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Energy-Efficiency Cost-Effectiveness Screening: *An overview of tests, key inputs, and practices from across the country*

Tucson Electric Power Cost-Effectiveness Workshop

Phoenix, Arizona

October 31, 2012

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Content of Report

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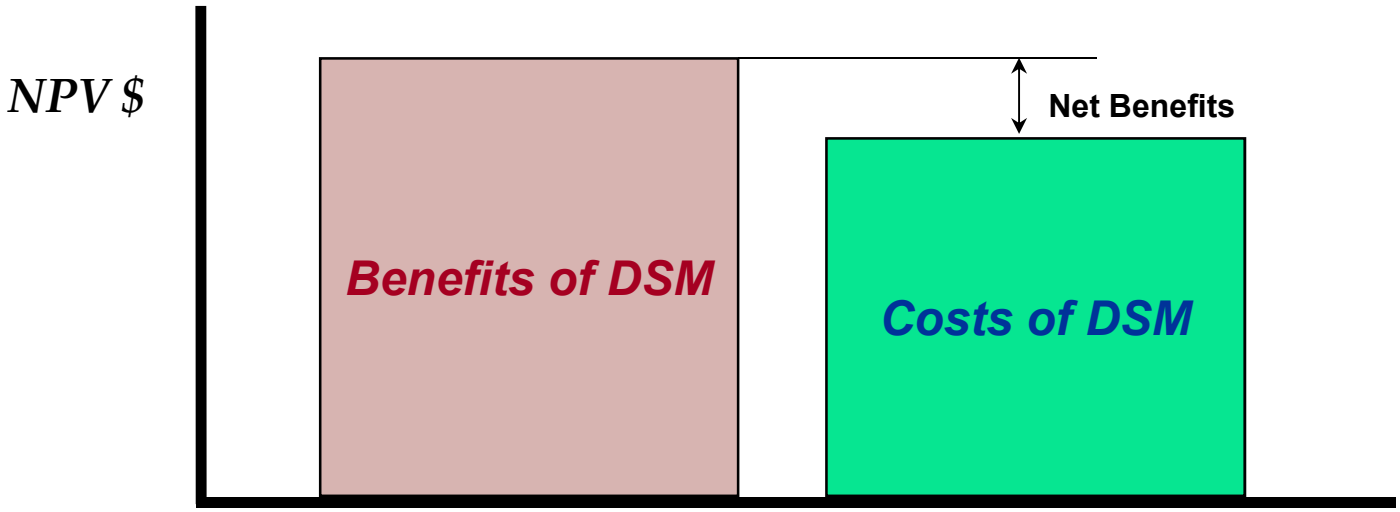
Objectives

- Introduce fundamental concepts and definitions based on "standard practice."
- Highlight study inputs that drive outcomes.
- Review key elements of analysis that are subject to interpretation.
- Provide context by summarizing other states' practices.

Overview of Cost-Effectiveness Analysis

- Role of cost-effectiveness tests
  - Results drive the amount of energy-efficiency (EE) resource potential that is tapped.
  - Arizona and 34 other states require energy-efficiency investments to be cost-effective.
- What does it mean to be cost-effective?
  - Net present value of stream of benefits outweighs net present value of costs.



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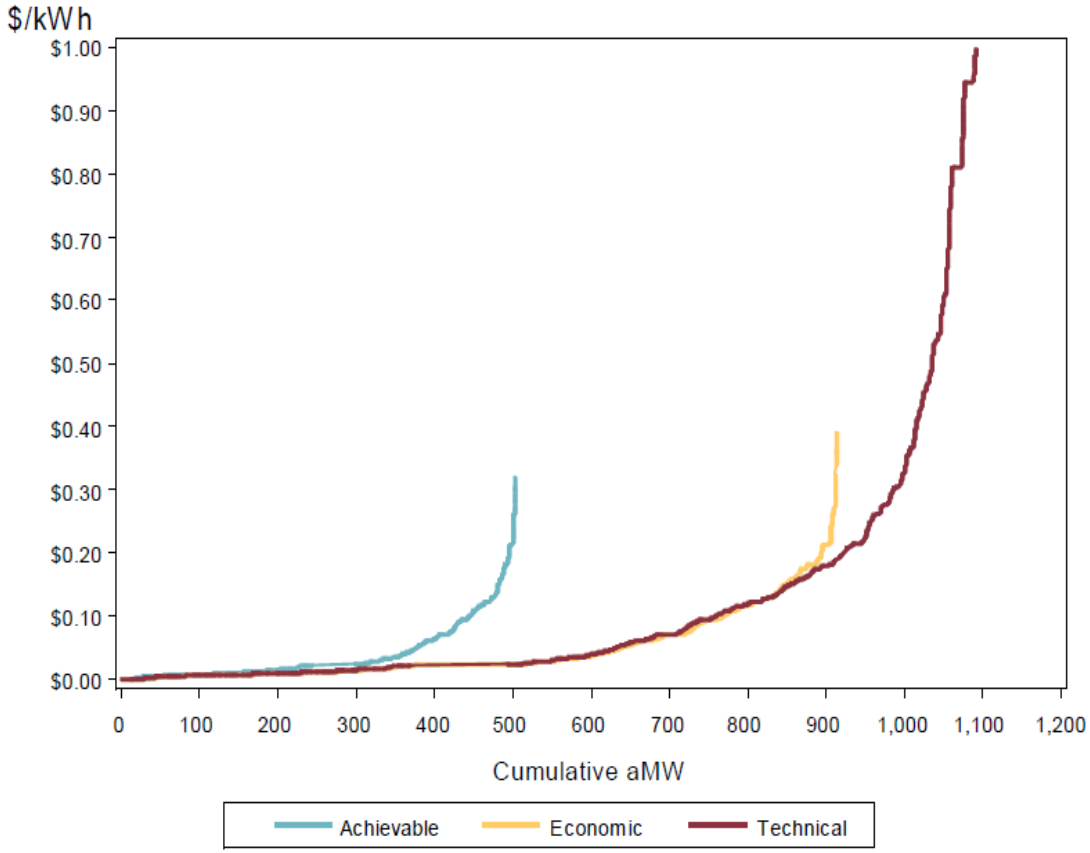
Overview of Cost-Effectiveness Analysis

- EE is often the least-cost resource, but costs increase as more is obtained.
- Cost-effectiveness tests help identify the point at which obtaining more EE resources is no long-longer the least-cost option.



Source: Quantec, Summit Blue Consulting and Nexant, Inc.. 2007. Assessment of Long-Term,System-Wide Potential for Demand-Side and Other Supplemental Resources. Prepared for PacifiCorp.

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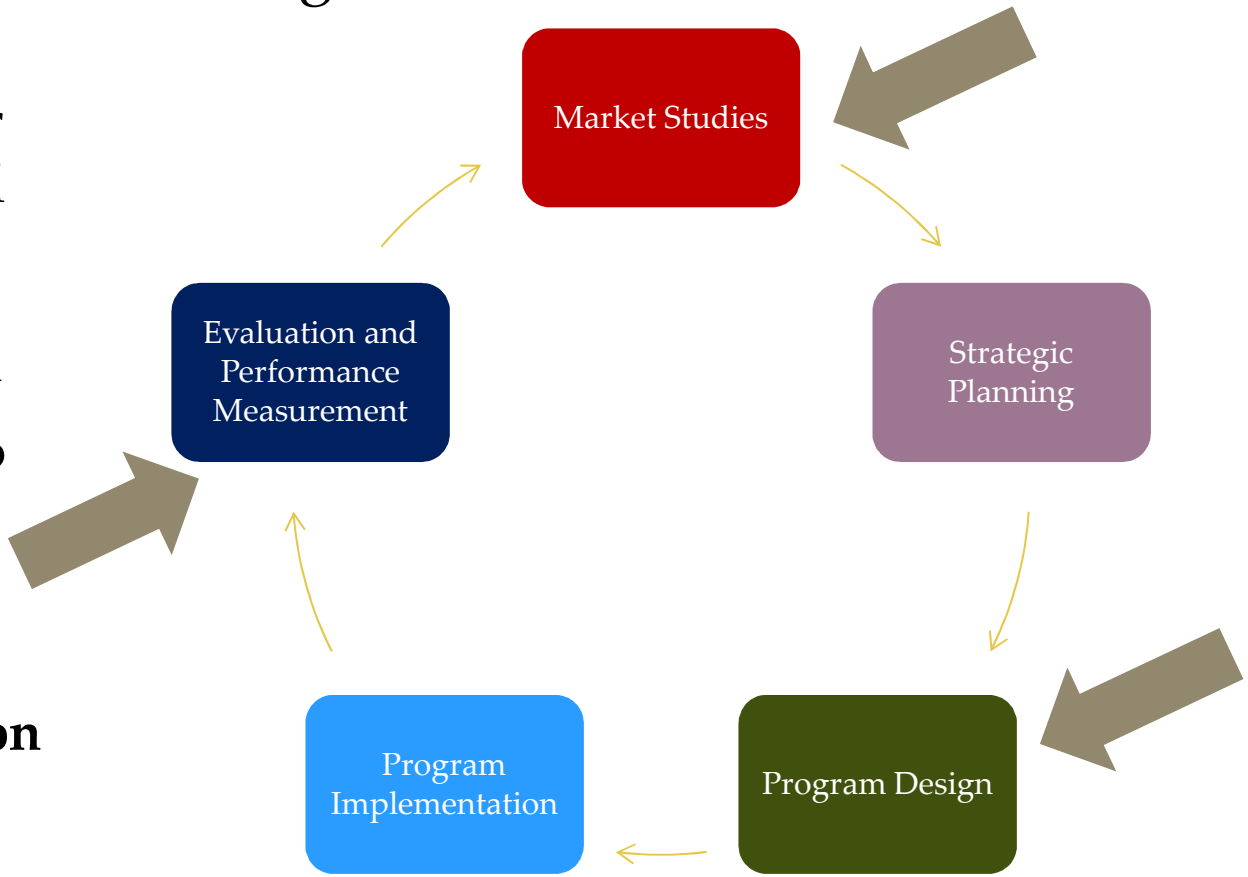
Overview of Cost-Effectiveness Analysis

When is cost-effectiveness testing used?

- In **market studies** for preliminary and final screening
  - distinguishes technical and economic potential
- In **program design** to incorporate detail characteristics and costs
- In **program evaluation** to measure results



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Overview of Cost-Effectiveness Analysis

» Five tests have been used since the 1980s as the main tools for screening DSM investments.
  - **Societal Cost Test (SCT)**
  - **Total Resource Cost Test (TRC)**
  - Program Administrator Cost Test (PACT)
  - Ratepayer Impact Measurement Cost Test (RIM)
  - Participant Cost Test (PCT)

» There is no one "best" test.
  - Each provides a different perspective (e.g., society, program administrator, participants, ratepayers overall).
  - Different tests used for different purposes.
  - Selection of test and details of the analysis can significantly affect whether an investment is deemed cost-effective.
  - Using multiple tests provides a more comprehensive understanding of investments.

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Overview of Cost-Effectiveness Analysis

» The elements included in an analysis depend on the test selected and judgment on the part of regulators and/or the utility or agency overseeing the analysis.

» Several potential elements:

Benefits

- Avoided energy and capacity costs
- Savings on equipment or labor purchases (negative "costs")
- Bill reductions
- Intangibles / Non-market goods
  - Externalities and "Non-Energy Benefits" (e.g., avoided environmental damage, improved comfort, job creation) may be accounted for in an "adder" or estimated in detail.

Costs

- Purchases of equipment, labor
- Administrative costs
- Increased purchases of energy
- Increases in other costs (e.g., O&M, water)
- Lost revenues

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Standard Practice References

- *California Standard Practice Manual: Economic Analysis Of Demand-Side Programs And Projects* (July 2002)
  - First Developed in 1983
  - Specifies four cost-effectiveness tests (SCT presented as variant of TRC)
  - Identifies strengths and weaknesses of each
  - Provides generic calculations
- *OPA Cost-Effectiveness Tests Guide* (Draft Version 1.0)
- National Action Plan for Energy Efficiency (2008). *Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers*. Energy and Environmental Economics, Inc. and Regulatory Assistance Project.

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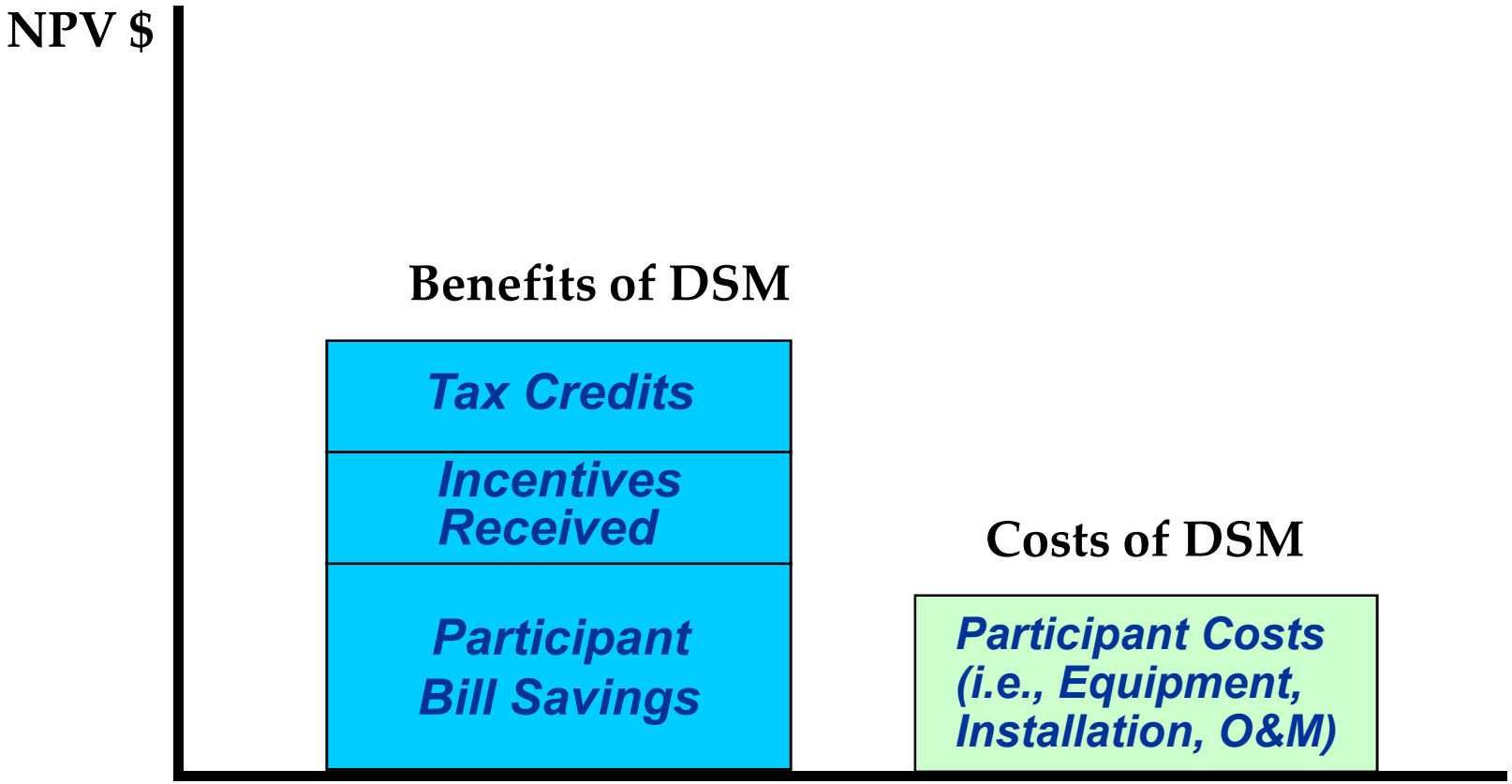
Participant Cost Test (PCT)



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Participant Cost Test (PCT)

» Asks: Will the participants benefit over the measure life?

» Compares: Costs and benefits for the customer installing the measure.

» Indicates desirability of program to potential participants, so useful in program design.

Benefits	Costs
• Incentives received • Bill savings • O&M savings • Tax credits or additional incentive	• Incremental equipment costs (over baseline) • Incremental installation costs

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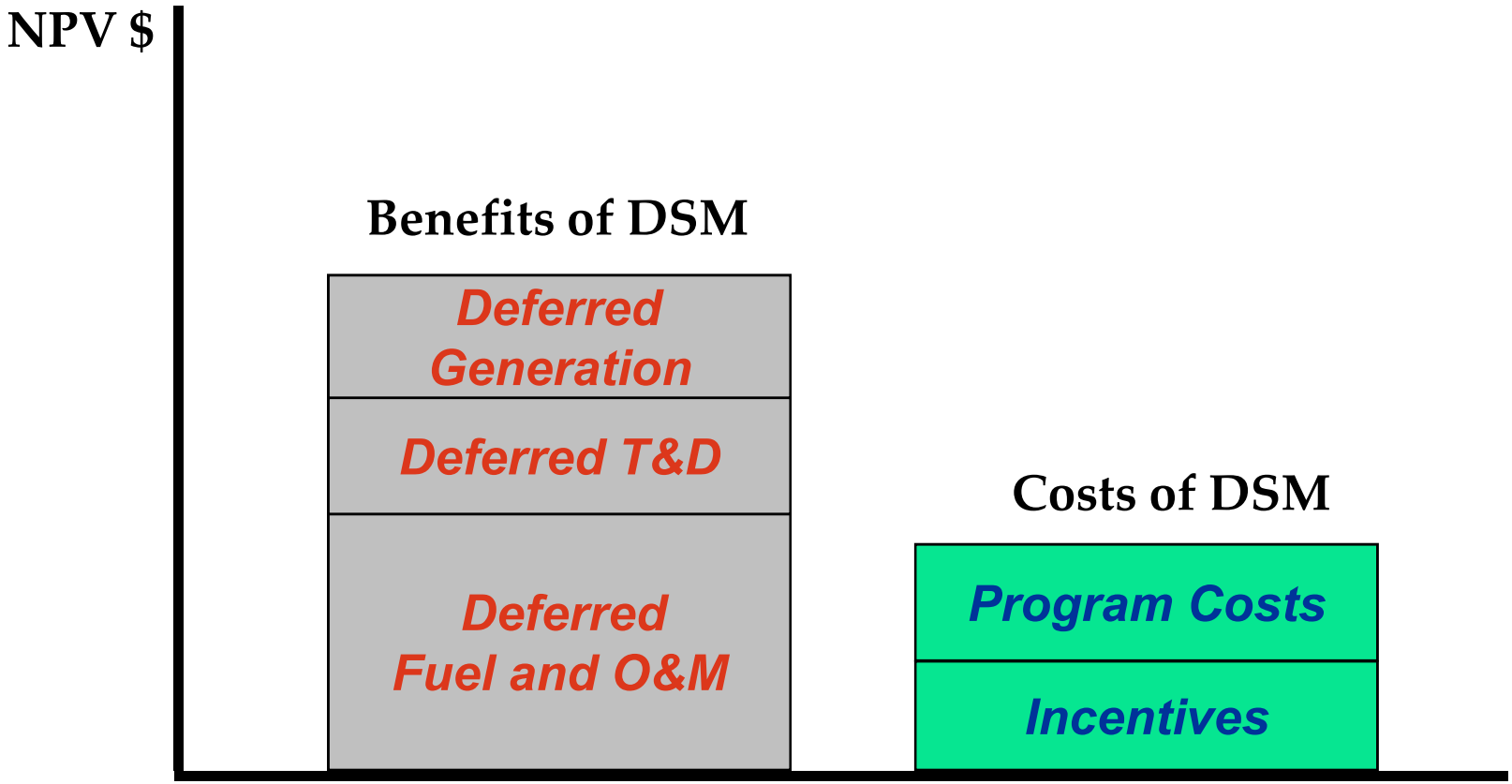
Program Administrator / Utility Cost Test (PACT)



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Program Administrator / Utility Cost Test (PACT)

» Asks: Are the utility's revenue requirements raised or lowered?

» Compares: Costs of procuring efficiency resources (program administrator costs) to cost of procuring supply-side resources.

Benefits

- Energy-related costs avoided by the utility
- Capacity-related costs avoided by the utility
- Avoided or deferred plant investment (generation, T&D, etc.)

Costs

- Net costs to utility
  - Includes program costs and incentives paid to participants

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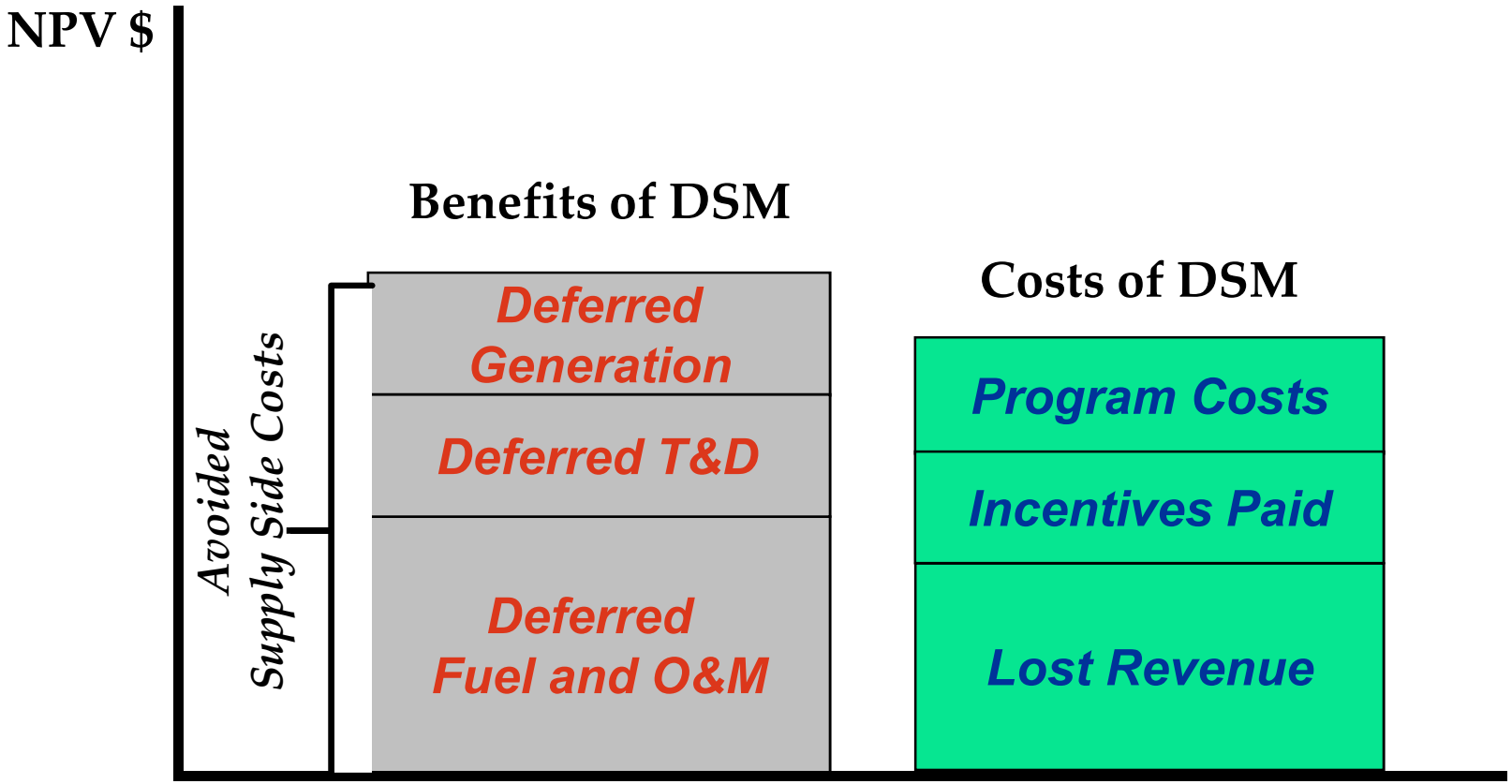
Ratepayer Impact Measurement Test (RIM)



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Ratepayer Impact Measurement Test (RIM)

» Asks: Will the utility rates increase? Considers rate impacts on all participants, and potential for cross-subsidization.

» Compares: administrator costs and bill reductions to supply-side costs.

» Defining Feature: Includes lost revenues.

» Of the five tests, an EE investment is least likely to pass this one. However, RIM does not take into consideration that the long-term costs of NOT making that EE investment (i.e. meeting that same demand with conventional generation) would likely be higher.

Benefits	Costs
• Energy-related costs avoided by the utility • Capacity-related costs avoided by the utility	• Program overhead costs • Incentives paid to participants • Program administrator installation / other costs • Lost revenue due to reduced energy bills

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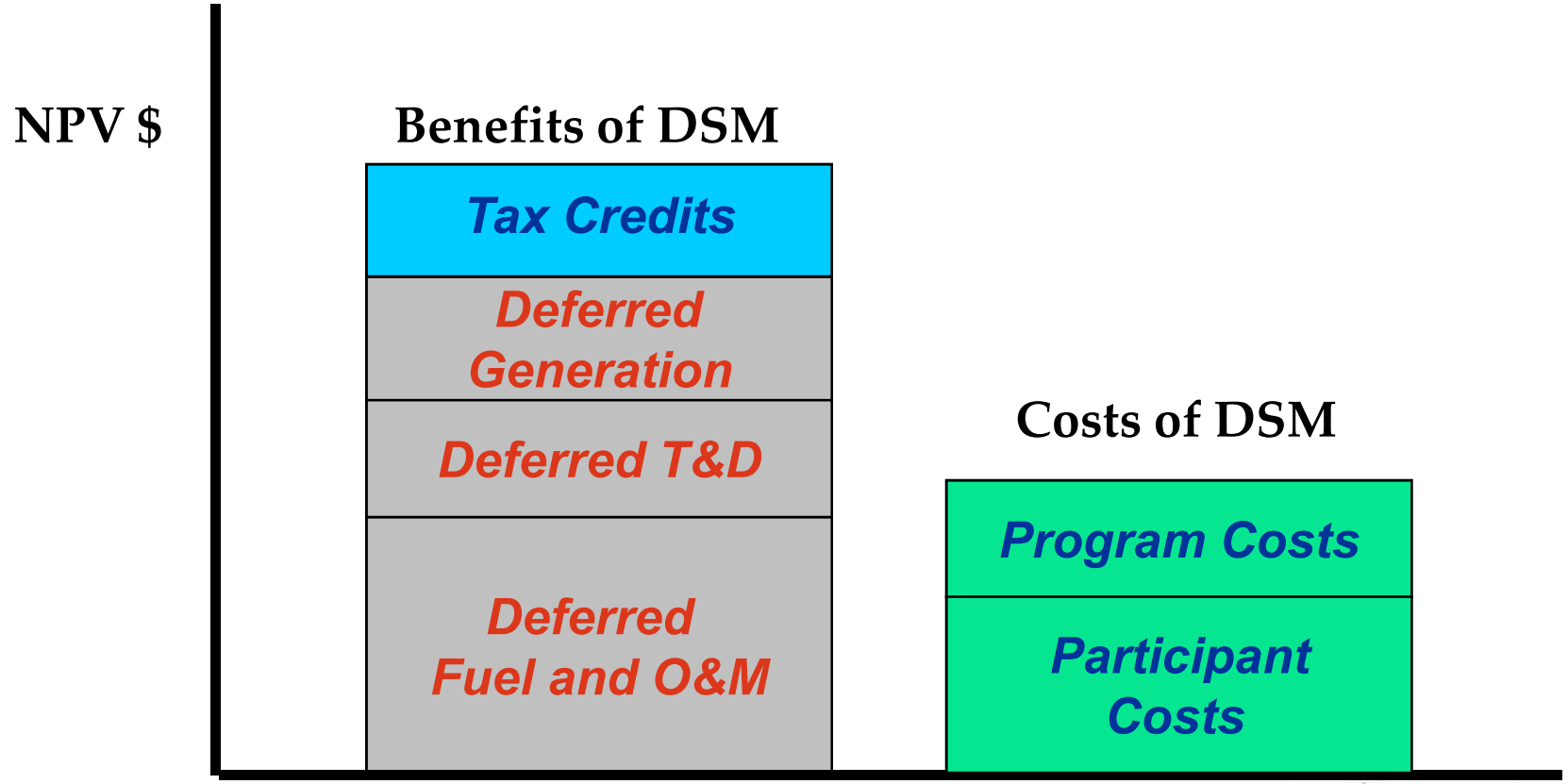
Total Resource Cost Test (TRC)

» For TRC and SCT, transfers between parties not included (incentives paid to customers, lower energy bills / lost utility revenue).



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Total Resource Cost Test (TRC)

» Asks: Will the total costs of energy in the utility service territory decrease?

» Compares: Program administrator AND customer costs to the utility resource savings.

» Transfers between utility and customer cancel out (incentives paid to customers, lower energy bills / lost utility revenue).

Benefits	Costs
• Energy-related costs avoided by the utility • Capacity-related costs avoided by the utility • Avoided or deferred plant investment (generation, T&D, etc.) • Some monetized environmental and non-energy benefits • Tax credits received by participants	• Net costs to utility and participants • Includes program costs and incentives paid to participants

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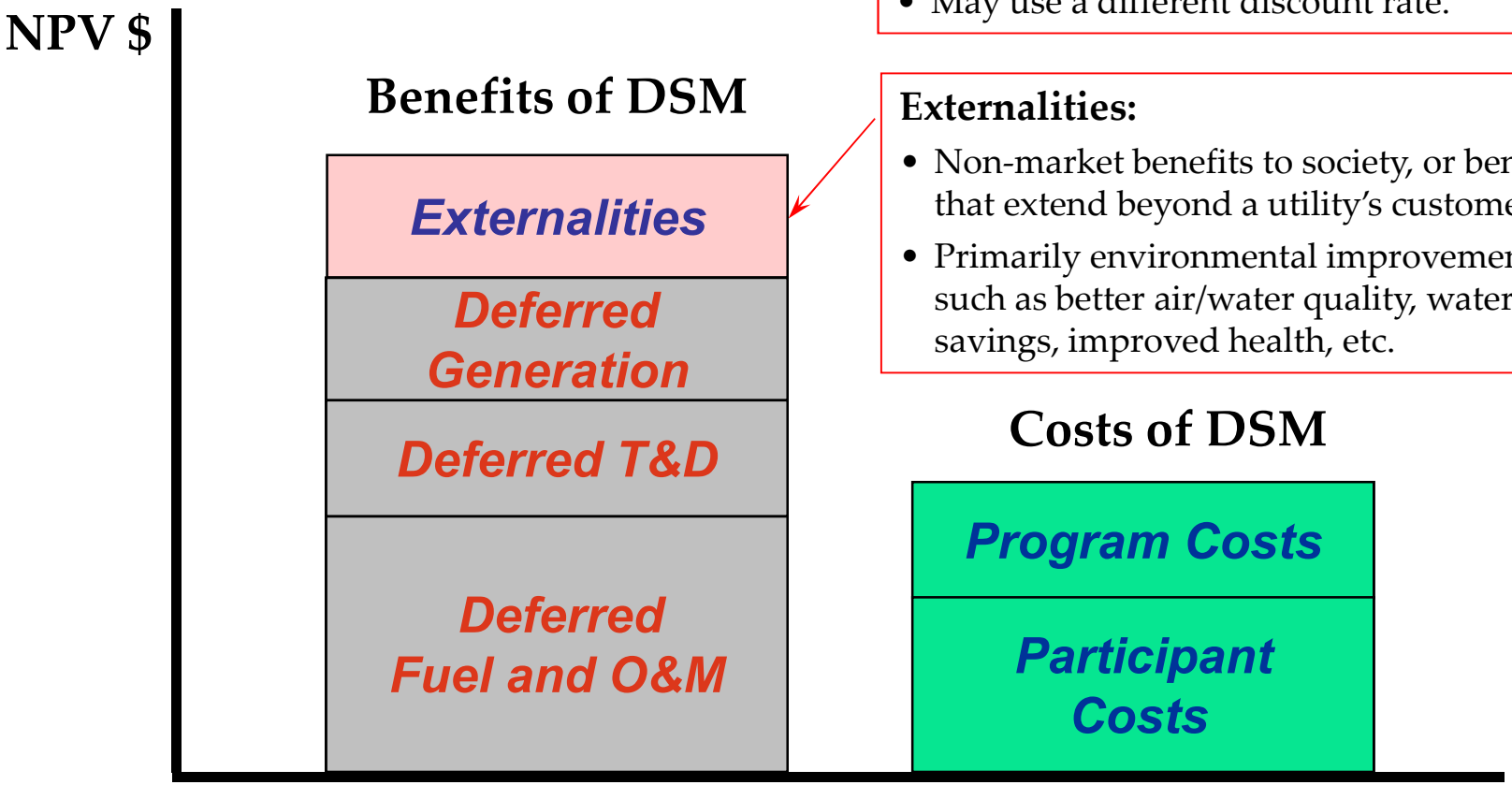
Societal Cost Test (SCT)

Differences from TRC:
- Includes externalities as a benefit.
- Excludes tax credit benefits.
- May use a different discount rate.



Externalities:
- Non-market benefits to society, or benefits that extend beyond a utility's customers.
- Primarily environmental improvements, such as better air/water quality, water savings, improved health, etc.

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Societal Cost Test (SCT)

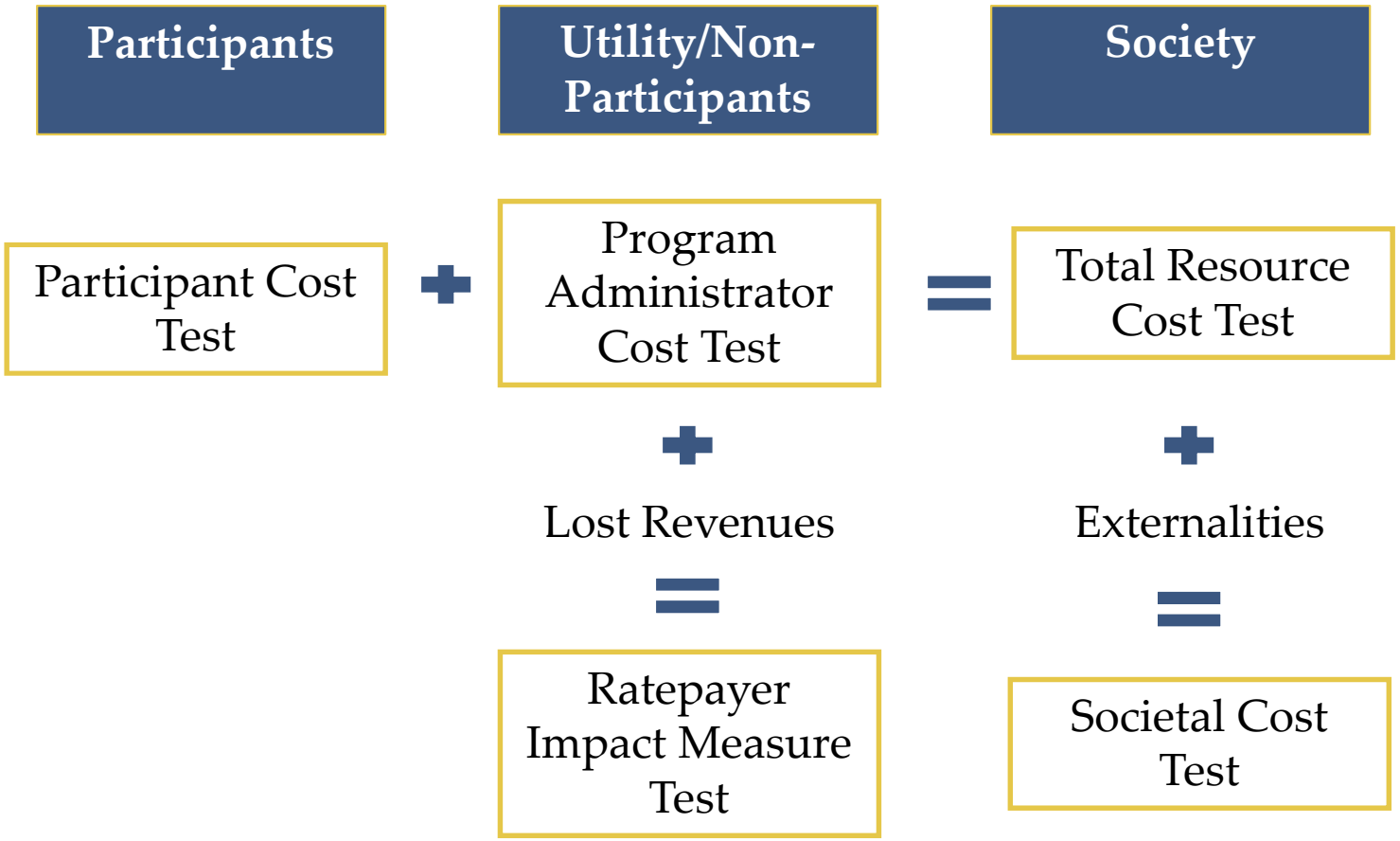
» Asks: Is society better off as a whole?

» Compares: Society's costs of energy efficiency to resource savings, including non-cash costs and benefits.

» Defining Feature: Its scope includes the full range of costs and benefits, including job creation, reliability, environmental impacts, etc., facilitating a more balanced comparison with supply-side options.

Benefits	Costs
• Energy-related costs avoided by the utility • Capacity-related costs avoided by the utility • Avoided or deferred plant investment (generation, T&D, etc.) • Applicable tax credits received by participants • Monetized environmental and non-energy benefits, including (theoretically) all externalities	• Net costs to utility and participants • Includes program costs and incentives paid to participants

Cost-Effectiveness Test Relationships



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Summary of Cost Test Components

Component	PCT	PACT	RIM	TRC	SCT
Energy and Capacity Avoided Costs		+	+	+	+
Externalities					+
Incremental Equipment and Installed Costs	-			-	-
Program Overhead Costs		-	-	-	-
Incentive Payments	+	-	-		
Bill Reductions	+		-		

Sources: California Standard Practice Manual, National Action Plan for Energy Efficiency (2008). Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers. Energy and Environmental Economics, Inc. and Regulatory Assistance Project.

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Cost Test Outputs

- Results reported in dollars (NPV), or as a ratio.
  - Net Benefits > $0 mean the program is cost-effective.
  - Benefit / Cost ratio > 1 means the program is cost-effective.
  - Levelized cost (for PACT, TRC, or SCT):
    - $/kWh or $/MMBtu saved; $/kW reduced
    - Easy to relate to the cost of energy

Basic approaches for calculating and presenting results of cost-effectiveness tests

Net Benefits (Difference)	Net Benefits_a (dollars)	=	$\text{NPV} \sum \text{benefits}_a$ (dollars) - $\text{NPV} \sum \text{costs}_a$ (dollars)
Benefit-Cost Ratio	$\text{Benefit-Cost Ratio}_a$	=	$\frac{\text{NPV} \sum \text{benefits}_a \text{ (dollars)}}{\text{NPV} \sum \text{costs}_a \text{ (dollars)}}$

Source: National Action Plan for Energy Efficiency (2008). Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers. Energy and Environmental Economics, Inc. and Regulatory Assistance Project. California Standard Practice Manual (2001).

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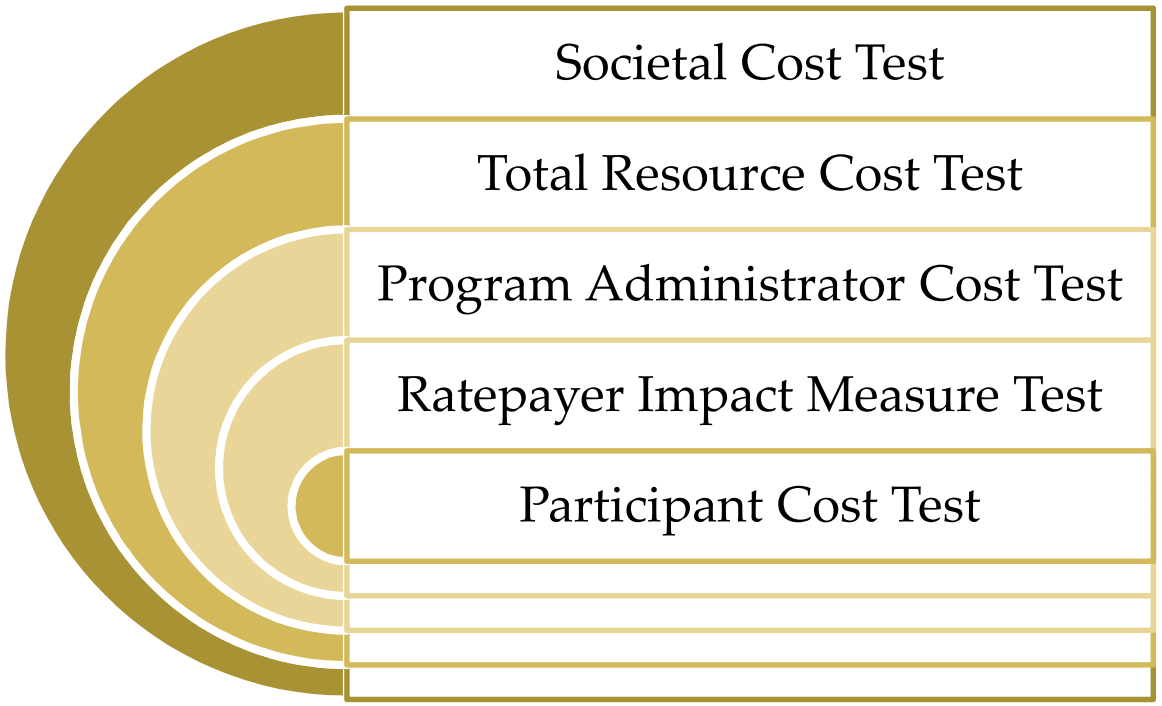
Which Test is Most Appropriate?

- Selection of test reflects intended scope, and overall public policy goals driving the analysis.
- Scope of test becomes broader as you move from the PCT to SCT.

- Tests with narrow scopes (PCT, RIM) are helpful during program design. However, they are generally considered too limited for use as the "primary" tools for evaluating cost-effectiveness.



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Selection of Test Affects Whether EE Investment is Deemed Cost-Effective

- For each of four utility programs, different tests were used to analyze the same data inputs.
- Different tests produce different results regarding a particular program's cost-effectiveness.

Test	Southern California Edison Residential Energy Efficiency Incentive Program	Avista Regular Income Portfolio	Puget Sound Energy Commercial/ Industrial Retrofit Program	National Grid MassSAVE Residential
	Benefit-Cost Ratio			
PCT	7.14	3.47	1.72	8.81
PACT	9.91	4.18	4.19	2.64
RIM	0.63	0.85	1.15	0.54
TRC	4.21	2.26	1.90	1.73
SCT	4.21	2.26	1.90	1.75

Source: E3 analysis, National Action Plan for Energy Efficiency (2008). *Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers*. Energy and Environmental Economics, Inc. and Regulatory Assistance Project. .

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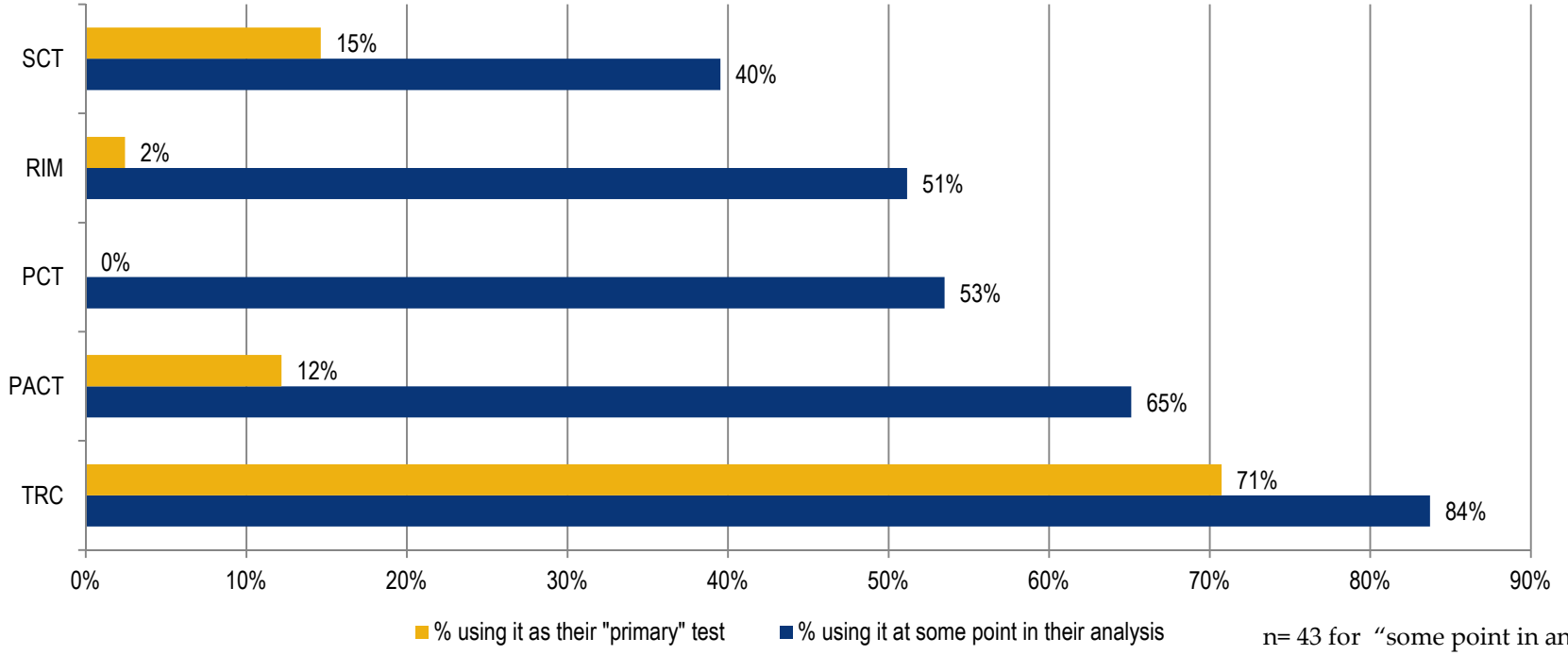
How are Other States Using the Tests?

» TRC test is used most frequently, both for general screening purposes, and for use as the "primary" test for decision-making.

Percentage of states using each test



n= 43 for "some point in analysis; n=41 for "primary test"

Source: Kushler M., et al. 2012. A National Survey of State Policies and Practices for the Evaluation of Ratepayer-Funded Energy Efficiency Programs. ACEEE.

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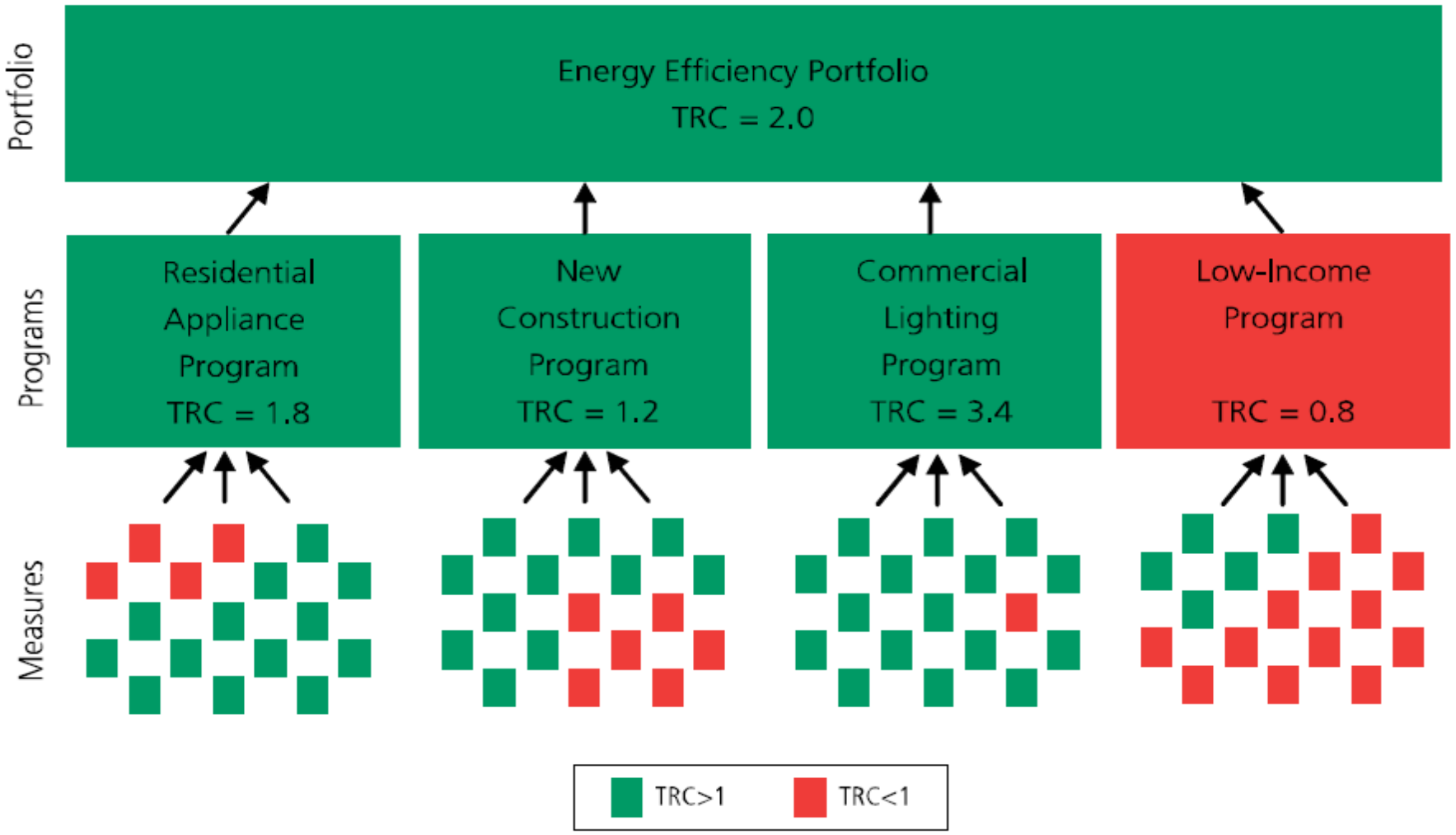
Impact of Screening at Measure / Program / Portfolio Levels



Source: National Action Plan for Energy Efficiency (2008). *Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers*. Energy and Environmental Economics, Inc. and Regulatory Assistance Project.

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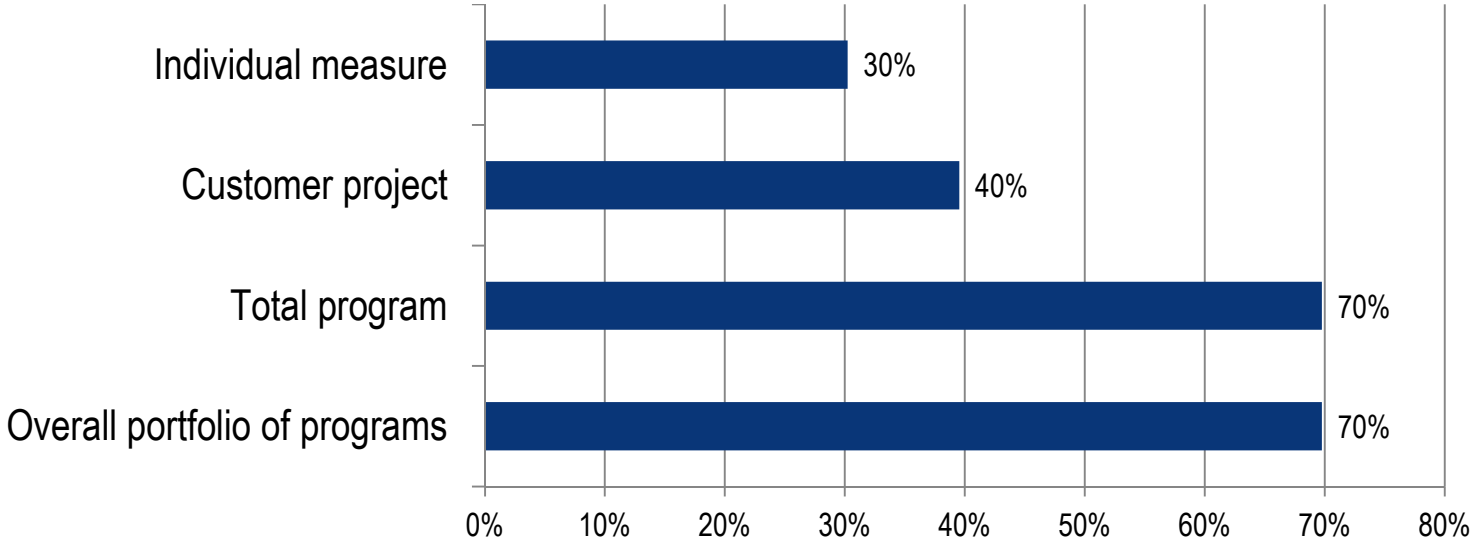
How are Other States Using the Tests?

- A majority of states require program and/or portfolio-level testing only, including: Colorado, Florida, Kentucky, Nebraska, New Mexico, North Carolina, Tennessee, Texas and Wyoming.
- Most states that require measure-level screening have some flexibility (e.g., allowing bundling of measures) or exceptions for certain types of programs, including: Iowa, Montana, and Oklahoma.

Percentage of states applying tests at various levels



n= 43 for "some point in analysis; n=41 for "primary test"

Source: Kushler M., et al. 2012. A National Survey of State Policies and Practices for the Evaluation of Ratepayer-Funded Energy Efficiency Programs. ACEEE.

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Challenges of Applying TRC and SCT

- Both TRC and SCT include inputs that can be challenging and resource-intensive to measure and forecast such as:
  - Environmental impacts, and
  - Non-energy impacts (NEIs) like improved comfort, job creation and other resource savings.
- Omitting relevant inputs from an analysis because they are difficult to measure can skew results against EE investment.
- Potential strategies for addressing challenges:
  - Invest resources in robust studies of only those NEIs likely to have the greatest impact;
  - Measure only those NEIs that are readily measurable;
  - Use an adder to capture value of hard-to-measure inputs like environmental externalities and NEIs (five states use adders to value externalities);
  - Estimate ranges of values and conduct scenario analysis.

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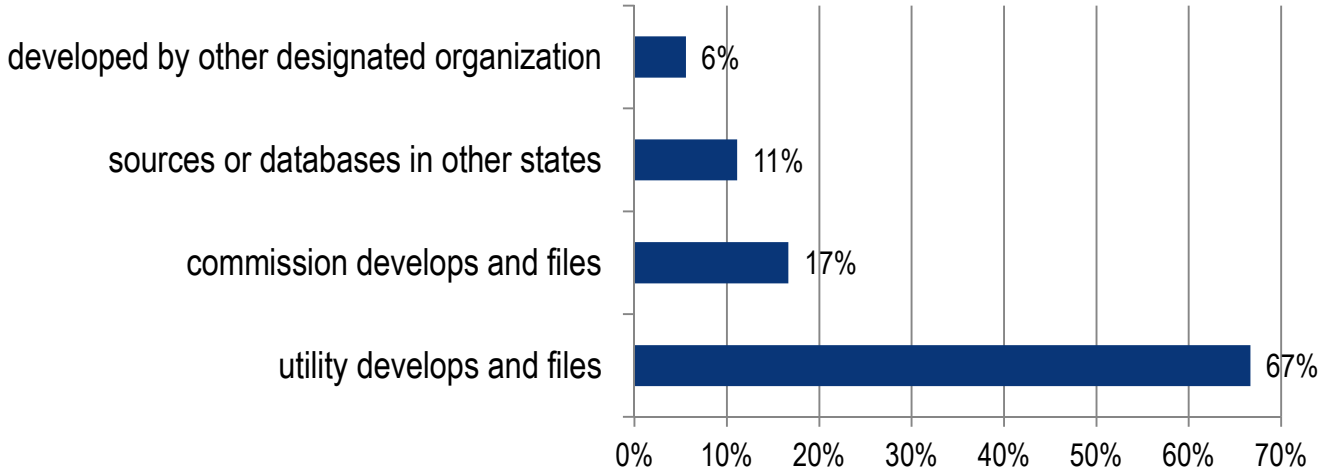
Avoided Costs

- Forecast costs that would be spent in the absence of EE.
- In most cases, utilities develop their own avoided costs.
  - Vertically-integrated utilities that go through Integrated Resource Planning (IRP) processes typically use IRP values.
- Two main forecast options: market forecast vs. production simulation.
- Simple vs. Complex:
  - Texas uses estimated cost of a new gas turbine.
  - California uses hourly avoided costs for 16 different climate zones.

Origins of utility system avoided cost estimates



Source: Kushler M., et al. 2012. A National Survey of State Policies and Practices for the Evaluation of Ratepayer-Funded Energy Efficiency Programs. ACEEE.

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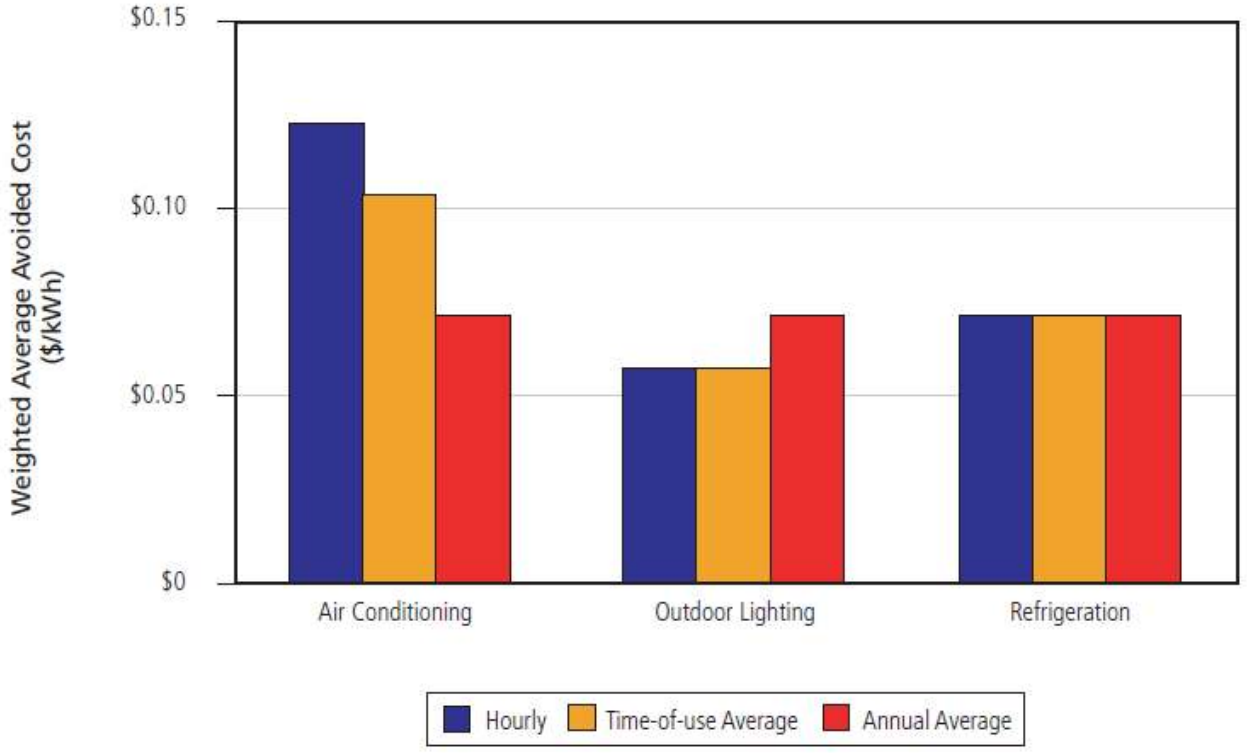
Avoided Costs

- Two main categories of avoided costs that are universally considered: 1) avoided energy costs; 2) avoided capacity costs.
- The specific benefits a given utility includes, and methods for calculating them vary and can significantly affect outcomes.

Effect of hourly pricing on avoided cost



National Action Plan for Energy Efficiency (2007). *Guide to Resource Planning with Energy Efficiency*. Prepared by Snuller Price et al., Energy and Environmental Economic, Inc.

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Avoided Costs

» These components are most often included in avoided cost calculations. Items shown on the *next* slide are *sometimes* included.

Avoided Component	Description
Electricity energy (with losses)	• Market-forecast of electricity procurement, or • Operating cost of power plants if using production simulation. • Loss factors.
Electricity capacity (with losses)	• Market-forecast of capacity, or • Assessment of deferred power plant construction based on adjusted load forecast. • Loss factors.
Natural gas commodity (with losses)	• Market-forecast of natural gas procurement with basis adjustment for delivery to utility city-gate. • Loss and compression factors.
Natural gas capacity (with storage and compression)	• Assessment of deferred infrastructure including pipelines, storage facility, and LNG terminals.

National Action Plan for Energy Efficiency (2007). *Guide to Resource Planning with Energy Efficiency*. Prepared by Snuller Price et al., Energy and Environmental Economic, Inc.

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Avoided Costs

Other Components	Description
Ancillary services	• Reduced costs of ancillary services associated with reduced energy and capacity.
Transmission and distribution capacity	• Deferral value of additional transmission and distribution capacity to meet customer peak demand growth. • For electricity, the transmission and distribution capacity avoided costs vary by sub-area within the utilities. Capacity costs also vary by hour, co-incident with the timing of the local area peak demands. Peak demand is correlated to local climate. • For natural gas, the avoided transmission and distribution costs vary by utility service territory and are typically driven by gas loads in the winter heating season.
Hedge of fossil fuel prices	• Depending on the approach taken to forecast market prices, this may already be included. For example, natural gas forward prices already contain the risk premium for changes in natural gas prices. Fundamental forecasts based on cost also include the risk premium.
Price effect of demand reduction	• Reduction in total spot market purchase costs attributable to reduction in demand curve. • Depending on the market conditions, the change in wholesale market prices may be large or small.
Savings in water, fuel oil, or other value streams	• Depending on region and the types of programs, additional avoided cost streams may be included.

National Action Plan for Energy Efficiency (2007). *Guide to Resource Planning with Energy Efficiency*. Prepared by Snuller Price et al., Energy and Environmental Economic, Inc.

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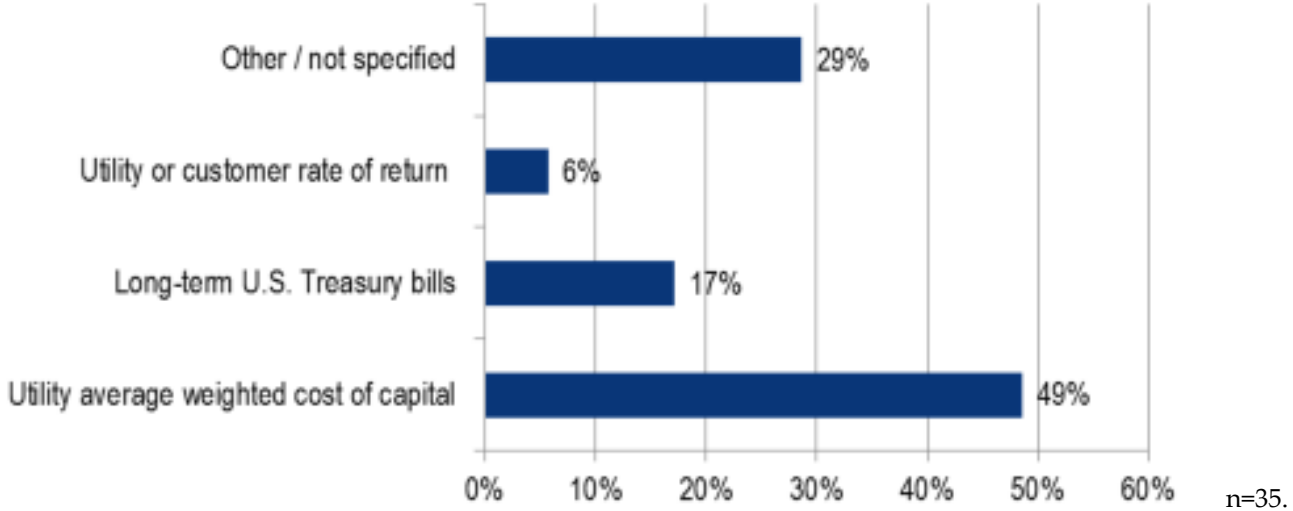
Discount Rate

» Discount rate determines the extent to which the present value of a cost or benefit decreases over time when calculating net present value (NPV).

» The literature identifies use of a social discount rate as a best practice for the SCT.

– Social Discount Rate is lower than rates assumed for private investments because it accounts for the reduced risk of an investment that is spread across all of society.

Basis for setting discount rates used in primary cost-effectiveness tests



n=35.

Source: Kushler M., et al. 2012. A National Survey of State Policies and Practices for the Evaluation of Ratepayer-Funded Energy Efficiency Programs. ACEEE.

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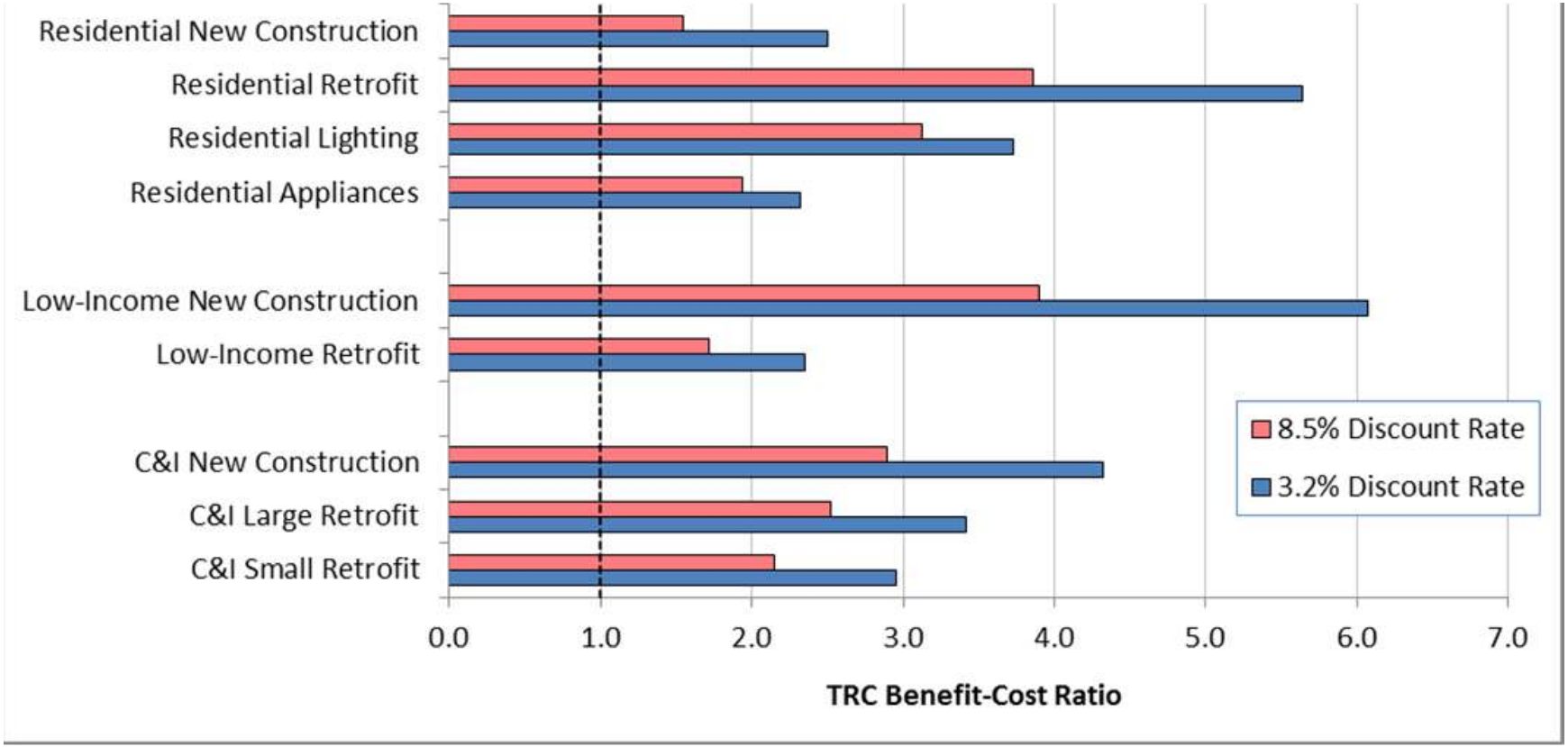
Discount Rate

» Selection of discount rate significantly affects outcomes of analysis.

Variation in cost-effectiveness with use of different discount rates



Source: Woolf, et al. 2012. Best Practices in Energy-Efficiency Program Screening: How to Ensure that the Value of Energy-Efficiency is Properly Accounted For. National Home Performance Council

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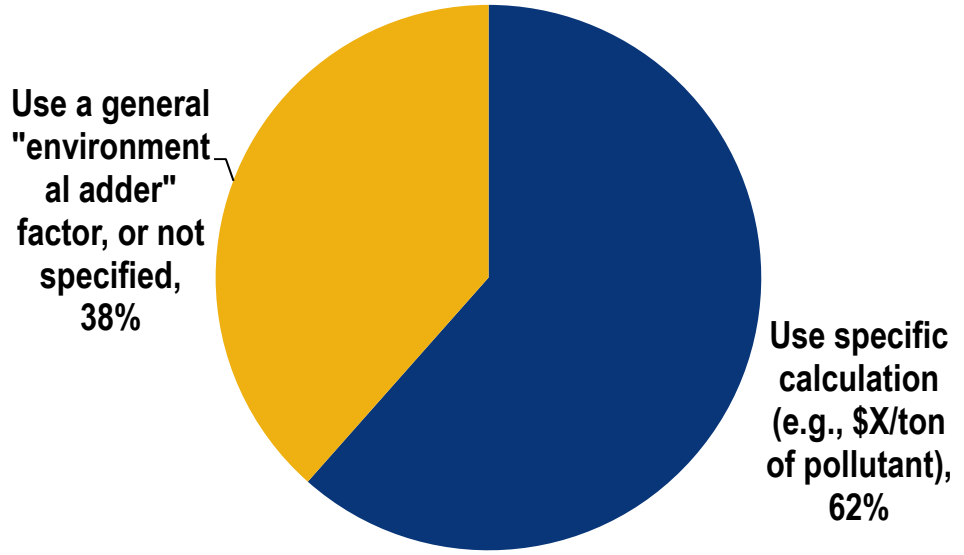
Externalities and Non-Energy Benefits

- Externalities: Impacts not captured by the market system, such as:
  - Avoided environmental damage;
  - Job creation;
  - Improved system reliability;
  - National security.
- Non-Energy Benefits / Impacts:
  - 12 states factor NEIs into primary CE test calculation.
  - When considering from the perspective of the participant, they may include:
    - reduced cooling and heating loads,
    - reduced equipment O&M,
    - improved lighting quality,
    - comfort and productivity,
    - improved property values, and
    - reduced tenant turnover.

Method for quantifying environmental externalities



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Source: Kushler M., et al. 2012. A National Survey of State Policies and Practices for the Evaluation of Ratepayer-Funded Energy Efficiency Programs. ACEEE.

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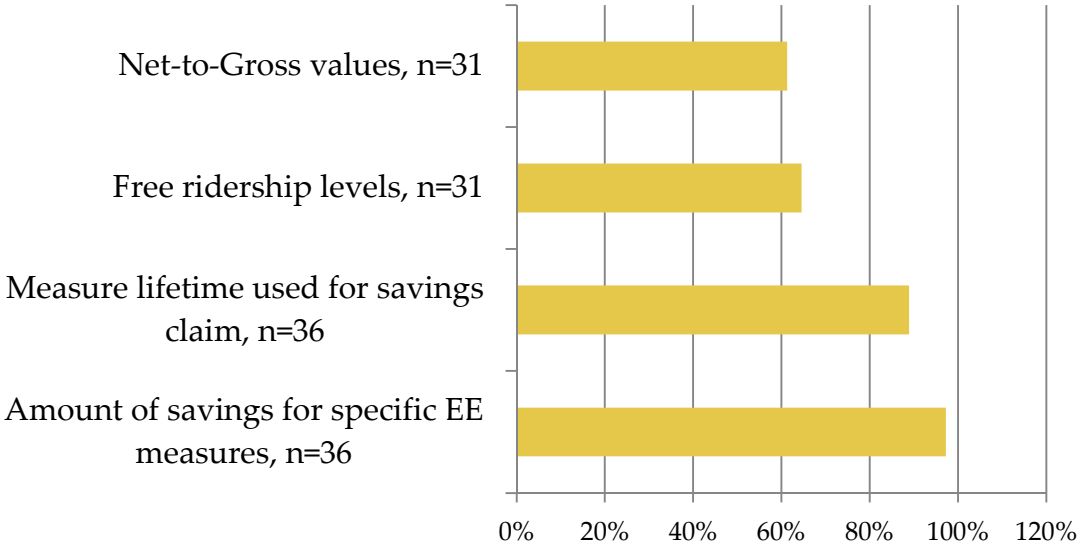
Other Factors to Consider

- Net-to-Gross Ratio: 1 – free ridership + spillover
  - Methods for estimating free ridership and spillover are inherently imprecise. However, fifty percent of states in ACEEE study report using net savings.
  - There are inconsistencies in how some states calculate net savings.
  - Some states (Maine, Minnesota) calculate free ridership but not spillover, producing skewed results.
- Use of Deemed Savings Values vs. Participant Data to Estimate Savings

States using "deemed" values for key variables



Source: Kushler M., et al. 2012. A National Survey of State Policies and Practices for the Evaluation of Ratepayer-Funded Energy Efficiency Programs. ACEEE.

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Other Factors to Consider

- Prospective v. Retrospective Application of Evaluation Results to Program Savings-Related Input Variables
  - 81 percent of states apply results prospectively,
  - 16 percent apply retrospectively,
  - 3 percent apply retrospectively for some purposes, and prospectively for others.
- Allocation of Indirect Administrative Costs (e.g., EM&V, broad awareness, IT)
  - Typically allocated at the portfolio level.
- Life of Measures
  - Use of a longer measure lifetime results in greater measured savings.
- Defining Incremental Cost of Measures
  - Assessing the cost of the efficiency measure relative to a baseline condition involves gathering data on participant-specific circumstances (e.g., whether it was a failure replacement, an early replacement, etc.)
- Interdependence of EE and RPS
  - If the marginal cost of complying with RPS is higher than avoided energy costs, acquiring EE resources can help reduce RPS compliance costs.

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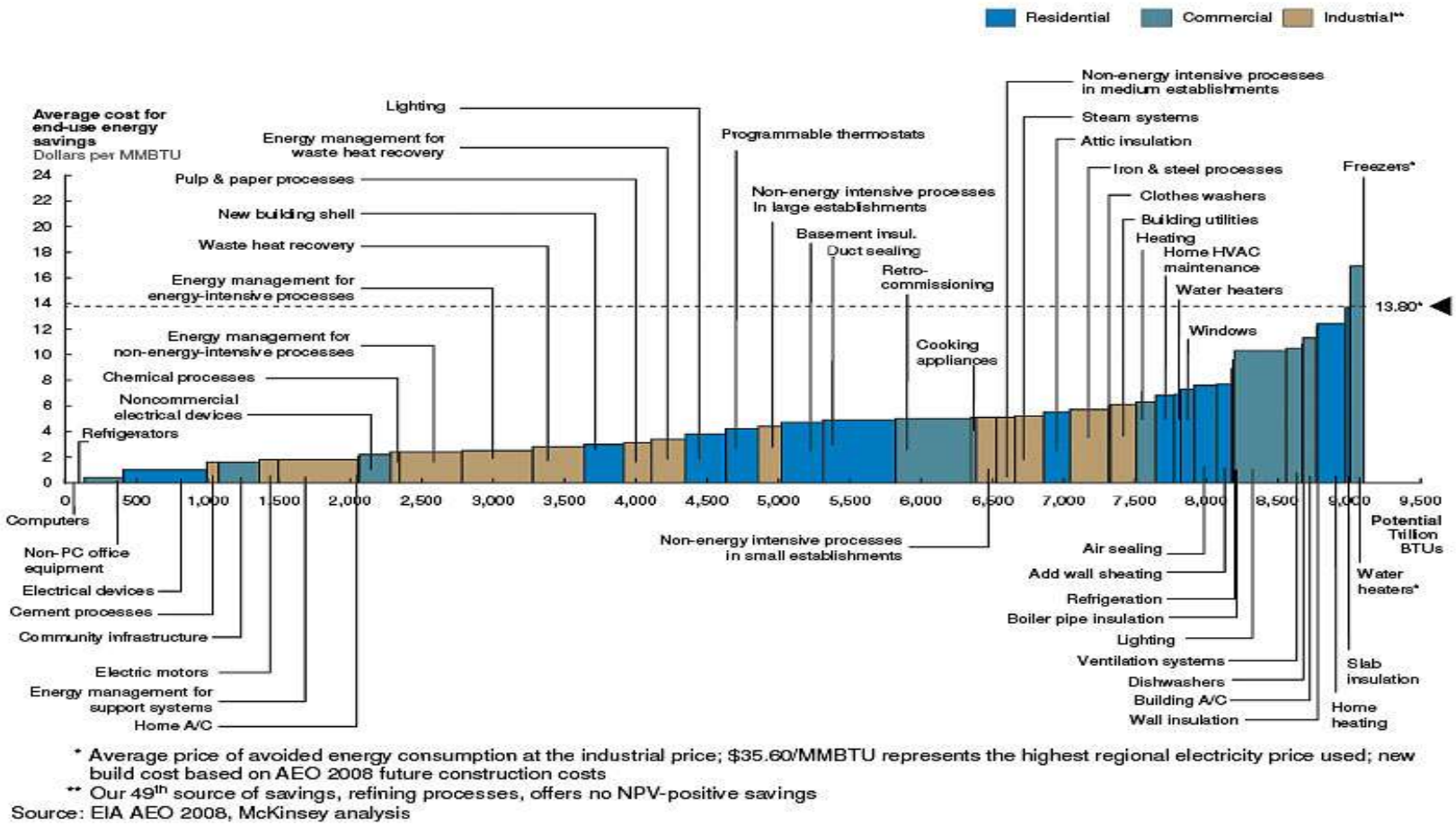
Evaluating EE as a Resource

EE Supply Curve



* Average price of avoided energy consumption at the industrial price; $35.60/MMBTU represents the highest regional electricity price used; new build cost based on AEO 2008 future construction costs

** Our 49th source of savings, refining processes, offers no NPV-positive savings

Source: EIA AEO 2008, McKinsey analysis

Source: EIA AEO 2008; McKinsey analysis.

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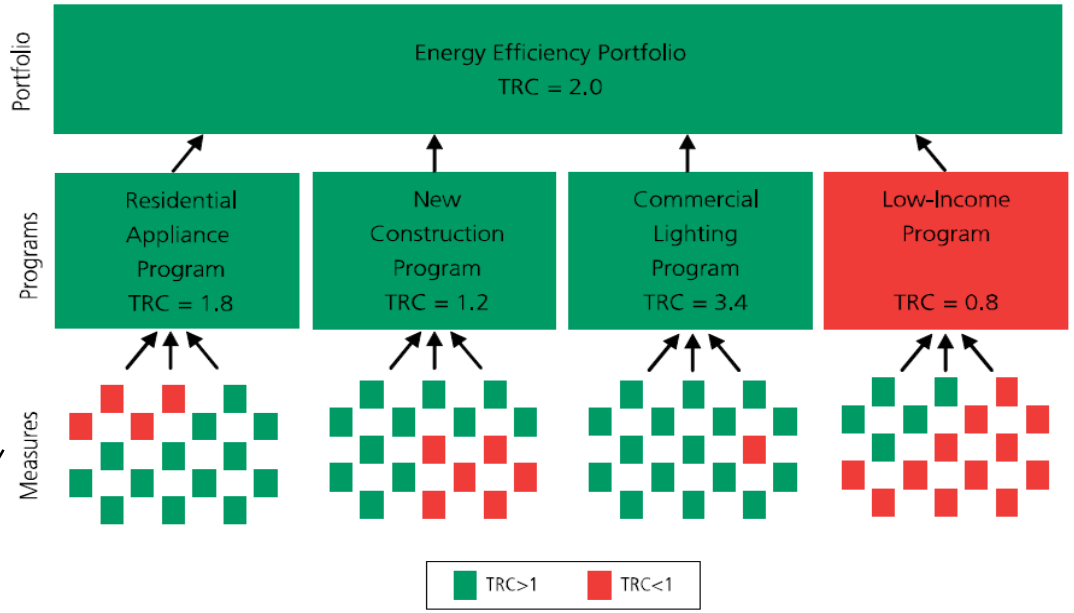
At what level should energy investments be screened?

Power plant?

Turbine?

Component Parts?

- A power plant investment is typically evaluated based on the CE of the overall investment – not at the component level.
- Should EE investments be considered at the "component" level?



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Conclusions

- A variety of cost-effectiveness tests are available. Each looks at cost-effectiveness from a different perspective.
- Selection of test, and decisions about test inputs should reflect public policy goals (e.g., if goal to recognize the value of environmental externalities, use SCT).
- Current best practice nationally is to use TRC applied at the program and/or portfolio level.
- Decisions about which test and inputs to use, and how to measure those inputs can significantly affect the amount of EE potential that is tapped.
- It is recognized in many jurisdictions that EE is often the least cost resource, and equitable CE analyses are needed to assess this resource as compared to other resource options

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