

Appendix B: Benefit-Cost Framework

	Mixed Cost-Benefit, Cost, or Benefit Category	System Attribute Benefit/Cost Driver	Candidate Methodologies (Includes options with increasing specificity where multiple methods per driver)	Potential Visibility Requirements
Power System Level	Energy Supply & Transmission Operating Value of Energy Provided or Saved (Time- & Location-specific LMP)	Bids, Offers, Marginal Losses, Constraints, & Scarcity in Time & Location specific LMP (+ Reactive Power requirements & Impacts on Distribution Assets in DLMP)	AESC Seasonal On- & Off-Peak Energy Price Forecasts	
			Expected Time- & Location-specific Bulk Power LMP for forecast period of resource operation	Requires interval or advanced metering functionality & Tracking of ISO Nodal Prices
			Expected Time-, Location-, & Product-specific Distribution LMP for forecast period of resource operation	Requires interval or advanced metering functionality & analysis of actual power flows
	Renewable Energy Credit Cost / Value	Cost of REC Obligation or REC Revenue Received	AESC Forecast of REC prices	
	Retail Supplier Risk Premium	Differential between retail prices and ISO market prices * retail purchases	Absent AMI + dynamic retail pricing, AESC estimate or risk adjusted observed differentials	Quantitative estimation requires detailed economic modeling
	Forward Commitment: Capacity Value	Whether an FCM Qualified Resource &, if so, FCA bid and Provision of Qualified Capacity	Estimate of likely FCA Auction bid capacity from FCM Qualified Resources	Quantitative estimation requires detailed economic modeling
		Change in Demand reflected (~4 yr. later) in a Revision of FCM forecast Capacity Requirements	Review of FCM capacity requirements & estimate of likely future impacts (Same as Capacity DRIPE below)	Quantitative estimation requires detailed economic modeling
	Forward Commitment: Avoided Ancillary Services Value	Whether it is a Qualified Ancillary Service Resource &, if so, Qualified Capacity	Forecasts of AS requirements / Provision of AS net of Energy supplied * Forecast AS prices	
Utility / Third Party Developer Renewable Energy, Efficiency, or DER costs	Direct Cost of New Non-customer Resources (Capital & Operating costs of resources) + Customer Program costs (Participant recruitment, administrative, incentive and EM&V costs)	Cost Estimates		

Power System Level	Mixed Cost-Benefit, Cost, or Benefit Category	System Attribute Benefit/Cost Driver	Candidate Methodologies (Includes options with increasing specificity where multiple methods per driver)	Potential Visibility Requirements
	Electric Transmission Capacity Costs / Value	Change in transmission capacity requirements associated in change in resource mix	Annualized statewide transmission capacity value associated with load growth * change in net demand (ICF)	
			Forecast impacts of specific resources on transmission planning requirements	Requires detailed planning studies
	Electric transmission infrastructure costs for Site Specific Resources	Cost to develop new transmission (For peak output + any contingency requirement)	Direct cost estimates for remotely sited resources (e.g. offshore wind)	Requires detailed planning studies
	Net risk benefits to utility system operations (generation, transmission, distribution) from 1) Ability of flexible resources to adapt, and 2) Resource diversity that limits impacts, taking into account that DER need to be studied to determine if they reduce or increase utility system risk based on their locational, resource, and performance diversity	Flexible DERs (storage, flexible demand) can reduce risk by enabling the system to respond to disruptive events	Use proxy value for ability of system to respond to disruptive events	
			Model system with additional flexible resources	Quantitative estimation requires detailed economic modeling
		DERs need to be studied to determine if they reduce or increase utility system risk based on their locational, resource, and performance diversity.	Use proxy values for size and locational and resource diversity.	
		Portfolio analysis with risk assessment technique	Quantitative estimation requires detailed economic modeling	

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	Option value of individual resources	Impacts of individual resources on the cost of other potential resources	Estimates of impacts of one resource on the costs of others	Quantitative estimation requires detailed economic modeling
			Option value calculation based on scenario analysis of potential future resource choices	Quantitative estimation requires detailed economic modeling
			Portfolio analysis - comparison of alternative portfolios	Quantitative estimation requires detailed economic modeling
	Investment under Uncertainty: Real Options Cost / Value	Impacts of reduced flexibility / discovery of new information	Scenario analysis: calculation of real option value associated with different decision times & resources	Quantitative estimation requires detailed economic modeling
	Energy Demand Reduction Induced Price Effect	Change in Energy price, Net of Any Capacity Cost Change from Net CONE	AESC Estimate of DRIPE (Need to clarify whether accounts for impact on Net CONE)	
Estimate of Energy Price change with an adjustment of impacts on Net CONE in ISO FCM			Quantitative estimation requires detailed economic modeling	

	Mixed Cost-Benefit, Cost, or Benefit Category	System Attribute Benefit/Cost Driver	Candidate Methodologies (Includes options with increasing specificity where multiple methods per driver)	Potential Visibility Requirements
Power System Level	Greenhouse gas compliance costs	Forecast prices under RGGI and other market-based regulations (e.g. Clean Power Plan) + changes other compliance costs under likely environmental regulations Forecast compliance costs associated with meeting the GHG emission targets in the Resilient Rhode Island Act Net marginal emissions or emissions avoided from changes in resource use	Forecasts of RGGI and CPP prices + estimates of likely compliance costs under any other GHG regulation Estimates of likely compliance costs under RI GHG regulation Forecast of net emissions impacts from change in regional dispatch and resource mix	Quantitative estimation requires detailed economic modeling Quantitative estimation requires detailed economic modeling Quantitative estimation requires detailed economic modeling
	Criteria air pollutant and other environmental compliance costs	Changes in forecast compliance costs under air pollution or other environmental regulations Net marginal emissions or emissions avoided from changes in resource use	Forecasts of the costs of compliance under affected environmental regulations Forecast of net environmental impacts from change in regional dispatch and resource mix	Quantitative estimation requires detailed economic modeling Quantitative estimation requires detailed economic modeling
	Innovation and Learning by Doing	Experimentation Costs	Direct costs of innovation / demonstration programs	

		Anticipated rate of cost reduction or performance improvement	Qualitative assessment	
Power System Level	Mixed Cost-Benefit, Cost, or Benefit Category	System Attribute Benefit/Cost Driver	Candidate Methodologies (Includes options with increasing specificity where multiple methods per driver)	Potential Visibility Requirements
	Distribution capacity costs	<p>Change in distribution capacity requirements generally with change in resources</p> <p>Forecasted change peak distribution circuit requirements</p> <p>Location-specific DER hosting capacity</p> <p>Impacts on system performance, thermal and reactive power constraints, and associated investment and operating costs</p>	<p>Annualized statewide distribution capacity value associated with load growth * change in net demand (ICF)</p> <p>Distribution planning studies</p> <p>Analysis of capability to host DER with existing and already-planned facilities</p> <p>Distribution planning studies</p>	<p>Requires detailed planning studies</p> <p>Requires detailed planning studies</p> <p>Requires detailed planning studies</p>
	Distribution delivery costs	<p>Location-specific distribution constraints, losses, equipment cycling, DLMP</p>	<p>Dynamic, multi-layered forecasts as a basis for circuit specific DER and Distribution System Plans</p> <p>Analysis of time-, location-, and product-specific DLMP value, potentially leading toward DLMP markets</p>	<p>Requires interval or advanced metering functionality, modeling, and planning studies</p> <p>Requires interval or advanced metering functionality & analysis of actual power flows</p>

	Mixed Cost-Benefit, Cost, or Benefit Category	System Attribute Benefit/Cost Driver	Candidate Methodologies (Includes options with increasing specificity where multiple methods per driver)	Potential Visibility Requirements	
Power System Level	Distribution system safety loss/gain	Changes in risks, real-time information on system conditions, and training	Qualitative Assessment, Tracking and Assessment of Safety Metrics	Distribution system safety loss/gain	
	Distribution system performance	Performance metrics include: voltage stability and equalization, conservation voltage reduction, operational flexibility, fault current / arc flash avoidance, and effective asset management	Distribution planning and benchmarking to best practices	Requires advanced metering functionality and / or distribution sensors	
	Utility low income	Energy efficiency impacts on reducing utility arrearage carrying costs, uncollectibles, customer service and collection costs Incremental utility costs for low income efficiency programs net of system energy cost savings	Marginal impacts on arrearages, uncollectibles, and other utility costs Direct costs net of system general system benefits	Voltage and power quality measurement and assessments	Requires advanced metering functionality and / or distribution sensors
		Expected impacts on customer voltages and power quality			

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Power System Level	Distribution system and customer reliability / resilience impacts	<p>Customer-specific & critical facility outage costs and value of uninterrupted service</p> <p>Expected impacts on the probability of outage</p> <p>Expected impacts on the duration of outages</p> <p>Expected impacts on customer voltages and power quality</p> <p>Costs of distribution improvements & microgrids</p>	<p>US DOE Interruption Cost Estimator</p> <p>Customer value of uninterrupted service studies</p> <p>Distribution system risk assessment studies</p> <p>Distribution system / microgrid resilience studies</p> <p>Voltage and power quality measurement and assessments</p> <p>Distribution planning and costing</p>	<p>Requires customer surveys</p> <p>Requires detailed planning studies</p> <p>Requires detailed planning studies</p> <p>Requires advanced metering functionality and / or distribution sensors</p> <p>Requires detailed planning studies</p>
	Distribution system safety loss/gain	Changes in risks, real-time information on system conditions, and training	Qualitative Assessment, Tracking and Assessment of Safety Metrics	

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Customer Level	Program participant / prosumer benefits / costs	<p>Direct participant / prosumer cost of technology, investment, and/or program participation costs</p> <p>Participant indirect costs (includes required behavioral changes and inconvenience costs)</p> <p>Participant non-energy impacts (includes value of improvements in quality of life)</p>	<p>Estimates of net direct costs</p> <p>Qualitative assessment</p> <p>Willingness to accept / pay estimates (observation or surveys)</p> <p>Qualitative value</p> <p>Deemed Benefits Not Reflected in Other Categories - Efficiency</p> <p>Technical Reference Manual</p> <p>Willingness to pay estimates (observation or surveys)</p>	Requires customer surveys
	Participant non-energy costs/benefits: Oil, Gas, Water, Waste Water	Value of Energy and Water Savings / Requirements	AESC Estimate of Avoided Natural Gas, Oil, and Other Fuel Costs	Requires customer surveys
			Estimate of Net Costs or Cost Savings	

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Customer Level	Low-Income Participant Benefits	Improved comfort, reduced noise, increased property value, increased property durability, lower maintenance costs, improved health, and reduced tenant complaints.	Begin with values from Rhode Island EE cost-effectiveness analyses.	May require interval or advanced metering functionality
	Consumer Empowerment & Choice	Retail Competition, Facilitation of Flexible Demand, Integration of Commodity & Energy Services, Development of Platform Market, & Third Party DER Development	Qualitative Assessment	
	Non-participant (equity) rate and bill impacts	Utility revenue requirements, cost allocation and rate design	Long-term rate and bill analysis Analysis of non-participant usage, price elasticity, and income patterns	May require interval or advanced metering functionality

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Societal Level	Greenhouse gas externality costs	GHG Externality Value net of RGGI costs	Customer willingness to pay for reductions in excess of compliance levels (observation or WTP surveys) Societal cost estimates	Requires customer surveys
		Net marginal emissions or emissions avoided from changes in the use of resources	Forecast of net emissions impacts from change in regional dispatch and resource mix	Quantitative estimation requires detailed economic modeling
	Criteria air pollutant and other environmental externality costs	Criteria Pollutant (e.g. Fine Particulates) and other Environmental Externality Value Net of any Emission Allowance / Emission Credit Value	Customer willingness to pay for reductions in excess of compliance levels (observation or WTP surveys) Societal cost estimates	Requires customer surveys
		Net marginal emissions or emissions avoided from changes in the use of resources	Forecast of net environmental impacts from change in regional dispatch and resource mix	Quantitative estimation requires detailed economic modeling
	Conservation and community benefits	Land use impacts (net of property costs for resource deployments): Loss of sink, habitat, historical value, sense of place	Value of carbon sink per acre Environmental and historical conservation easement cost	
		Equity in distribution of harmful or nuisance infrastructure	Qualitative assessment MW of infrastructure per acre, \$ of infrastructure per value of property	

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Societal Level	Non-energy costs/benefits: Economic Development	Estimate of Impacts on State Product or Employment, Effects of land use change on property tax revenue	Qualitative Assessment Economic modeling (e.g. input / output life-cycle analysis, property tax base studies)	Quantitative estimation requires detailed economic modeling
	Innovation and knowledge spillover (Related to demonstration projects and other RD&D preceding larger scale deployment)	RD&D, Strength of innovation ecosystem, knowledge capture & sharing from public / utility/private sector funded initiatives	Qualitative Assessment	
	Societal Low-Income Impacts	Poverty alleviation, reduced energy burden, reduced involuntary disconnections from service, reductions in the cost of other social services, local economic benefits, etc.	Qualitative assessment or Adder	
			Direct estimate of cost savings	
			Alternate input factor in modeling of local economic impacts	Quantitative estimation requires detailed economic modeling
	Public Health	Indoor air quality, heating, cooling, and noise impacts of efficiency programs (Additional environmental and economic impacts on vulnerable customers addressed elsewhere)	Qualitative Assessment	
National Security and US international influence	Impacts on oil imports	Analysis of oil imports into Rhode Island and the region		