Cost-Effectiveness Evaluation

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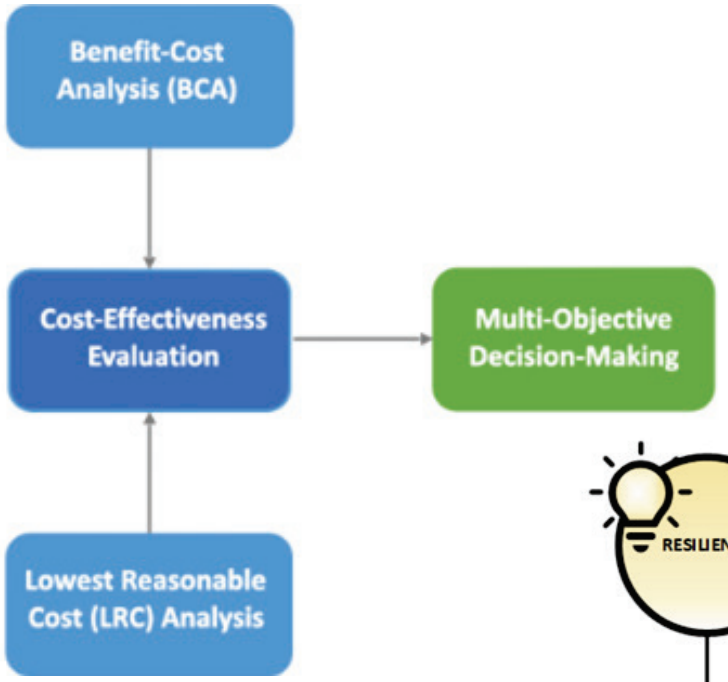
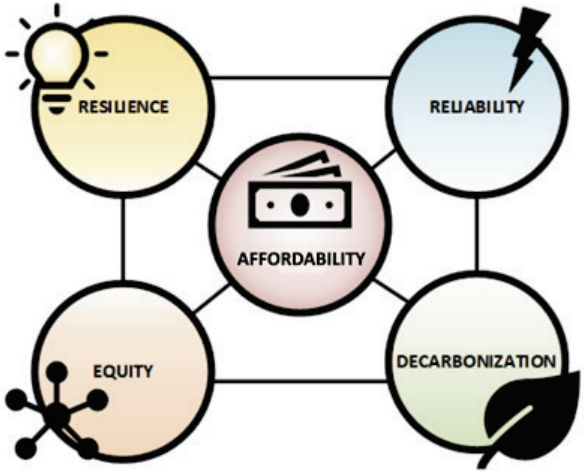
Cost-Effectiveness Evaluation

- Cost-effectiveness evaluation assesses the benefits and costs of utility decisions – along with qualitative factors – to determine an optimal course of action
  - Used to demonstrate that proposed grid investments and programs are reasonable and merit cost-recovery
- Two key approaches*
  1. *Benefit-Cost Analysis* (BCA) is a quantitatively focused method for monetizing benefits and costs of an investment over a period of time
  2. *Lowest Reasonable Cost* analysis focuses on need for the investment and quantitative and qualitative assessment of benefits and costs
- *Multi-objective decision-making* is a set of methods for analyzing investment decisions to maximize value across various objectives





*Optimized modeling can be used for some investments (e.g., resources in Integrated Resource Planning)

Poll

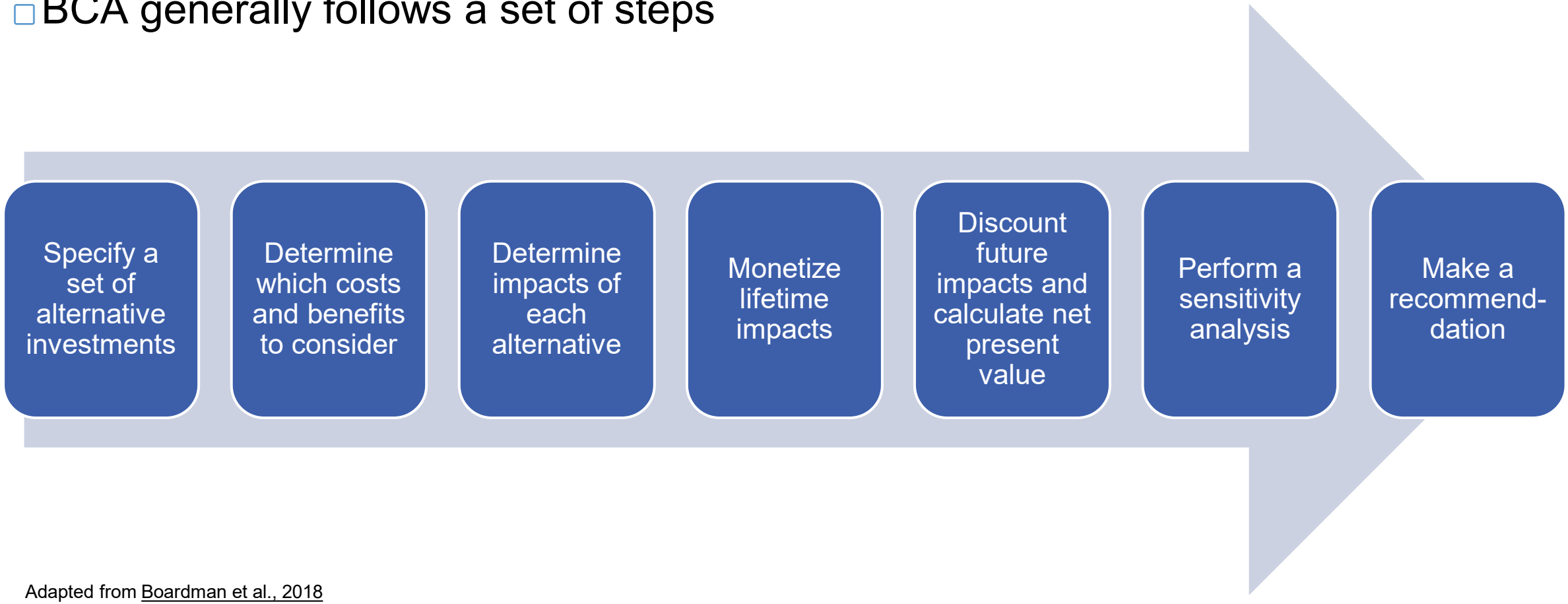
Which U.S. president first mandated BCA for federal regulatory impact analysis by signing an Executive Order that stated: “regulatory action shall not be undertaken unless the potential benefits to society from the regulation outweigh the potential costs to society.”

1. Ronald Reagan in 1981
2. Richard Nixon in 1972
3. Bill Clinton in 1993
4. George W. Bush in 2001

Benefit-Cost Analysis

Steps of Benefit-Cost Analysis

- BCA generally follows a set of steps



Adapted from Boardman et al., 2018

Specify a Set of Alternative Investments

- Determine the set of alternatives to analyze, including one “status quo” option which would be displaced if an alternative were selected to proceed
  - If status quo is not feasible, alternatives should be compared against each other
- Determine the timeline of the analysis based on the set of alternatives
  - How far into the future will the alternatives provide benefits?

Determine Costs and Benefits to Consider

- Which perspective is most important for the analysis?
- Five principal cost-effectiveness tests for demand-side management programs
  - Tests illustrate different perspectives
  - Some of the tests can be used for grid investments (e.g., NY)

Test	Perspective	Question
Societal Cost Test (SCT)	The utility system and society as a whole	Will total costs to society decrease?
Total Resource Cost Test (TRC)	The utility system plus participating customers	Will the sum of utility costs and program participants' costs decrease?
Utility Cost Test (UCT) / Program Administrator Cost (PAC)	The utility system	Will utility costs decrease?
Participant Cost Test (PCT)	Program participants	Will program participants' costs decrease?
Ratepayer Impact Measure (RIM)	Rates	Will utility rates decrease?

Source: National Standard Practice Manual For Benefit-Cost Analysis of Distributed Energy Resources, 2020; California Standard Practice Manual, 2001

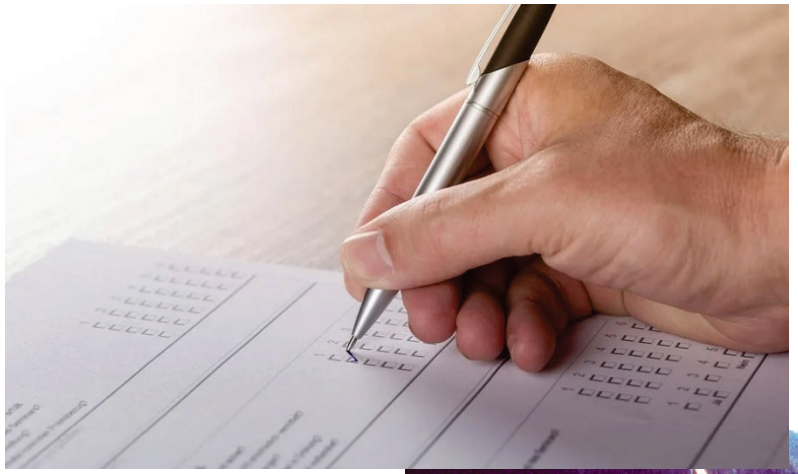
Determine Impacts of Each Alternative

- Estimate the impacts of each alternative – relative to the status quo
- Determine measurement indicators to represent the impacts – for example:

	Utility System Perspective	Societal Perspective
Demand-side management program	Avoided energy generation (MWh) Avoided T&D capacity (MW)	Avoided greenhouse gas emissions (tons CO^2e)
Grid investment	Avoided truck rolls Avoided customer calls	Avoided outage minutes Avoided fatalities

Monetize Lifetime Impacts – Methods

- Convert impacts (measurement indicators) to dollars for each year throughout the project lifespan
- Utility avoided costs can be estimated using budget figures or outputs from the utility's cost of service study
- Societal avoided costs are often based on non-market valuation methods, which estimate the value of goods and services not bought and sold directly (e.g., value of reliability to customers)
  - *Stated preference studies* use surveys to elicit willingness to pay for value of these goods and services
  - *Revealed preference methods* infer the value of these goods and services from other market decisions that people make



Monetize Lifetime Impacts – Examples

Demand-side management program

Utility System Perspective

- Avoided energy generation (MWh)
  Market prices
- Avoided T&D capacity (MW)
  Calculated savings from deferring or avoiding upgrades

Societal Perspective

- Avoided greenhouse gas emissions (tons CO^2e)
  Social cost of greenhouse gases[1]

Grid investment

Utility System Perspective

- Avoided truck rolls
  Estimate from utility cost data
- Avoided customer calls
  Estimate from utility cost data

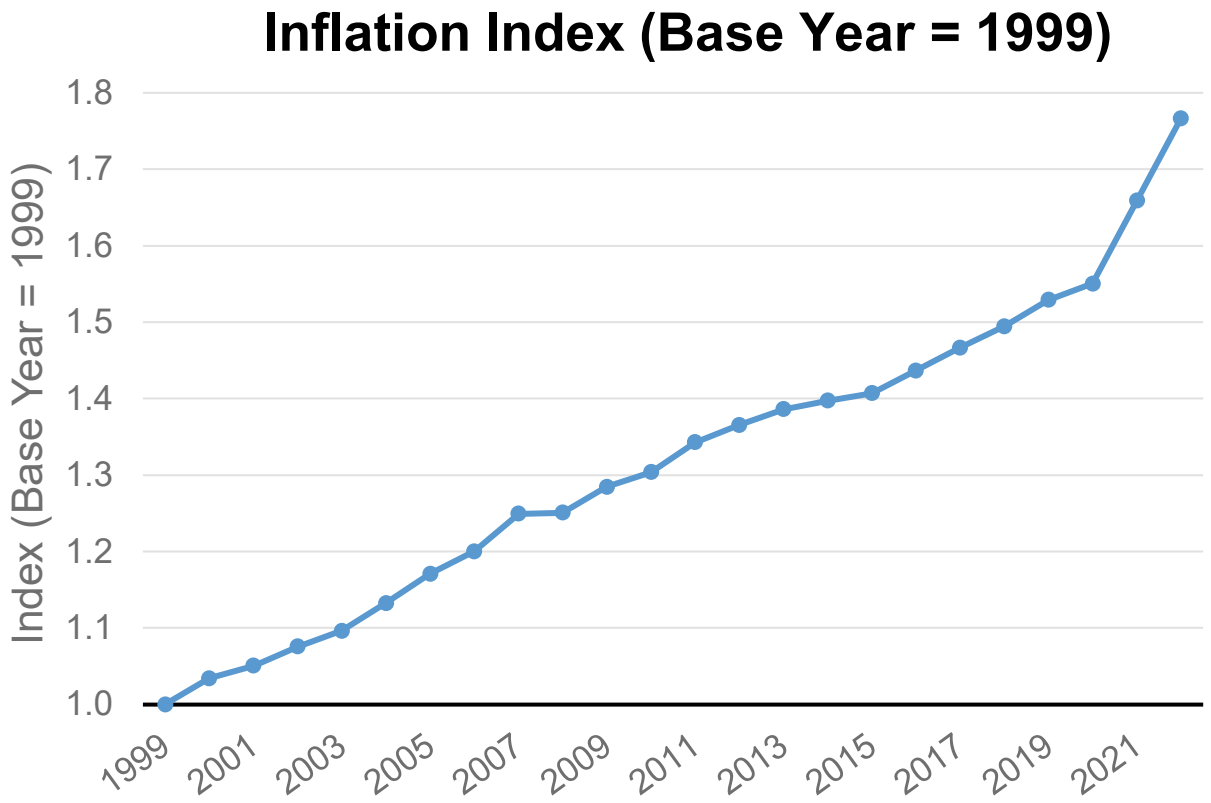
Societal Perspective

- Avoided outage minutes
  Customer interruption costs – ICE Calculator[2]
- Avoided fatalities
  Value of a Statistical Life[3]

1. EPA Report on the Social Cost of Greenhouse Gases, 2023
2. ICE Calculator
3. U.S. Department of Transportation, 2023

Discount Future Impacts – Accounting for Inflation

- Convert nominal dollars to real dollars
  - Consumer Price Index (CPI) is a common deflator
- Peg real dollars to a “base year” to ensure units are consistent



Data Source: U.S. Bureau of Labor Statistics

Discount Future Impacts – Choosing a Discount Rate

- Discount rate reflects time preferences
  - The higher the discount rate, the less value the analysis will place on future benefits
  - A discount rate of 0% would value today's benefits equally with benefits at any point in the future (controlling for inflation)
- The choice of discount rate is a policy decision and should reflect the time preference chosen by regulators on behalf of customers
- Typical discount rates

Type of Discount rate	Indicator of Time Preference	Typical Values
Investor Owned Utility	Weighted Average Cost of Capital (WACC)	5% to 8%
Publicly Owned Utility	Cost of Borrowing	3% to 5%
Low Risk	Interest rate on 10-year Treasury Bond	-1.0% to 3%
Societal	Societal cost of capital, adjusted to consider intergenerational equity or other societal values	<0% to 3%

Source: National Standard Practice Manual For Benefit-Cost Analysis of Distributed Energy Resources, 2020

Calculate Net Present Value – Example

- The present values of costs and benefits are the sums of the discounted costs and benefits, respectively
  - Present value is expressed in real dollars, pegged to Year 0
- Net present value = present value of benefits minus present value of costs
- Illustrative example (below) shows the process for calculating net present value

		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Discount Rate (s)	6.0%						
Discount Factor (1/(1+s)^{year})		1.00	0.94	0.89	0.84	0.79	0.75
Costs							
Total Costs		$ (1,000,000)	$ (10,000)	$ (10,000)	$ (10,000)	$ (10,000)	$ (10,000)
Discounted Costs		$ (1,000,000)	$ (9,434)	$ (8,900)	$ (8,396)	$ (7,921)	$ (7,473)
Present Value - Costs		**$ (1,042,124)**					
Benefits							
Avoided Cost 1			$ 40,000	$ 40,000	$ 50,000	$ 50,000	$ 75,000
Avoided Cost 2			$ 100,000	$ 100,000	$ 100,000	$ 200,000	$ 200,000
Avoided Cost 3			$ 50,000	$ 50,000	$ 100,000	$ 100,000	$ 150,000
Total Avoided Costs			$ 190,000	$ 190,000	$ 250,000	$ 350,000	$ 425,000
Discounted Benefits			$ 179,245	$ 169,099	$ 209,905	$ 277,233	$ 317,585
Present Value - Benefits		**$ 1,153,067**					
Net Present Value		**$ 110,943**		**Benefit/Cost Ratio = 1.11**			

Source: Myles Collins, Berkeley Lab

Poll

The "Rule of [*what number?*]" is a shortcut we can use for calculating the number of years it would take to halve the discount factor. The formula is:

$$\frac{[number]}{discount\ rate} = years\ to\ get\ discount\ factor\ of\ 0.5$$

1. Rule of 86
2. Rule of 50
3. Rule of 25
4. Rule of 72

Perform a Sensitivity Analysis

- Assesses how sensitive net present value is to the set of assumptions used
- Adjust assumptions and see how the net present value changes
- Determine which assumptions have the most (and least) influence on the end result
- Monte Carlo simulation is a useful tool when one or more inputs are represented by a distribution and a mathematical model can be used to calculate results
  - The method generates model inputs randomly from the distributions and uses the model to calculate results
  - The input generation and calculation process is repeated thousands of times and results are aggregated

Make a Recommendation

- Assess any other factors which may be important to stakeholders, but which are not captured in the quantitative results of the BCA, such as:
  - Distributional impacts*
    - Are certain customers bearing more of the costs and others realizing more of the benefits?
    - Are vulnerable or disadvantaged communities benefitting from the decision?
  - Impact of uncertainty
    - How robust are results to broken assumptions?
    - Is uncertainty sufficiently deep that hedging should be considered?
  - Other potential benefits that could not be monetized (e.g. job creation, customer experience)
- Recommend an alternative based on results of BCA and consideration of other factors

*For example, see Berkeley Lab, 2024, *Distributional Equity Analysis for Energy Efficiency and Other Distributed Energy Resources: A Practical Guide*

Other Cost-Effectiveness Evaluation Methods

Lowest Reasonable Cost

- Lowest reasonable cost / best fit is a cost-effectiveness test with the goal to minimize utility revenue requirement — e.g., for utility investments to meet grid needs

	Need	Purpose	Application	Costs	Benefits
Lowest Reasonable Cost / Best Fit	Need for the investment has been established	To identify the investment that meets the need at lowest cost	Which option is the lowest-cost way to meet the need?	Included Typically includes only utility system costs	Not Required Benefits are not necessarily accounted for; presumed to be worth the costs
BCA	Need for the investment has not been established	To determine whether to make the proposed investment	Do the benefits of the investment outweigh the costs?	Included Extent of costs depends upon BCA test chosen	Included Extent of benefits depends upon BCA test chosen

Source: Woolf & Havumaki, 2022

Multi-Criteria Decision Analysis

- A systematic approach to scoring alternatives when decision-makers face multiple conflicting objectives
- Useful when some criteria are difficult or impossible to monetize (e.g., alignment with a policy objective)
- General process
  - Determine set of criteria
  - Determine weighting of each criterion
  - Score each alternative along each criterion
  - Calculate total weighted score
- Results of BCA (e.g., benefit-cost ratio) can be one of the criteria
- Perspectives are incorporated through weighting of policy objectives
  - Stakeholder engagement is important for determining criteria weighting

Illustrative Example Comparing Three Alternatives

	Reliability		Sustainability		Electrification		Equity		
	Score	Weight	Score	Weight	Score	Weight	Score	Weight	**Total Score**
Alternative A	5	0.40	3	0.20	5	0.10	2	0.25	**3.6**
Alternative B	3	0.40	3	0.20	2	0.10	2	0.25	**2.5**
Alternative C	2	0.40	4	0.20	1	0.10	5	0.25	**3.0**

Value-Spend Efficiency

- Provides a way to compare multiple alternatives
- For each alternative, divides total score by the cost to create a normalized efficiency score
- Can be used to prioritize mutually exclusive projects and select more than one for implementation

	Reliability		Sustainability		Electrification		Equity				
	Score	Weight	Score	Weight	Score	Weight	Score	Weight	**Total Score**	**Cost**	**Spend Efficiency**
Alternative A	5	0.40	3	0.20	5	0.10	2	0.25	**3.6**	**$5.0M**	**0.72**
Alternative B	3	0.40	3	0.20	2	0.10	2	0.25	**2.5**	**$2.0M**	**1.25**
Alternative C	2	0.40	4	0.20	1	0.10	5	0.25	**3.0**	**$3.1M**	**0.95**

Source: Myles Collins, Berkeley Lab

Questions/Comments

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