NASEO-NARUC GEBs BCA Webinar

E4TheFuture, ICF, SEPA

Kate Strickland
SEPA

David Pudleiner
ICF

08/10/2022

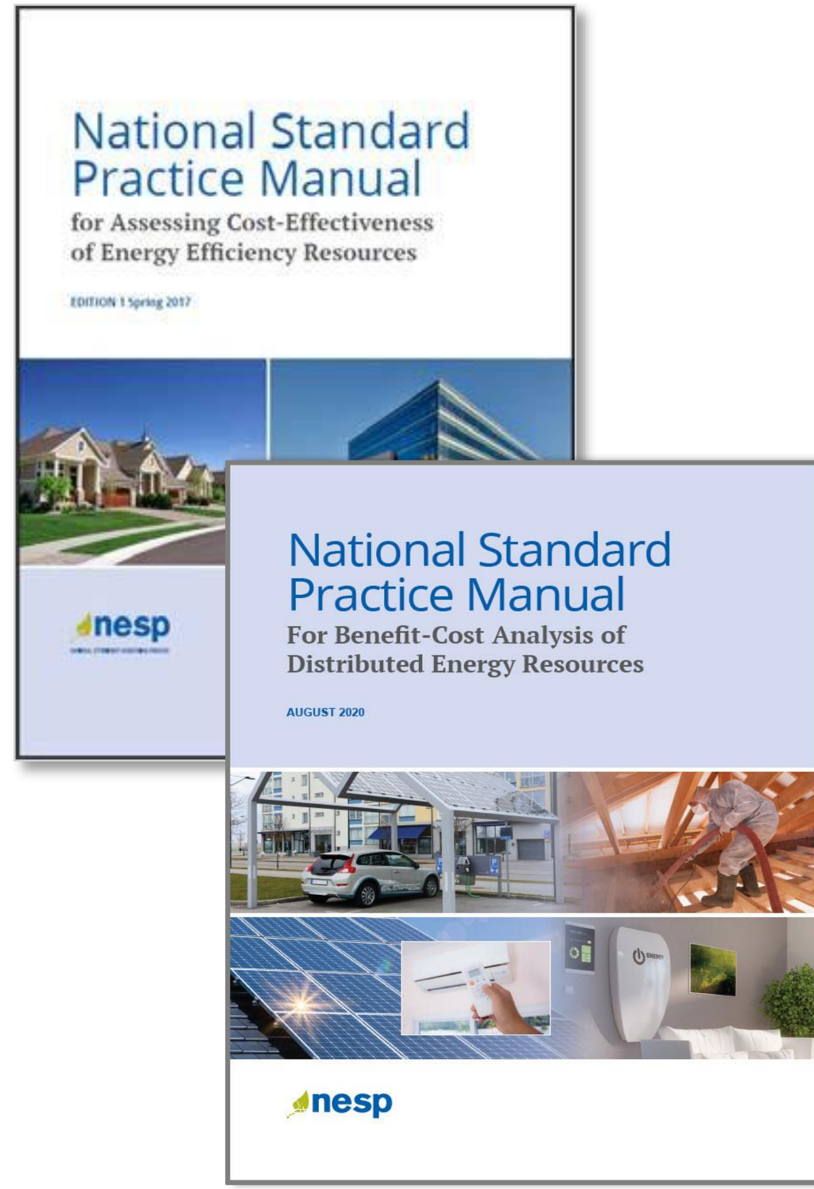
Introduction

What is the NSPM for DERs?

What: "NSPM for DERs" = *National Standard Practice Manual for Benefit-Cost Analysis of Distributed Energy Resources (DERs)* (2020).

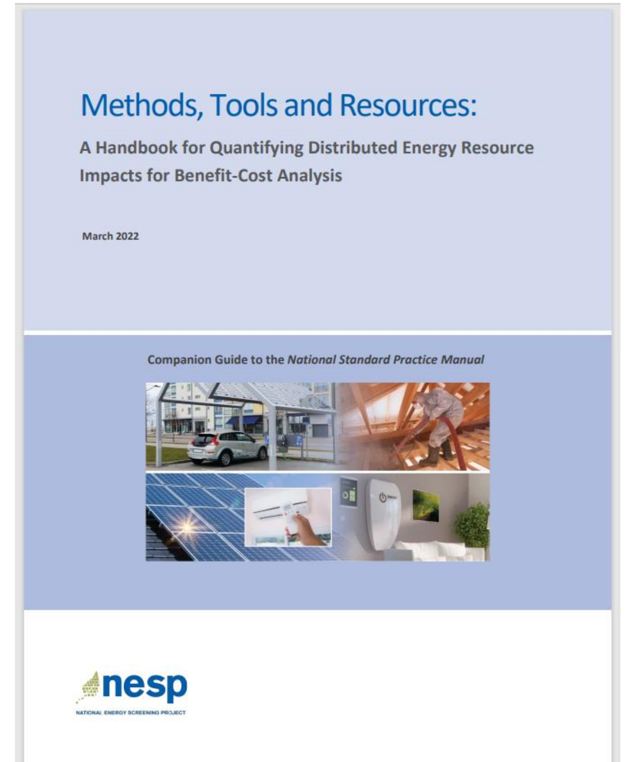
Description:

- Comprehensive framework for cost-effectiveness assessment of DERs.
- Intended for use by jurisdictions to help inform which resources to acquire to meet the jurisdiction's specific policy goals and objectives
- Set of policy-neutral, non-biased, and economically-sound principles, concepts, and methodologies to support single- and multi-DER benefit-cost analysis (BCA) for:
  - Energy efficiency (EE)
  - Demand response (DR)
  - Distributed generation (DG)
  - Distributed storage (DS)
  - Electrification (building and vehicle)



MTR Handbook for Quantifying DER Impacts (2022)

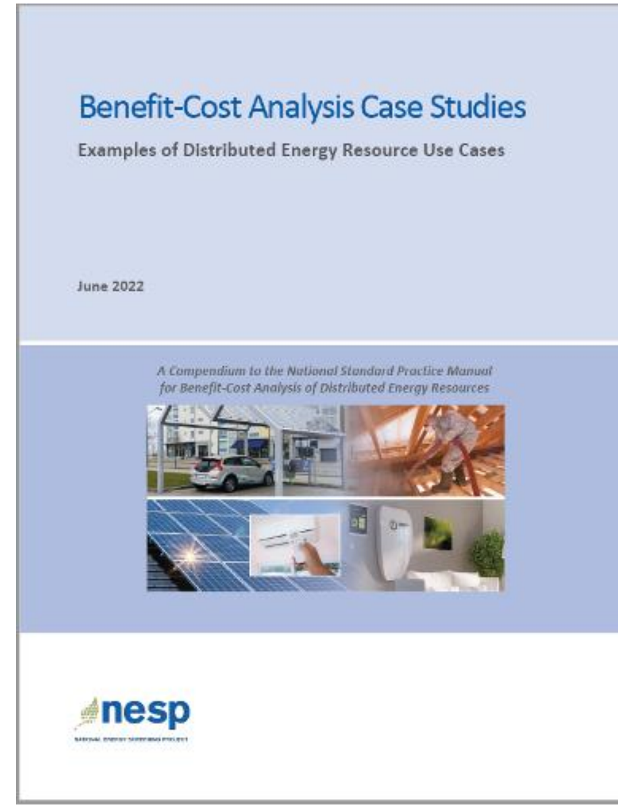
- NSPM provides guidance on ***what*** inputs to include in BCA tests.
- MTR Handbook provides guidance on ***how*** to determine those inputs to those BCA tests.
- Contents:
  - *Key Components to Calculate BCA Impacts*
  - *Electric Utility System Impacts*
  - *Gas Utility System Impacts*
  - *Other Fuel System Impacts*
  - *Host customer Impacts*
  - *Societal Impacts*
  - *Reliability & Resilience*
  - *Energy Equity*
  - *Uncertainty & Risk*
  - *Load Impact Profiles*



Available at: https://www.nationalenergyscreeningproject.org/resources/quantifying-impacts/

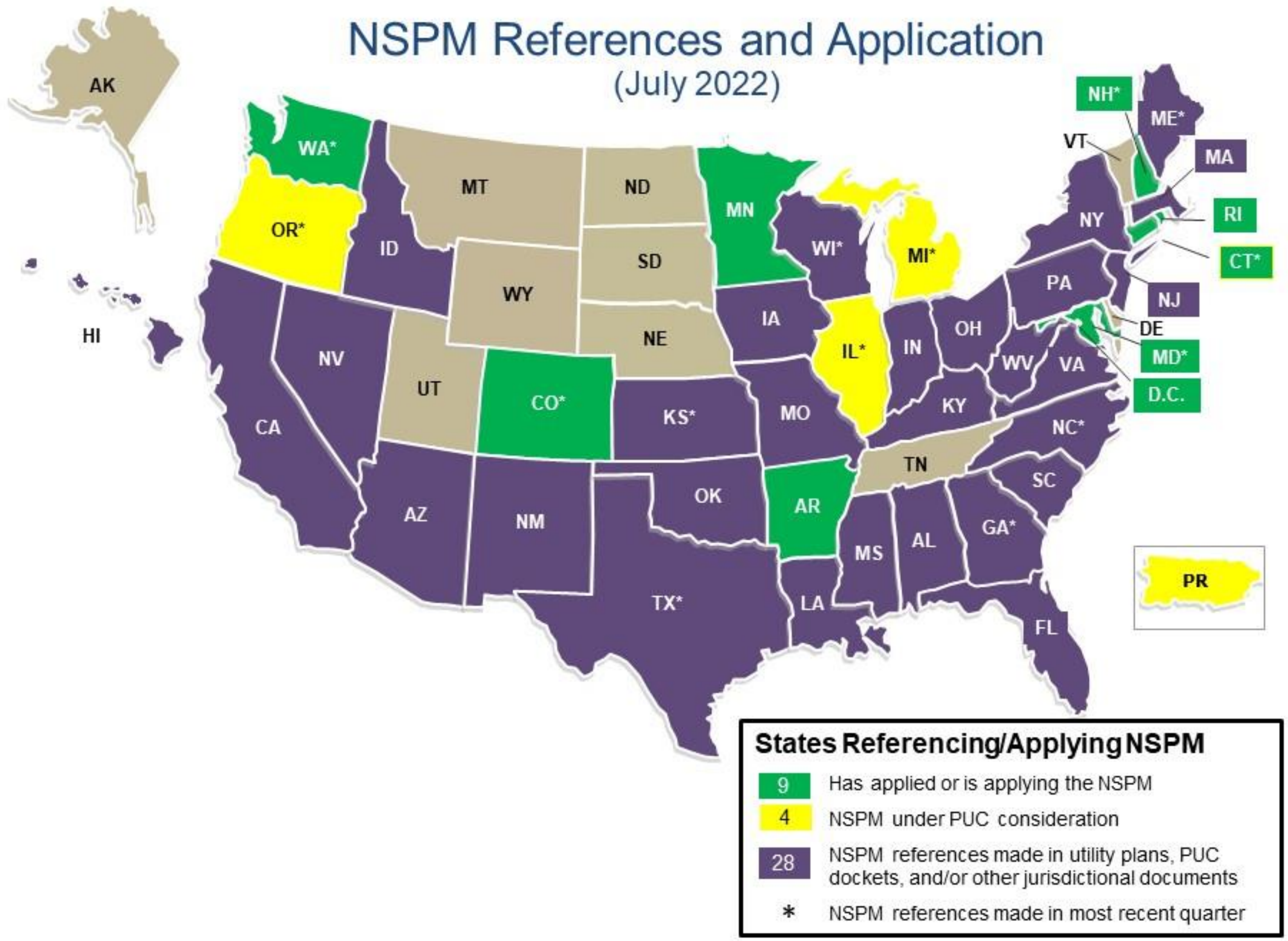
NESP Benefit-Cost Analysis Case Studies: Examples of Distributed Energy Resource Use Cases

- Three Use Cases Covered:
  - Residential EV Managed Charging in the Midwest
  - Commercial Solar + Storage Controlled Dispatch in the West
  - **Residential Grid-interactive Efficient Building (GEB) Retrofit in the Mid-Atlantic**
    - Weatherization
    - Smart thermostats
    - Heat pumps

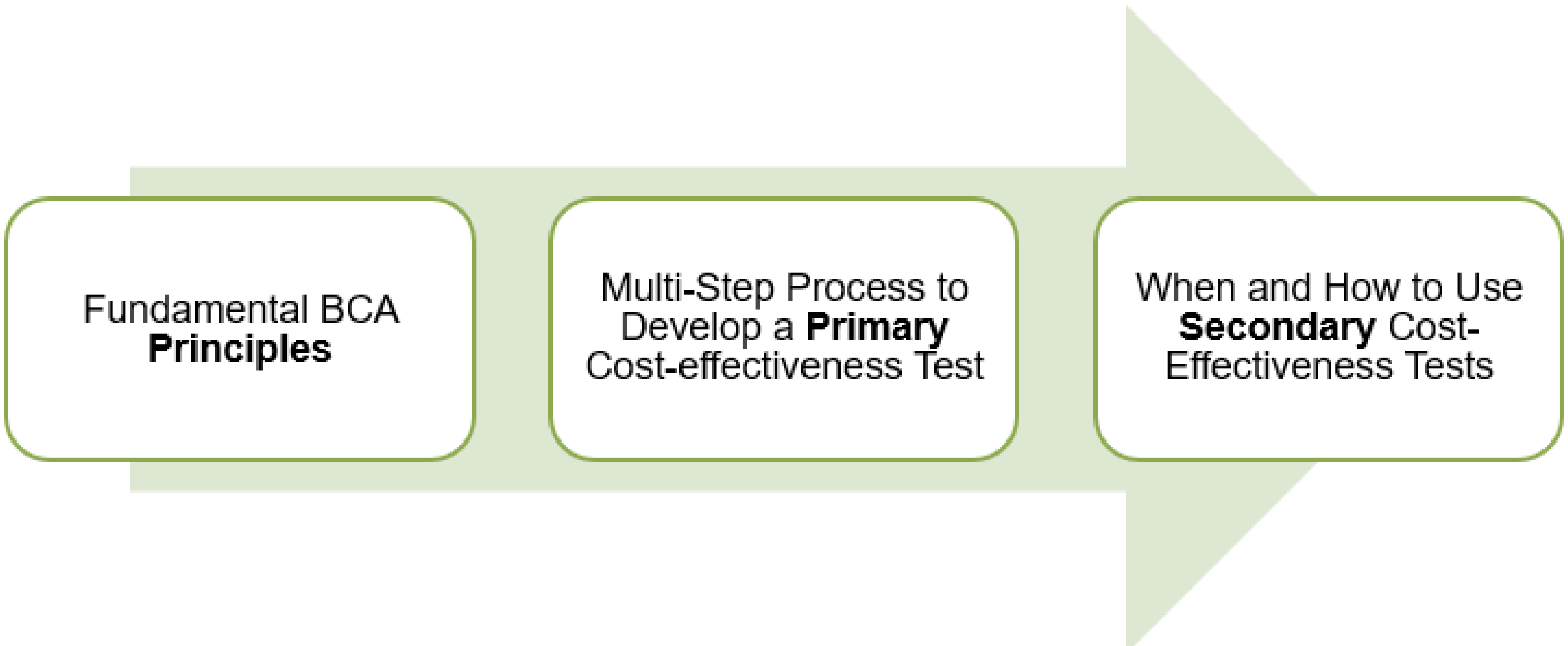


Available at: https://www.nationalenergyscreeningproject.org/resources/case-studies/

NSPM Guidance Application to Real-world Use Cases: BCA Case Studies (2022)



NSPM References & Application



NSPM Benefit-Cost Analysis Framework

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 primary 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.

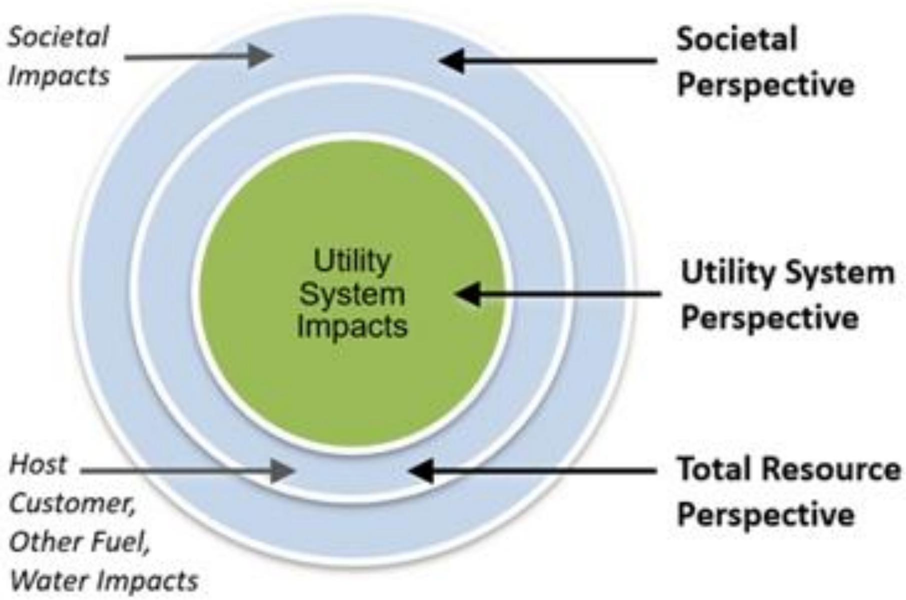
7. Ensure transparency in presenting the benefit-cost analysis and results.

8. Conduct BCA separate from Rate Impact Analyses because they answer different questions.

NSPM BCA Principles

Cost-Effectiveness Testing Perspectives

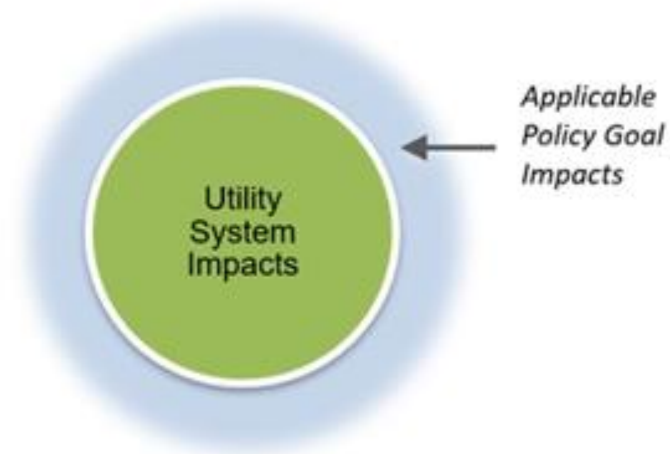
Traditional Perspectives



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

NSPM for DERs

Regulatory Perspective



- 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.

STEP 1

Articulate Applicable Policy Goals
Articulate the jurisdiction's applicable policy goals related to DERs.

STEP 2

Include All Utility System Impacts
Identify and include the full range of utility system impacts in the primary test, and all BCA tests.

STEP 3

Decide Which Non-Utility System Impacts to Include
Identify those non-utility system impacts to include in the primary test based on applicable policy goals identified in Step 1

STEP 4

Ensure that Benefits and Costs are Properly Addressed
Ensure that the impacts identified in Steps 2 and 3 are properly addressed.

STEP 5

Establish Comprehensive, Transparent Documentation
Establish comprehensive, transparent documentation and reporting.

Steps to Defining a Primary BCA Test

Foundational to any BCA test – always include!

Type	Utility System Impact	Description
Generation	Energy Generation	The production or procurement of energy (kWh) from generation resources on behalf of customers
	Capacity	The generation capacity (kW) required to meet the forecasted system peak load
	Environmental Compliance	Actions to comply with environmental regulations
	RPS/CES Compliance	Actions to comply with renewable portfolio standards or clean energy standards
	Market Price Effects	The decrease (or increase) in wholesale market prices as a result of reduced (or increased) customer consumption
	Ancillary Services	Services required to maintain electric grid stability and power quality
Transmission	Transmission Capacity	Maintaining the availability of the transmission system to transport electricity safely and reliably
	Transmission System Losses	Electricity or gas lost through the transmission system
Distribution	Distribution Capacity	Maintaining the availability of the distribution system to transport electricity or gas safely and reliably
	Distribution System Losses	Electricity lost through the distribution system
	Distribution O&M	Operating and maintaining the distribution system
	Distribution Voltage	Maintaining voltage levels within an acceptable range to ensure that both real and reactive power production are matched with demand
General	Financial Incentives	Utility financial support provided to DER host customers or other market actors to encourage DER implementation
	Program Administration	Utility outreach to trade allies, technical training, marketing, and administration and management of DERs
	Utility Performance Incentives	Incentives offered to utilities to encourage successful, effective implementation of DER programs
	Credit and Collection	Bad debt, disconnections, reconnections
	Risk	Uncertainty including operational, technology, cybersecurity, financial, legal, reputational, and regulatory risks
	Reliability	Maintaining generation, transmission, and distribution system to withstand instability, uncontrolled events, cascading failures, or unanticipated loss of system components
	Resilience	The ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions

1

Electric Utility System Impacts

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

Type	Other Fuels*
Other Fuels	Fuel and O&M
	Delivery Costs
	Environmental Compliance
	Market Price Effects

*Other fuels include oil, propane, wood, and gasoline

Gas Utility System and Other Fuel Impacts

Inclusion depends on policy goals

Host Customer Impact	Description
Host portion of DER costs	Costs incurred to install and operate DERs
Interconnection fees	Costs paid by host customer to interconnect DERs to the grid
Risk	Uncertainty including price volatility, power quality, outages, and operational risk related to failure of installed DER equipment and user error; this type of risk can depend on the type of DER
Reliability	The ability to prevent or reduce the duration of host customer outages
Resilience	The ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions
Tax incentives	Federal, state, and local tax incentives provided to host customers to defray the costs of some DERs
Non-energy Impacts (NEIs)	Benefits and costs of DERs that are separate from energy-related impacts

Breakout of Host Customer Non-Energy Impacts (NEIs)

Host Customer NEI	Description
Transaction costs	Costs incurred to adopt DERs, beyond those related to installing or operating the DER itself (e.g., application fees, customer time spent researching DERs, paperwork, etc.)
Asset value	Changes in the value of a home or business as a result of the DER (e.g., increased building value, improved equipment value, extended equipment life)
Productivity	Changes in a customer's productivity (e.g., in labor costs, operational flexibility, O&M costs, reduced waste streams, reduced spoilage)
Economic well-being	Economic impacts beyond bill savings (e.g., reduced complaints about bills, reduced terminations and reconnections, reduced foreclosures—especially for low-income customers)
Comfort	Changes in comfort level (e.g., thermal, noise, and lighting impacts)
Health & safety	Changes in customer health or safety (e.g., fewer sick days from work, reduced medical costs, improved indoor air quality, reduced deaths)
Empowerment & control	Satisfaction of being able to control one's energy consumption and energy bill
Satisfaction & pride	Satisfaction of helping to reduce environmental impacts (e.g., key reason why residential customers install rooftop PV)
Reduced Utility Bills	Only relevant if using a Participant Cost Test

Host Customer Impacts

Inclusion of any of these impacts depends on policy goals

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

Societal Impacts

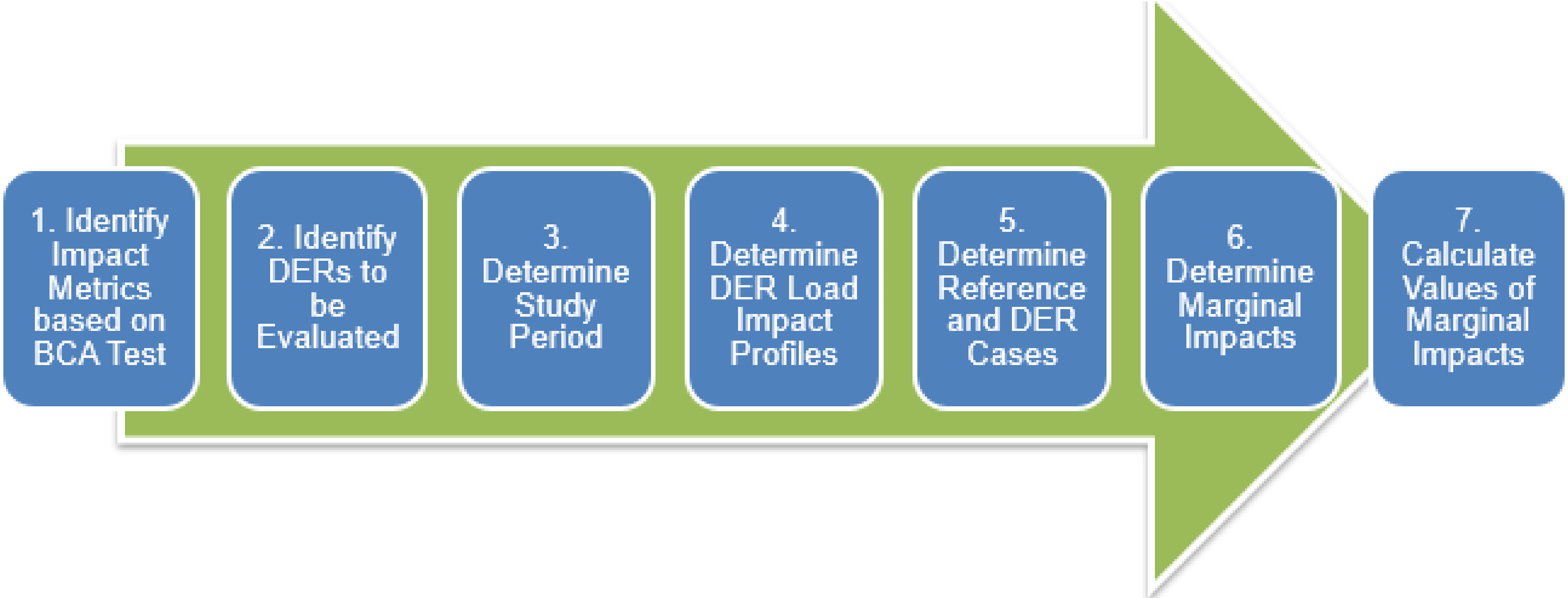


Figure from NESP MTR handbook (March 2022)

GEBs Use Case

Key Components to Calculating DER Impacts

Category/Type	GEB Retrofit Case Study (JST 3)
Electric Utility System Impacts	All impacts included in JST though some values are zero where impact is not relevant to the use case and/or DER
Natural Gas Impacts	Included in JST consistent with jurisdiction's policy
Host Customer Impacts	Included in JST consistent with jurisdiction's policy
Societal Impacts	GHG emission impacts (beyond any compliance costs) and public health impacts included consistent with jurisdiction's policy

Summary of Impacts Included in GEBs Case Study

Reference Case

- Residential SF home with gas furnace, central AC, and no smart devices

DER Case

- Ceiling insulation, reduced air leakage, ASHP, smart thermostat with DR program participation

Policy Scenario

- Include host customer, natural gas, GHG and public health impacts in JST

Utility Scenario

- Municipal utility in the Mid-Atlantic, connected to PJM
- Moderate avoided energy and capacity costs
- Generation mix comparable to PJM market mix

Diving into Case Study

Applicable Value Streams

Gas Utility System Impacts
Energy fuel cost and variable O&M cost
Environmental compliance cost
Risk impacts

Host Customer Impacts
Measure capital cost (net incentives)
Operations & Maintenance (O&M) costs
Electric service upgrade costs
Non-energy impacts

Electric Utility System Impacts
Avoided energy costs
Avoided environmental compliance costs
Market price effects
Avoided generation capacity costs
Avoided transmission capacity costs
Avoided distribution capacity costs
Avoided Renewable Portfolio Standard (RPS) compliance costs
Avoided ancillary services costs
Financial incentives to host customers
Program administration costs
Risk impacts
Distributed energy resource management system costs

Societal Impacts
GHG Emissions
Public Health

N/A Because of JST Formulation

Societal Impacts
Resilience
Energy security

N/A Because of DER Use Case Examined

Electric Utility System Impacts
Avoided credit and collection costs
Reliability impacts
Resilience impacts
Utility performance incentives

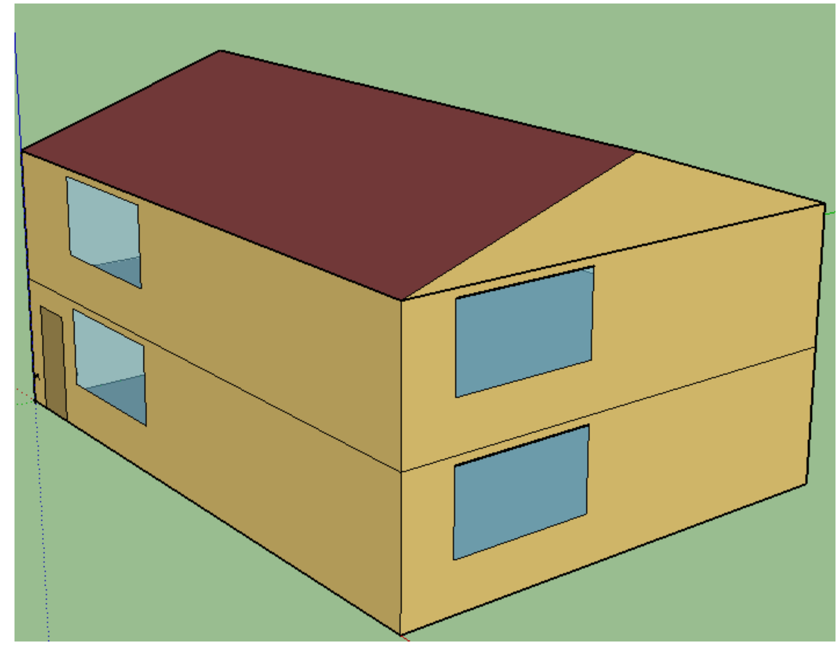
Host Customer Impacts
Interconnection fees
Tax incentives
Risk, reliability, resilience impacts

Identification of Relevant Value Streams

- Utilized hourly building energy simulation to model combined impacts of measures

- Leveraged NREL's Openstudio (built on DOE's EnergyPlus)

- Killed two birds with one stone
  - Interactive impact accounting between the multiple DERs
  - Production of hourly load shapes for granular impact accounting

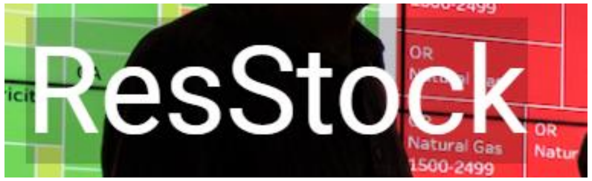


1

2

→ Interactive Impact Accounting

1 Screenshot from Sketchup with OpenStudio Plugin
2 Logos of OpenStudio and EnergyPlus, opensource tools



[1]

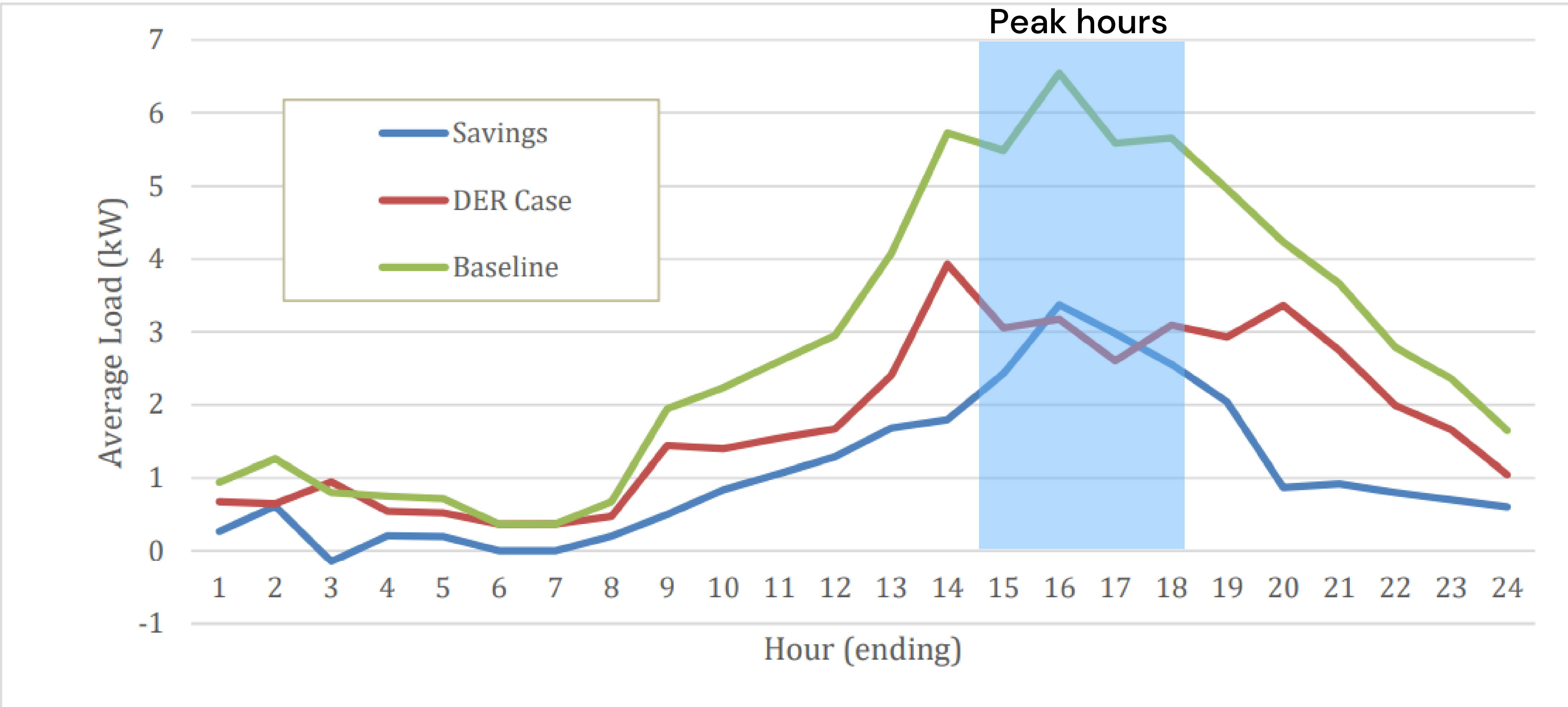
Housing stock characteristics database + Physics-based computer modeling + High-performance computing

[2]

Tools Utilized for Modeling

1 [Screenshot from NREL ResStock website]

2 Logos of OpenStudio and EnergyPlus, opensource tools



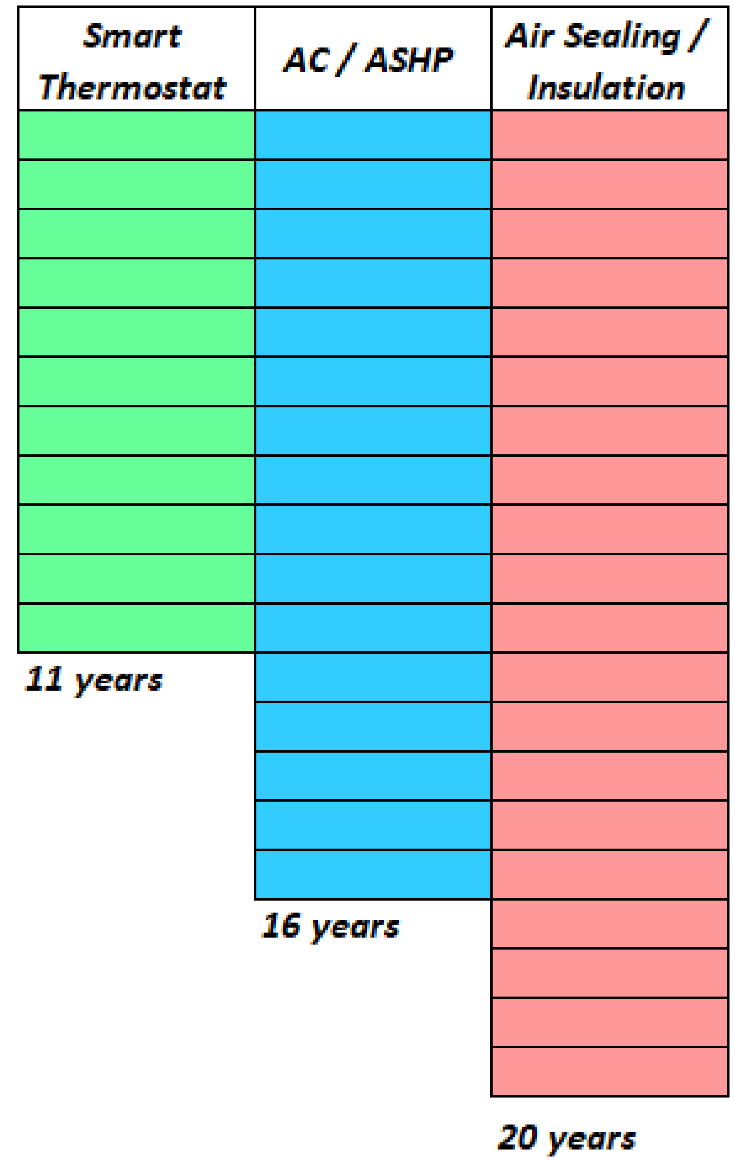
Summer Load Shapes (Averaged Across Peak Days)

- When modeling multiple resources, need to account for differences in measure lives

- Two ways to address this:

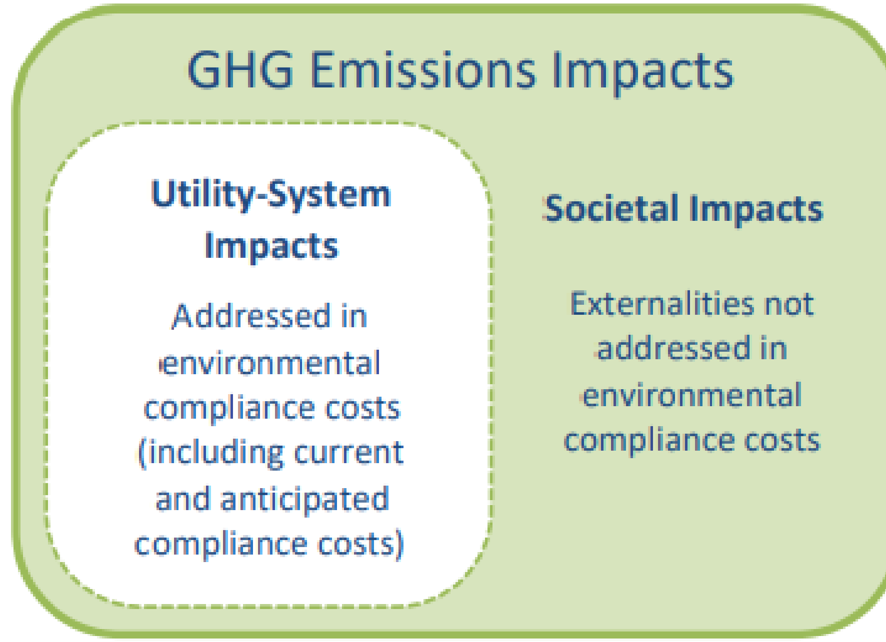
1. Use multiple load shapes to model the load impacts for different measure combinations
2. Annualize costs and standardize measure lives so that one load shape can be used

- Set measure life to 20 years for GEBs package



Handling Measure Lives and Interactive Impacts

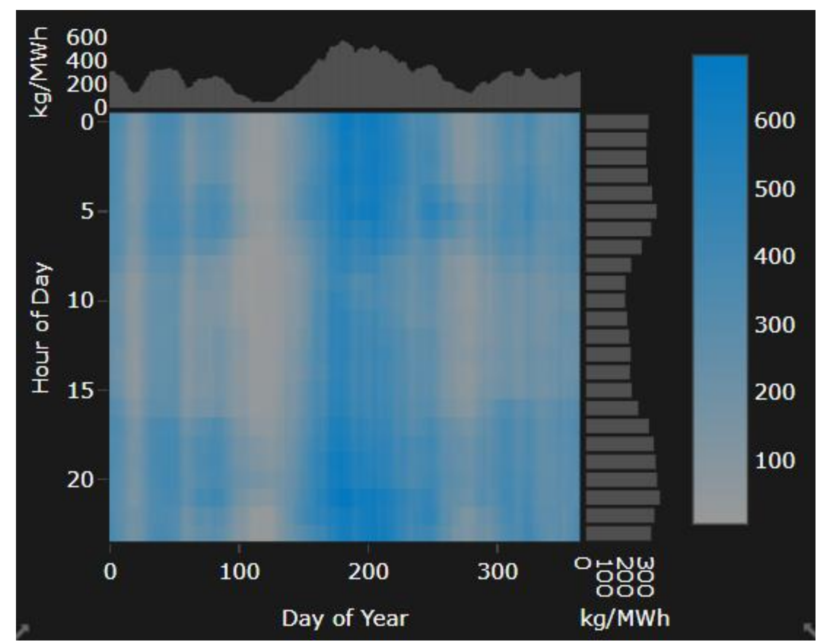
- Whether societal impacts are relevant depends on utility planning & policy
  - If planning in line with policy, no need for societal valuation



1

- This case study valued GHG emissions from both utility system & societal perspectives

- GHG emissions impacts were calculated on an hourly basis



2

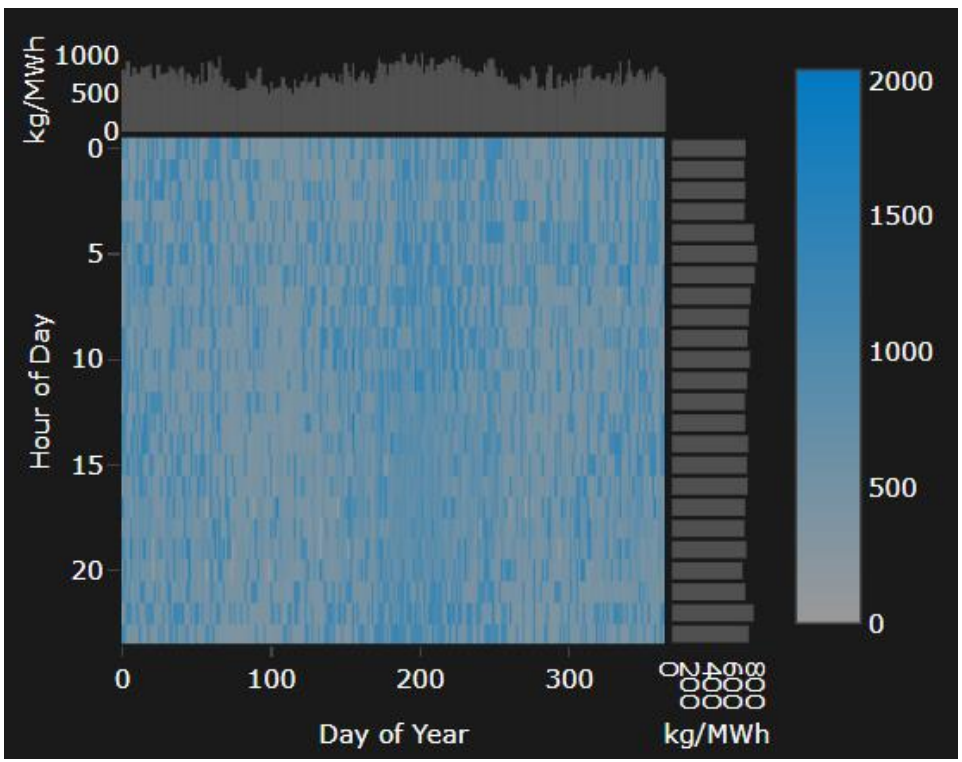
GHG Modeling: Utility System Cost vs Societal Cost

1 NESP MTR Handbook
2 Screenshot from NREL Cambium Viewer

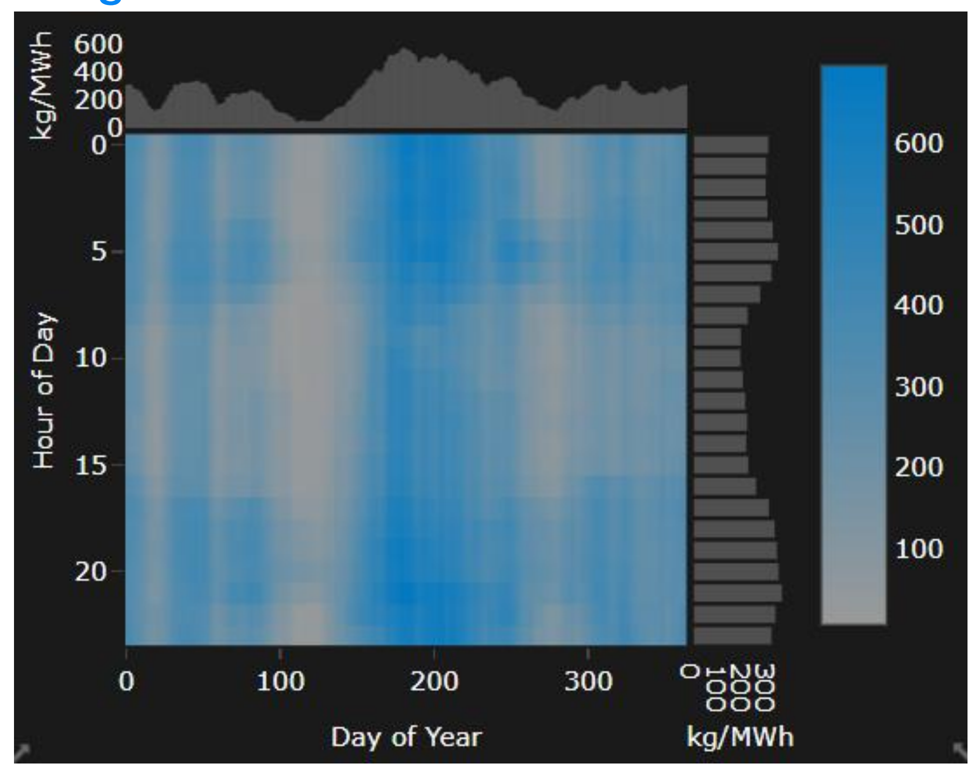
Short Run Marginal Rate: The emissions rate of the marginal generating unit

Long Run Marginal Rate: The emissions rate of generation added to the grid due to a persistent change in the regions end use

Short Run



Long Run



GHG Modeling: Short Run Marginal versus Long Run Marginal Rates

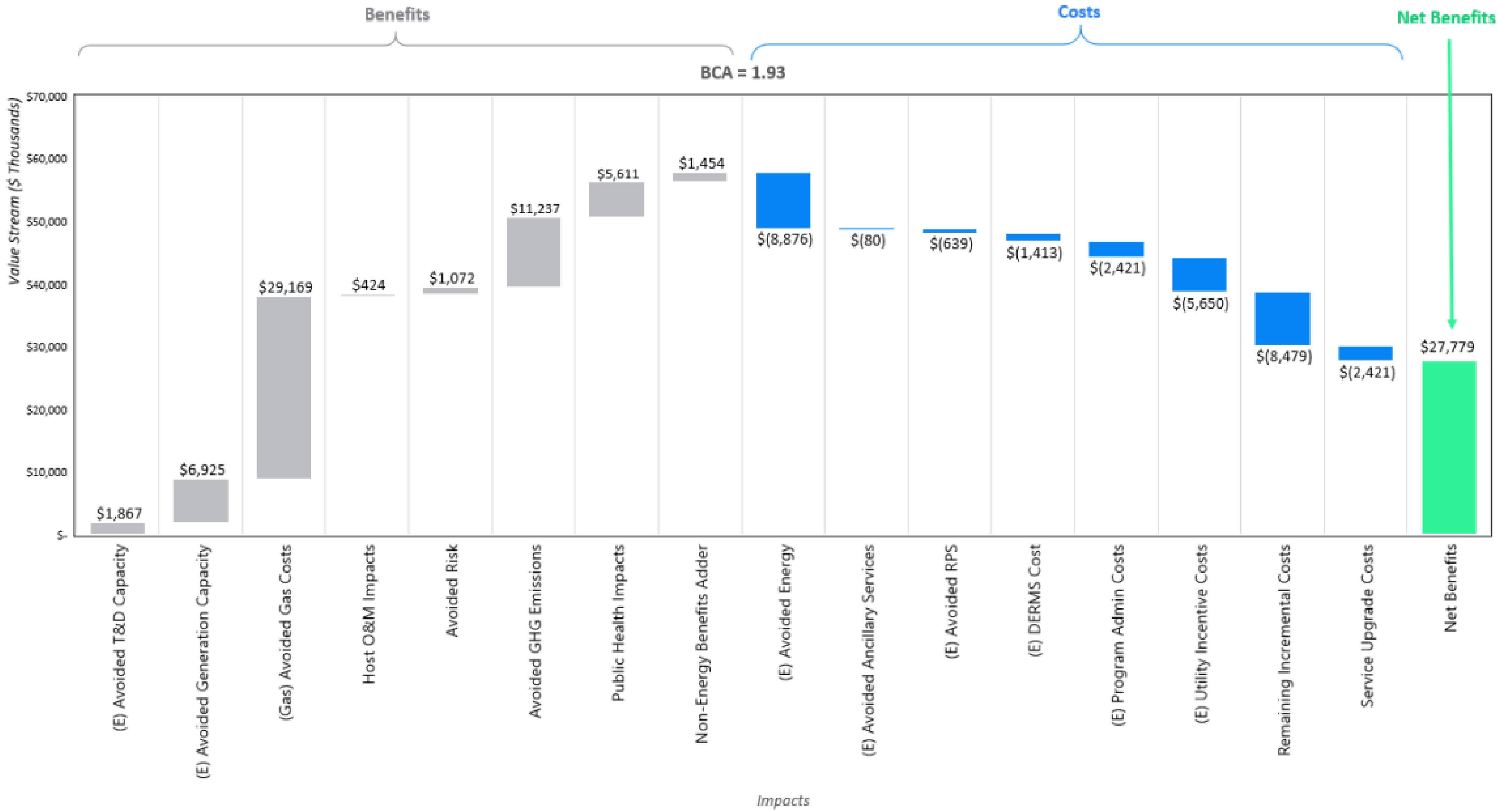
Screenshots from NREL Cambium Viewer

- What is the future GHG emissions rate of the gas utility?
  - Assumed that the GHG intensity of the gas system does not change over the analysis period (next 20 years)

- Will the grid switch from summer peaking to winter peaking, and when?
  - Assumed that grid stays summer peaking for the duration of the analysis (next 20 years)

Assumed Future versus Created Future

Images owned by ICF

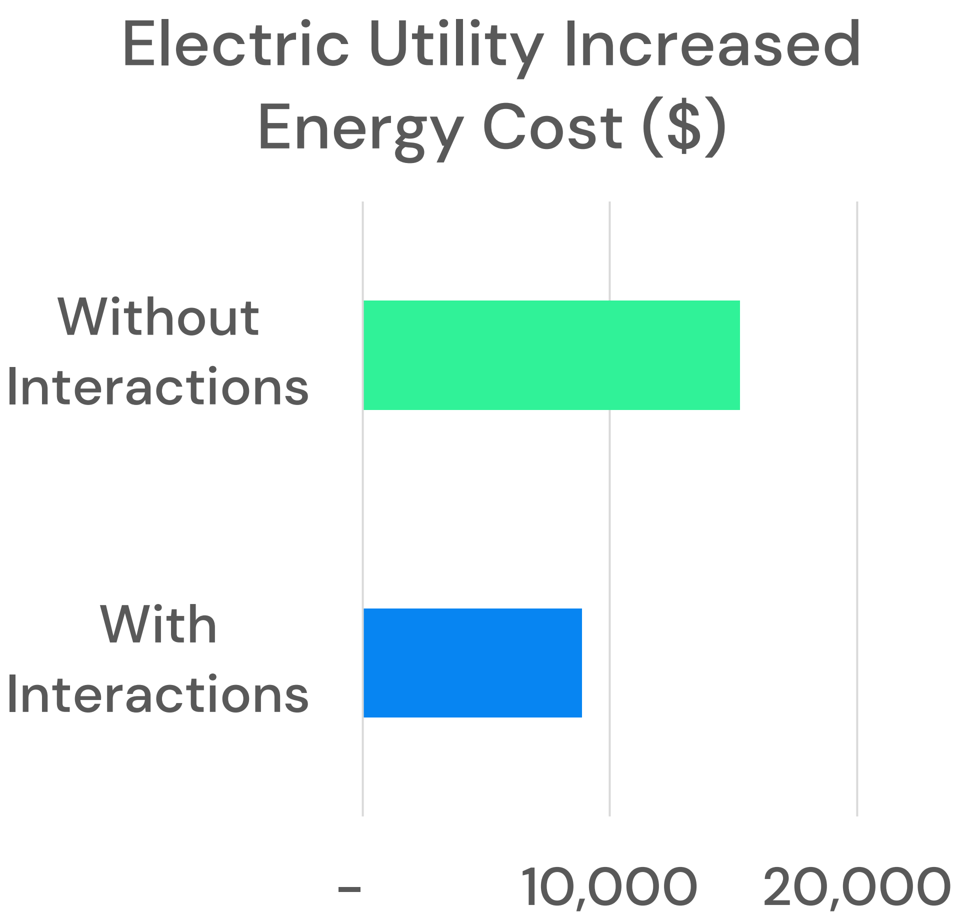


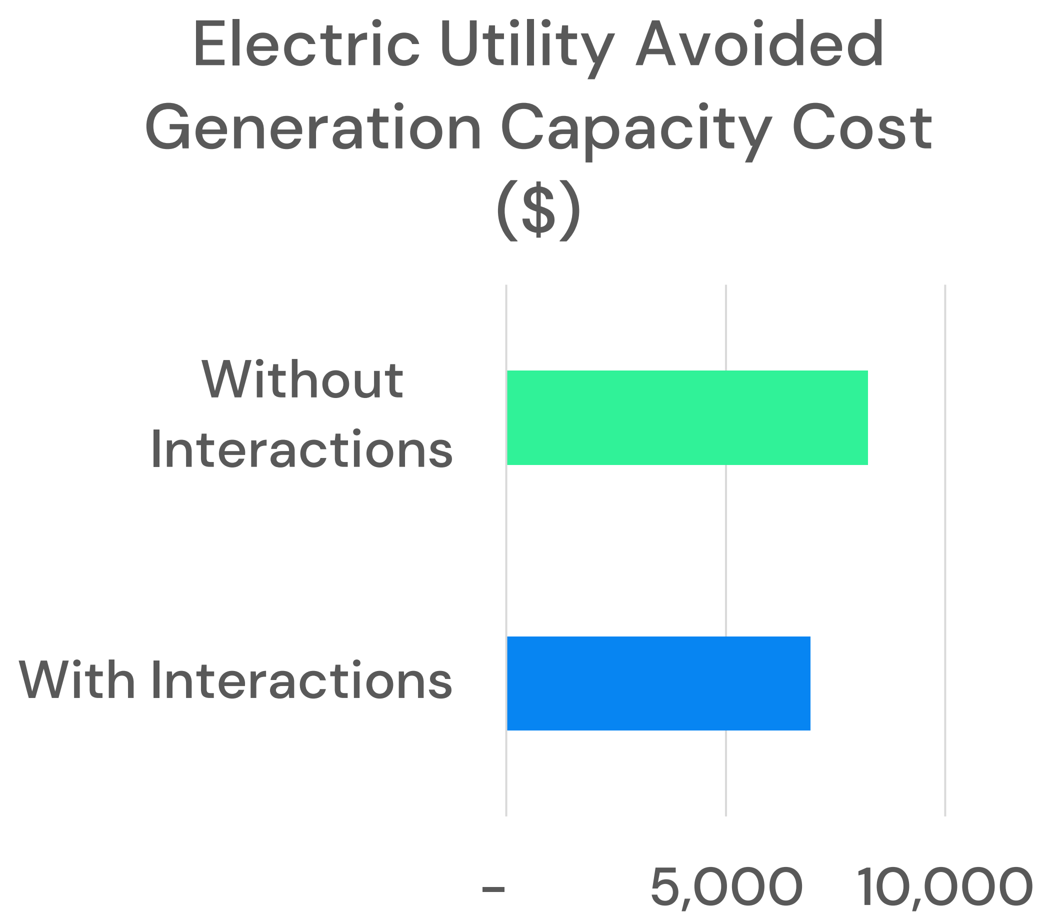
Key: (E) = Electric Utility System Impacts (Gas) = Gas Utility System Impacts Gray = Estimated Benefits Blue = Estimated Costs Green = Net Benefits

Avoided Gas Cost is the Most Influential Value Stream

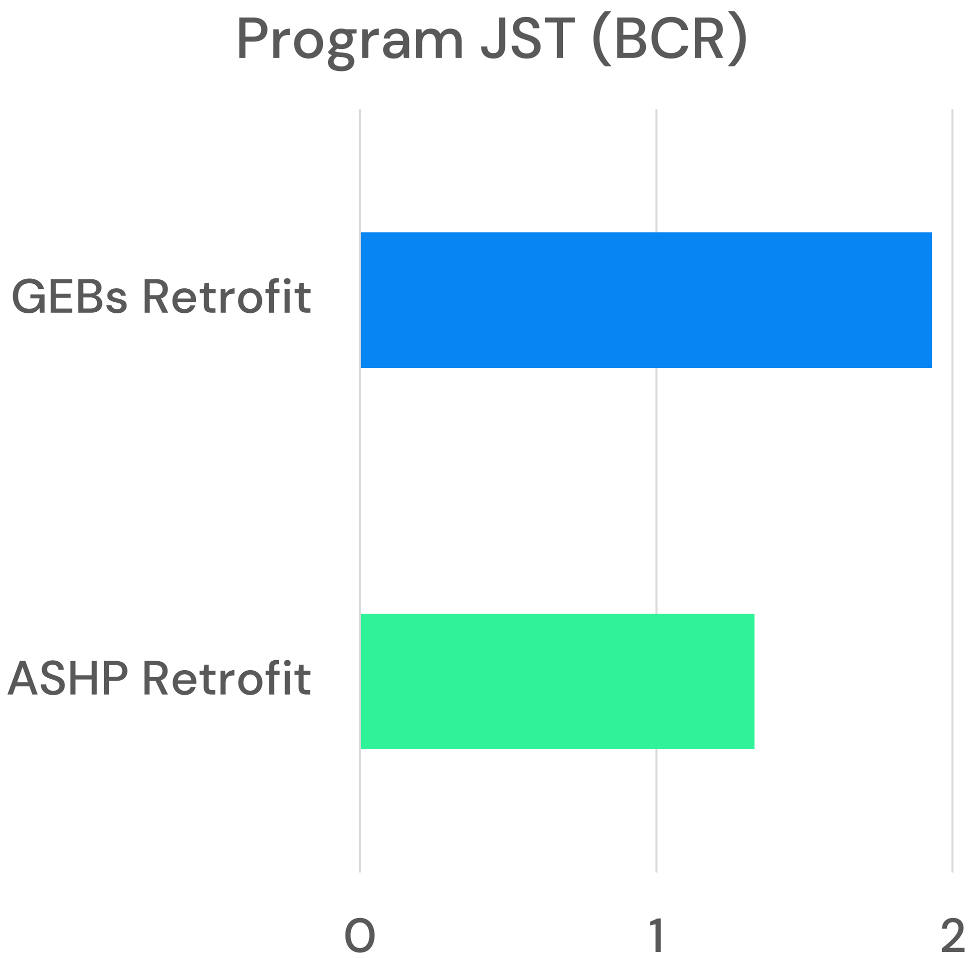
- Avoided Gas Cost
  - Climate – electrification less influential in warmer areas
  - Avoided/Supply cost of natural gas
- Avoided Societal GHG Emissions
  - Assumption of no gas decarbonization
- Incremental Cost of Measures / Service Upgrade Costs
  - Highly variable cost of electrification based on home vintage
- Avoided Generation Capacity
  - Assumption of summer peak

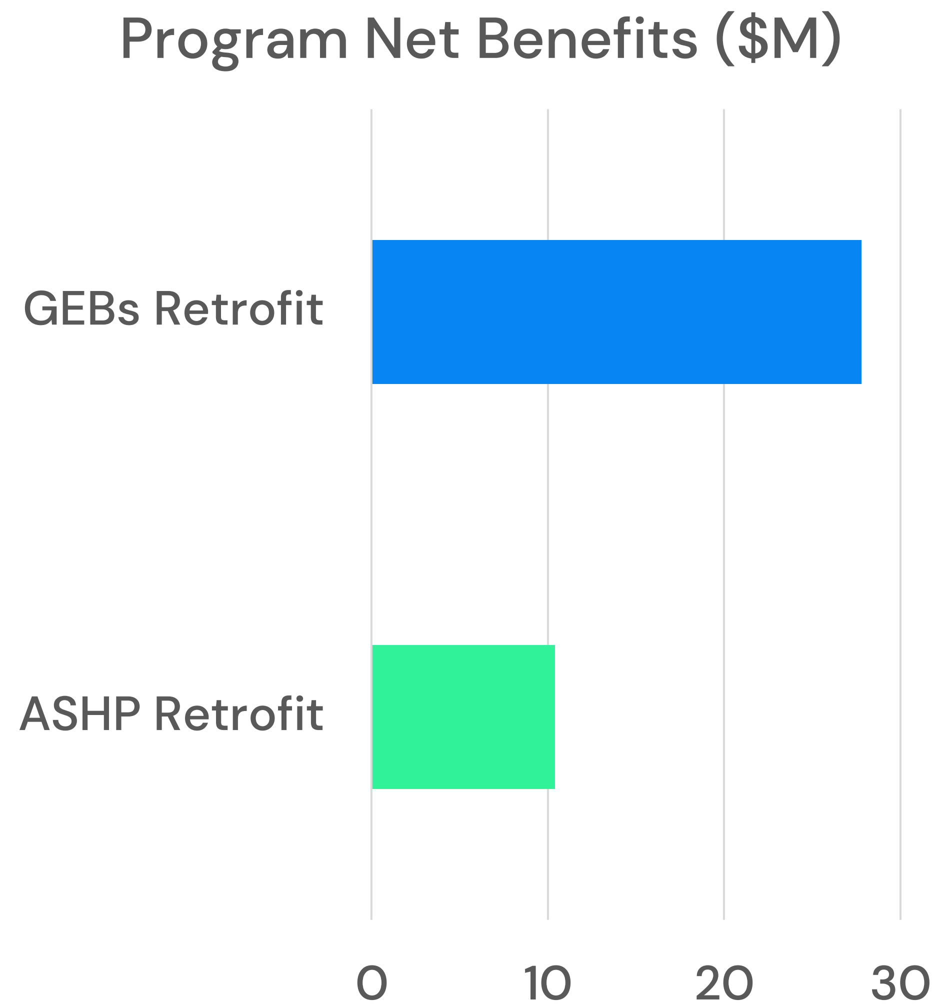
Sensitivity of the CBA results: What are the Most Influential Factors?





Failing to account for interactions over/underestimates value streams by as much as 72%

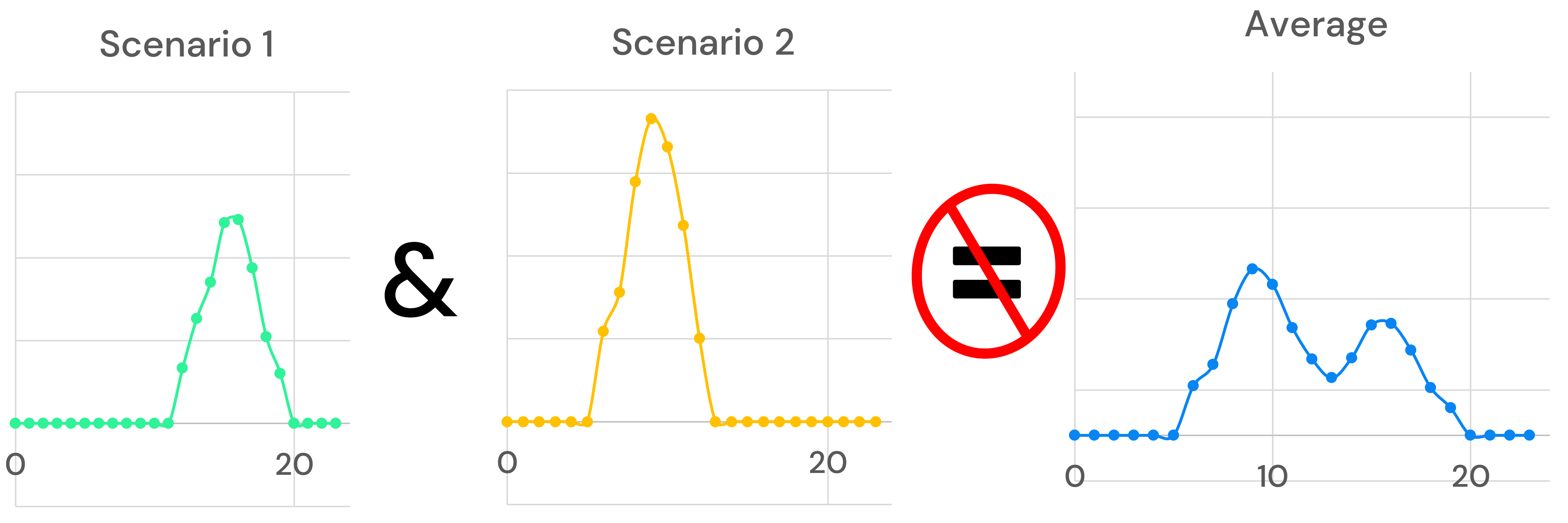




→ **Demand flexibility and energy efficiency have a big part to play in cost-effective electrification**

- GEBs (and all dispatchable resources) have potential value in their flexibility

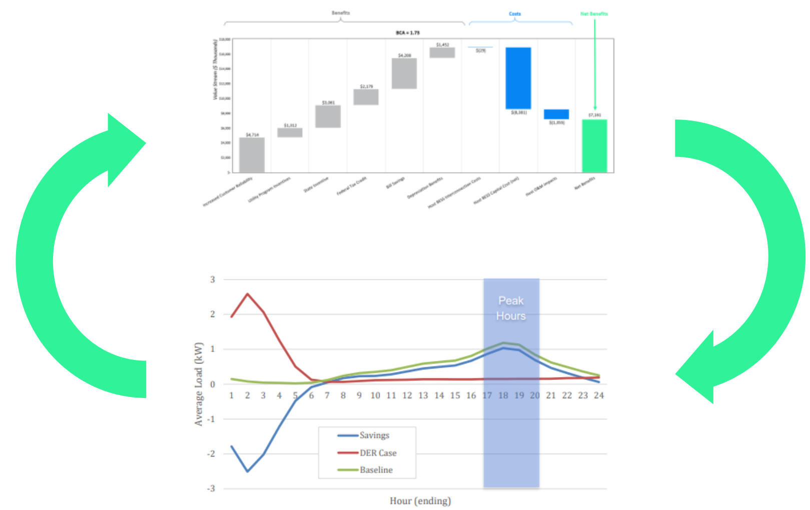
- No deterministic analysis will accurately capture this value, requires a probabilistic accounting methodology



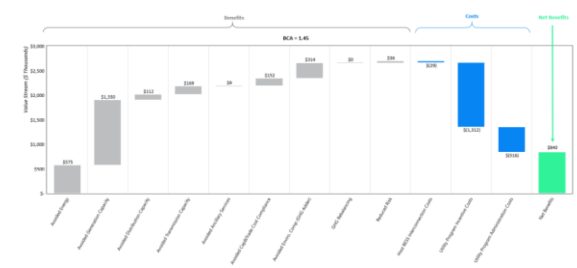
→ **Future Research: Utilizing Multiple Load Shapes to Value Flexibility**

- Assumed utility control of GEB flexibility for utility's purpose
- Inherent conflict of interest in GEB operation due to disconnect between retail rates and jurisdiction benefits/costs
- Further complicated by FERC 2222
- Requires optimizing load profiles based on building owner POV, then plugging into JST to see jurisdiction benefits/costs

Customer POV Optimization



Utilize Load Shape in JST Calculation



→ **Future Research: Balancing Building Owner and Grid Perspectives**