



Regulatory
Training
Initiative

Benefit-Cost Analysis of Distributed Energy Resources

RTI On-Line Training Day 1

May 3-5, 2022

Topics we will cover over next 3 days

DAY 1 – focus for today

- What and why is a benefit-cost analysis (BCA)?
- Key categories and inputs to BCA
- Foundational BCA principles and using a BCA framework

DAY 2

- Developing a primary cost-effectiveness test for BCA
- BCA across different types of DERs
- Presenting BCA results

DAY 3

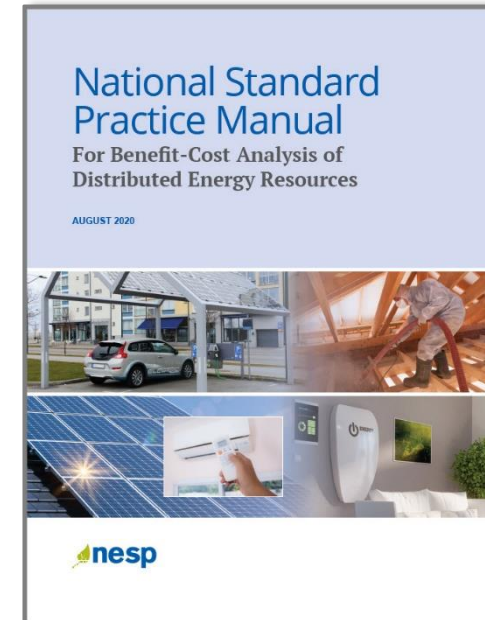
- How does BCA differ from rate and bill impact analyses?
- Accounting for energy equity in BCA and distributional equity analyses
- Key steps to quantifying impact values for a BCA

Key Sources of Information Used for Training

National Standard Practice Manual for Benefit Cost Analysis of Distributed Energy Resources ('NSPM for DERs' or just 'NSPM')

Developed by [National Energy Screening Project](#) (NESP) in 2020

- NSPM builds on the California Standard Practice Manual (CaSPM) developed in 1983, updated 2001
- CaSPM focuses on EE, NSPM addresses all DERs
- See NESP website for examples of states that have or are actively applying NSPM BCA framework



What is a Benefit-Cost Analysis (and why do we conduct BCAs)?

General Example Applications of Benefit-Cost Analysis

- Investment Decisions.
Investopedia: <https://www.investopedia.com/terms/c/cost-benefitanalysis.asp>
- General Business Decisions.
Harvard Business School Online: <https://online.hbs.edu/blog/post/cost-benefit-analysis>
- Epidemiological Decisions.
Science Direct: BCA & Epidemiology:
<https://www.sciencedirect.com/topics/psychology/cost-benefit-analysis>
- Disaster Prevention Decisions.
FEMA Mitigation Projects: <https://www.sciencedirect.com/topics/psychology/cost-benefit-analysis>



Background on Benefit-Cost Analysis

- **Benefit-cost analysis (BCA)** – referred to also as cost-benefit analysis (CBA). An economic tool used to compare the benefits versus costs of a ‘project’ investment
- **1936 Flood Control Act** - considered ‘beginning of BCA’ in the US, addressing investments in water resource public works programs: “if the benefits to whomsoever they may accrue are in excess of the estimated costs...”
- **Today**, BCA used in many industries and applications such as federal agencies (OMB, FEMA), state government, businesses, utility industry, etc.



What is a Benefit-Cost Analysis?

- A systematic approach for assessing the cost-effectiveness of investments by *comparing the benefits and costs of alternative options*:
 - One *without* the proposed DERs ('baseline or reference' case) and one *with* the proposed DERs ('DER' case)
 - Over the life of the resource/DER being proposed

Benefit-Cost Ratio (BCR):

- If benefits \geq costs, i.e., $BCR \geq 1.0$, then investment is typically considered to be **cost-effective**
- If benefits $<$ costs, i.e., $BCR < 1.0$, then investment is typically considered to be **not cost-effective**

$$\text{Benefit-Cost Ratio} = \frac{\text{NPV } \sum \text{ benefits (dollars)}}{\text{NPV } \sum \text{ costs (dollars)}}$$



- Discount rates – used to calculate the value stream of benefits and costs of a DER investment over time to the Present Value (PV)
 - Depending on discount rate level, greater value is placed on earlier years vs later years, or vice versa

Let's first review some key terms...

'Benefit-cost analysis' (BCA) vs 'cost-effectiveness testing' ('CE' testing) – often but not always used interchangeably.

- For this training we use them interchangeably

Benefits and costs together are referred to as 'impacts'

DERs = distributed energy resources. Includes energy efficiency, demand response, distributed solar, distributed storage, building and transportation electrification

Focus of this training is on assessing cost-effectiveness of DERs

See [NSPM for DERs](#) for list of acronyms and glossary of terms



Time Value of Money and Discounts Rates

- **Real vs nominal dollars:** When conducting a BCA, all monetary amounts must be in comparable units – either all in real dollars or all in nominal (constant) dollars.
 - **Real dollars** take inflation into account, adjusting the value of future benefits and costs to reflect expected inflation.
 - **Nominal (constant) dollars** do not take inflation into account.
- **Present Values (PV)** account for the time preference by discounting a future stream of costs and benefits using a **discount rate**

Time Value of Money: “Removing Time” from the Equation

Compounding: Present to Future

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

$$\textit{Dollar Tomorrow} = \textit{Dollar Today} * (1 + i)^n$$

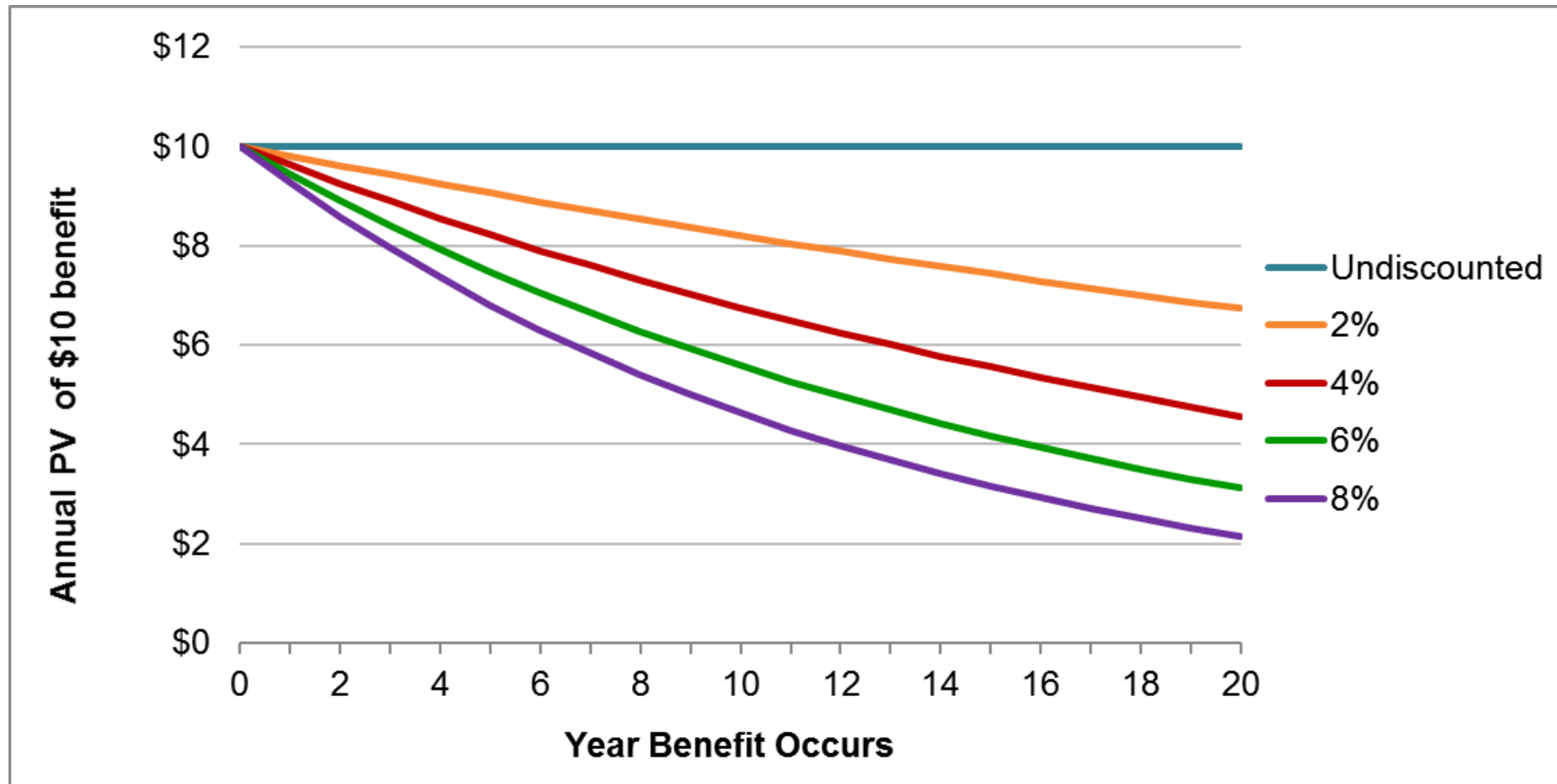
Discounting: Future to Present

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

$$\textit{Dollar Today} = \frac{\textit{Dollar Tomorrow}}{(1 + i)^n}$$



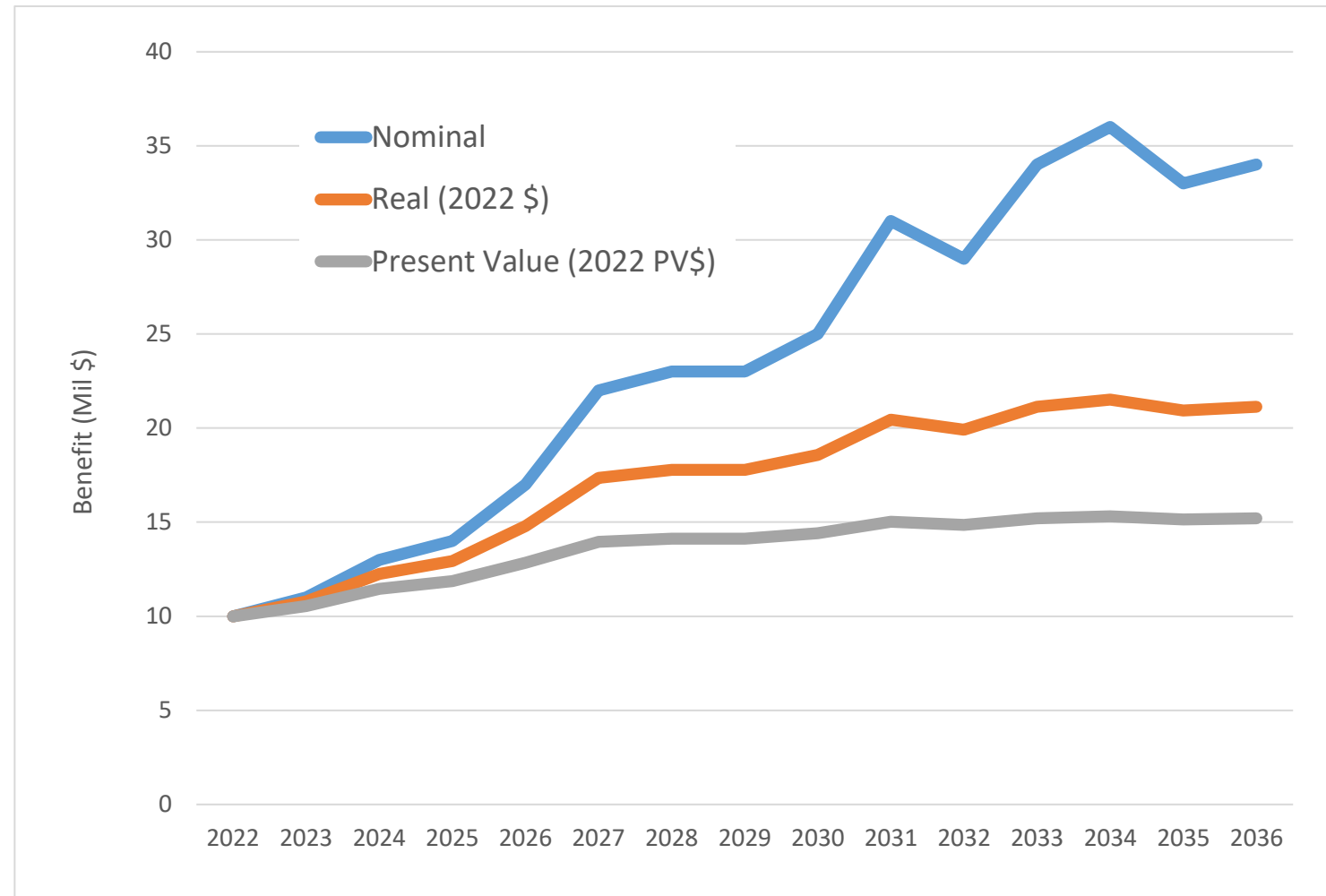
Implications of Different Discount Rates



Nominal, Real, and Present Value Dollars

How time, inflation rate, and discount rate impact estimates

- Nominal values are current values in each year
- Real values account for inflation (or deflation)
- PV discount rate values account for the time preference
- Lower discount rates give greater weight to near-term impacts and higher discount rates give greater weight to long-term impacts
- For analytical ease, real values are best
- To compare streams of values, use PV terms



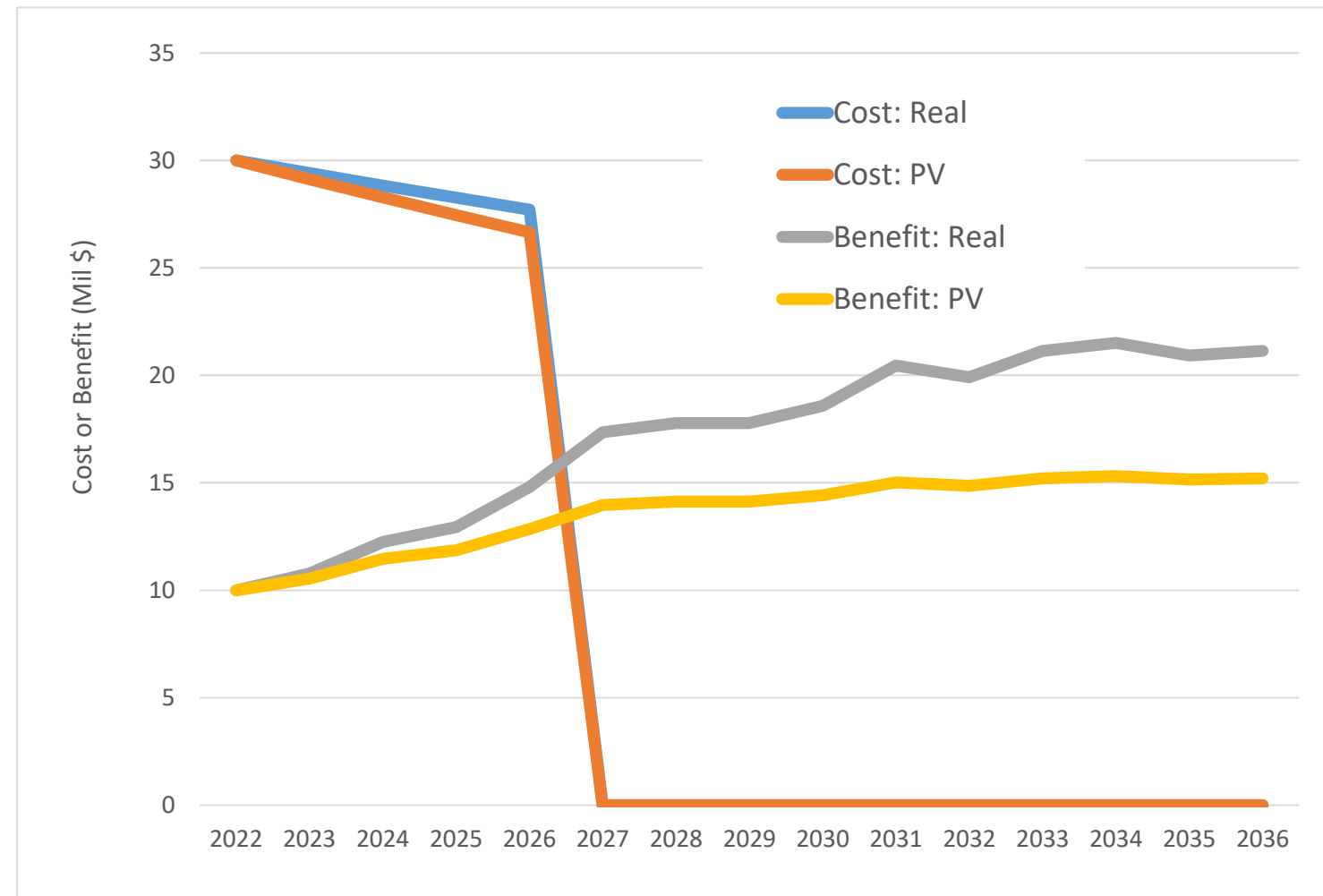
Example uses 2% inflation; 3% PV discount rate

Real and PV Analysis Example

How discount rate higher than inflation impacts costs & benefits

- Assumes costs for first 5 yrs; benefits in all years
- Again, positive PV values give less weight to future benefits and costs
- Cumulative PV of benefits is \$204
- Cumulative PV of costs is \$142
- Net benefits = \$62
- Benefit-Cost Ratio = 1.44
- Program is cost-effective

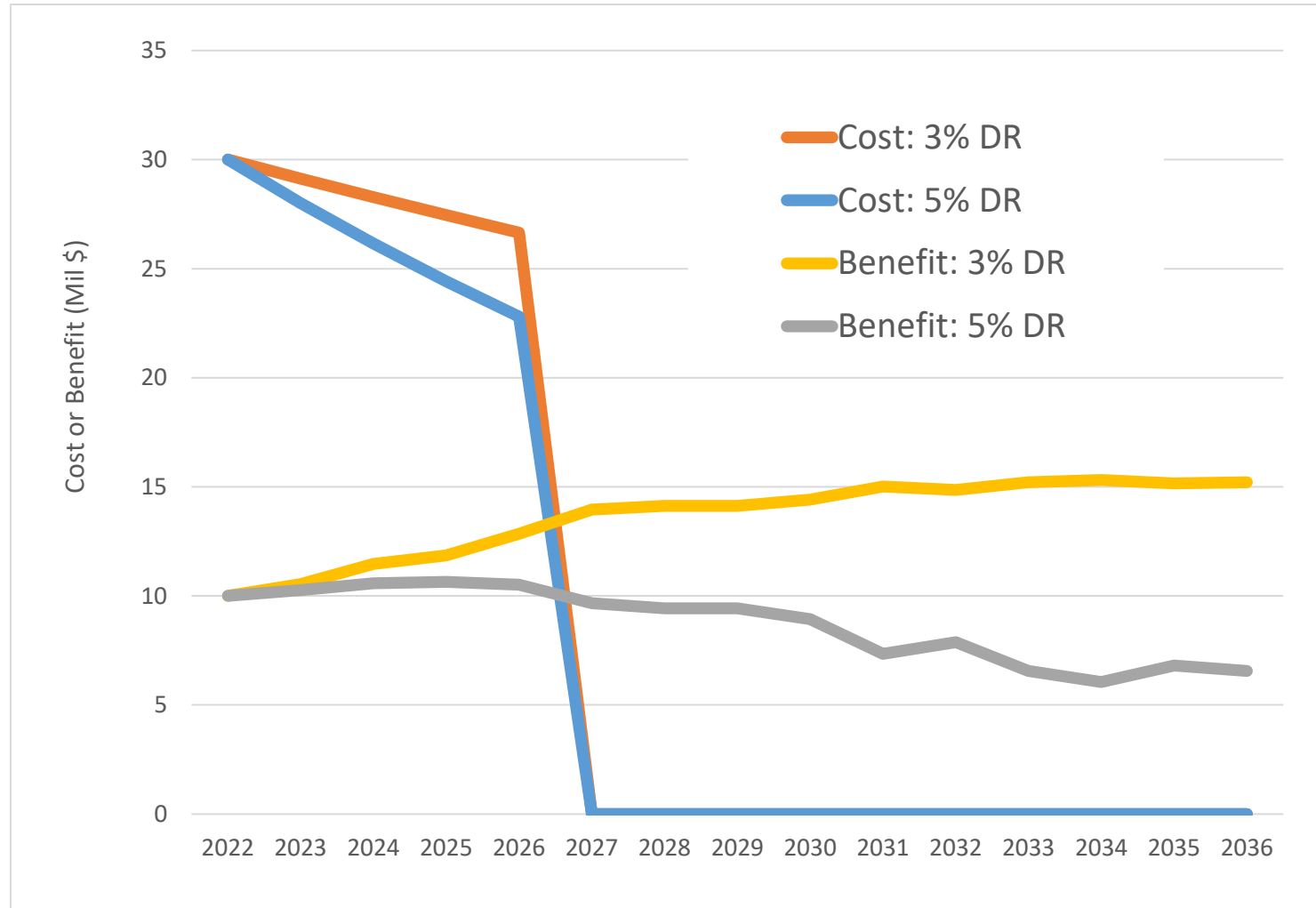
**Example uses 2% inflation;
3% PV discount rate**



PV Analysis with Different Discount Rates Example

How higher discount rates impact value of costs & benefits

- Assumes costs for first 5 yrs; benefits in all years
- Again, positive PV values give less weight to future benefits and costs
- 5% DR (vs 3%) reduces PV of benefits and costs, impacting benefits more than costs since over more years
- At 5% DR (vs 3%), cumulative PV of benefits decreases from \$204 to \$131, costs decreases from \$142 to \$136, with net benefits at = -\$5
- Benefit-Cost Ratio = 0.96
- Program is NOT cost-effective



Example compares 3% vs. 5% PV discount rates

Why BCA in the Context of Different Regulatory Settings?

Context	Application	Goal of BCA	Role of Costs & Benefits
Programs	EE, DR, DG, Storage, EVs	determine whether to implement the program	compare program benefits to costs
Procurement	DERs, NWA, PPA,	determine the ceiling price	ceiling price should equal the benefits of the procurement
Pricing	Rate design	estimate long-run marginal costs	long-run marginal costs should equal the benefits of modifying consumption
	DER compensation	determine the value of DER	value of DER is the sum of benefits
Planning	Optimize DERs	identify optimal DER portfolio	compare portfolio benefits to costs
	DP, IDP, IRP, IGP	identify preferred resource scenario	compare scenario benefits to costs
	GHG plans	achieve GHG goals at low cost	compare GHG plan benefits to costs
	State Energy Plans	identify resources to meet state goals	compare state plan benefits to costs
Infrastructure Investments	Grid Mod, AMI, EV infrastructure, etc.	determine whether to make the investment	compare investment benefits to investment costs
Prudence Reviews	Retrospective review	determine whether past utility decision was appropriate	compare benefits and costs using test in place at the time the decision was made
	Prospective review	determine whether proposed utility decision is appropriate	compare benefits and costs using test currently in place



Poll #1: In what regulatory context is BCA most relevant to your jurisdiction or to your work?

Select multiple from list of options:

- DER Programs
- DER Pricing
- Procurement
- Distribution System Planning
- Integrated Resource Planning
- State Energy Plans
- Infrastructure Investments
- Other

Questions on BCA basics so far?

Beyond BCA Basics...

Next up:

- What do we mean by BCA impacts?
 - Utility System Impacts
 - Host Customer Impacts
 - Societal Impacts

- How does one determine which benefits and costs to include in a jurisdiction's BCA?
 - Foundational BCA Principles



BCA Impact Categories

Utility System Impacts

Electric Utility System Impacts

Type	Utility System Impact
Generation	Energy Generation
	Capacity
	Environmental Compliance
	RPS/CES Compliance
	Market Price Effects
	Ancillary Services
Transmission	Transmission Capacity
	Transmission System Losses
Distribution	Distribution Capacity

Type	Utility System Impact cont.
Distribution	Distribution Capacity
	Distribution System Losses
	Distribution O&M
	Distribution Voltage
General	Financial Incentives
	Program Administration
	Utility Performance Incentives
	Credit and Collection
	Risk
	Reliability
	Resilience



Gas Utility System

Type	Gas Utility System
Energy/Supply	Fuel and Variable O&M
	Capacity (e.g., local storage)
	Environmental compliance
	Market price effects
Transportation	Pipeline capacity
	Pipeline losses
Delivery	Local delivery capacity
	Local delivery line losses
	Local delivery O&M
General	Financial incentives
	Program admin costs
	Performance incentives
	Credit and collection costs
	Risk, reliability, resilience

These are the utility system impacts to account for when a gas utility is implementing the DERs being evaluated in a BCA.



Host Customer Impacts

Host Customer Impacts – Key Examples

Host Customer Impact
Host portion of DER costs
Interconnection fees
Risk
Reliability
Resilience
Tax incentives
Non-energy Impacts (NEIs)



Breakout of Host Customer Non-Energy Impacts (NEIs)

Host Customer NEI
Transaction costs
Asset value
Productivity
Economic well-being
Comfort
Health & safety
Empowerment & control
Satisfaction & pride
Reduced Utility Bills*

*Depends on test perspective

Societal Impacts

Societal Impacts - Examples

Type	Societal Impact	Description
Societal	Resilience	Resilience impacts beyond those experienced by utilities or host customers
	GHG Emissions	GHG emissions created by fossil-fueled energy resources
	Other Environmental	Other air emissions, solid waste, land, water, and other environmental impacts
	Economic and Jobs	Incremental economic development and job impacts
	Public Health	Health impacts, medical costs, and productivity affected by health
	Low Income/Vulnerable Populations: Society	Poverty alleviation, environmental justice, reduced home foreclosures, etc.
	Energy Security	Energy imports and energy independence



Other Fuel Impacts

Other Fuel Impacts

For DERs implemented by **electric utilities**, other fuels include:

- **Gas** utility system impacts
- Oil, propane, wood, gasoline, etc.

For DERs implemented by **gas utilities**, other fuels include:

- **Electric** utility system impacts
- Oil, propane, wood, gasoline, etc.

Other fuels should be included in the primary BCA test if dictated by policy goals.

Type	Impacts
Oil, Propane, Wood, Gasoline	Fuel and O&M
	Delivery Costs
	Environmental Compliance
	Market Price Effects

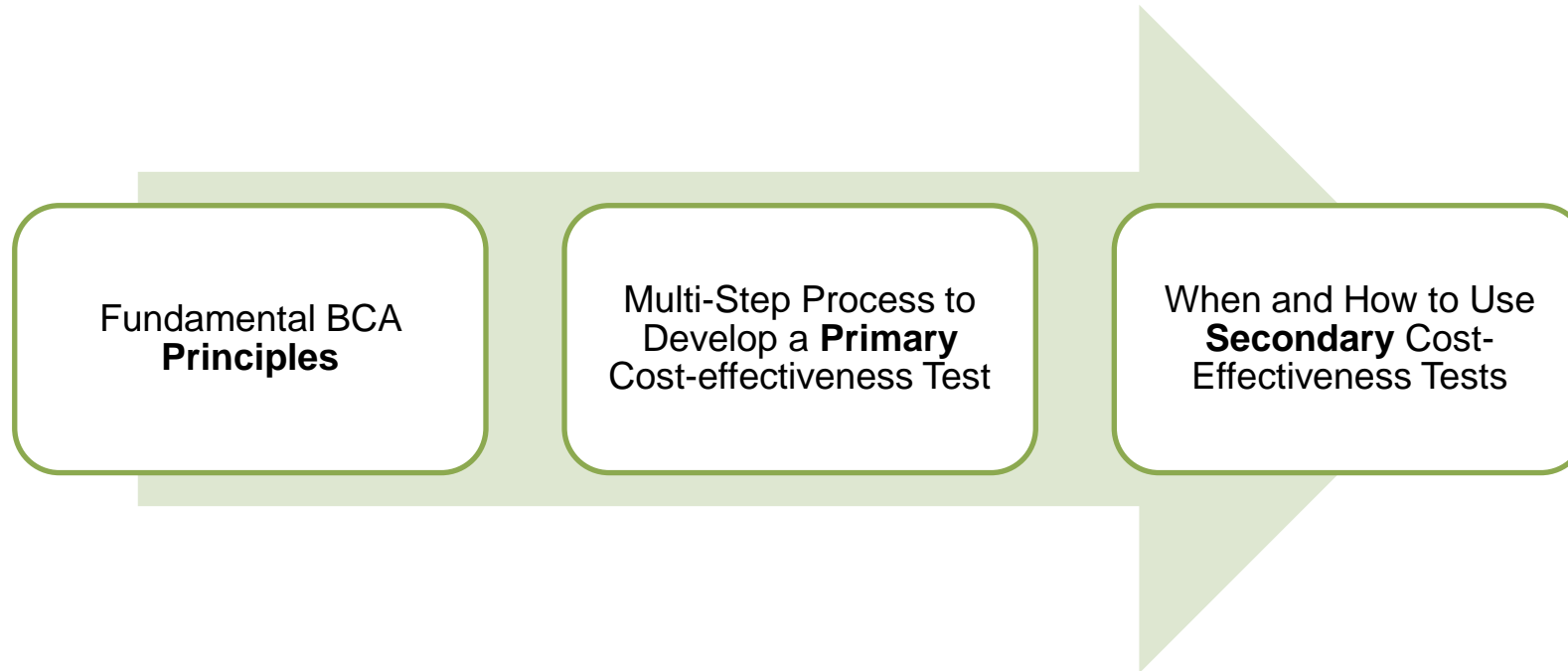
Poll #2: In what categories do you think the following impacts belong?

Select all that apply

	Host customer	Utility	Societal	It Depends
Demand Flexibility	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Resilience	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Energy equity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Questions on BCA Impact Categories

BCA Framework



Together, the above framework components can guide development of (or modification to) primary cost-effectiveness tests, and selection of any secondary tests.

Fundamental BCA Principles

1. Recognize that DERs can provide energy/power system needs and should be compared with other energy resources and treated consistently for BCA.
2. Align cost-effectiveness test with jurisdiction's applicable policy goals.
3. Ensure symmetry across costs and benefits.
4. Account for all relevant, material impacts (based on applicable policies), even if hard to quantify.
5. Conduct a forward-looking, long-term analysis that captures incremental impacts of DER investments.
6. Avoid double-counting through clearly defined impacts.
7. Ensure transparency in presenting the benefit-cost analysis and results.
8. Conduct BCA separate from Rate Impact Analyses because they answer different questions.



Principle #1: Why Consistency in BCA across DERs?

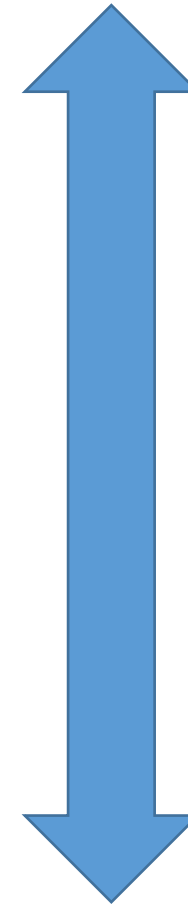
- Consistent BCA framework reduces risk of either over or under-investing in a resource (or combination thereof)
- Siloed approach to valuing different DERs can be complex and overwhelming for commissions, utilities, and stakeholders
- Allows for comparison and prioritizing of DER investment options and strategies to answer questions such as:
 - *How cost-effective is one DER type relative to another type?*
 - *How to evaluate a program that includes multiple DER types, e.g., NWAs, NPAs, grid-integrated efficient buildings.*
 - *How to optimize across multiple types of DERs.*
- Opportunity/challenge: ‘Connecting the dots’ across different regulatory contexts and planning continuum



The Planning Continuum

(and why BCA consistency matters)

- Bulk Power System Planning
 - integrated resource planning
 - ISO/RTO planning
 - transmission planning
- Distribution Planning
 - distribution reliability
 - grid modernization
 - non-wires alternatives
 - BCA and LCBF
- DER Assessment and Planning
 - BCA of DERs



Consistent BCA principles and concepts should be applied across all of these, especially where utilities are expected to conduct integrated planning.

See NASEO/NARUC Task Force on Comprehensive Electricity Planning for current efforts to better integrate all these: <https://www.naruc.org/taskforce/>

Principle #2: Articulate Policy Goals

Example Goals: as articulated in statute, regulations, decisions, etc.

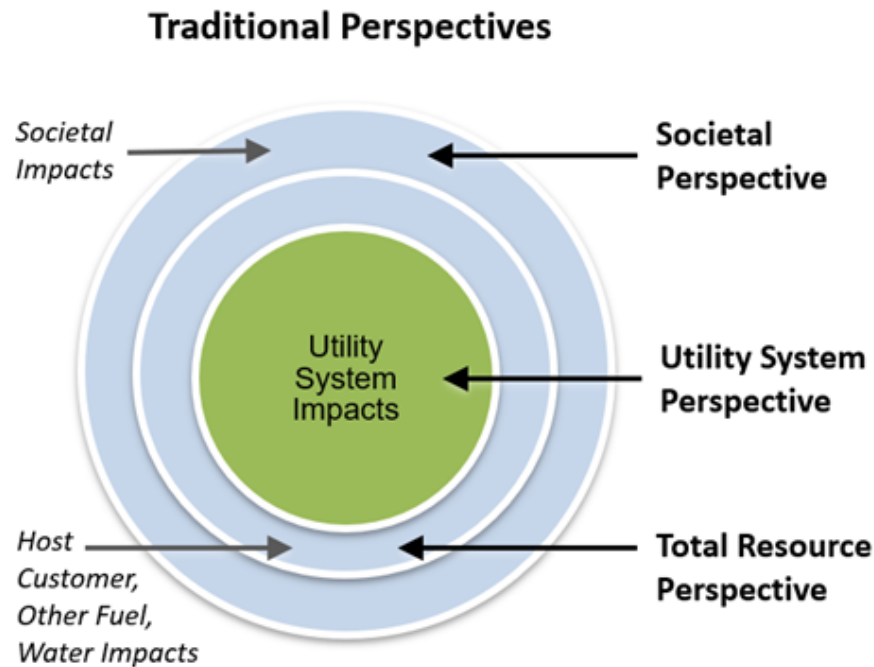
Common Overarching Goals: Provide safe, reliable, reasonably priced electricity and gas services; support fair and equitable economic returns for utilities; promote customer equity; protect/reduce energy burden for low-income and vulnerable customers.

Resource Goals: Reduce electricity and gas system costs; develop least-cost energy resources; improve system reliability and resiliency; reduce system risk; promote resource diversity; increase energy independence; reduce price volatility; provide demand flexibility.

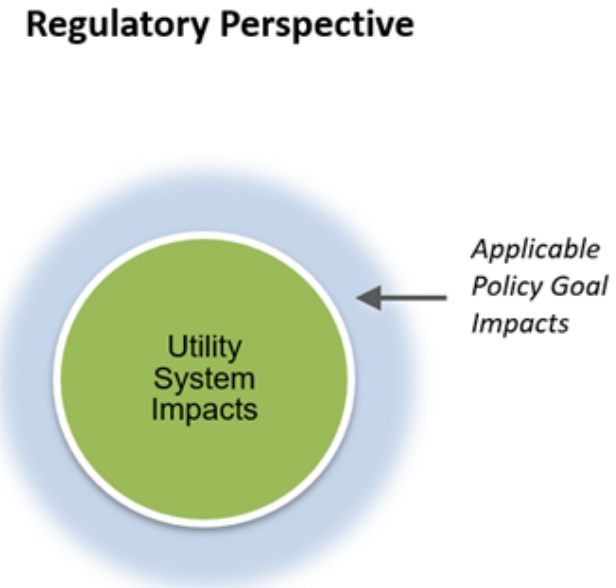
Other Applicable Goals: Ensure stable energy markets; reduce environmental impact of energy consumption; promote jobs and local economic development; improve health associated with reduced air emissions and better indoor air quality.



Principle #2 – Aligning Cost-Effectiveness Test Perspective with Applicable Policy Goals



- Three perspectives define the scope of impacts to include in the most common traditional cost-effectiveness tests.



- Perspective of public utility commissions, legislators, muni/coop boards, public power authorities, and other relevant decision-makers.
- Accounts for utility system plus impacts relevant to a jurisdiction's applicable policy goals (which may or may not include host customer impacts).
- Can align with one of the traditional test perspectives, but not necessarily.

Traditional Cost-Effectiveness Tests

- Utility Cost Test
 - aka Program Administrator Cost Test
 - Total Resource Cost Test
 - Societal Cost Test
 - Participant Test
 - Ratepayer Impact Test
- Primary Tests Used in Most States
- ← Only used to inform program design
- ← Not a cost-effectiveness test; rather a test of equity between participants and non-participants

Regulatory Perspective → Jurisdiction Specific Test (JST)

Test	Perspective	Key Question Answered	Categories of Benefits and Costs Included
Jurisdiction-Specific Test	Regulators or decision-makers	Will the cost of meeting utility system needs, <i>while achieving applicable policy goals</i> , be reduced?	Utility system impacts, and other impacts (host customer and/or societal) associated with achieving applicable policy goals
Utility Cost Test*	The utility system	Will utility system costs be reduced?	Utility system impacts
Total Resource Cost Test	The utility system plus host customers	Will utility system costs and host customers' costs collectively be reduced?	Utility system impacts, and host customer impacts
Societal Cost	Society as a whole	Will total costs to society be reduced?	Utility system impacts, host customer impacts, and societal impacts (e.g., environmental, economic development, public health impacts, etc.)

*Also referred to as Program Administrator Cost Test (PACT)



Principle #3: Ensure Symmetry of Benefits & Costs

Illustrative Example: Treatment of Host Customer Costs and Benefits

Costs and Benefits	Asymmetry	Symmetry	
	A. Host Customer Costs Included , Benefits Excluded	B. Host Customer Costs and Benefits Both Included	C. Host Customer Costs and Benefits Both Excluded
DER Costs			
Utility System Costs:			
- Rebate/Incentive	\$1,875	\$1,875	\$1,875
- Administrative Costs	\$1,500	\$1,500	\$1,500
Host Customer Costs:	\$5,625	\$5,625	not included
Total Costs Accounted for:	\$9,000	\$9,000	\$3,375
DER Benefits			
Utility System Avoided Costs	\$6,000	\$6,000	\$6,000
Host Customer Non-Energy Benefits	not included	\$4,000	not included
Total Benefits Accounted for:	\$6,000	\$10,000	\$6,000
Net Benefit/Cost	(\$3,000)	\$1,000	\$2,625
Benefit-Cost Ratio (BCR):	0.67	1.11	1.78
Treatment of Host Customer Impacts	X Asymmetrical	✓ Symmetrical	✓ Symmetrical



Principle #4: Account for All *Relevant* Impacts

Even if hard to quantify – Consider range of methodological options

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.

* NSPM Companion Guidance: [Methods, Tools & Resources - A Handbook for Quantifying DER Impacts for BCA \(March 2022\)](#)



Principle #5: Conduct Incremental, Forward-looking BCA

- Incremental: What would have occurred relative to baseline (reference) case
 - Has implications for avoided costs.
- Forward looking: Sunk costs and benefits are not relevant
 - Why the 'rate impact measure' (RIM) test is not a “cost-effectiveness test”
 - Lost / gained revenues (and bill impacts to customers) are important but *not* relevant to BCA (more on this later)
- Long-term: Should capture full lifecycle costs and benefits of DER(s) .
 - Has implications for the length of the study period

Principle #6: Avoid Double Counting of any Impacts

Examples:

- Utility system risk impacts might overlap with other utility system impacts, e.g., avoided generation costs
- Costs for complying with environmental regulations may overlap with societal environmental costs
- Public health impacts may overlap with either host customer health and safety impacts or societal environmental costs

Principle #7: Establish Comprehensive, Transparent Documentation

- Use transparent process involving all interested stakeholders to inform jurisdiction's BCA practices: development of test(s) and inputs
- 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
 - Flexibility needed to incorporate evolution of policies over time
- Review of policy goals may require consultation with other government agencies (environmental agency, transportation commission, health and human services, etc.)



Principle #8: Conduct BCA Separately from Rate Impact Analysis

The two analyses answer different questions

	Benefit-Cost Analysis	Rate Impact Analysis
Purpose	To identify which DERs utilities should invest in or otherwise support on behalf of their customers	To identify how DERs will affect rates, in order to assess equity concerns
Questions Answered	What are the future costs and benefits of DERs?	Will customer rates increase or decrease, and by how much?
Results Presented	<ul style="list-style-type: none">• Cumulative costs (PV\$)• Cumulative benefits (PV\$)• Cumulative net benefits (PV\$)• Benefit-cost ratios	<ul style="list-style-type: none">• Rate impacts (c/kWh, %)• Bill impacts (\$/month, %)• Participation rates (#, %)

The Rate Impact Measure (RIM) Test is sometimes used for BCA purposes. However, it combines the two analyses and therefore makes it difficult to answer either question



Poll #3: Which of the following is consistent with the foundational BCA principles we just reviewed?

Select one for each of the following:

	YES	NO	NOT SURE
■ If an impact is relevant but hard to quantify, it can be omitted from the BCA if considered to be immaterial.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
■ A jurisdiction's primary cost-effectiveness test should align with its applicable policy goals.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
■ BCAs should account for any lost or gained revenues as a utility system impact.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
■ Investments in energy resources should be based using a consistent primary cost-effectiveness test.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Questions on BCA Principles

Defining the Primary BCA Test



A Primary Test answers the question:

Which resources have benefits that exceed costs and therefore merit potential utility acquisition or support on behalf of their customers?

Developing a Primary CE Test – Overview

(this will be focus for Day 2 session)

STEP 1 **Articulate Applicable Policy Goals**

STEP 2 **Include All Utility System Impacts**

STEP 3 **Decide Which Non-Utility System Impacts to Include**

STEP 4 **Ensure that Benefits and Costs are Properly Addressed**

STEP 5 **Establish Comprehensive, Transparent Documentation**

Use of Secondary Tests

While a jurisdiction's primary cost-effectiveness test informs whether a utility DER investment has benefits greater than costs, secondary tests can help to:

- Address situations where there are inconsistent policy goals across different DER types
- Address DERs that are marginally cost-effective
- Assess implications of achieving policy goals

Example: Societal discount rate in primary test; utility discount rate (WACC) in secondary test.

Recap of the Day

Key take aways from today:

1. Purpose of BCA
2. Use of discount rates
3. Overview of benefits and costs for different impact categories
4. Foundational BCA Principles and why they matter
5. Differentiating between purpose of primary and secondary cost-effectiveness tests

Questions & Discussion

