

Demand Response Participation A Behind-the-Meter Perspective

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Which factors are crucial for increasing
the participation of buildings
in demand flexibility?

Supply-demand balance in traditional vs smart electric grid

Traditional electric grid

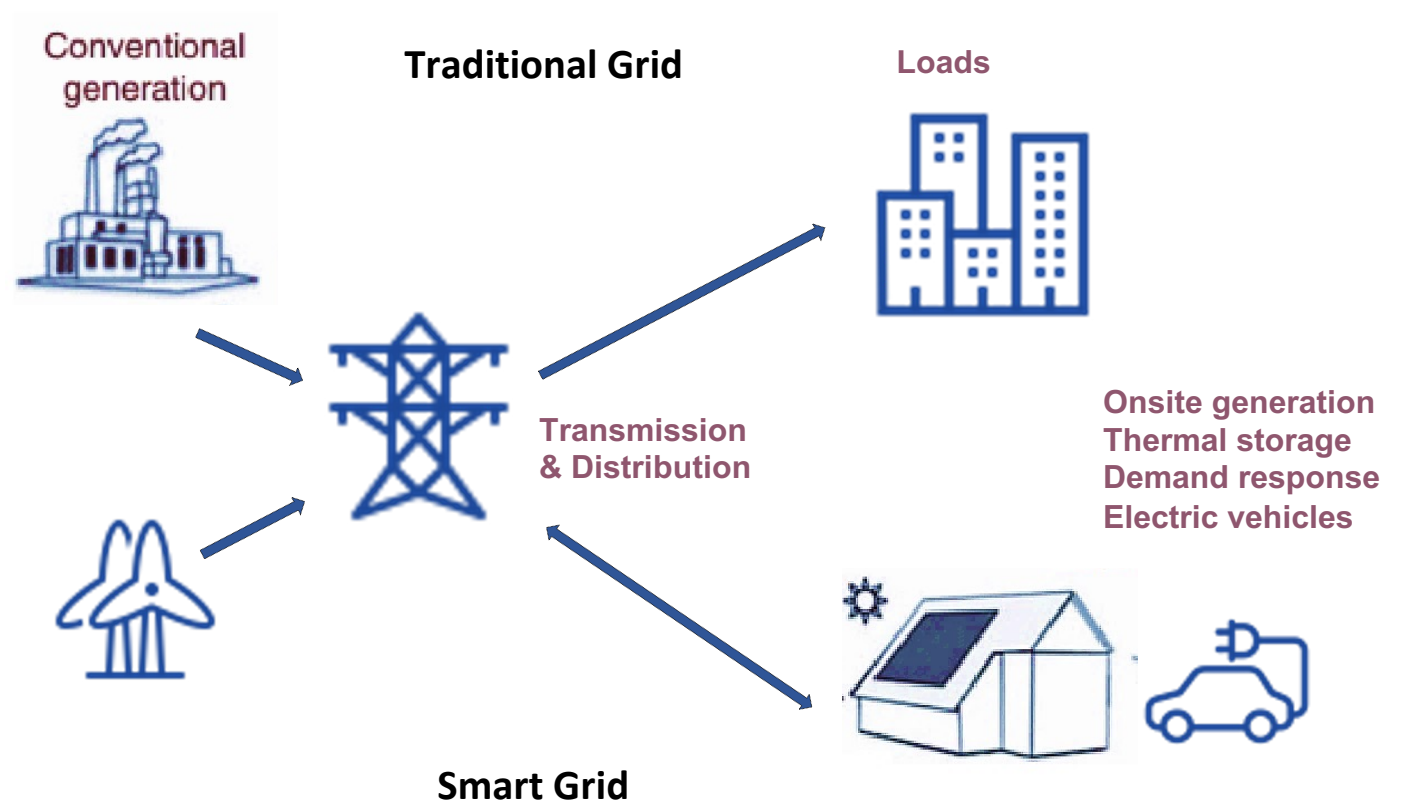
- Managed at supply side
- Peaker plants
- Fossil fuels

Smart electric grid

- Managed at demand side
- Flexibility of loads
- Renewable generation

Advantage

- Reduce reliance on fossil fuels



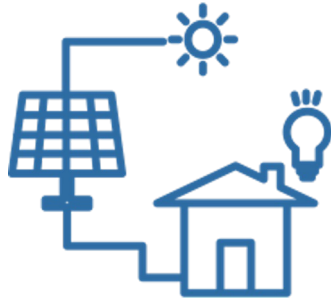
Source: Adapted and Modified from Gilbert Masters, 2013

Demand flexibility

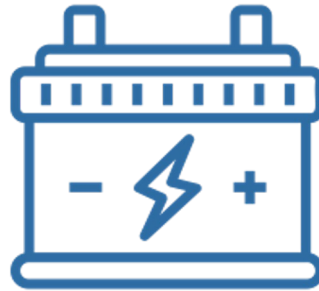
What

Balancing supply-demand by adjusting loads rather than increasing generation

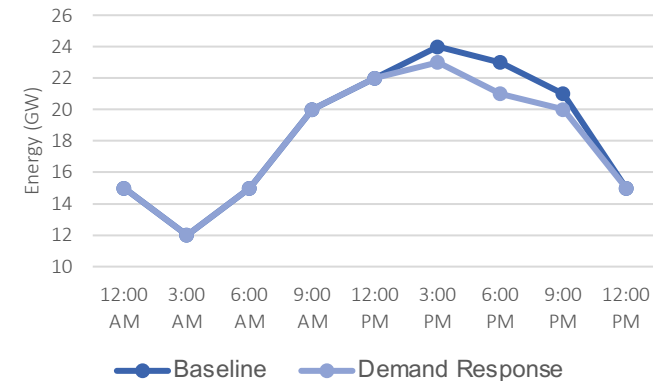
How



On-site generation



Storage



Demand response

Why

- Meet decarbonization targets
- Increase renewable mix
- Reduce peaker plant

Emissions from one Peaker plant
~ 20,000 tons CO₂

What makes building loads demand flexible?

Thermal Inertia

- Pre-heat or pre-cool (Load Shift)
- Lower heating/cooling loads (Load Shed)
- Frequency/voltage regulation (Modulate)

Flexible Loads

- Defer to off-peak (Load Shift)

Examples:

Multi-family



Retail



Warehouse



Education



Aggregate
building loads

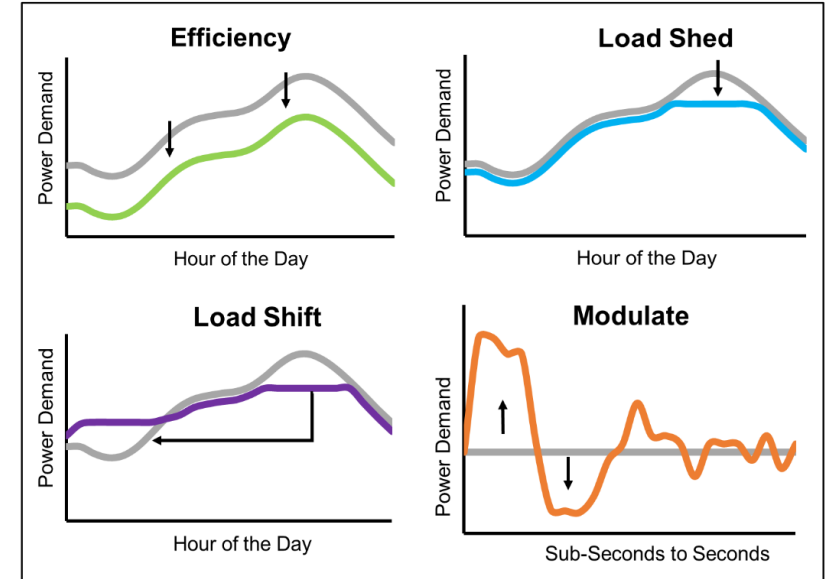


Image credit: Neukomm et al. 2019

Demand response measures in U.S. residential and commercial buildings

End-uses

- Space cooling
- Space/water heating

Measures

- Air conditioner duty cycling
 - 10 -30 minutes off/hour
- Space temperature change
 - 2°F - 6°F change from baseline
- Light dimming (Commercial only)
 - 20% - 40% dimming

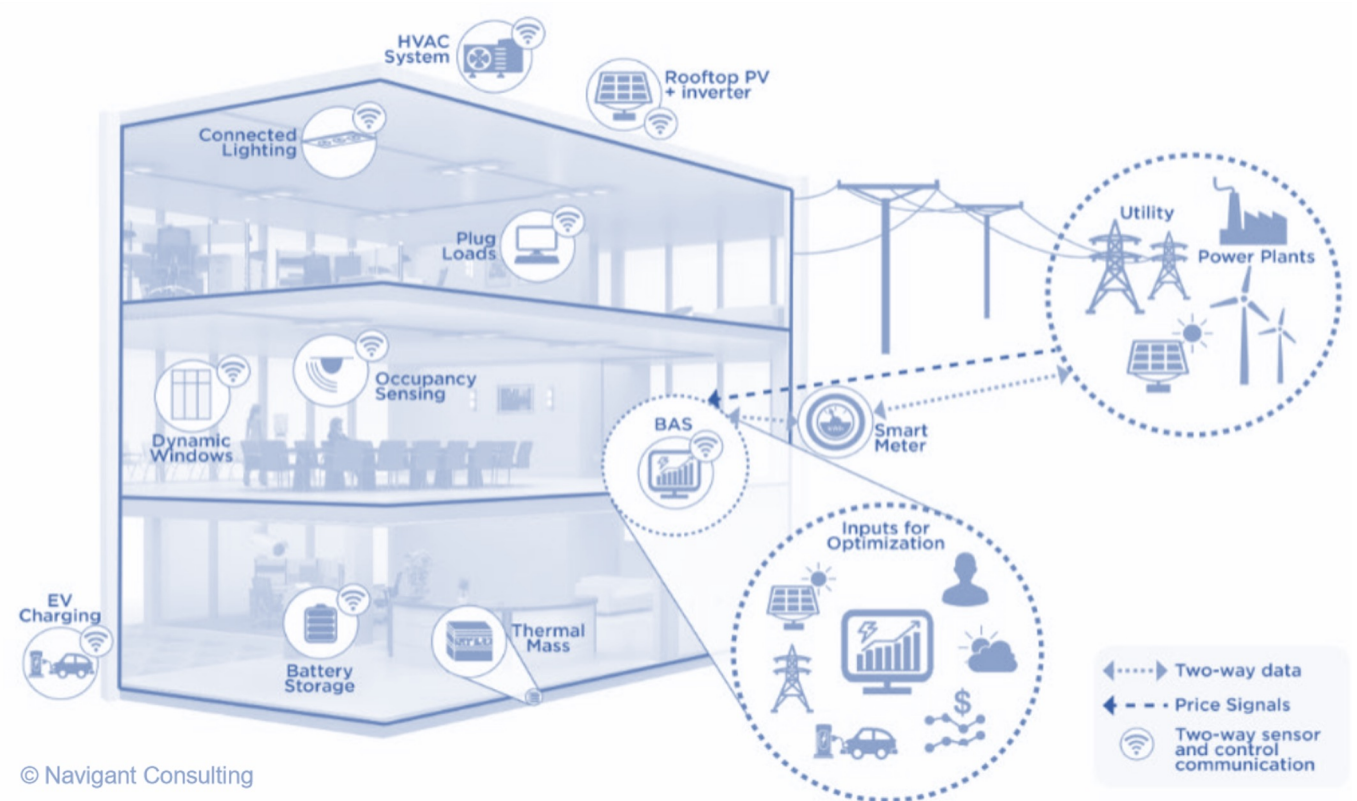


Image credit: Neukomm et al. 2019

Demand flexibility potential of U.S. residential and commercial buildings

Existing Potential

- Annual energy savings
 - 221 TWh
- Current battery storage
 - 402 MW



Annual Energy Use of ~ 20k U.S. Homes

2030 Potential

- Annual energy savings
 - 505 TWh – 622 TWh



Annual Energy Use of ~ 50k U.S. Homes

Value of demand response participation to building sector

Building Sector

- Attract investments for building decarbonization
- Compliance pathway
- Increase ROI of energy efficiency investments

Building Owners/Occupants

- Financial
- Consumer to prosumer

Societal

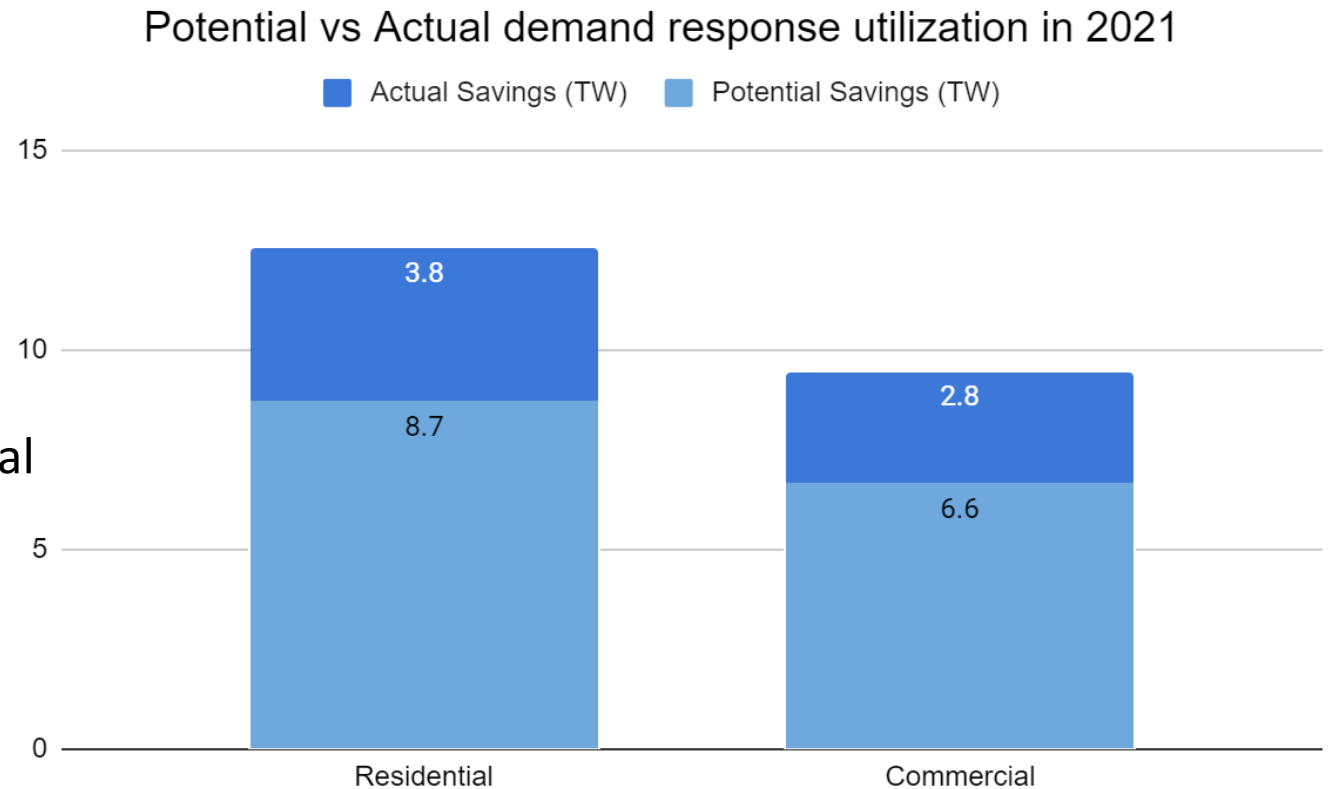
- Air quality
- Health
- Energy resilience



Current utilization of residential and commercial demand response

Potential vs Actual Savings

- % of peak demand
 - Potential-10%
 - Actual-4%
- Utilization
 - Actual 43% of estimated potential



Data Source: EIA, 2021; Alstone et al. 2017

More than 50% of savings are unrealized!

Participation rate <5 %

Which factors are crucial for increasing
the participation of buildings
in demand flexibility?

Barriers to demand response participation: Literature

Technological

- Enabling devices
- Communication
- Coordination
- Computing

Economic

- Regulatory
- Market structure
- Stakeholder incentive
- Program complexity

Social

- Inertia
- Awareness
- Education
- Thermal comfort

Adapted from N. Good et al. 2017

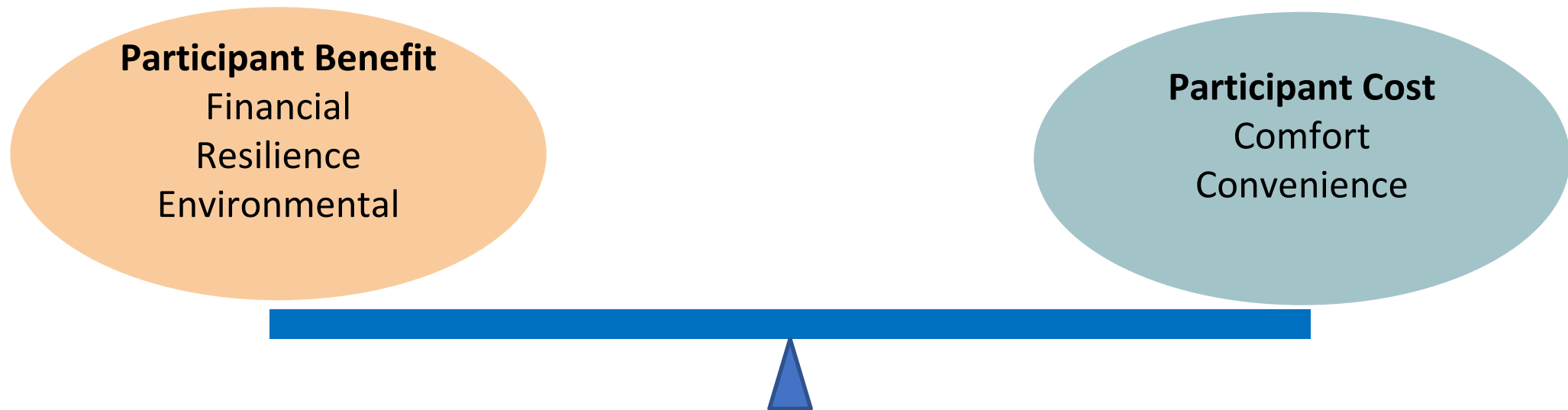
Participant benefit vs cost framework

Demand response program attributes:

Rate Structure, Technology,
Communication, Feedback

Participant characteristics:

Socio-demographics, Preferences,
Proclivities, Building characteristics



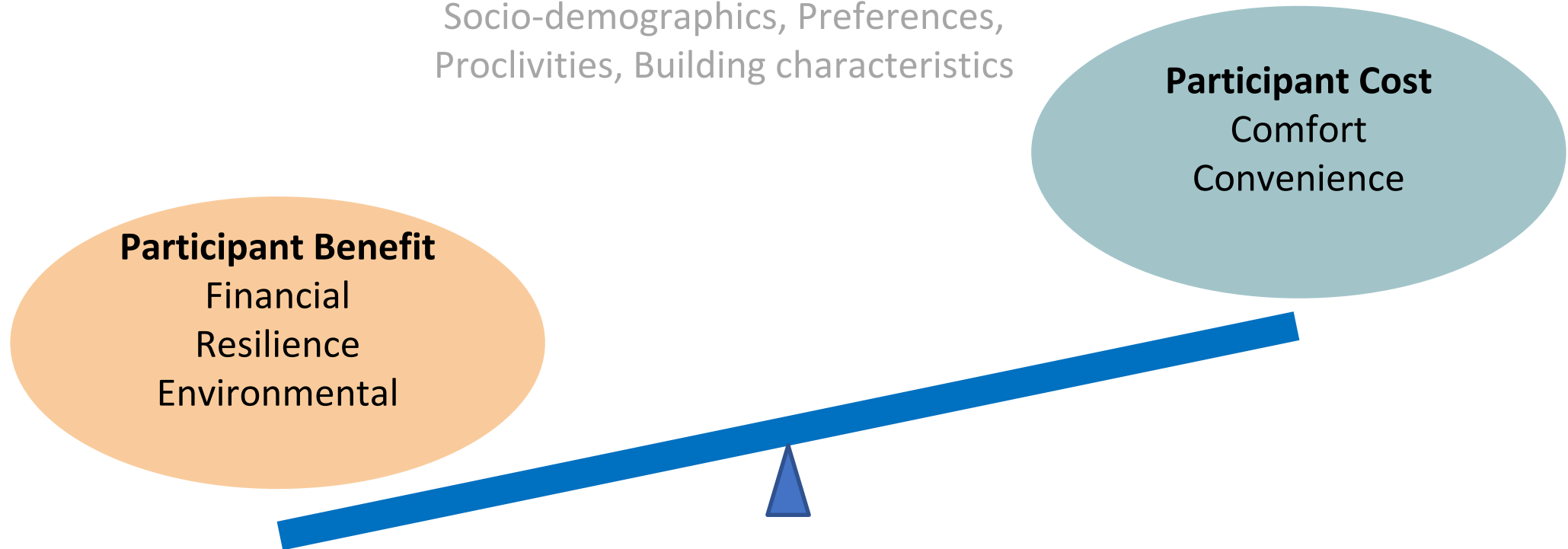
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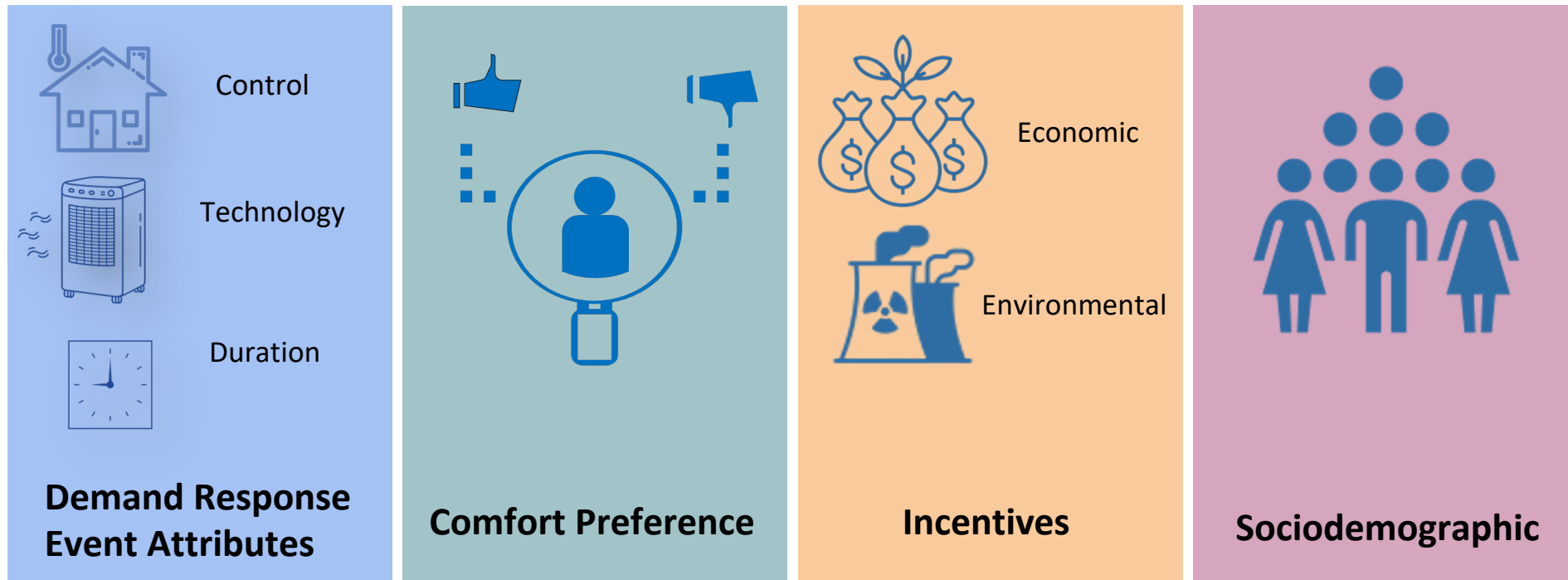
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What factors impact demand response participation and actual savings?



Improve the participation decision making process and effectiveness of demand response

Q&A

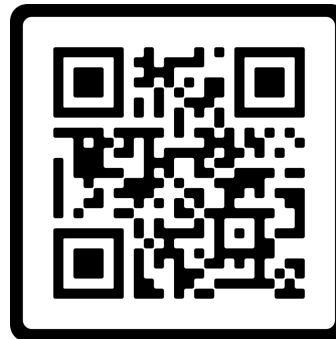
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<https://qrco.de/bdtsdl>

SUMMARY SLIDESHOW PDF TEMPLATE

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Demand response participation: building sector perspective

Objective

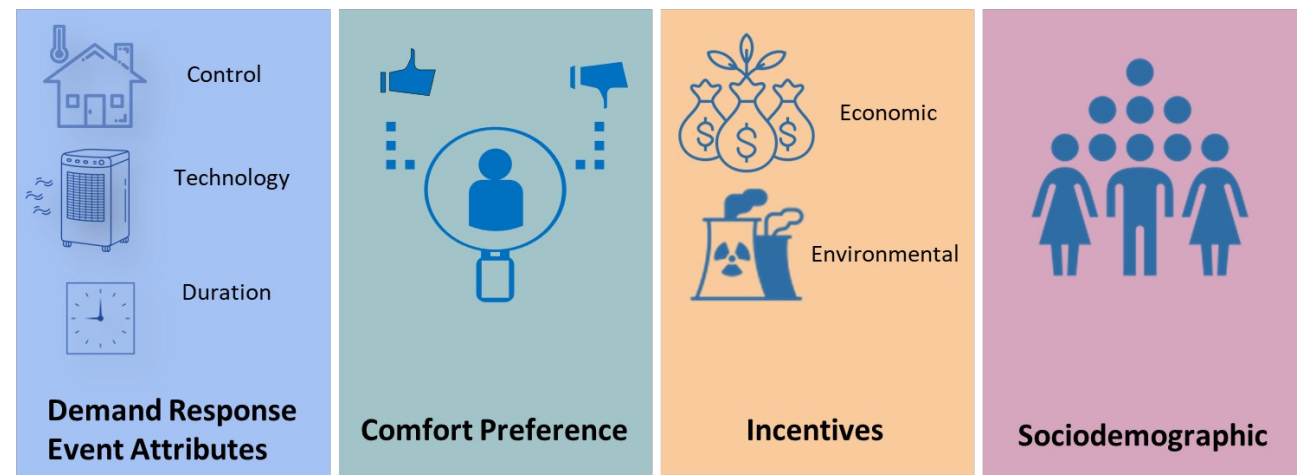
- Identify factors to improve building electric load demand flexibility

Approach

- Identify need for participation
- Identify barriers and impact of thermal discomfort in participation decisions
 - Field studies
 - Behavioral modeling

Funding

- U.S. Department of Energy
- CalFlexHub and CBE



Factors impacting demand response participation and actual savings

\$100 B opportunity but currently underutilized

The opportunity

- Worth \$100 B
- Current participation is less than 5%
- Building sector can benefit financially
- A compliance pathway to meet current and future regulatory requirements

Barriers to participation

- Social barriers- particularly concerns around thermal discomfort is not well quantified in literature
- Factors impacting participation decisions include:
 - Attributes of the decision maker(socio economics, comfort preferences)
 - Attributes of the demand response event (technology, event duration)
- Research Gap: Identify how these factors interact to impact participation and aggregate savings

Research Impact

Improve the potential of demand response participation to be:

- Occupant-centric and
- Equitable
- For all residential and commercial building types

Facilitate demand response participation as a practical pathway for decarbonization

- To improve energy resilience and
- Improve air quality