal

Category	Item	NPV ($MM)
Benefits	Total	$3.02
	SCT	$3.02
	UCT	$3.02
	RIM	$3.02

Costs	Total	$1.0
	CapEx split	$0.1
	O&M split	$1.0
	SCT	$1.0
	UCT	$1.0
	RIM	$1.0

Cost-Effectiveness Tests	SCT Ratio	2.9
	UCT Ratio	2.9
	RIM Ratio	2.9

Category	Benefit / Cost	SCT	UCT	RIM	NPV ($MM)	% of total	CapEx (NPV)	O&M (NPV)
	Net Non-Energy Benefits (Customer Acquisition Costs)	Y	Y	Y	$3.02	100%		
	TOTAL BENEFITS	$3.0	$3.0	$3.0	$3.02			
Cost	Program Administration Costs	Y	Y	Y	$0.98	95%	$0.00	$0.98
	Incremental T&D and DSP Costs	Y	Y	Y	$0.05	5%	$0.05	$0.00
	TOTAL COSTS	$1.0	$1.0	$1.0	$1.03		$0.1	$1.0

NiMo BCA for DERs: DR Management System

Category	Item	NPV ($MM)
Benefits	Total	$7.1
	SCT	$7.1
	UCT	$7.1
	RIM	$7.1

Costs	Total	$4.3
	CapEx split	$3.9
	O&M split	$0.4
	SCT	$4.3
	UCT	$4.3
	RIM	$4.3

Cost-Effectiveness Tests	SCT Ratio	1.7
	UCT Ratio	1.7
	RIM Ratio	1.7

Category	Benefit / Cost	SCT	UCT	RIM	NPV ($MM)	% of total	CapEx (NPV)	O&M (NPV)
Benefit	AGCC	Y	Y	Y	$7.13	100%		
	TOTAL BENEFITS	$7.1	$7.1	$7.1	$7.13			
Cost	Program Administration Costs	Y	Y	Y	$0.39	9%		$0.39
	Incremental T&D and DSP Costs	Y	Y	Y	$3.93	91%	$3.93	
	TOTAL COSTS	$4.3	$4.3	$4.3	$4.32		$3.9	$0.4

NiMo BCA for DERs: Storage

Category	Item	NPV ($MM)
Benefits	Total	$6.6
	SCT	$3.8
	UCT	$3.8
	RIM	$6.6

Costs	Total	$4.6
	CapEx split	$4.6
	O&M split	$0.0
	SCT	$4.6
	UCT	$4.6
	RIM	$4.6

Cost-Effectiveness Tests	SCT Ratio	0.8
	UCT Ratio	0.8
	RIM Ratio	1.4

Category	Benefit / Cost	SCT	UCT	RIM	NPV ($MM)	% of total	CapEx (NPV)	O&M (NPV)
Benefit	Avoided Generation Capacity Costs	Y	Y	Y	$1.51	23%		
	Avoided LBMP	Y	Y	Y	$0.00	0%		
	Avoided Distribution Capacity Infrastructure	Y	Y	Y	$2.32	35%		
	Net Avoided CO2	Y			$0.00	0%		
	Revenue from Wholesale Market Particiaption			Y	$2.77	42%		
	TOTAL BENEFITS	$3.8	$3.8	$6.6	$6.6			
Cost	Program Administration Costs	Y	Y	Y	$1.48	32%	$1.48	
	Incremental T&D and DSP Costs	Y	Y	Y	$3.15	68%	$3.15	$0.00
	TOTAL COSTS	$4.6	$4.6	$4.6	$4.6		$4.6	$0.0

NiMo BCA for DERs: Electric Vehicles

Category	Item	NPV ($MM)
Benefits	Total	$39.3
	SCT	$23.8
	UCT	$0.0
	RIM	$15.5

Costs	Total	$28.0
	CapEx split	$13.4
	O&M split	$7.5
	SCT	$28.0
	UCT	$28.0
	RIM	$28.0

Cost-Effectiveness Tests	SCT Ratio	0.8
	UCT Ratio	0.0
	RIM Ratio	0.6

Category	Benefit / Cost	SCT	UCT	RIM	NPV ($MM)	% of total	CapEx (NPV)	O&M (NPV)
Benefit	Net Avoided CO2	Y			$5.40	14%		
	Net Avoided CO2 (Non-Attributable EV's)	Y			$0.17	0%		
	Net Avoided SO2 and NOx	Y			$0.00	0%		
	Net Avoided SO2 and Nox (Non-Attributable EV's)	Y			$0.00	0%		
	Increased Utility Revenue			Y	$15.09	38%		
	Increased Utility Revenue (Non-Attributable EV's)			Y	$0.41	1%		
	Avoided Non-Electric Fuel Cost	Y			$18.21	46%		
	TOTAL BENEFITS	$23.8	$0.0	$15.5	$ 39.28			
Cost	Program Administration Costs	Y	Y	Y	$7.46	27%	-	$7.46
	Incremental T&D and DSP Costs	Y	Y	Y	$13.38	48%	$13.38	-
	Participant DER Cost	Y			$0.00	0%		
	Increased Generation Capacity Costs	Y	Y	Y	$0.00	0%		
	Increased LBMP	Y	Y	Y	$6.99	25%		
	Increased LBMP (Non-Attributable EV's)	Y	Y	Y	$0.19	1%		
	TOTAL COSTS	$28.0	$28.0	$28.0	$28.03		$13.4	$7.5

NiMo AMF Benefit-Cost Analysis

20-Year NPV ($ in Millions)		A: Full Deployment		B: Urban Deployment		C: Dispersed Deployment	
Number of Electric Meters		1.7M		0.7M		0.17M	
Number of Gas Meter ERTs		0.7M		0.3M		0.07M	
MA/NY Back-Office IT/IS Cost Sharing		NY 55%	NY 100%	NY 42%	NY 100%	NY 15%	NY 100%
Pricing Program Participation Rates		80%	20%	90%	20%	100%	20%
Scenario		1	2	1	2	1	2
Benefits	SCT Benefits	603.22	451.46	248.09	193.56	143.77	84.69
	UCT / RIM Benefits	467.54	339.77	195.39	145.33	131.45	73.81
Costs	Capital – Full AMF	382.77	392.21	185.55	197.75	73.37	91.53
	Capital – AMR Replacement	(110.15)	(110.15)	(43.89)	(43.89)	(15.67)	(15.67)
	AMF Net Capital Expenditures	272.62	282.06	141.66	153.86	57.80	75.86
	Operating Expenditures	147.85	168.94	106.08	133.33	150.35	190.67
	SCT Costs	420.47	451.00	247.74	287.20	208.16	266.53
	UCT / RIM Costs	420.47	451.00	247.74	287.20	208.16	266.53
SCT Ratio		**1.43**	**1.00**	**1.00**	0.67	0.69	0.32
UCT / RIM Ratio		**1.11**	0.75	0.79	0.51	0.63	0.28
Est. Monthly Customer Impact (per meter)[3]		$ 2.37	$ 2.49	$ 3.04	$ 3.41	$ 9.25	$ 11.58

Figure 2: Benefit-Cost Analysis

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Optional Material

Better Options for Assessing Rate Impacts

A thorough understanding of rate impacts requires a comprehensive analysis of three important factors:

- Rate impacts, to provide an indication of the extent to which rates for all customers might increase.
- Bill impacts, to provide an indication of the extent to which customer bills might be reduced for those customers that install distributed energy resources.
- Participation impacts, to provide an indication of the portion of customers that will experience bill reductions or bill increases.

Taken together, these three factors indicate the extent to which customers will benefit from energy efficiency resources.

Participation impacts are also key to understanding the extent to which energy efficiency resources are being adopted over time.

Example Bill Impact Analysis – Rhode Island

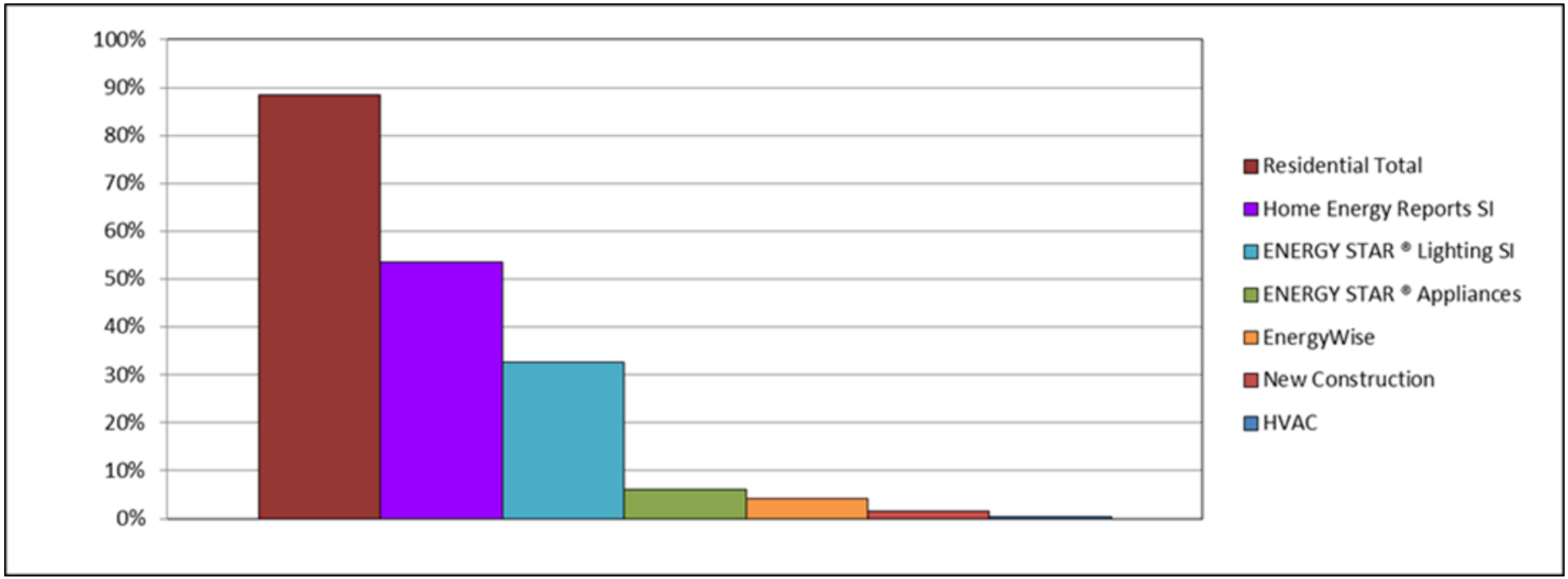
Table 2: Residential Bill Impact Analysis – A16 (2018 EE Plan vs. No EE)

Residential	Long-Term Rate Impacts	Typical Energy Savings	Typical Bill Savings
	(% of Total Rate)	(% per Participant)	(% of Total Bill)
Average Participant	1.31%	2.02%	1.56%
Non-Participant	1.31%	0.00%	-1.31%
Average Customer	1.31%	1.87%	1.35%

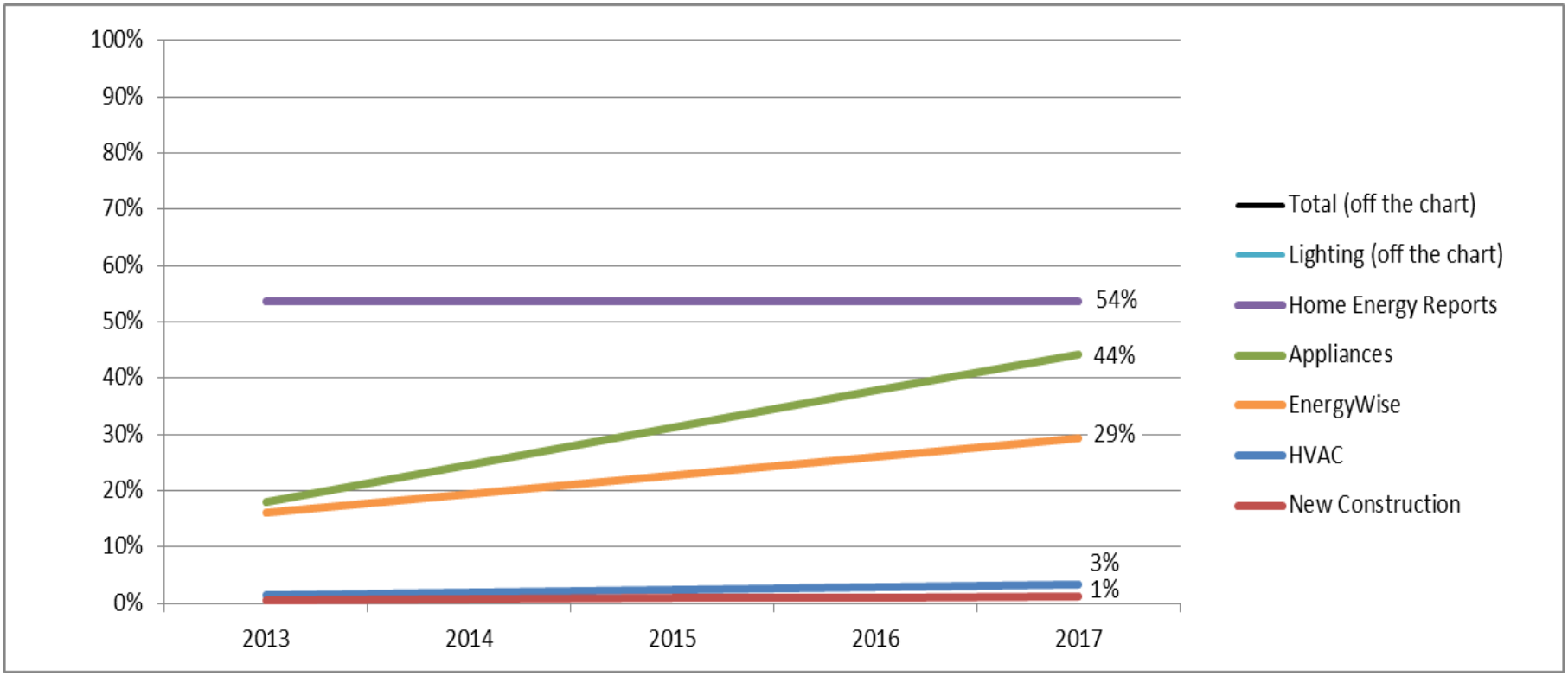
Table 4: Small Commercial Bill Impact Analysis – C06 (2018 EE Plan vs. No EE)[5]

	Long-Term Rate Impacts	Typical Energy Savings	Typical Bill Savings
	(% of Total Rate)	(% per Participant)	(% of Total Bill)
Small C&I Participant	0.54%	17.60%	15.80%
Non-Participant	0.54%	0.00%	-0.54%
Average Customer	0.54%	1.45%	0.81%

Rhode Island EE Participation - Annual



Rhode Island EE Participation - Cumulative



Participation Can be Increased by Program Design

- EE programs should address all end-uses.
- EE programs should address all customer types.
- EE programs should address all relevant markets:
  - retrofit, new construction, point-of-sale, upstream, etc.
- All customers should have an opportunity to participate.
- Customer incentives and support should be tailored to assist all customers in overcoming barriers to energy efficiency.
- Program Administrators should actively pursue the non-participants and those who have not participated in a while.

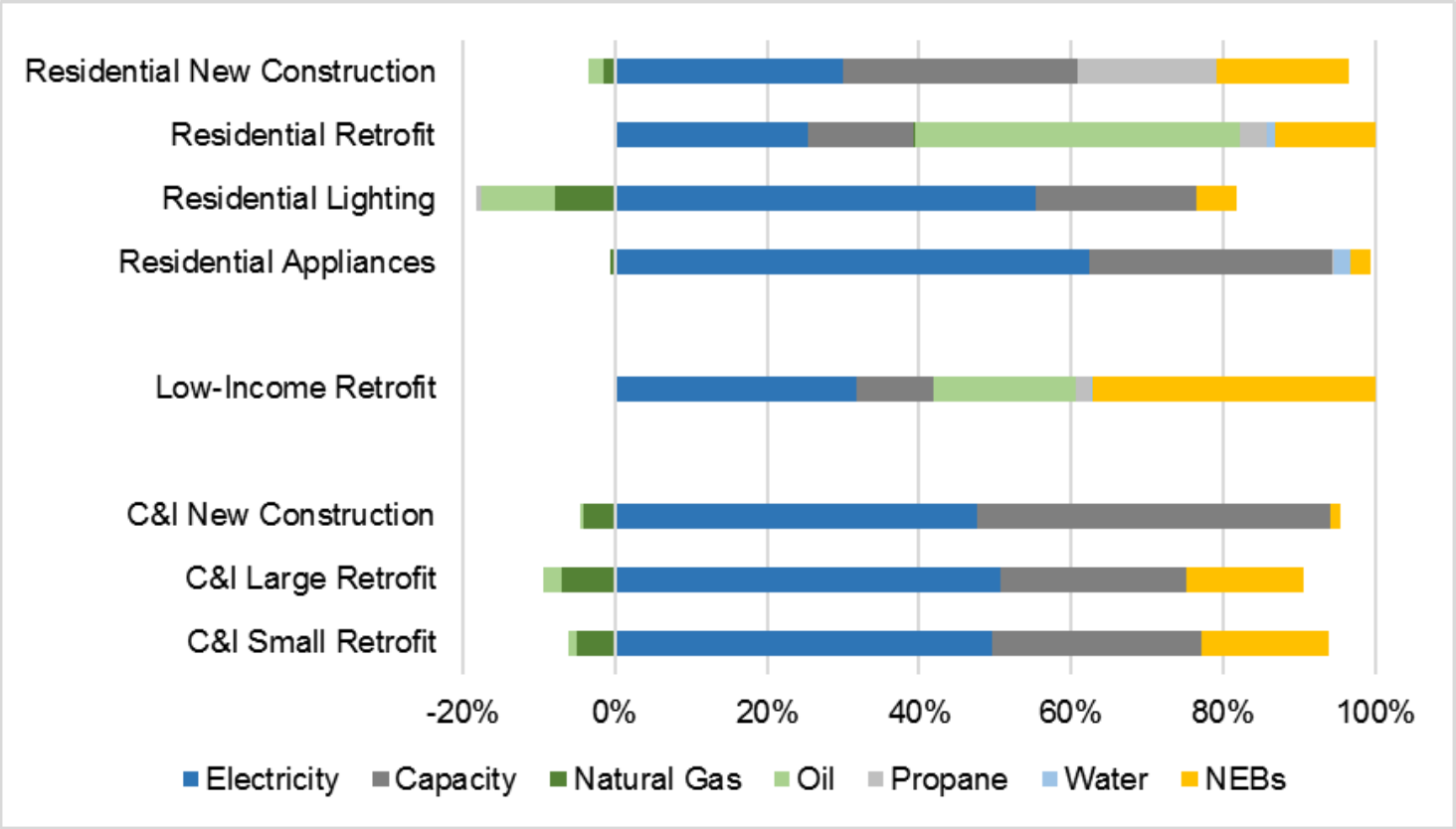
Participation Can Be Increased by Policy Directives

- Increase budgets to increase participation.
  - This is the exact opposite of the typical response to rate impact concerns.
- Require program administrators to gather better data on participation.
- Require program administrators to analyze participation rates when designing programs.
- Include participation requirements in efficiency plans and goals.
- Incorporate participation rates in utility shareholder incentives.
- Make the participation goal explicit:
  - Achieving all cost-effective energy efficiency means serving all customers.

Integration and Optimization of DERs

Level	Description	Modeling of DERs	Modeling of Bulk Resources	Modeling of Temporal Values	Modeling of Locational Values	Example
1. Single DER Screening	Each Type of DER Assessed Independently	A single type of DER is a static input	Static input to the calculation	Approximate temporal value of G used	not modeled	Energy efficiency cost-effectiveness screening
2. Multiple DER Screening	Multiple types of DERs are assessed Together	Multiple types of DERs are static inputs	Static input to the calculation	Approximate temporal value of G used	not modeled	EE, DR, and DG cost-effectiveness screening
3. Multiple DER Integration	All types of DERs are integrated with bulk resources	All types of DERs are dynamically modeled	Dynamically modeled	Hourly temporal value of G modeled	not modeled	Integrated resource planning
4. Multiple DER Integration, Temporal	All types of DERs integrated Using temporal values	All types of DERs are dynamically modeled	Dynamically modeled	Temporal values of G, T, & D modeled	not modeled	Expanded IRP
5. Multiple DER Optimization	All types of DERs integrated using temporal and locational values	All types of DERs are dynamically modeled	Dynamically modeled	Temporal values of G, T, & D modeled	Model accounts for locational value of D	Integrated Distributed Energy Resource (IDER) Planning

Impacts of Participant NEBs



Source: Eversource 2017 Energy Efficiency Annual Report, taken from the NSPM.

Overlap between BCA and Value of D (or T, or G)

- The general concepts behind BCA and Value of D are the same
- Future, long-run, marginal costs used to identify value (benefits)
- Value of D temporal:
  - identify top 10 hours of summer peaks (SEIA prefers top 400 hours)
  - Match generator profile with those hours
- Value of D locational:
  - System-wide and location-specific
- Customer offered a tariff
  - DPV: buy-all sell-all
  - Fixed price for 10 years
  - Price can change for new customers, current customers are grandfathered.

Contact Information

Synapse Energy Economics is a research and consulting firm specializing in energy, economic, and environmental topics. Since its inception in 1996, Synapse has grown to become a leader in providing rigorous analysis of the electric power and natural gas sectors for public interest and governmental clients.

Tim Woolf
Vice-President, Synapse Energy Economics
617-453-7031
twoolf@synapse-energy.com

www.synapse-energy.com