CADMUS

Cost-Effectiveness Testing

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DSM Economics

Metrics

Time Value of Money

Multiple Tests

Key Issues:

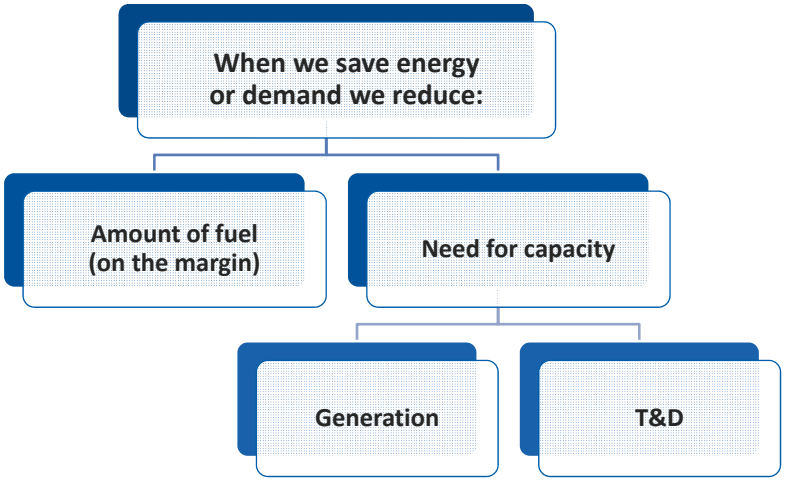
- Discounting
- NTG Treatment
- Externalities
- NEBs

The Why

Cost-effectiveness Levels

Portfolio Level	Across Service Territories
Sector Level	Residential / Commercial / Industrial
Program Level	Commercial Retrofit, Residential Appliances, Low Income, Fuel Substitution
Participant Level	Home X; Retail Store Y
Measure Level	Super T8 lighting retrofit, VFDs, etc.

What is Being "Avoided"?



Time Value of Money

What is Interest?

Do Humans Have a Time Preference?

$ Today ≠ $ Tomorrow

How to "Remove" Time from the Equation

Compounding: Present to Future

$$Future\ Value = Present\ Value * (1+i)^n$$

$$Dollar\ tomorrow = Dollar\ today * (1+i)^n$$

Discounting: Future to Present

$$Present\ Value = \frac{Future\ Value}{(1+i)^n}$$

$$Dollar\ today = \frac{Dollar\ tomorrow}{(1+i)^n}$$

Simple Example

Period	Value @ Beginning of Period	Increase in Value During the Period	Value @ End of Period
1	$1,000.00	$50.00	$1,050.00
2	$1,050.00	$52.50	$1,102.50
3	$1,102.50	$55.13	$1,157.63

Or with equations

$$FV = 1{,}000 * (1.05)^3$$

In 1626, Manhattan Island was purchased for 60 Dutch Guilders ≈ $24

Periods / Years	Value @ Beginning of Period	Increase in Value During the Period	Value @ End of Period
383	$24.00	$3,131,214,231.24	$3,131,214,255.24

Future Value of $24 in 383 years at a 5% interest rate

= $3,131,214,255.24

Now, Metrics

Payback period	Net Present Value	Benefit Cost Ratio	Cost of Conserved Energy
Program Design	Evaluation	Evaluation	Planning

Net Present Value

Present Value of Benefits − Present Value of Costs

Always in dollars

\+ = ☺

− = ☹

Favors larger projects

Payback

Initial project cost: $1,000

Annual savings in energy cost: $2,000

Payback period is _____.

$$\text{Payback Period} = \frac{\text{Initial Cost}}{\text{Net Annual Return}}$$

Project	Initial Cost	YR1	YR2	YR3	Payback
A	$3,000	$3,000	$2,000	$2,000	
B	$10,000	$4,000	$4,000	$4,000	
C	$15,000	$10,000	$10,000	$4,000	

Project	Initial Cost	YR 1	YR 2	YR 3	YR 4	YR 5	Payback
I	$10k	$10K					
II	$10k	$5K	$5K	$5K	$5K	$5K	

Benefit/Cost Ratio

$$\frac{Present\ Value\ of\ Benefits}{Present\ Value\ of\ Costs}$$

>1 = ☺

<1 = ☹

Normalized – that's good

Cost of Conserved Energy

$$CRF = \frac{i(1+i)^n}{(1+i)^n - 1}$$

What is the CCE of a DSM program if:

1. Total initial cost is $10,000,
2. Resulted in installation of measures with expected economic life of 10 years and 50,000 kWh in savings,
3. The cost of capital is 10%?

$$\frac{initial\ cost * CRF}{savings} = \frac{10{,}000 * 0.1627}{50{,}000} = 3.25 \frac{\text{cents}}{\text{annual kWh}}$$

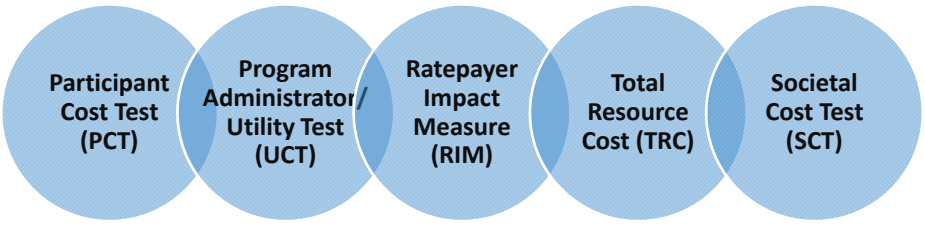
Switch to Excel

Where does it come from?

Cost of capital is a weighted average of debt and equity cost (WACC)

$$K_w = K_e * W_e + K_d * W_d$$

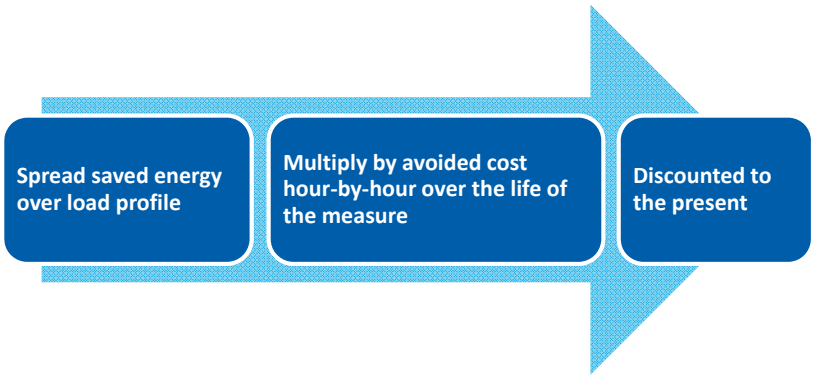
Now, the Traditional Tests



There is also a 'new' test **– the Resource Value Test –** which is based on a framework for a developing a jurisdiction's primary test where the test components are determined based on alignment with a state's applicable policy goals (we cover this later today)

Elements	TRC	RIM	UCT	PCT	SCT	RVT
BENEFITS						
Avoided Power Supply Costs	✓	✓	✓		✓	✓
Avoided Capacity Costs	✓	✓	✓		✓	✓
Bill Reductions				✓		
Non Energy Benefits	Participant				✓	If applicable
Incentives				✓		
COSTS						
Direct Utility DSM Costs	✓	✓	✓	✓	✓	✓
Direct Customer DSM Costs	✓			✓	✓	If applicable
Utility Program Administration	✓	✓	✓		✓	
Lost Revenues		✓				

In All Cases



Inputs

- Measure life
- Incremental installed cost
  - Cost above baseline equipment
- Incentive (rebate)
- Annual energy savings (at meter)
- Peak demand reduction (at meter)

Example

Program Inputs - 16 SEER AC Unit (3 ton)

- 898 kWh energy savings
- 0.43 kW demand savings
- $1,100 incremental measure cost (base 13 SEER)
- 15 year measure life
- 1,000 a/c units installed
- $22,000 in administrative costs

Scenarios

- $1,100 incentive paid by utility
- $585 incentive paid by utility
- $585 incentive with 50% freeridership

Utility Assumptions

Avoided Costs		
Year	**kWh**	**kW**
2014	$0.0469	$188.80
2015	$0.0510	$194.46
2016	$0.0554	$200.30
2017	$0.0602	$206.31
2018	$0.0655	$212.50
2019	$0.0712	$218.87
2020	$0.0774	$225.44
2021	$0.0841	$232.20
2022	$0.0914	$239.17
2023	$0.0994	$246.34
2024	$0.1080	$253.73
2025	$0.1174	$261.34
2026	$0.1276	$269.18
2027	$0.1387	$277.26
2028	$0.1508	$285.58

Line Losses	
Sector	**Energy Line Losses**
Residential	6.24%

Discount Rates	
Test	**Value**
TRC	7.29%
Societal	3.50%
RIM	7.29%
Utility	7.29%
Participant	10.00%

Average Rates		Escalator
Electric /kWh	$0.101	1%

Annual Results - $585 Incentive

	TRC		Utility		Participant		RIM		Societal + NEBs	
	Benefits	Costs	Benefits	Costs	Benefits	Costs	Benefits	Costs	Benefits	Costs
2014	$130,994	$1,122,000	$130,994	$607,000	$675,698	$1,100,000	$130,994	$697,698	$144,094	$1,122,000
2015	$137,474	$0	$137,474	$0	$91,605	$0	$137,474	$91,605	$151,222	$0
2016	$144,371	$0	$144,371	$0	$92,521	$0	$144,371	$92,521	$158,808	$0
2017	$151,716	$0	$151,716	$0	$93,446	$0	$151,716	$93,446	$166,887	$0
2018	$159,543	$0	$159,543	$0	$94,381	$0	$159,543	$94,381	$175,497	$0
2019	$167,890	$0	$167,890	$0	$95,325	$0	$167,890	$95,325	$184,679	$0
2020	$176,797	$0	$176,797	$0	$96,278	$0	$176,797	$96,278	$194,476	$0
2021	$186,308	$0	$186,308	$0	$97,241	$0	$186,308	$97,241	$204,939	$0
2022	$196,470	$0	$196,470	$0	$98,213	$0	$196,470	$98,213	$216,117	$0
2023	$207,335	$0	$207,335	$0	$99,195	$0	$207,335	$99,195	$228,069	$0
2024	$218,959	$0	$218,959	$0	$100,187	$0	$218,959	$100,187	$240,855	$0
2025	$231,401	$0	$231,401	$0	$101,189	$0	$231,401	$101,189	$254,542	$0
2026	$244,728	$0	$244,728	$0	$102,201	$0	$244,728	$102,201	$269,201	$0
2027	$259,010	$0	$259,010	$0	$103,223	$0	$259,010	$103,223	$284,911	$0
2028	$274,324	$0	$274,324	$0	$104,255	$0	$274,324	$104,255	$301,757	$0
PV	$1,724,036	$1,122,000	$1,724,036	$607,000	$1,385,441	$1,100,000	$1,724,036	$1,528,973	$2,439,992	$1,122,000
B/C	**1.54**		**2.84**		**1.26**		**1.13**		**2.17**	
NPV	**$602,036**		**$1,117,036**		**$285,441**		**$195,063**		**$1,317,992**	

Annual Results - $1,100 Incentive

	TRC		Utility		Participant		RIM		Societal + NEBs	
	Benefits	Costs	Benefits	Costs	Benefits	Costs	Benefits	Costs	Benefits	Costs
2014	$130,994	$1,122,000	$130,994	$1,122,000	$1,190,698	$1,100,000	$130,994	$1,212,698	$144,094	$1,122,000
2015	$137,474	$0	$137,474	$0	$91,605	$0	$137,474	$91,605	$151,222	$0
2016	$144,371	$0	$144,371	$0	$92,521	$0	$144,371	$92,521	$158,808	$0
2017	$151,716	$0	$151,716	$0	$93,446	$0	$151,716	$93,446	$166,887	$0
2018	$159,543	$0	$159,543	$0	$94,381	$0	$159,543	$94,381	$175,497	$0
2019	$167,890	$0	$167,890	$0	$95,325	$0	$167,890	$95,325	$184,679	$0
2020	$176,797	$0	$176,797	$0	$96,278	$0	$176,797	$96,278	$194,476	$0
2021	$186,308	$0	$186,308	$0	$97,241	$0	$186,308	$97,241	$204,939	$0
2022	$196,470	$0	$196,470	$0	$98,213	$0	$196,470	$98,213	$216,117	$0
2023	$207,335	$0	$207,335	$0	$99,195	$0	$207,335	$99,195	$228,069	$0
2024	$218,959	$0	$218,959	$0	$100,187	$0	$218,959	$100,187	$240,855	$0
2025	$231,401	$0	$231,401	$0	$101,189	$0	$231,401	$101,189	$254,542	$0
2026	$244,728	$0	$244,728	$0	$102,201	$0	$244,728	$102,201	$269,201	$0
2027	$259,010	$0	$259,010	$0	$103,223	$0	$259,010	$103,223	$284,911	$0
2028	$274,324	$0	$274,324	$0	$104,255	$0	$274,324	$104,255	$301,757	$0
PV	$1,724,036	$1,122,000	$1,724,036	$1,122,000	$1,900,441	$1,100,000	$1,724,036	$2,043,973	$2,439,992	$1,122,000
B/C	**1.54**		**1.54**		**1.73**		**0.84**		**2.17**	
NPV	**$602,036**		**$602,036**		**$800,441**		**($319,937)**		**$1,317,992**	

Annual Results - $585 Incentive, 50% Freeridership

	TRC		Utility		Participant		RIM		Societal + NEBs	
	Benefits	Costs	Benefits	Costs	Benefits	Costs	Benefits	Costs	Benefits	Costs
2014	$65,497	$572,000	$65,497	$607,000	$675,698	$1,100,000	$65,497	$652,349	$72,047	$572,000
2015	$68,737	$0	$68,737	$0	$91,605	$0	$68,737	$45,802	$75,611	$0
2016	$72,185	$0	$72,185	$0	$92,521	$0	$72,185	$46,261	$79,404	$0
2017	$75,858	$0	$75,858	$0	$93,446	$0	$75,858	$46,723	$83,444	$0
2018	$79,771	$0	$79,771	$0	$94,381	$0	$79,771	$47,190	$87,748	$0
2019	$83,945	$0	$83,945	$0	$95,325	$0	$83,945	$47,662	$92,339	$0
2020	$88,398	$0	$88,398	$0	$96,278	$0	$88,398	$48,139	$97,238	$0
2021	$93,154	$0	$93,154	$0	$97,241	$0	$93,154	$48,620	$102,469	$0
2022	$98,235	$0	$98,235	$0	$98,213	$0	$98,235	$49,106	$108,059	$0
2023	$103,668	$0	$103,668	$0	$99,195	$0	$103,668	$49,598	$114,034	$0
2024	$109,479	$0	$109,479	$0	$100,187	$0	$109,479	$50,094	$120,427	$0
2025	$115,701	$0	$115,701	$0	$101,189	$0	$115,701	$50,594	$127,271	$0
2026	$122,364	$0	$122,364	$0	$102,201	$0	$122,364	$51,100	$134,600	$0
2027	$129,505	$0	$129,505	$0	$103,223	$0	$129,505	$51,611	$142,456	$0
2028	$137,162	$0	$137,162	$0	$104,255	$0	$137,162	$52,128	$150,878	$0
PV	$862,018	$572,000	$862,018	$607,000	$1,385,441	$1,100,000	$862,018	$1,067,987	$1,219,996	$572,000
B/C	**1.51**		**1.42**		**1.26**		**0.81**		**2.13**	
NPV	**$290,018**		**$255,018**		**$285,441**		**($205,969)**		**$647,996**	

Key Issues with C/E

- Discount rate
- NEBS
- Incremental costs
- Symmetry
- Simplicity

Discount Rates Matter A LOT

Benefit	$ 1	$ 1
Years	30	30
Discount Rate	3%	10%
PV	$ 0.41	$ 0.06

- Risk adjusted?
- Societal?
- Weighted Average Cost of Capital?
- Other discount rate that reflects time preference of state's policy goals (e.g. blend of above?)

Many argue that benefits to future generations should have higher value than those accruing in the present. (This argument is not based entirely on moral grounds.)

A pure economic argument is that as resources dwindle and emissions increase, the value of future resources increase and the value of one fewer ton of carbon in future should also increase. (This argument, at its extreme, calls for negative discount rate.)

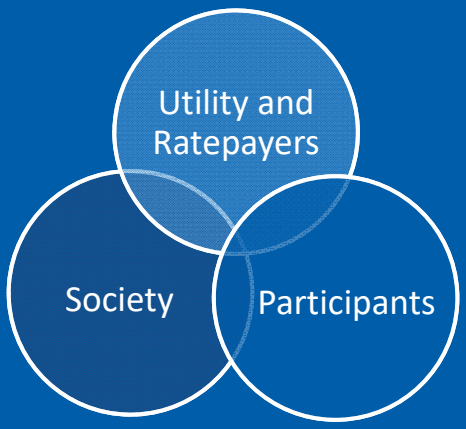
Following a presentation on benefit cost tests at the 2008 National Association of Regulatory Commissioners (NARUC) in Washington D.C., a utility commissioner asked the presenter:

"In a global climate, in which climate change impacts will increase each year--causing a ton of carbon released in the future to be more destructive than a ton of carbon released today--why is a ton of carbon saved in year 25 not worth more than a ton of carbon saved today?"

"If we are really serious about carbon reduction and our climate future, should the discount rate be a negative number so that its financial importance increases over time rather than decreases?"

What Else..

NEBs and Which Test



Symmetry

Incremental Cost

What is Wrong with Current Tests?

TRC

- Lack of symmetry
- NEBs or No NEBs
- Incremental Cost?

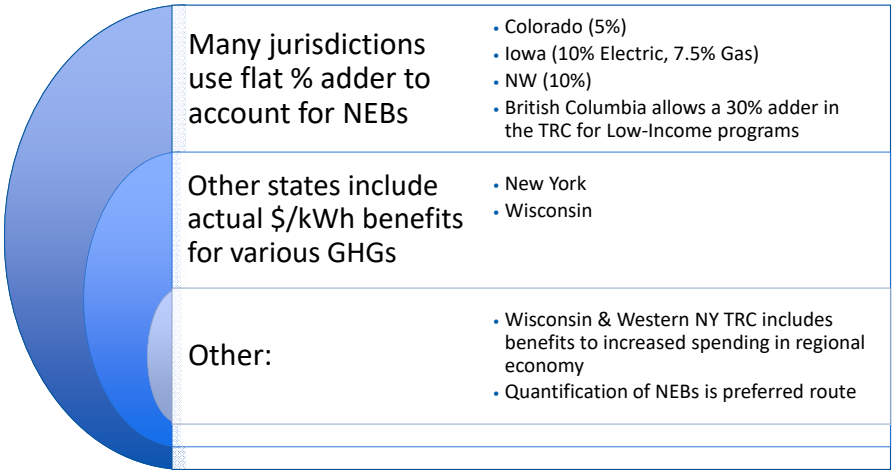
Societal

- Cannot FULLY measure NEBs

UCT/PACT

- Nothing
- Ok, ok, … possible abuse?

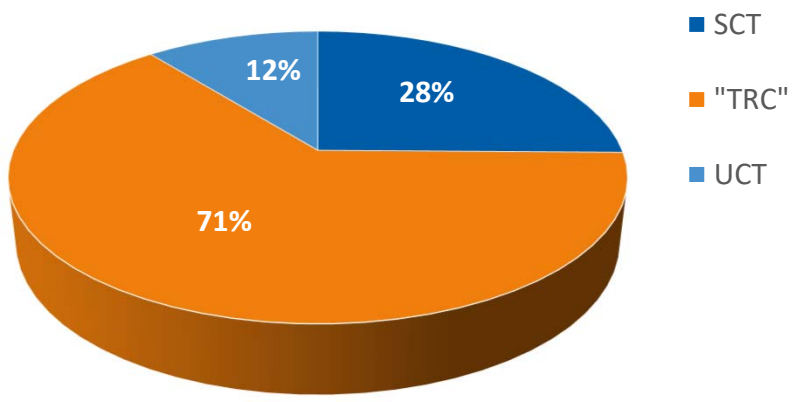
Non-Energy Benefits In Practice



Which is the Right Test?

Participant	Is participant better off?
RIM	Are rates going to increase?
UCT/PACT	Change in revenue requirements?
TRC	How do total costs compare to "total" benefits?
Societal	How do total societal costs compare to benefits?

Resource Value Test: new test designed to reflect a jurisdiction's applicable policy goals. Departs (or could potentially align) with conceptually forms of the above tests



How Does Adoption of UCT/PACT Make Life Simpler?

- No need to worry about cost or incremental cost
- No need to worry about NEBS
- Symmetry is good

National Standard Practice Manual (NSPM)

National Standard Practice Manual

New guidelines for determining cost-effectiveness testing

Drivers…

- Traditional tests may not be address all needs and are often modified so not comparable
- Efficiency is not accurately valued in many jurisdictions
- Lack of transparency on why/how tests were chosen

National Standard Practice Manual

Who is behind the NSPM?

- National Efficiency Screening Project (NESP) – national group working to improve cost-effectiveness analyses
- Over 75 organizations representing a range of perspectives

Who drafted the NSPM?

- Tim Woolf, Synapse Energy Economics
- Chris Neme, Energy Futures Group,
- Marty Kushler, ACEEE
- Steve Schiller, Schiller Consulting
- Tom Eckman (Consultant and former Director of Power Planning, Northwest Power and Conservation Council)

Who reviewed the NSPM?

- ~40 experts representing a variety of organizations from around the country
- Provided several rounds of review/feedback on draft manual

Who Coordinated and Funded the NPSM Project?

- Coordinated and funded by E4TheFuture
- Managed by Julie Michals, E4TheFuture
- Earlier work on the NESP and NSPM was managed by the Home Performance Coalition

For more information:
http://www.nationalefficiencyscreening.org/

NSPM: Purpose

- Defining policy-neutral *principles* for developing cost-effectiveness tests
- Establishing a framework for selecting and developing a test
- Providing *guidance on key inputs*

NSPM

- Selected B/C test is referred to as the Resource Value Test (RVT)
- These may differ by jurisdiction
- May end up being the same as one of the existing tests, or different

NSPM Principles

1. Recognize that energy efficiency is a resource.
2. Account for applicable policy goals.
3. Account for all relevant costs & benefits, even if hard to quantify impacts.
4. Ensure symmetry across all relevant costs and benefits.
5. Conduct a forward-looking, long-term analysis that captures incremental impacts of energy efficiency.
6. Ensure transparency in presenting the analysis and the results.

NSMP Steps

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.

STEP 1 Identify and Articulate Applicable Policy Goals

Laws, Regulations, Orders:	Policy Goals Reflected in Laws, Regulations, Orders, etc.					
	Low-Cost	Fuel Diversity	Risk	Reliability	Environ-mental	Economic Development
PSC statutory authority	X			X		
Low-income protection						X
EE or DER law or rules	X	X	X	X	X	X
State energy plan	X	X	X	X	X	X
Integrated resource planning		X	X		X	X
Renewable portfolio standard		X	X		X	X
Environmental requirements					X	

- Each jurisdiction has a constellation of energy policy goals embedded in statutes, regulations, orders, guidelines, etc.
- This table illustrates how those laws, regulations, orders, etc. might establish applicable policy goals.

STEP 2 Include All Utility System Costs and Benefits in the Test

Illustrative Utility System Costs	Illustrative Utility System Benefits
EE Measure Costs (utility portion – e.g. rebates)	Avoided Energy Costs
EE Program Technical Support	Avoided Generating Capacity Costs
EE Program Marketing/Outreach	Avoided T&D Upgrade Costs
EE Program Administration	Avoided T&D Line Losses
EE Program EM&V	Avoided Ancillary Services
Utility Shareholder Performance Incentives	Wholesale Price Suppression Effects
	Avoided Costs of RPS Compliance
	Avoided Costs of Environmental Compliance
	Avoided Credit and Collection Costs
	Reduced Risk
	Increased Reliability

The principle of treating energy efficiency as a resource dictates that utility system costs and benefits serve as the foundation for all tests

STEP 3 Include Non-Utility System Impacts Based on Jurisdiction's Applicable Policy Goals

Applicable policy goals include all policy goals adopted by a jurisdiction that could have relevance to the choice of which energy resources to acquire. Examples include:

Common Overarching Goals:	Provide safe, reliable, low-cost electricity and gas services; protect low-income and vulnerable customers; maintain or improve customer equity.
Efficiency Resource Goals:	Reduce electricity and gas system costs; develop least-cost energy resources; promote customer equity; improve system reliability and resiliency; reduce system risk; promote resource diversity; increase energy independence (and reduce dollar drain from the jurisdiction); reduce price volatility.
Other Applicable Goals:	Support fair and equitable economic returns for utilities; provide reasonable energy costs for consumers; ensure stable energy markets; reduce energy burden on low-income customers; reduce environmental impact of energy consumption; promote jobs and local economic development; improve health associated with reduced air emissions and better indoor air quality.

These goals are established in many ways:

- Statutes
- Regulations
- Commission Orders
- EE Guidelines
- EE Standards
- Directives
- And Others

STEP 3

Illustrative Non-Utility System Impacts

Impact	Description
Participant impacts	Impacts on program participants, includes participant portion of measure cost, other fuel savings, water savings, and participant non-energy costs and benefits
Impacts on low-income customers	Impacts on low-income program participants that are different from or incremental to non-low-income participant impacts. Includes reduced foreclosures, reduced mobility, and poverty alleviation
Other fuel impacts	Impacts on fuels that are not provided by the funding utility, for example, electricity (for a gas utility), gas (for an electric utility), oil, propane, and wood
Water impacts	Impacts on water consumption and related wastewater treatment
Environmental impacts	Impacts associated with CO2 emissions, criteria pollutant emissions, land use, etc. Includes only those impacts that are not included in the utility cost of compliance with environmental regulations
Public health impacts	Impacts on public health; includes health impacts that are not included in participant impacts or environmental impacts, and includes benefits in terms of reduced healthcare costs
Economic development and jobs	Impacts on economic development and jobs
Energy security	Reduced reliance on fuel imports from outside the jurisdiction, state, region, or country

This table is presented for illustrative purposes, and is not meant to be an exhaustive list.

STEP 4

Ensure Symmetry Across Benefits and Costs

Ensure that the test includes costs and benefits symmetrically

- If category of cost is included, corresponding benefits should be too

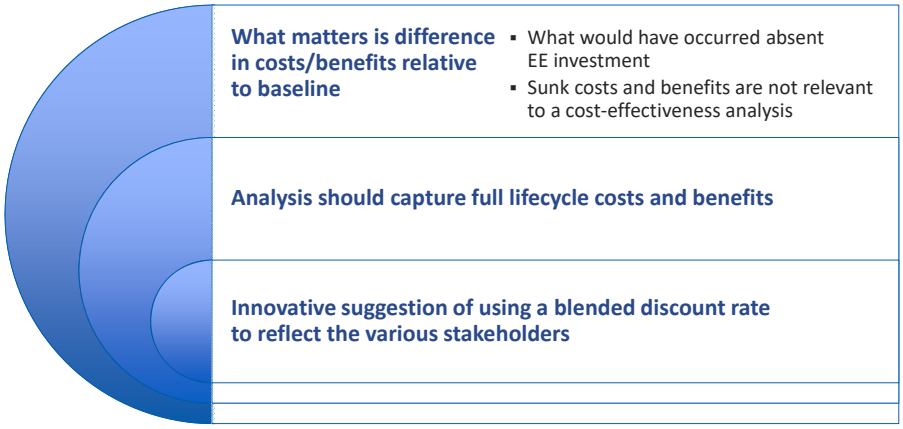
(e.g., if participant costs included, participant benefits should also be included)

Symmetry is necessary to avoid bias:

- If some costs excluded, the framework will be biased in favor of EE;
- If some benefits excluded, the framework will be biased against EE.
- Bias in either direction can result in misallocation of resources (over or under investment)
  - higher than necessary costs to meet energy needs
  - too little or too much investment in actions to achieve jurisdiction's energy related policies goals

STEP 5

Conduct Incremental, Forward Looking and Long Term Analysis



STEP 6

Develop Methodologies and Inputs to Account for All Impacts, Including Hard-to-Quantify Impacts

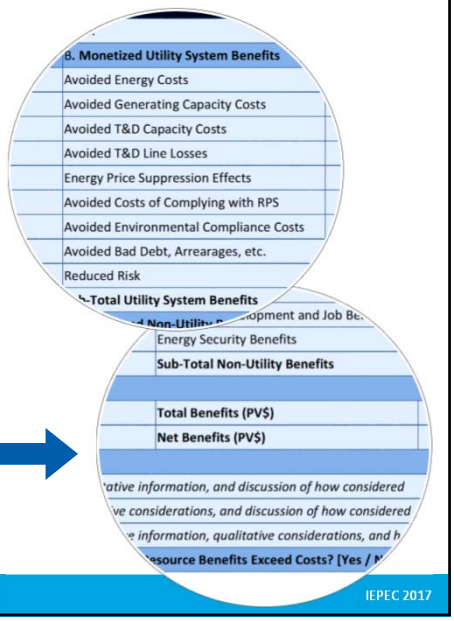
Approach	Application
Jurisdiction-specific studies	Best approach for estimating and monetizing relevant impacts.
Studies from other jurisdictions	Often reasonable to extrapolate from other jurisdiction studies when local studies not available.
Proxies	If no relevant studies of monetized impacts, proxies can be used
Alternative thresholds	Benefit-cost thresholds different from 1.0 can be used to account for relevant impacts that are not monetized.
Other considerations	Relevant quantitative and qualitative information can be used to consider impacts that cannot or should not be monetized.

STEP 7

Ensure Transparency in Reporting

Sample Template

Efficiency Cost-Effectiveness Reporting Template			
Program/Sector/Portfolio Name:		Date:	
A. Monetized Utility System Costs		**B. Monetized Utility System Benefits**	
Measure Costs (utility portion)		Avoided Energy Costs	
Other Financial or Technical Support Costs		Avoided Generating Capacity Costs	
Program Administration Costs		Avoided T&D Capacity Costs	
Evaluation, Measurement, & Verification		Avoided T&D Line Losses	
Shareholder Incentive Costs		Energy Price Suppression Effects	
		Avoided Costs of Complying with RPS	
		Avoided Environmental Compliance Costs	
		Avoided Bad Debt, Arrearages, etc.	
		Reduced Risk	
Sub-Total Utility System Costs		**Sub-Total Utility System Benefits**	
C. Monetized Non-Utility Costs		**D. Monetized Non-Utility Benefits**	
Participant Costs	*These impacts would be included to the extent that they are part of the Resource Value (primary) test.*	Participant Benefits	*These impacts would be included to the extent that they are part of the Resource Value (primary) test.*
Low-Income Customer Costs		Low-Income Customer Benefits	
Other Fuel Costs		Other Fuel Benefits	
Water and Other Resource Costs		Water and Other Resource Benefits	
Environmental Costs		Environmental Benefits	
Public Health Costs		Public Health Benefits	
Economic Development and Job Costs		Economic Development and Job Benefits	
Energy Security Costs		Energy Security Benefits	
Sub-Total Non-Utility Costs		**Sub-Total Non-Utility Benefits**	
E. Total Monetized Costs and Benefits			
Total Costs (PV$)		**Total Benefits (PV$)**	
Benefit-Cost Ratio		**Net Benefits (PV$)**	
F. Non-Monetized Considerations			
Economic Development and Job Impacts	*Quantitative information, and discussion of how considered*		
Market Transformation Impacts	*Qualitative considerations, and discussion of how considered*		
Other Non-Monetized Impacts	*Quantitative information, qualitative considerations, and how considered*		
Determination:	**Do Efficiency Resource Benefits Exceed Costs? [Yes / No]**		



STEP 7

Ensure Transparency in Decisions on Which Non-Utility System Impacts to Include

Process should be open to all stakeholders.

Stakeholder input can be achieved through a variety of means:

- rulemaking process,
- generic jurisdiction-wide docket,
- working groups or technical sessions,

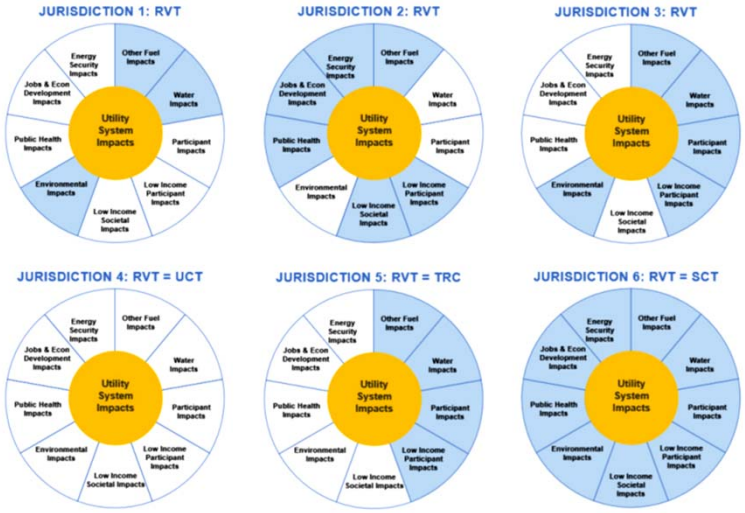
Address objectives based on current jurisdiction policies

- However, be flexible to incorporate evolution of policies through time.

Policy goals may require consultation with other government agencies

- Environmental protection
- Health and human services
- Economic development

Relationship of Resource Value Test to Traditional Tests – Your Results May Differ



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Questions?

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