A National Roadmap for Grid-Interactive Efficient Buildings

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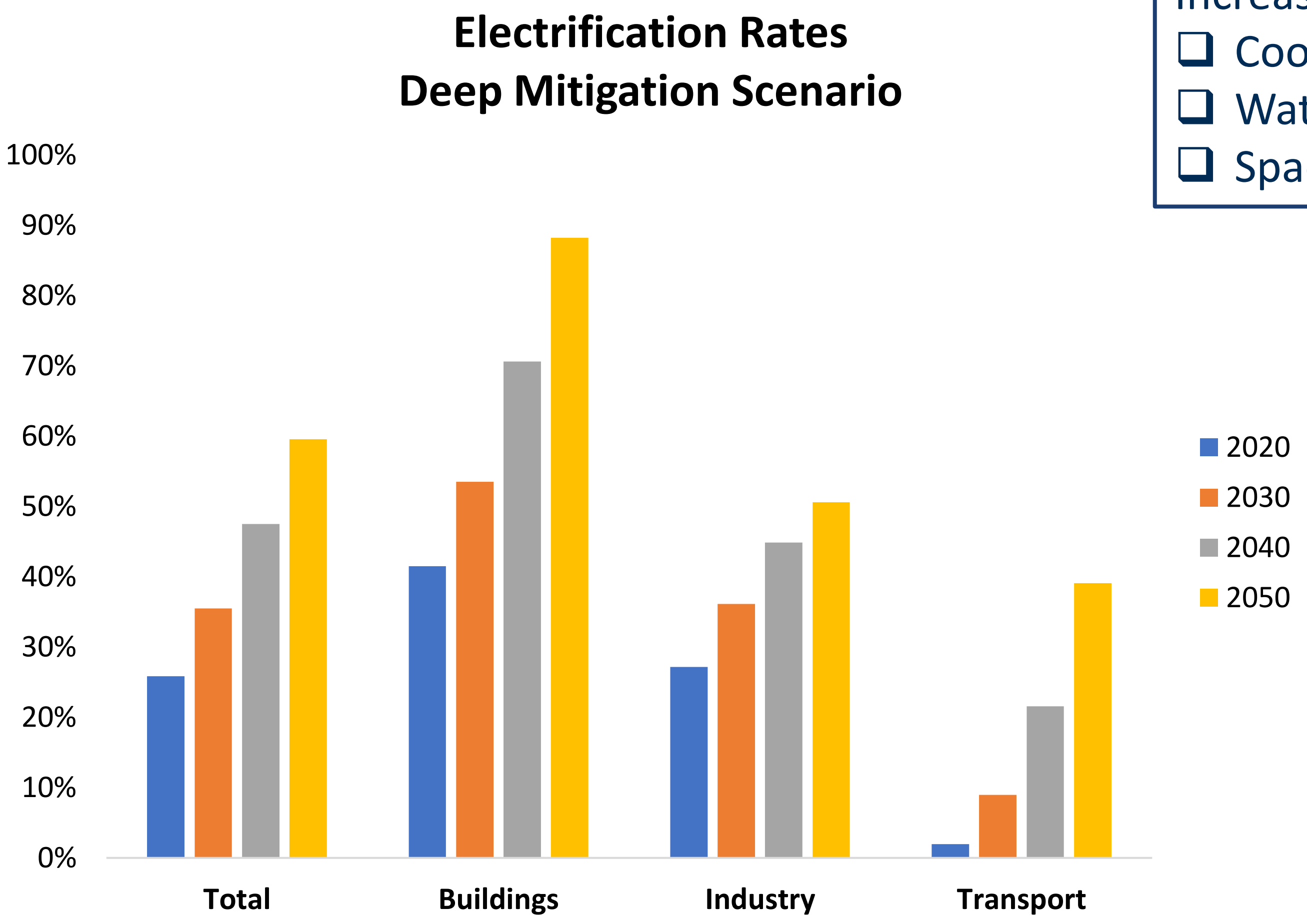
Energy Technologies Area
BERKELEY LAB

Electrification in China

In China Energy Outlook's Deep Mitigation Scenario, overall electrification reaches 60%, led by buildings at 88%; industry only reaches 50% while transport is at 40% due to challenges electrifying some forms of trucking along with shipping and aviation.

Increased building electrification for
- ❑ Cookstove
- ❑ Water Heating
- ❑ Space heating



Note: Industry does not include electricity inputs to transformation sectors

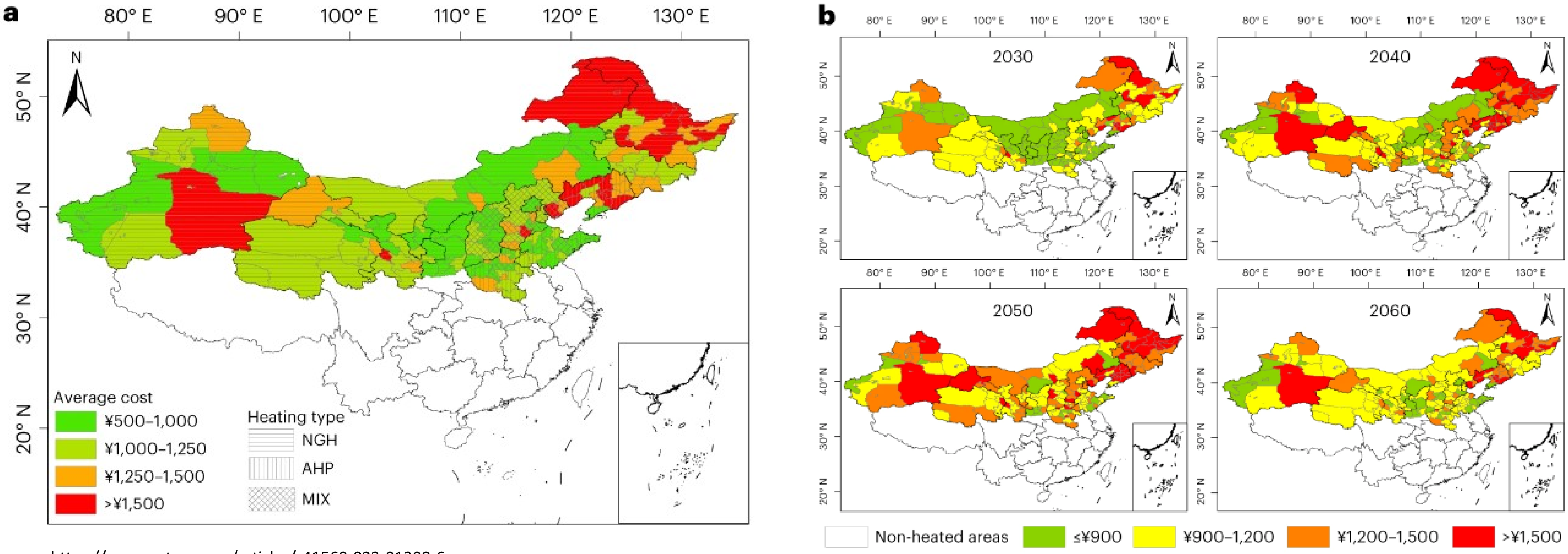
Key Building Milestones

Reference Scenario
Deep Mitigation Scenario

	Scenario	2021	2025	2030	2050
Net zero energy buildings (share of the total building stock)	Reference	2%	3%	5%	15%
	Deep Mitigation	2%	10%	24%	60%
Electrification of space heating (North)	Reference	2%	3%	4%	6%
	Deep Mitigation	2%	10%	20%	45%
Average heating efficiency	Reference	97%	97%	97%	98%
	Deep Mitigation	97%	128%	128%	166%
Average cooling efficiency	Reference	250%	262%	274%	298%
	Deep Mitigation	250%	270%	290%	370%
Distributed renewable energy penetration in buildings	Reference	4%	6%	8%	16%
	Deep Mitigation	4%	6%	8%	25%

Transition from fossil fuel-based heating to cleaner alternatives is likely to disproportionately increase residential heating costs

Annualized cost of household heating per capita



https://www.nature.com/articles/s41560-023-01308-6

The gap in heating burden between different regions will be widened under a fosil-free scenario. The average heating burden in Heilongjiang Province is as high as 5.7%, which is 4.4 times that of Beijing.

Why Grid-Interactive Efficient Buildings (GEBs)?

Integrate the growing share of variable renewable energy

Reduce costs to replacing aging electricity system infrastructure and improve system reliability

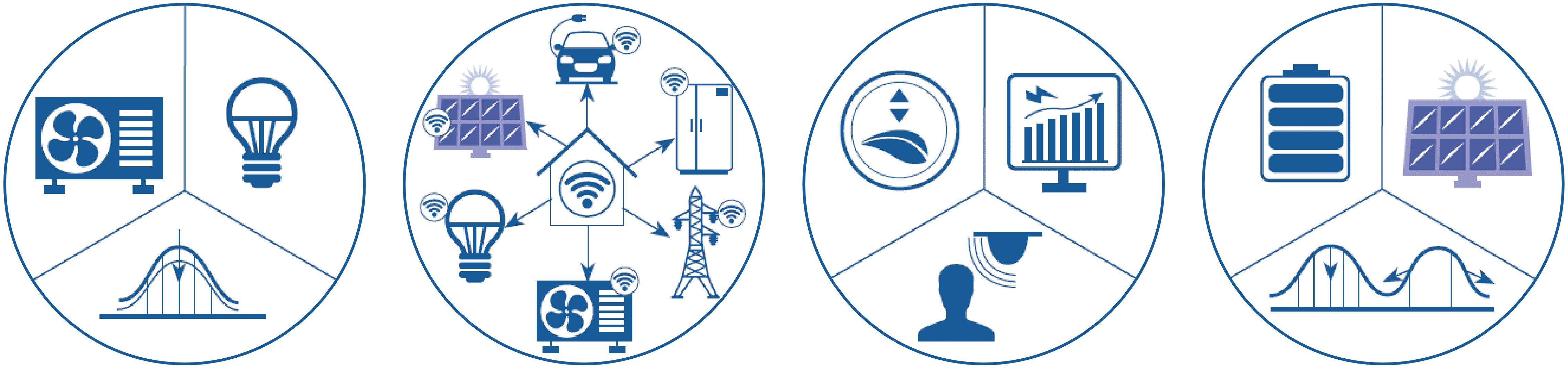
Assist in achieving decarbonization goals through reduced fossil fuel generation and increased heating electrification

Optimize energy use based on customer preferences

FLEXIBLE BUILDING LOADS CAN BENEFIT OWNERS, OCCUPANTS, AND THE ELECTRIC GRID

Source: A National Roadmap for Grid-Interactive Efficient Buildings. https://gebroadmap.lbl.gov/

GEBs are characterized by active, continuous, and integrated energy use



EFFICIENT	CONNECTED	SMART	FLEXIBLE
Persistent low energy use minimizes demand on grid resources and infrastructure	Two-way communication with flexible technologies, the grid, and occupants	Analytics supported by sensors and controls co-optimize efficiency, flexibility, and occupant preferences	Flexible loads and distributed generation/ storage can be used to reduce, shift, or modulate energy use

Figure source: Neukomm et al. (2019). Grid-interactive Efficient Buildings: Overview. US DOE Report.

The *Roadmap* presents key actions that could be taken immediately by a wide range of industry stakeholders

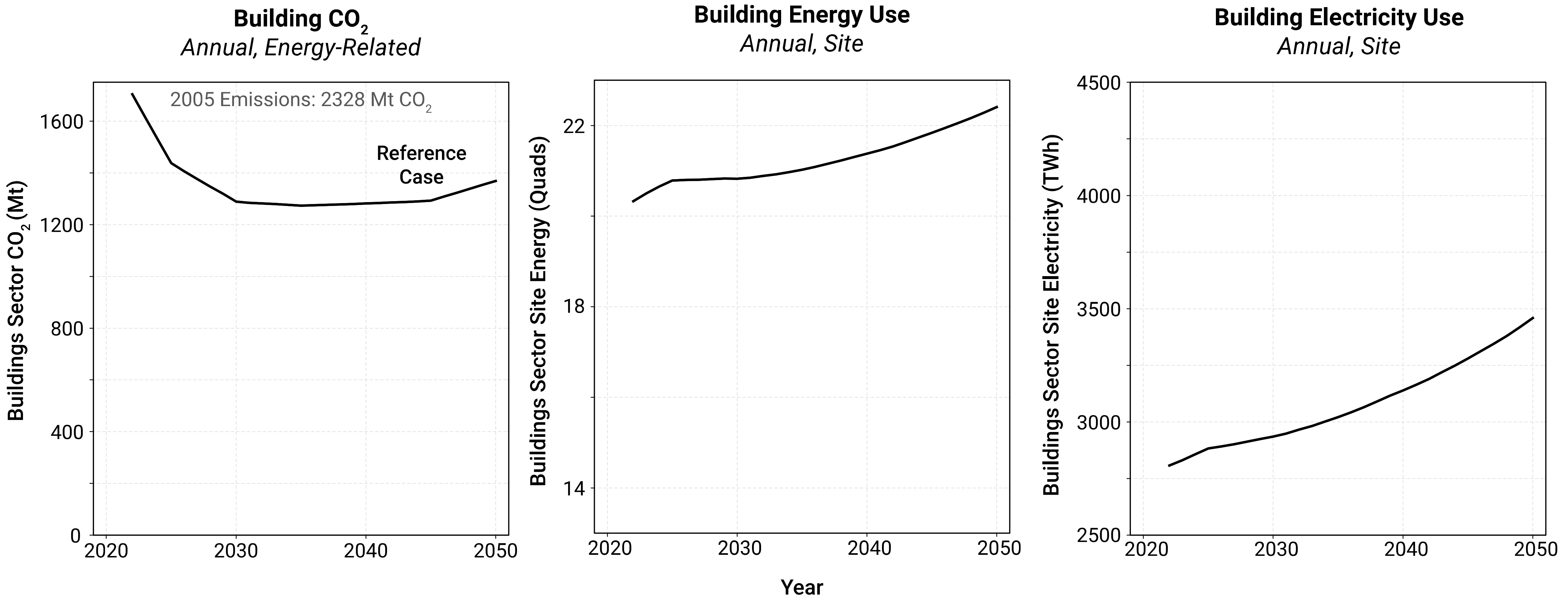
Roadmap objectives

- Estimate the value of the untapped GEB opportunity to the power system
- Define GEB technology features and integration considerations
- Identify and prioritize barriers, and recommend key actions for all industry stakeholders

More than 100 practitioners, researchers, regulators, policymakers, and other experts contributed to developing this *Roadmap*

- Efficient lighting and appliances plus a tight building envelope
- Load shedding allows the building to cut demand during peak hours
- Load shifting takes advantage of cheaper or cleaner power by shifting demand from one time of day to another when renewable energy is abundant on the grid.
- Modulating load with batteries and other electronic devices allows the building to maintain grid frequency or control system voltage.
- Generating power, like from rooftop solar, cuts bills, reduces losses on the grid, and reduces the need for more power plants.

U.S. building CO_2 emissions could be reduced up to 91% vs. 2005 by 2050 without increasing electricity demand



EIA AEO Reference Case: Decreasing emissions stall ~2030 while energy use and electricity both increase

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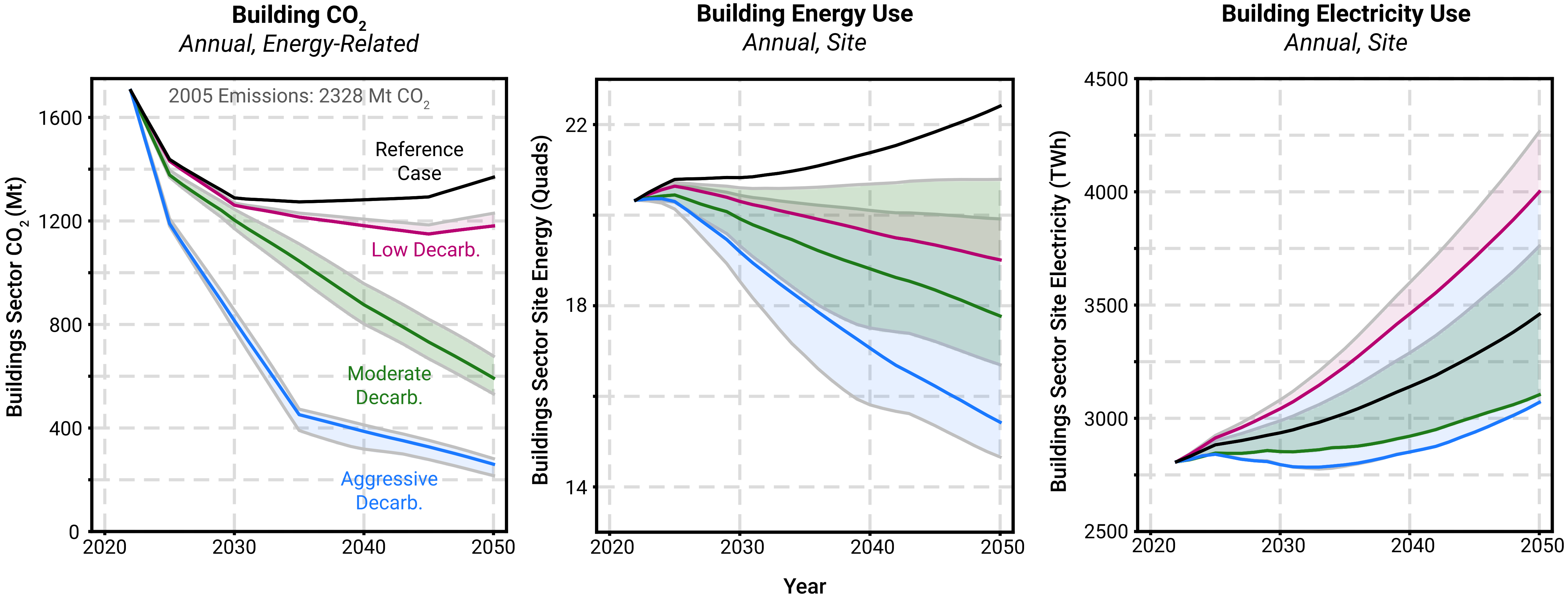


Overall: A wide range of possible futures; the most aggressive may be compatible w/ net zero economy-wide

- Plausible emissions offsets allocated in proportion to building sector GHG emissions total ~400 Mt CO_2

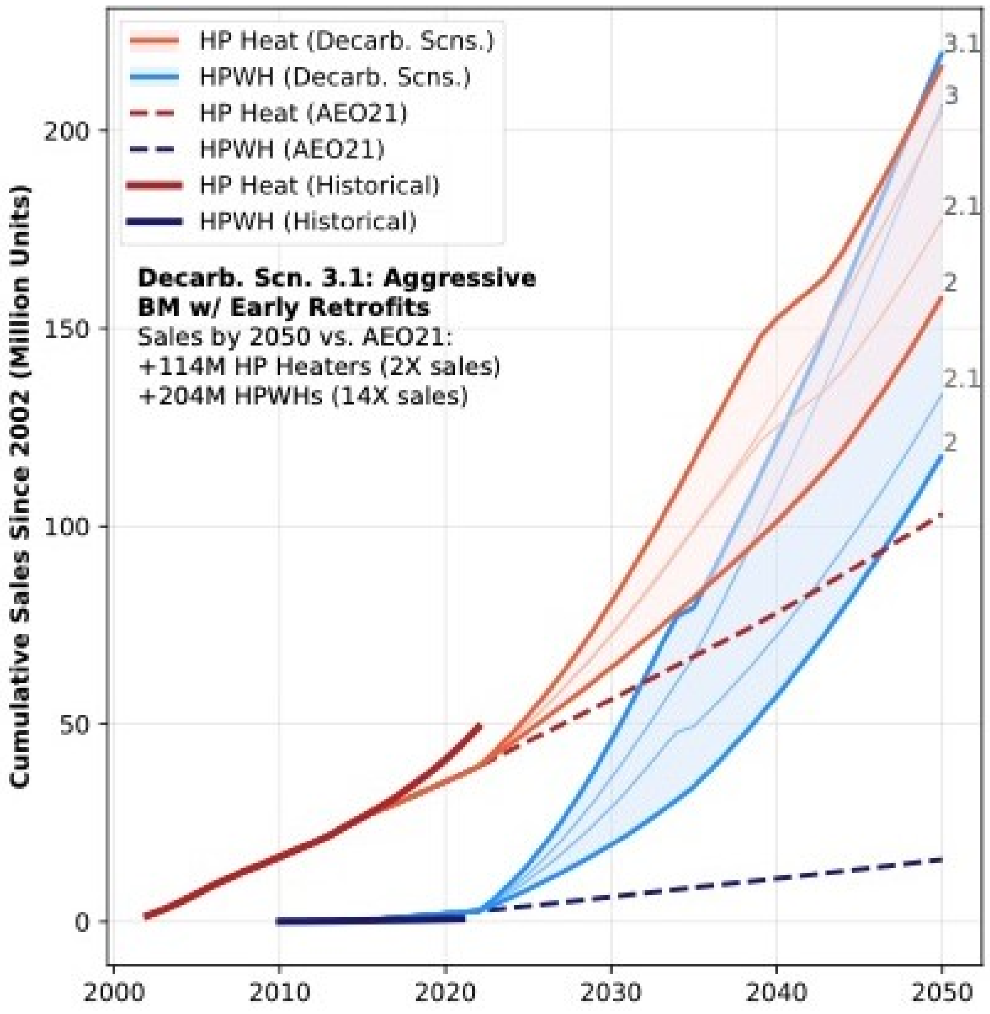
The most favorable scenarios require an unprecedented degree of change in the building sector that starts now

In our aggressive benchmark scenario (#3) between now and 2050:

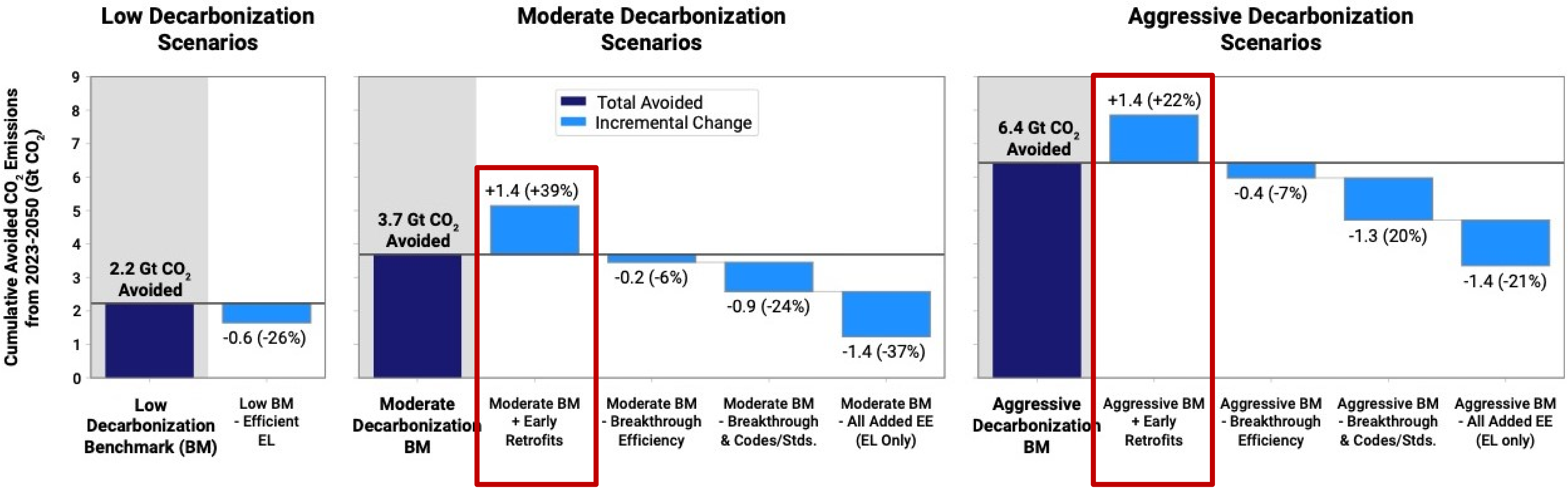
98M and 141M fossil- or resistance-based furnaces and water heaters converted to efficient heat pumps *(>half sales converted)*

Efficient envelope retrofits for 109M existing homes and 43B existing commercial sq.ft. *(~3% homes and ~2% commercial sf/yr.)*

>3/4 of homes and >1/2 commercial buildings have advanced controls for HVAC



Cumulative demand-side CO_2 reductions (2023-2050): Early retrofitting emerges as a factor with high near-term impacts



Early retrofitting behavior (e.g., replacement before end-of-life of equipment or component) is most impactful on cumulative emissions from 2023-2050 and has strongest influence before 2040

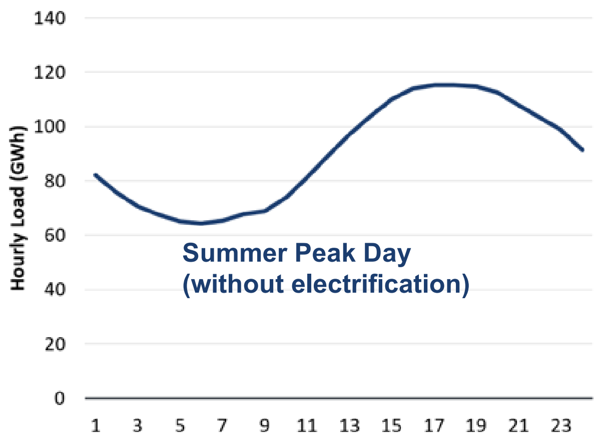
Analyzing the system benefits of EE, DF and efficient EL

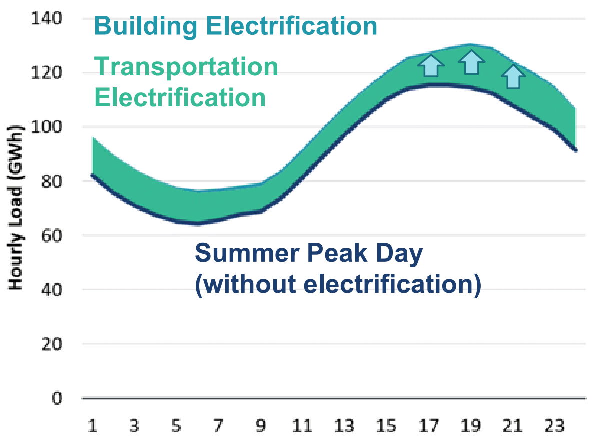
Our analysis considers three areas in which the measures provide cost savings to the bulk power system

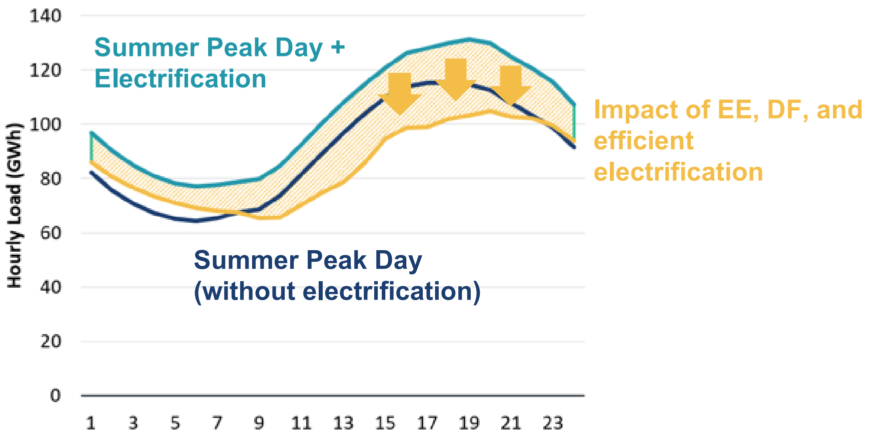
Benefit or Cost Category	Description
Reduced electricity generation variable costs	Reduced cost of generating electricity (i.e., fuel and variable O&M). Forecasted with hourly granularity using GridSIM.
Reduced electricity generation fixed costs	Reduced investment in generation capacity and fixed O&M. Driven by load growth and clean energy requirements, as forecasted using GridSIM.
Reduced transmission costs	Deferred investment in transmission system due to load reductions. GridSIM accounts for transmission investment costs by allowing for increases in transmission connections between regions.

Efficiency and flexibility mitigate electrification load increases

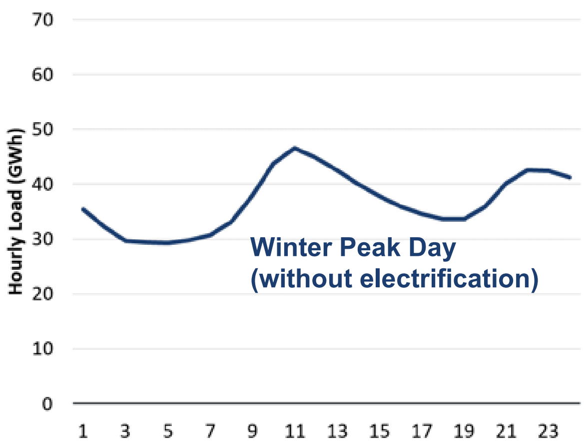
Texas 2050: Summer peak day with electrification and energy efficiency/demand response impacts

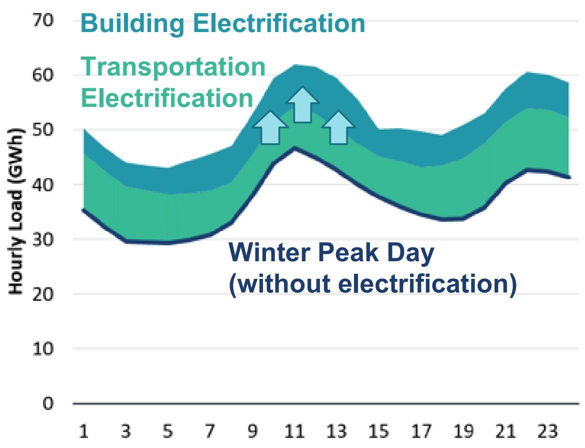


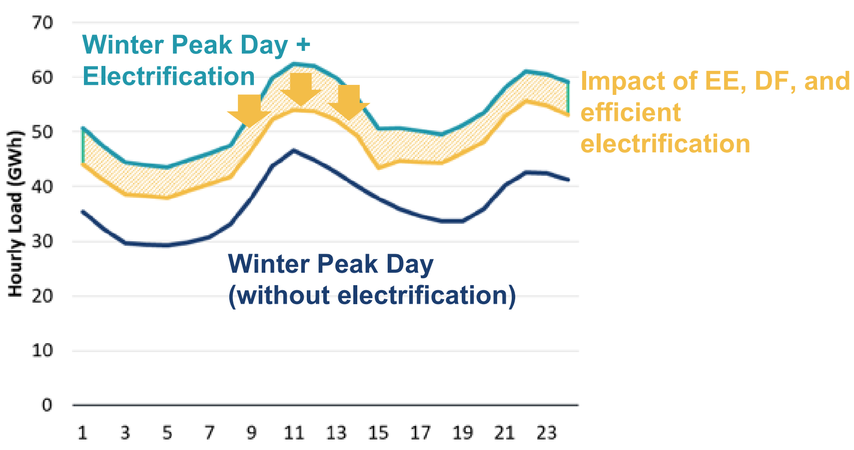




Northwest 2050: Winter peak day with electrification and energy efficiency/demand response impacts



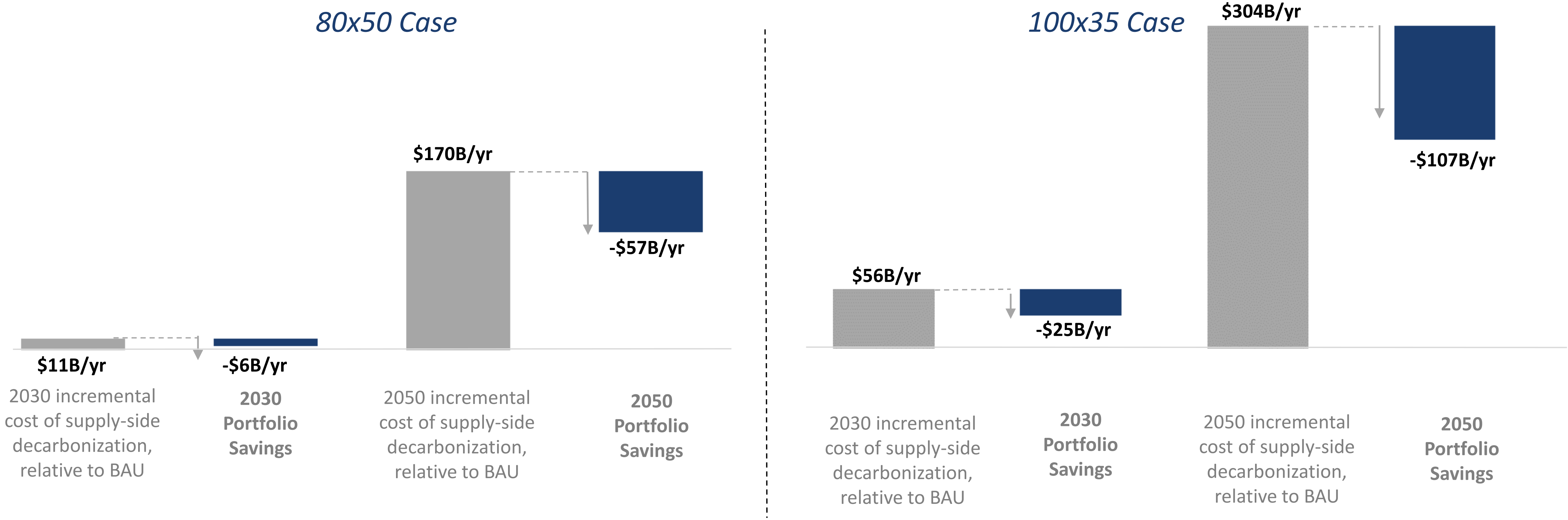




Gross benefits of the full portfolio

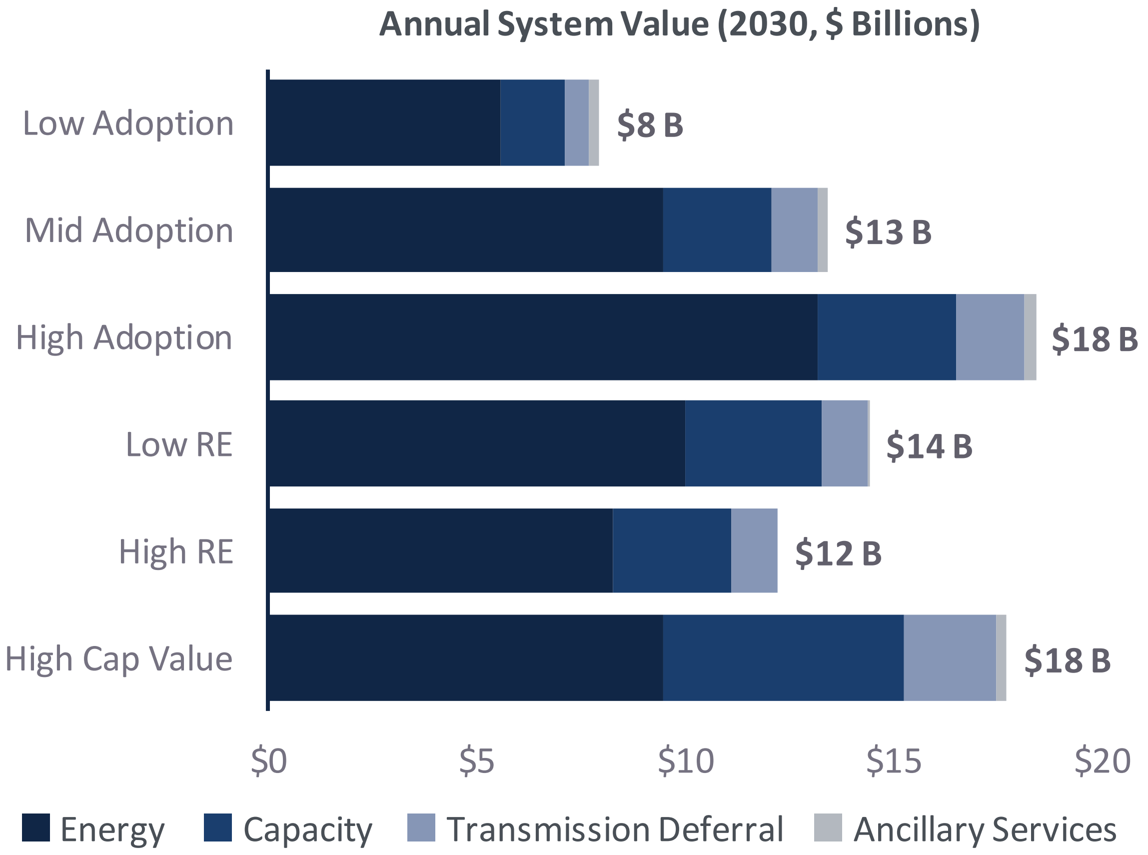
To put the cost savings in context, in 2050 gross benefits of the total portfolio would offset approximately 33-35% of the incremental cost of decarbonizing the power system.

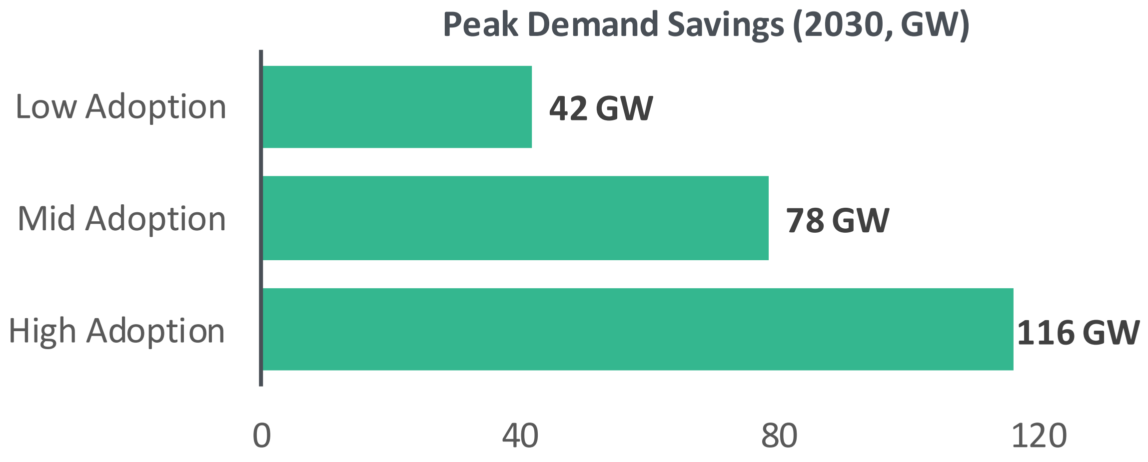
Reduction in Incremental Cost of Power System Decarbonization due to EE, DF, and Efficient EL

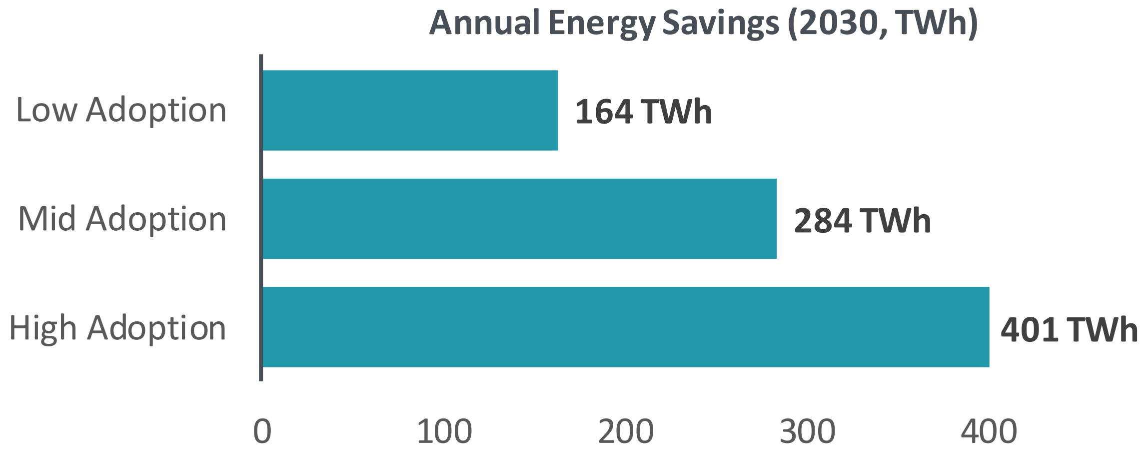


Note: $2022. Measure savings are derated to account for measure competition.

GEBs could save up to $18 billion per year in power system costs by 2030, or roughly **$100 to $200 billion** between 2020 and 2040

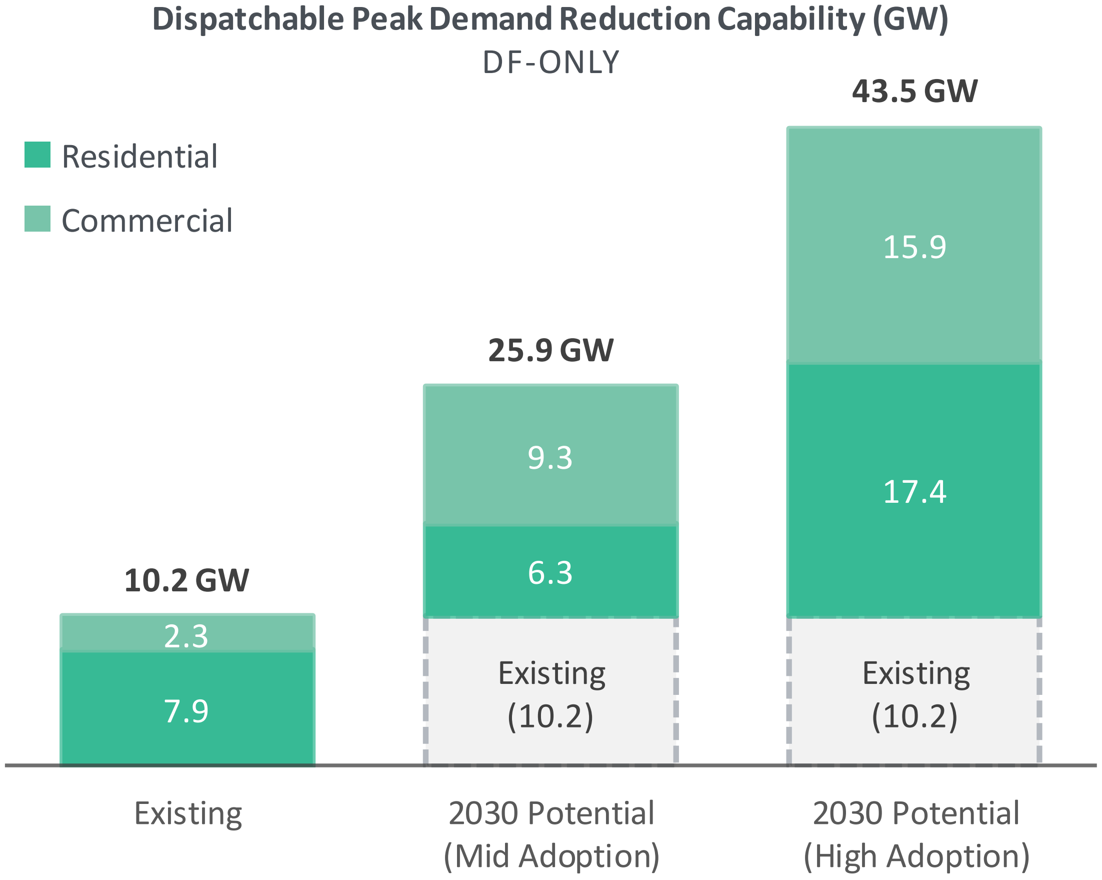


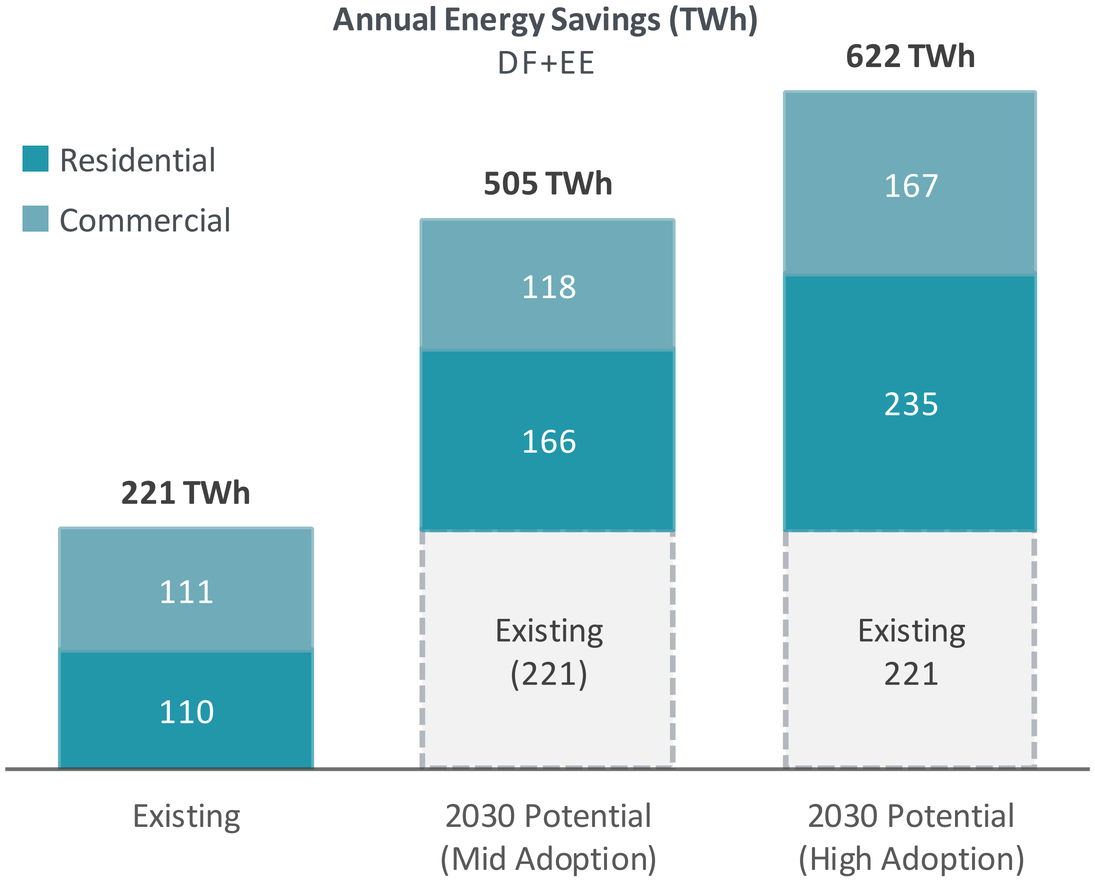




Notes: All in 2019 dollars. Peak demand savings are computed as the sum of impacts during each region's coincident peak hour. $100 - $200 billion reflects the NPV at a social discount rate of 4% nominal (2% real).

GEB adoption would significantly increase existing U.S. demand response and energy efficiency capability





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Additional GEB benefits not captured in this study could significantly increase the value estimate

Avoided or deferred need for distribution capacity: Geographically targeted EE and DF deployments can help to alleviate the need for demand-related distribution system upgrades

Reduced need for RPS-related builds: By reducing system load, EE reduces the amount of investment in renewable generation that is otherwise required to satisfy RPS requirements

"Option value": The benefits in this study are based on normal weather and load conditions. System costs can be disproportionately higher when load increases due to extreme conditions

Other consumer benefits: In addition to reduced costs and improved reliability, GEBs can improve the satisfaction of building owners and occupants, increasing choice and flexibility in how electricity is consumed, and in some cases, improve the overall comfort of building occupants.

Electrification: GEB benefits in this study would be considerably higher in a future scenario that involves significant electrification of heating and transportation. Higher electricity demand will increase the need for supporting grid infrastructure, which can be displaced through EE and demand flexibility.

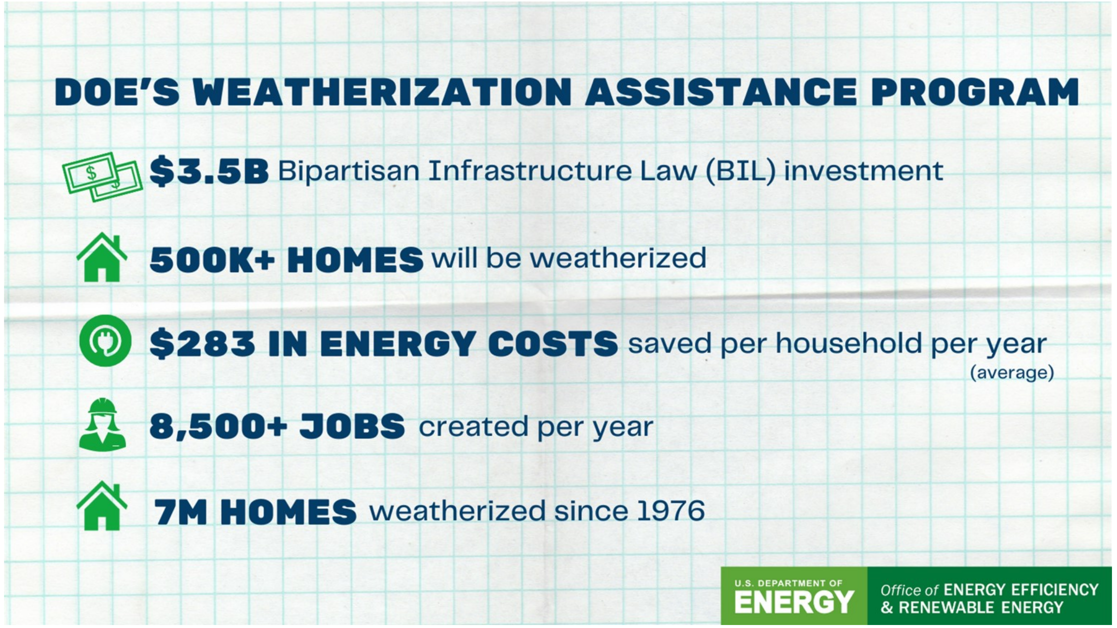
Thoughts on GEBs Research Agenda for China

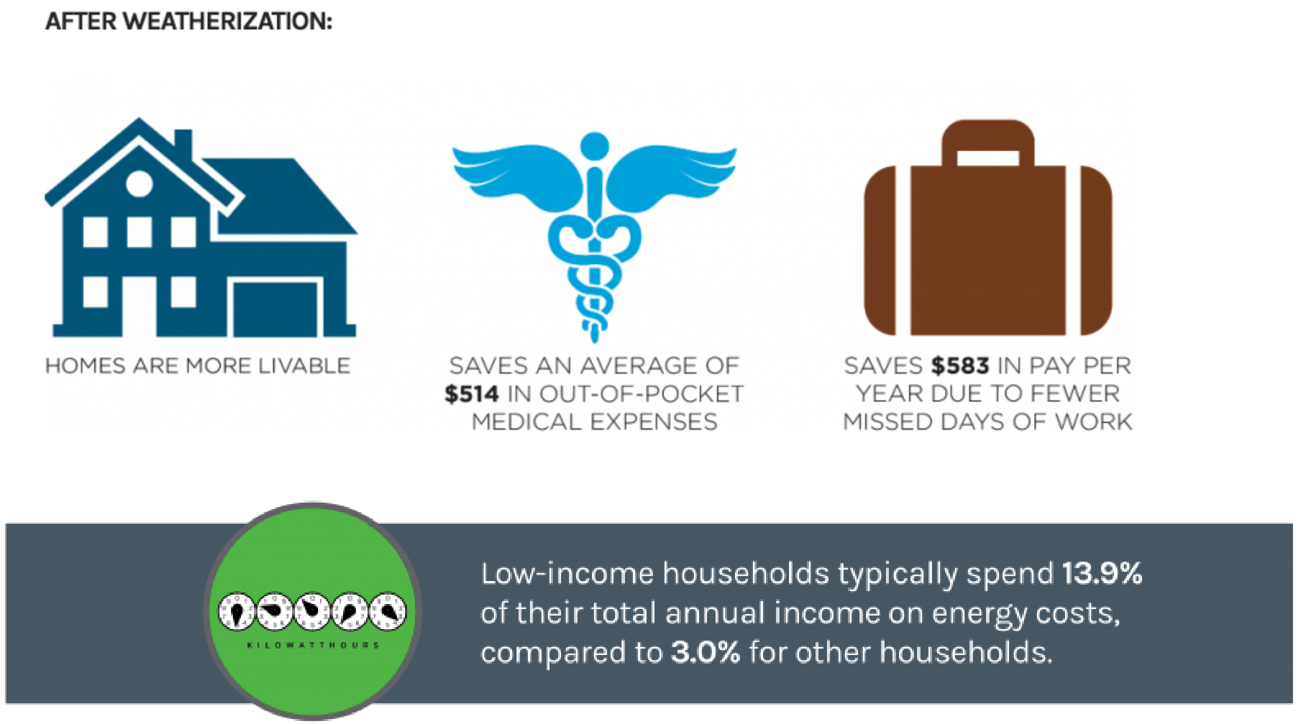
- ❑ Demonstrate the benefits of demand-side solutions to enable and accelerate electrification
- ❑ Pilot grid-interactive efficient buildings & connected communities
- ❑ Pilot large-scale building retrofit programs
- ❑ Develop weatherization program and subsidies for underserved population

Best practices in building retrofit incentive: Weatherization Assistance Program in the United States

Weatherization has operated for more than 40 years and is the nation's largest single "whole-house" energy efficiency program

Weatherization returns **$2.78** in non-energy benefits for every **$1.00** invested in the Program





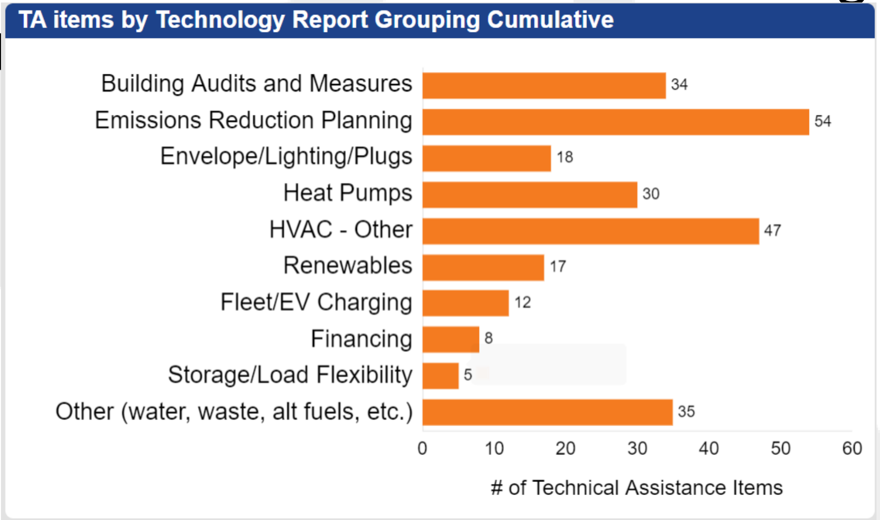
Best practices in building retrofit voluntary program: Better Climate Challenge in the United States

Technical

- Cold climate heat pumps
- Thermal storage
- Owner/Tenant system integration
- Central plant decarbonization
- Transitioning away from district steam

Better Climate Challenge

Work with market leaders to prove out new technologies, handle technical challenges, and set the example for the rest of the market. Develop case studies and other materials to magnify impact



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Piloting grid-interactive buildings

Piloting grid-interactive net-zero buildings, together with distributed energy systems and EV; to gradually achieve zero carbon emissions annually, monthly, daily, and hourly

https://newscenter.lbl.gov/wp-content/uploads/2023/07/2023_HOF_Infographic_11x17inches_V2.pdf

Connected Communities

Characteristics of a Connected Community

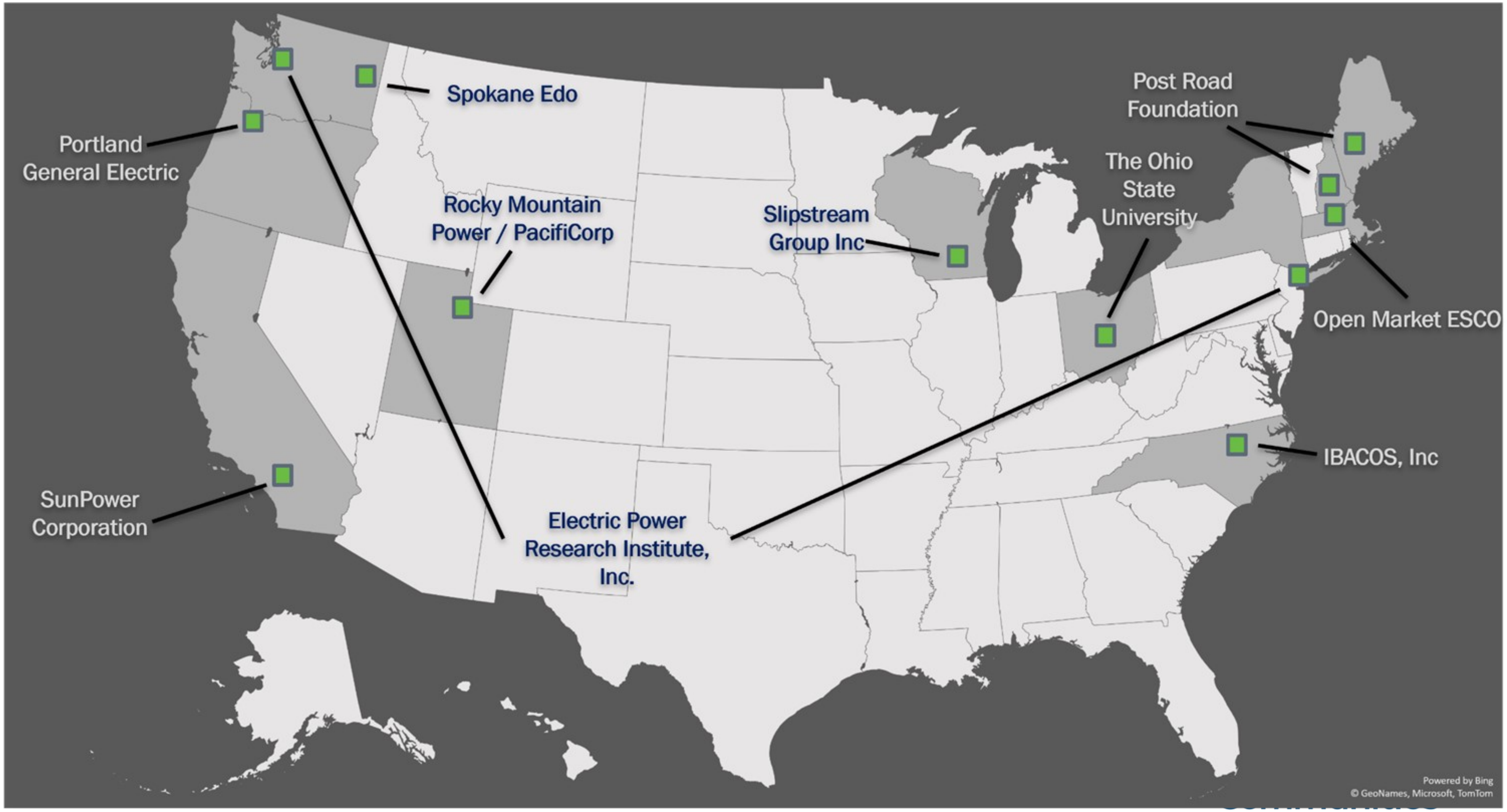
A group of grid-interactive efficient buildings (GEBs) with diverse, flexible end use equipment and other distributed energy resources (DERs) that collectively work to maximize building, community, and grid efficiency while meeting occupants' comfort and needs.

Connected Communities
U.S. DEPARTMENT OF ENERGY

Selected *Connected Communities* Projects

10 Selected Projects

- $61 Million Total funding
- Final Awards made March 2023



www.energy.gov/eere/buildings/articles/meet-does-newest-connected-communities-grid-interactive-efficient-buildings

U.S. DEPARTMENT OF ENERGY

BERKELEY LAB

Thank you!

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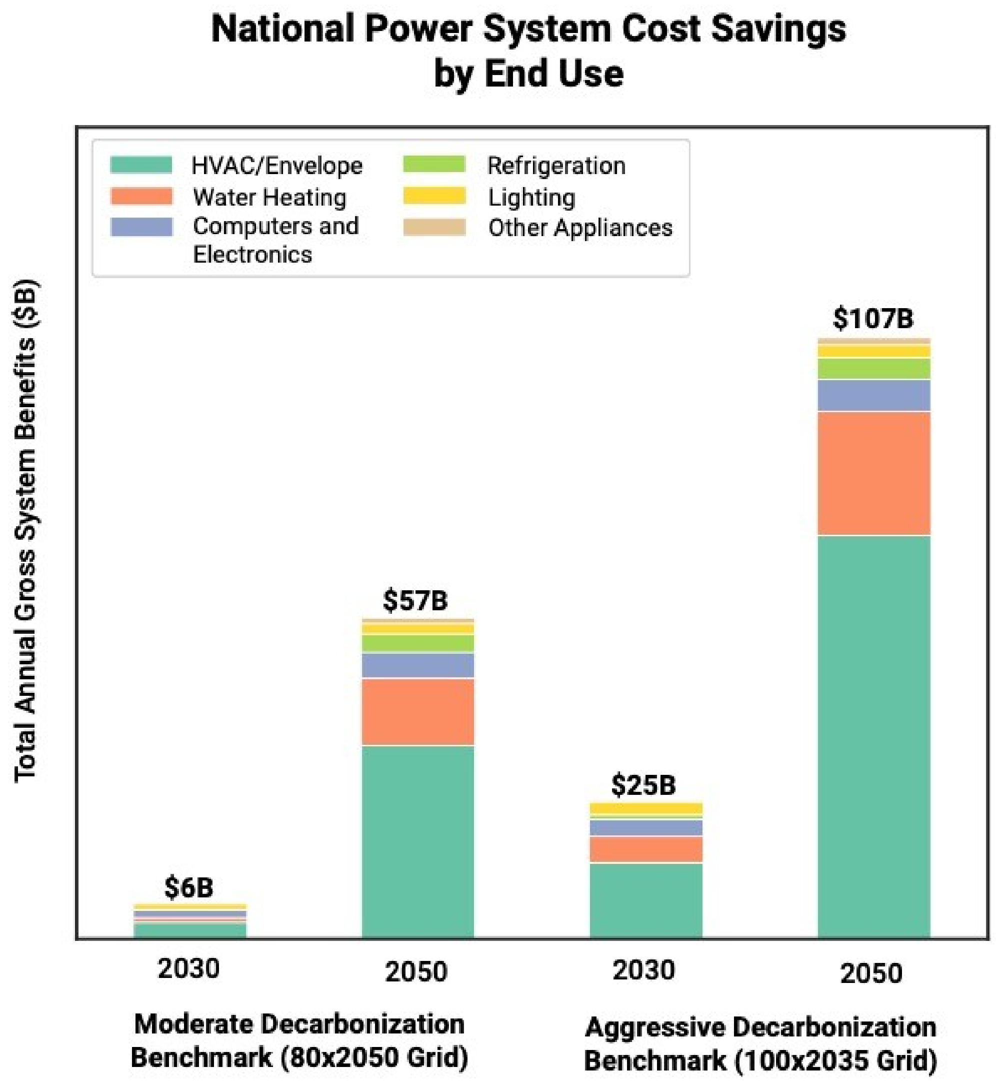
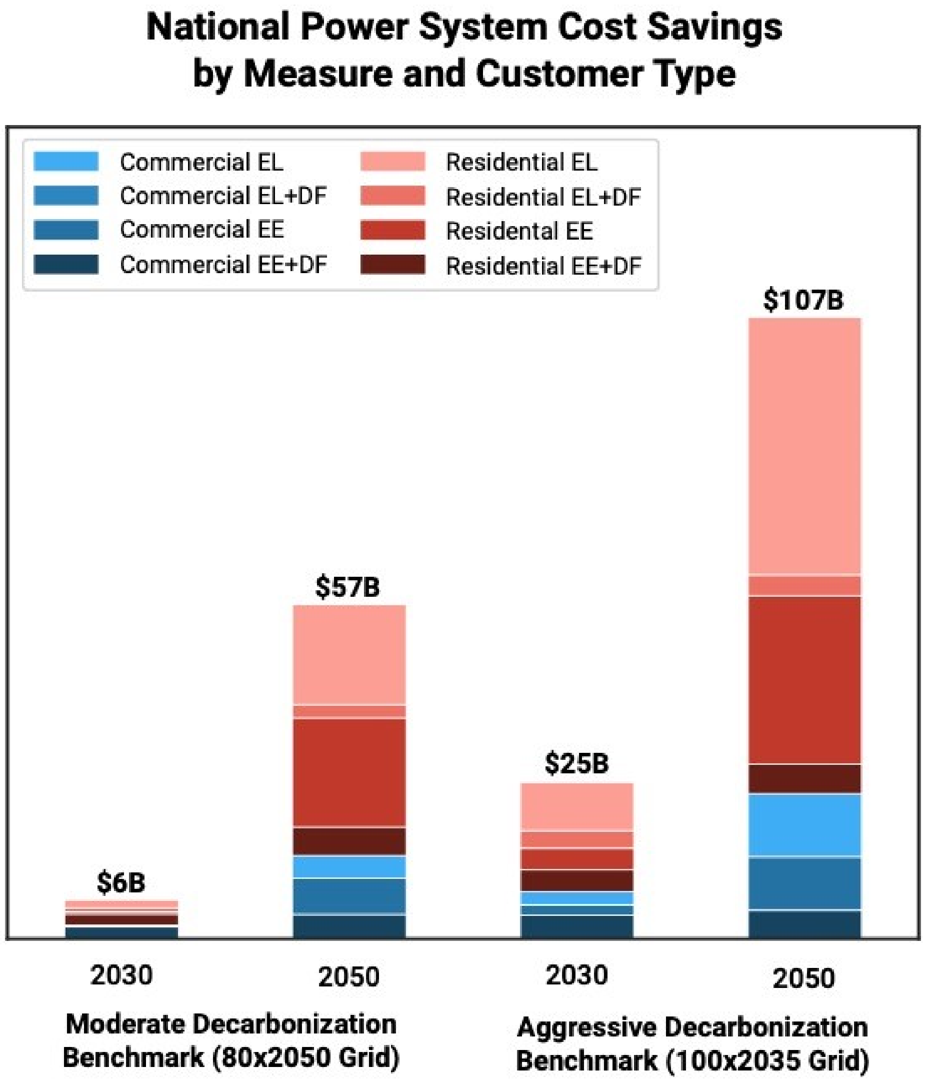
BENEFIT 1:
Avoid costly investment on the supply side; reduce the cost of energy transition

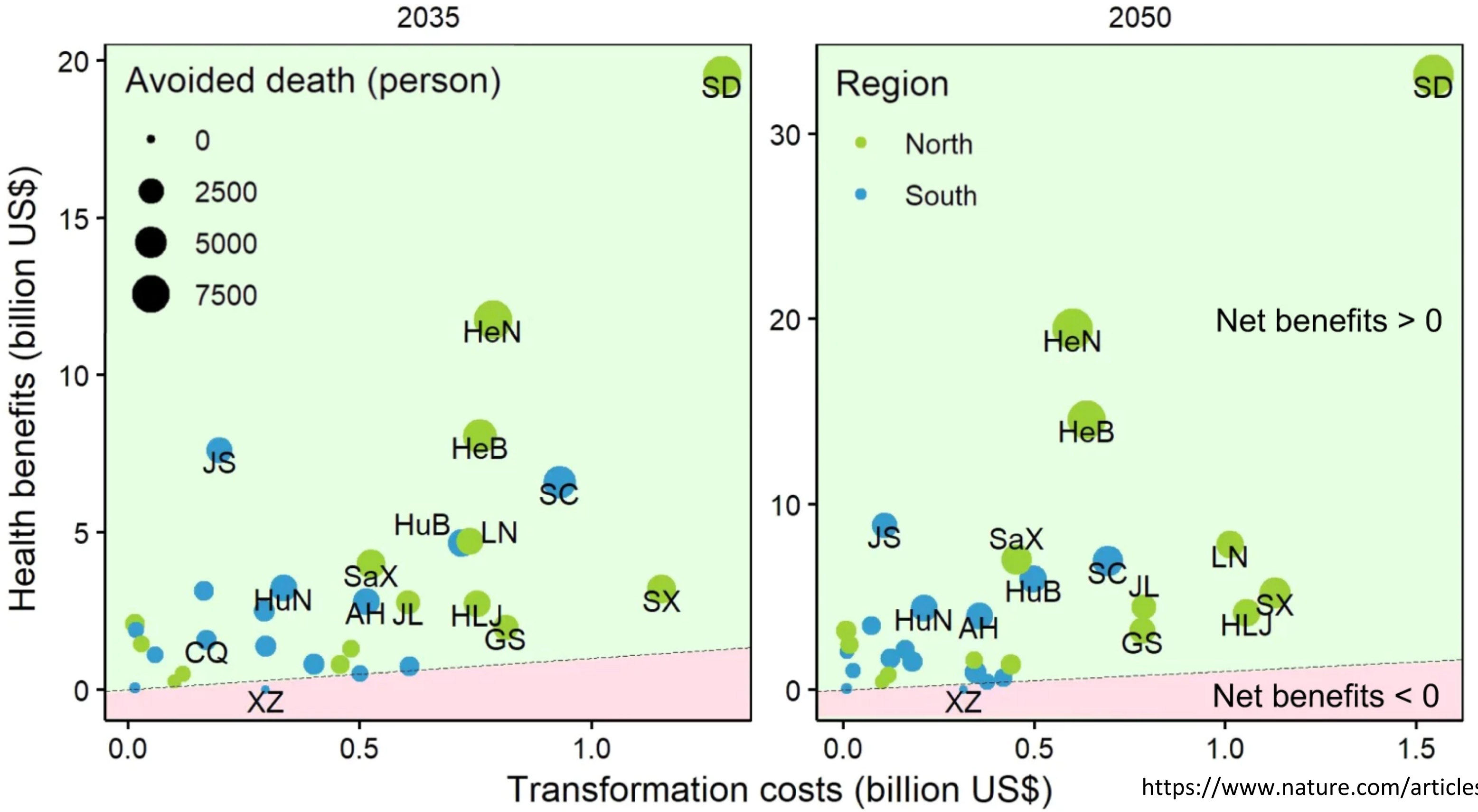




Source: buildings2050.lbl.gov

BENEFITS 2: improved air quality and health benefits

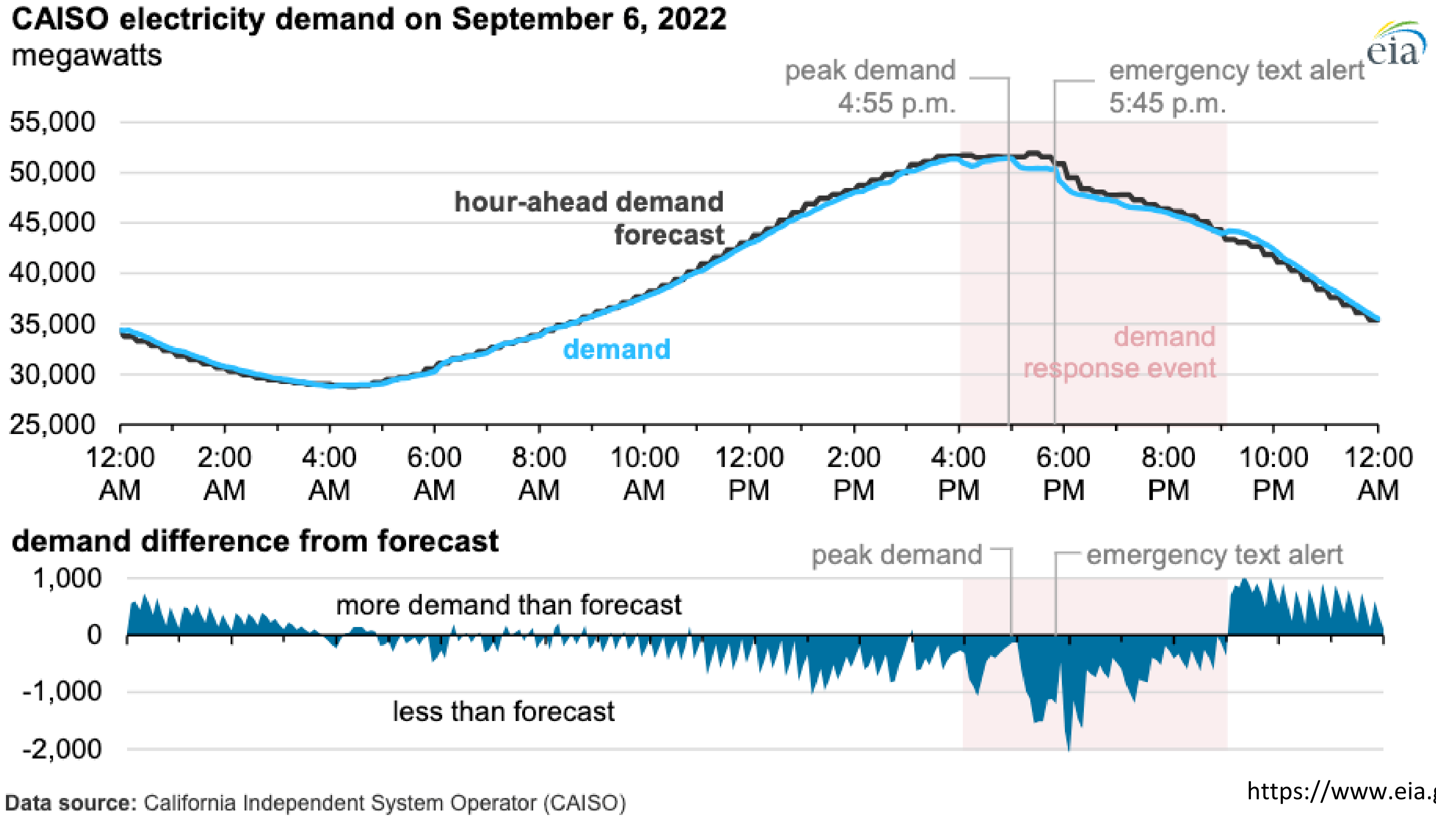
Rural cooking and heating transformation costs and monetized health benefits related to avoided $PM_{2.5}$-associated premature deaths at the medium value of statistical life (VSL) level in 2035 and 2050



https://www.nature.com/articles/s41467-023-41707-7

Energy transition and electrification can provide significant long-term net benefits to rural populations, though short-term energy burden may increase and will require financial assistance

BENEFIT 4:
Maintain grid reliability during extreme weather events



https://www.eia.gov/todayinenergy/detail.php?id=54039

During an extreme heat wave in early September 2022, California's power grid had trouble meeting record-breaking electricity demand as consumers turned up their air conditioning to keep cool. Within five minutes of the text alert, electricity demand in CAISO declined by more than 2,100 MW from the hour-ahead forecast.

BENEFIT 5:
Enhance energy security through GEBs solutions

Effect of policy interventions on 12 energy security indicators, in number of countries (*n* = 14)

Shading indicates the number of countries where energy security improved (●) or worsened (●) based on the given indicator due to the intervention. Policy interventions appear in decreasing order of performance.

SUPPLY INDICATORS	UE 2 - TRANSPORT ELECTRIFICATION	UE 1 - LOW-TEMP. HEAT DEMAND REDUCTION	FE 1 - FUEL SUBSTITUTION	PE 1 - IMPORT DIVERSIFICATION
Share of nonfossil fuels	14	9	14	–1
Import independency	13	9	13	0
Shannon diversity index PE	8	6	5	0
Compound Shannon diversity index PE	8	6	5	1
Compound Shannon diversity index PE with import diversification	10	8	6	10
DEMAND INDICATORS				
Compound Shannon FE	11	3	9	–1
Compound Shannon FE including electricity by source	7	7	9	1
Final energy efficiency	13	14	0	1
% of energy expenditures/GDP	14	13	13	–1
Savings in energy expenditures/ fossil total PE/GDP	12	11	10	–2
Savings in energy expenditures/ GDP	14	14	12	1
Savings in primary energy demand	14	14	–8	1
Total (improved net of worsened)	**138**	**114**	**88**	**10**
Total worsened	12	23	29	9
Total improved	150	137	117	19

FE, final energy; GDP, gross domestic product; PE, primary energy; UE, useful energy.

The *Roadmap* presents key actions that could be taken immediately by a wide range of industry stakeholders

Roadmap objectives

- Estimate the value of the untapped GEB opportunity to the power system
- Define GEB technology features and integration considerations
- Identify and prioritize barriers to GEB deployment and to achieving the untapped potential
- Define options for overcoming the barriers, and recommend key actions for all industry stakeholders

More than 100 practitioners, researchers, regulators, policymakers, and other experts contributed to developing this *Roadmap*

Roadmap scope and boundaries

SCOPE & APPROACH

- Focuses on **opportunities for residential and commercial building loads** over the next ten years (to 2030)
- **Discusses all DERs** with a particular focus on the efficiency and active management of building electricity consumption

AUDIENCE

- Includes **actionable recommendations for all electricity industry stakeholders** with a potential interest in GEBs
- Does not prescribe specific actions but **provides options to realize GEB benefits**

The $100-$200 Billion GEB Opportunity

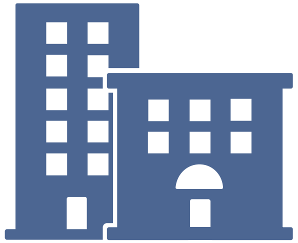
The power system value of GEBs was quantified using a sophisticated suite of modeling tools developed by DOE, LBNL, NREL, and Brattle

Define GEB measures to represent the best commercially available technology for major building end-uses

LBNL/NREL analysis

Simulate GEB technology performance for thousands of individual buildings on an 8,760 hourly basis

NREL's ResStock & DOE's Commercial Prototype models



Scale building characteristics by region, to align with the size, mix, and weather characteristics of 22 U.S. regions

BTO's Scout model

Adjust estimates to reflect achievable adoption rates and stock turnover, based on review of regional and national EE and DR studies

Brattle analysis

Develop forecasts of system costs through 2030, including generation capacity, energy, ancillary services, and transmission capacity

NREL's Cambium dataset

Evaluate ability of GEB measures to avoid forecasted system costs, including dynamic dispatch of DF measures

Brattle's LoadFlex model

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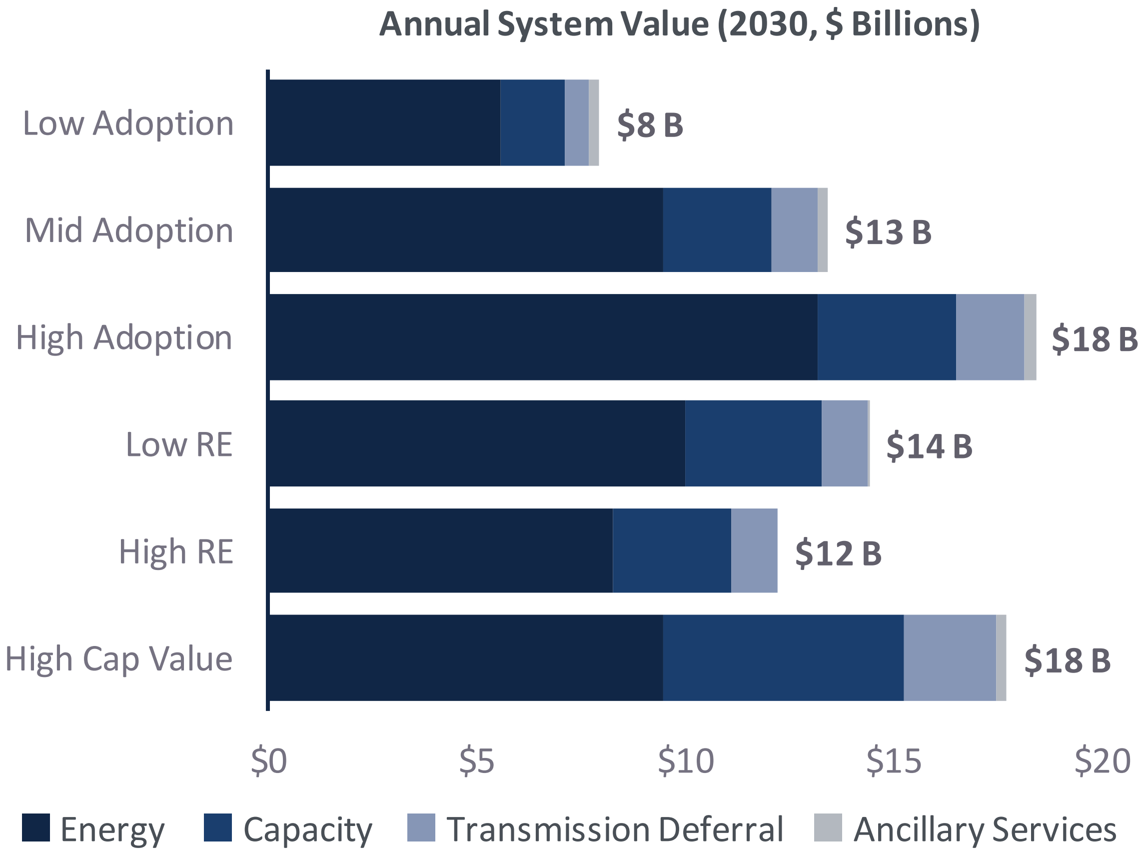

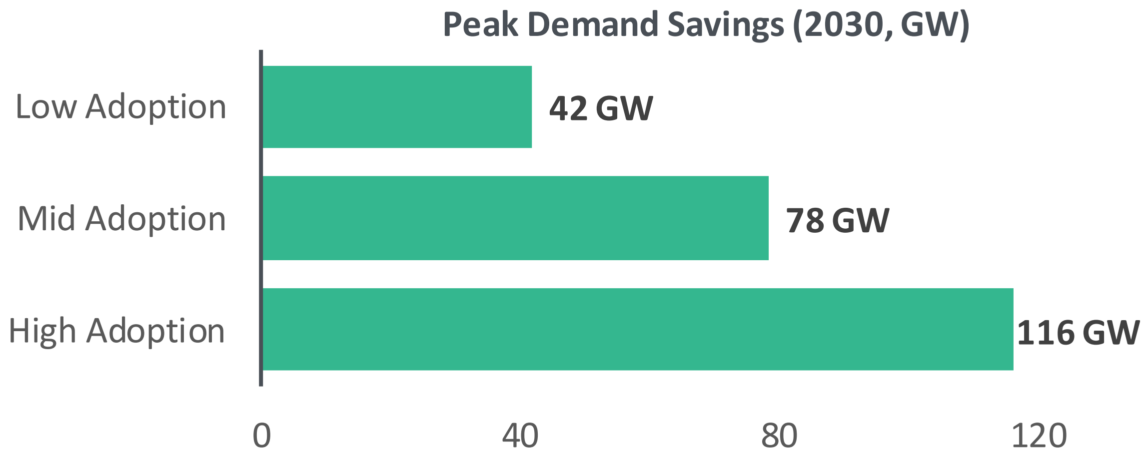

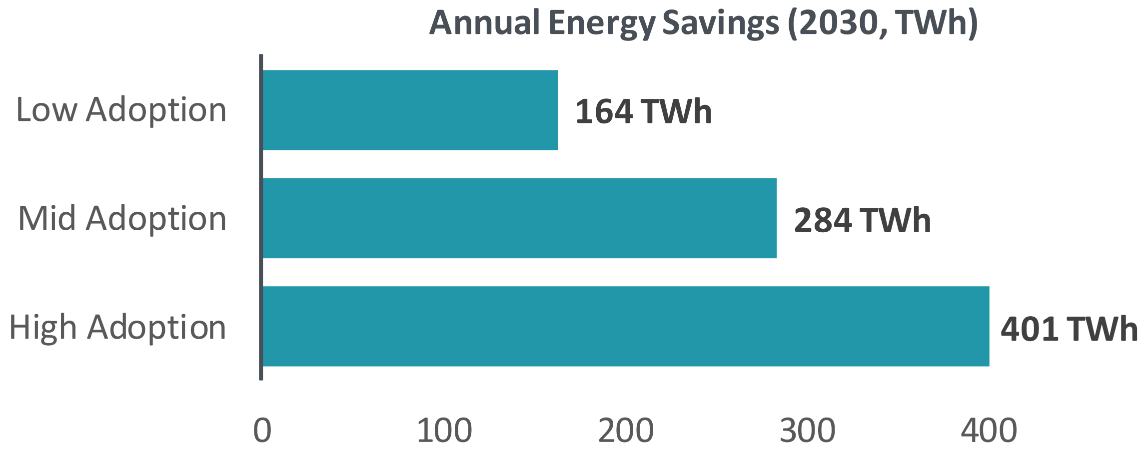

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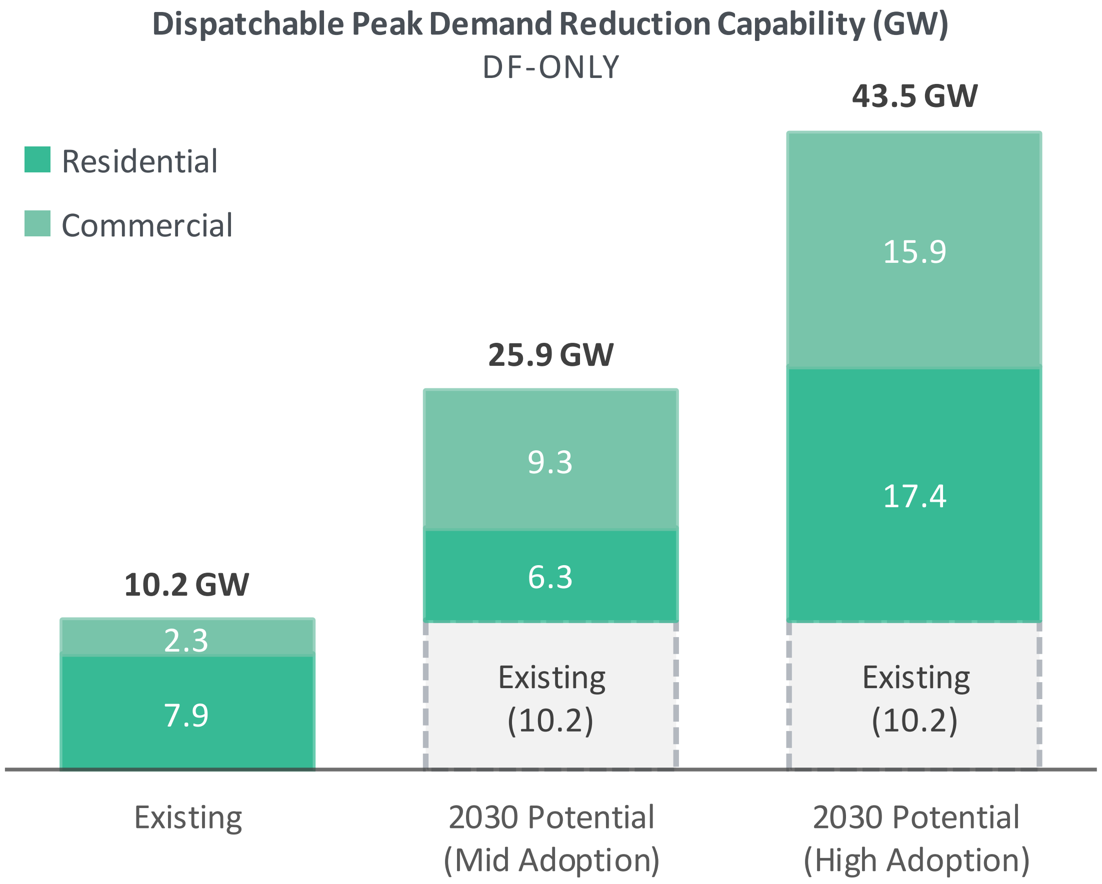

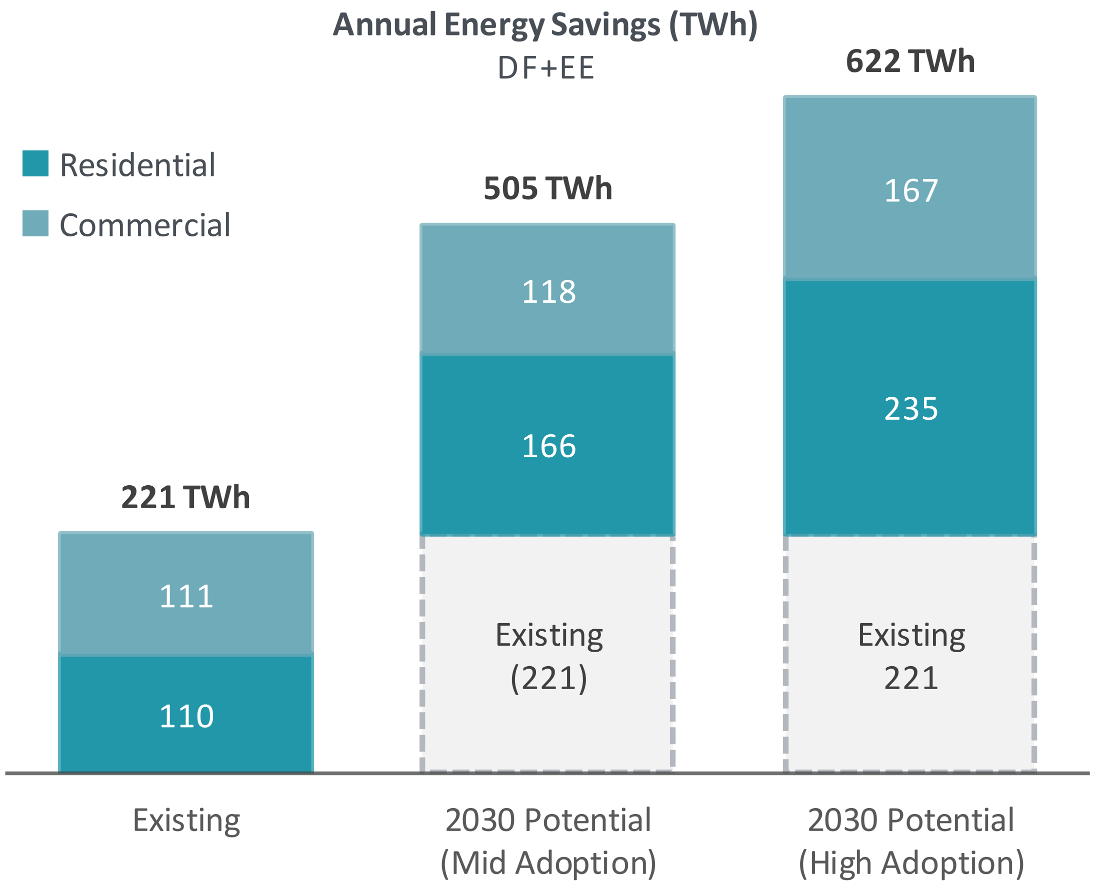

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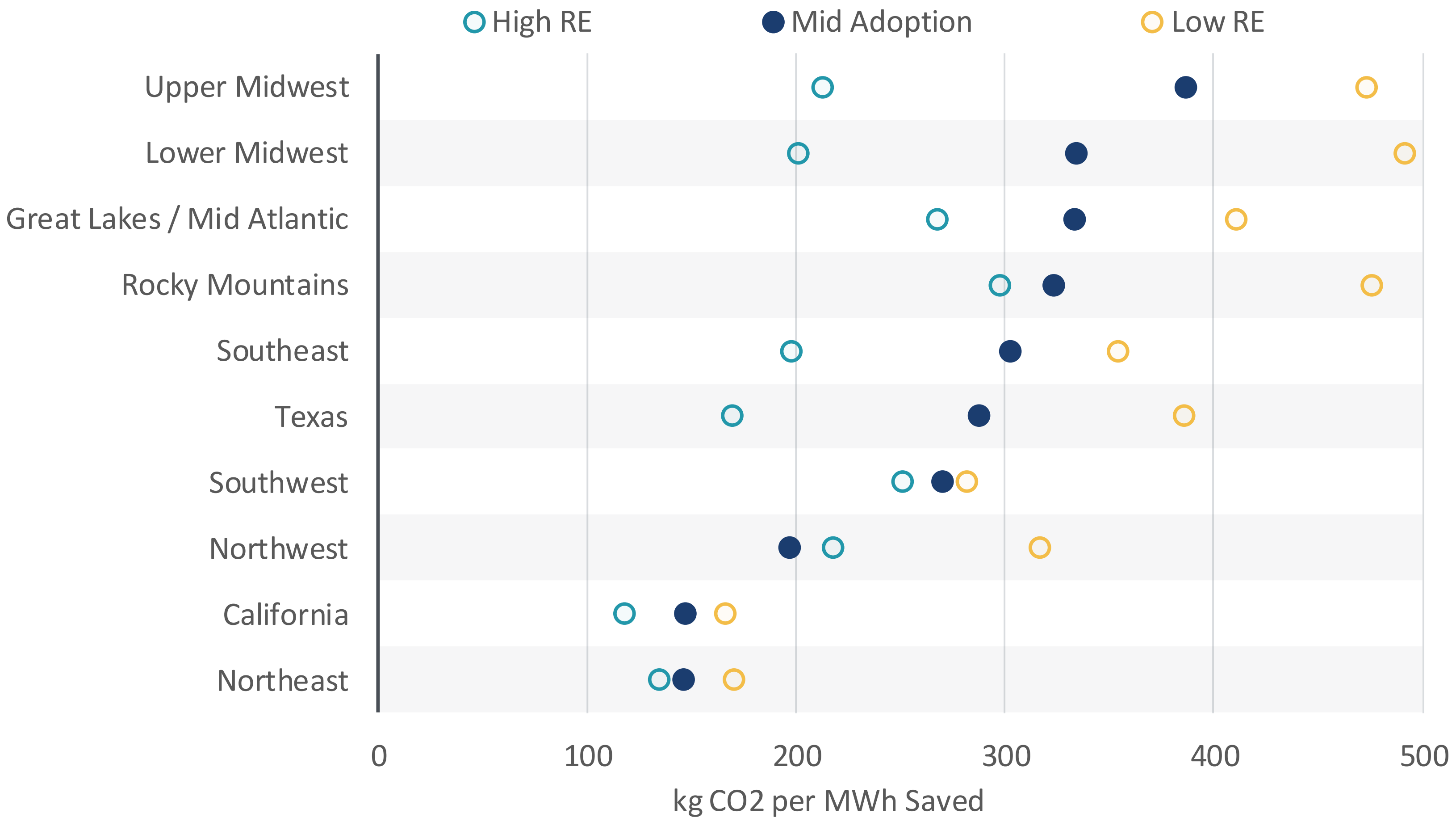
Nationally, GEBs could save 80 million tons of CO_2 annually by 2030, or 6% of all power sector CO_2 emissions

- Equivalent to more than 50 medium-sized coal plants, or 17 million cars
- CO_2 savings opportunities vary by region

Regional Emissions Reduction per MWh of Energy Savings from GEBs (2030)



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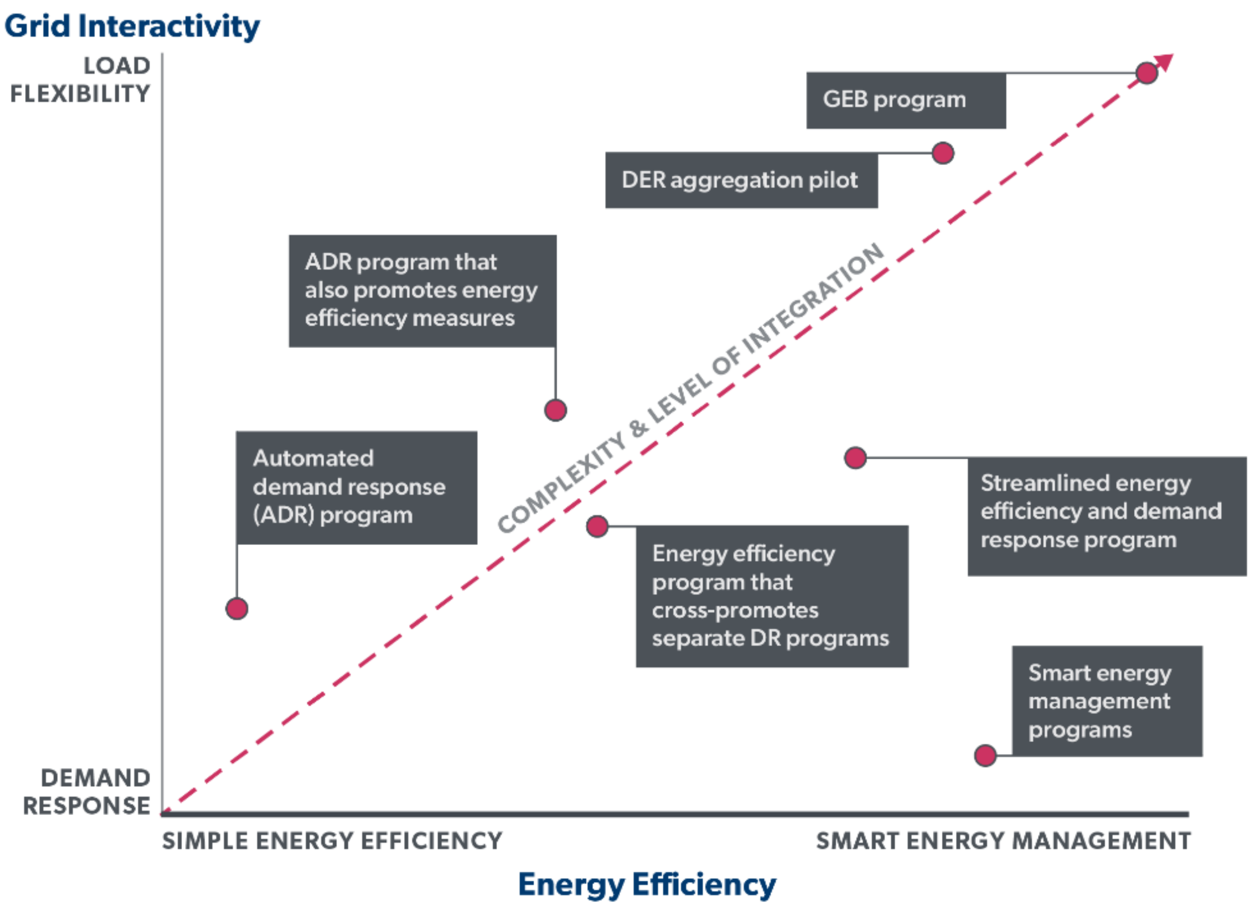
The GEB Vision and Integration

The GEB vision is to transition buildings toward more sophisticated and valuable forms of energy efficiency and grid interactivity

The Building Efficiency and Grid Interactivity Spectrum

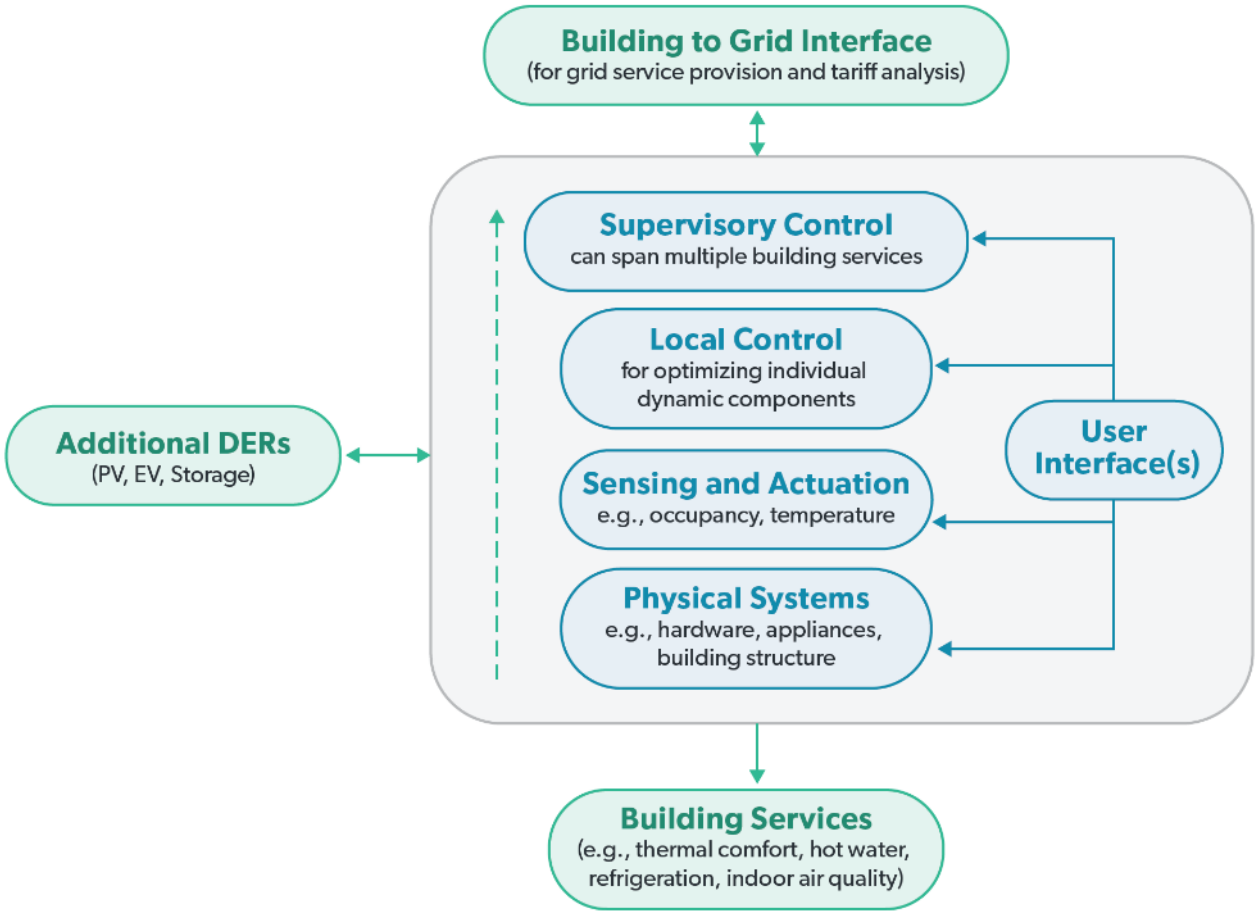


Source: Adapted from the American Council for an Energy-Efficient Economy (ACEEE) (2020)

For GEB performance to advance, various systems, technologies, and user interfaces will need to be integrated

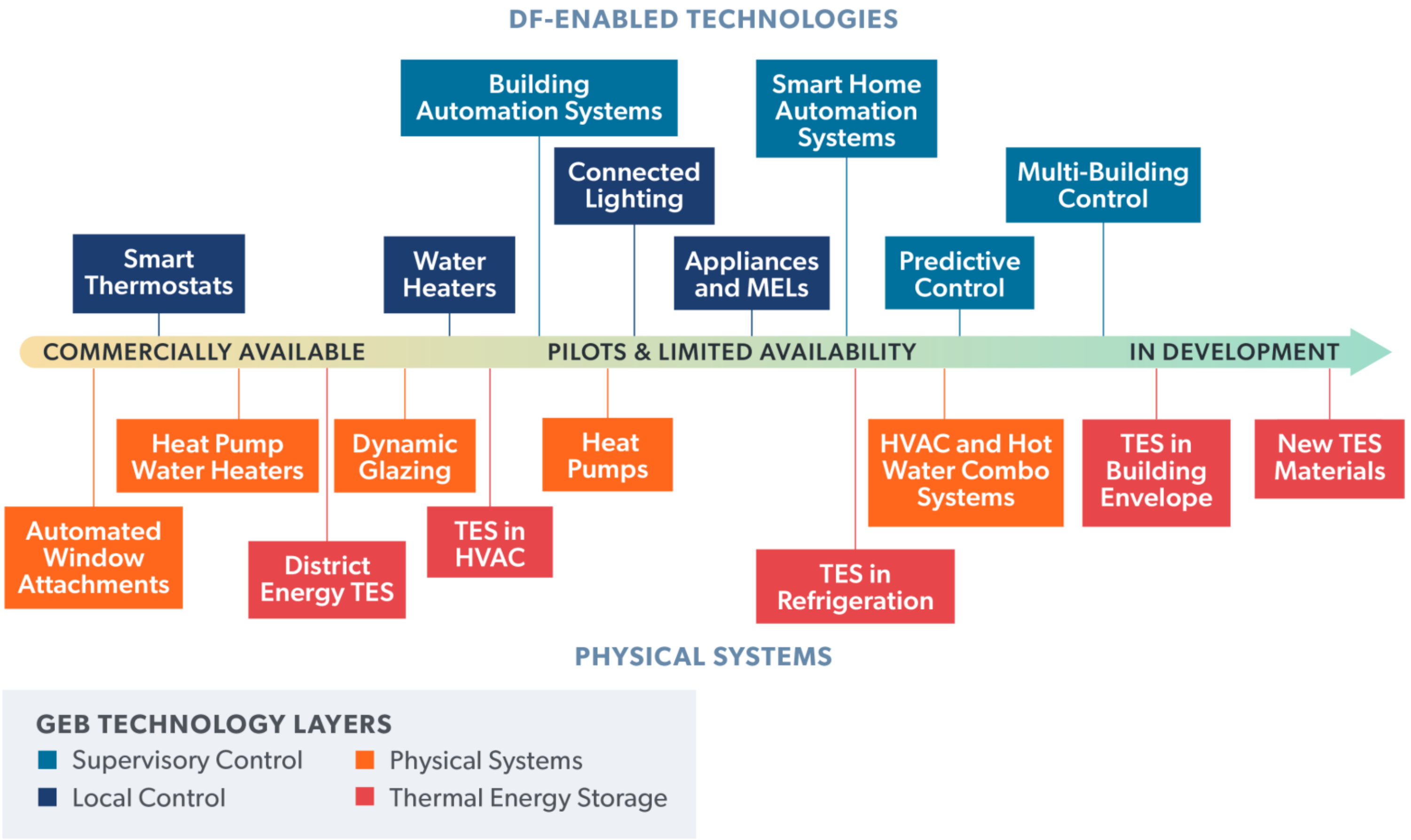
- There are several layers of systems between the building and the grid
- Two types of technology integration will be important:
  1. **Integration between layers**, which maximizes performance and avoids conflicts between competing objectives
  2. **Integration across multiple end-uses**, which takes advantage of synergies between end-use systems

GEB Technology Layers



Developing the GEB technology pipeline will unlock new opportunities to improve building efficiency and grid-interactivity

GEB Technology Pipeline, with Examples for Each Technology Layer



The integration of DERs with buildings is a critical element of the GEB vision

Cross-cutting Research Needs for Increased Integration of DERs in GEBs

- Improved tools that quantify the market potential and communicate the value proposition of GEB-DER integration to designers, construction firms, building owners, and customers.
- Data for building load forecasts and operational optimization, and the validation of continual benefits and durability of technologies.
- Cost-effective upgrades to existing buildings with grid-interactive technologies and include advanced diagnostics and integrate DER controls.
- Workforce education and training to close knowledge gaps regarding how to best integrate DERs with demand flexibility.
- Exploring the pros and cons of integrated DERs at individual buildings versus larger-scale DERs where building loads are integrated as part of a community scale-controlled system.

Recommendations for Accelerating GEB Adoption

Barriers at all points in the value chain need to be overcome in order to maximize the value of GEBs

The GEB Value Chain and Key Barriers

Develop

Software/Hardware Developers
Researchers

Example barriers
- Lack of standardization and interoperability
- Insufficient algorithms for controlling flexible loads
- Lack of thermal storage tech to provide flexibility

Deploy

Installers
Aggregators/ESCOs
Utilities

Example barriers
- Restrictive wholesale market rules limit aggregator incentives to deploy technology
- EE & DF value under-represented in utility planning, limiting aggregator opportunities
- Lack of awareness or training among installers

Adopt

Consumers
Building Owners/Managers

Example barriers
- Insufficient value proposition
- Lack of awareness or understanding of opportunities
- Technology too complex
- Technology too expensive
- Privacy/cybersecurity concerns

Utilize

Utilities
ISOs/RTOs

Example barriers
- Don’t trust DF performance, or view it as risky resource
- Lack of incentive to pursue EE & DF over traditional investments
- Strong lobbying by competing resources creates uneven playing field for demand-side resources

Regulate, Support, Facilitate

State and Federal Policymakers and Regulators
Researchers and Advocacy Groups

Example barriers
- Lack of information upon which to develop supporting policies
- Lack of EE and DF “champion”
- Status quo bias

Recommendations in the Roadmap are organized around four "pillars" that are integral to supporting GEB adoption and overcoming the barriers

PILLAR 1

Advancing GEBs through **research and development**

PILLAR 2

Enhancing the value of demand flexibility to consumers

PILLAR 3

Empowering GEB users and operations

PILLAR 4

Supporting demand flexibility deployment through state and federal **enabling programs and policies**

Pillar 1: Advancing GEBs through research and development

Recommendation	Example Action
Research, Develop and Accelerate Deployment of GEB Technologies	Support development and field testing of user-friendly, affordable integrated whole-building control and grid service delivery
Accelerate Technology Interoperability to Optimize Efficiency and Demand Flexibility Performance	Accelerate adoption of existing open standards, particularly at the application layer
Collect and Provide Data and Develop Methods for Benchmarking and Evaluating Demand Flexibility Technology & Whole Building Performance	Expand EE benchmark dataset and benchmarking tools to incorporate demand flexibility

Pillar 2: Enhancing the Value of GEBs to Consumers and Utilities

Recommendation	Example Action
Improve and Expand Innovative Customer Demand Flexibility Program Offerings	Design and market demand flexibility programs with a focus on consumer preferences
Expand Consumer Knowledge and Consideration of Price-based Programs	Plan for full scale deployment
Introduce Incentives for Utilities to Deploy Demand Flexibility Resources	Identify and evaluate the appropriate incentive mechanisms to encourage investment in demand-side programs
Comprehensively Incorporate Demand Flexibility into Utility Resource Planning	Ensure that a comprehensive list of demand-side measures are considered in the analysis, and account for all applicable value streams

Pillar 3: Empowering GEB Users and Operations

Recommendation	Example Action
Understand How Users Interact with GEBs and the Role of Technology	Evaluate the relationship between prices, incentives, technology and load flexibility
Develop Tools to Support Decision Making on Design and Operation of GEBs	Enhance capabilities of existing building performance tools to include demand flexibility and GHG emissions information
Leverage Existing Building-Related Workforce Programs to Integrate Advanced Building Technology and Operations Education and Training	Establish building training and assessment centers

RECOMMENDATIONS FOR ACCELERATING GEB ADOPTION

Pillar 4: Supporting GEB Deployment through State and Federal Enabling Programs and Policies

Recommendation	Example Action
Lead by Example	Government building participation in demand response and energy efficiency programs and markets
Expand Funding and Financing Options for GEB Technologies	Identify how requirements of existing financing and funding mechanisms for EE can be modified to include demand flexibility
Expand Codes and Standards to Incorporate Demand Flexibility	Combine grid-interactive requirements and open standards for automated communication with energy efficiency requirements
Consider Implementing Demand Flexibility in State Targets or Mandates	Consider establishing statewide or utility-specific demand flexibility procurement requirements

Putting the recommendations into action

DOE has established a goal of tripling energy efficiency and demand flexibility in residential and commercial buildings by 2030, relative to 2020 levels

- All stakeholders play an important role in successfully implementing the Roadmap recommendations and achieving this ambitious goal
- Strong leadership that works effectively across all key market actors, policy and program actors, and other stakeholder groups is necessary to successfully realize this enormous opportunity
- Given its national scope, resources, legal authorities, convening power, and new commitment to forceful measures to mitigate CO_2 emissions, DOE will play a central role in advancing GEBs as a resource for the future U.S. clean energy economy and modern electric grid, and to make the nation's homes and buildings more affordable and sustainable.

Appendix

Pillar 1: Advancing GEBs through research and development

RECOMMENDATION 1

Research, Develop and Accelerate Deployment of GEB Technologies

- Set R&D targets to make grid-interactive equipment cost-effective and easier to install and operate, prioritizing thermal energy systems
- Explore opportunities to integrate and control affordable thermal energy storage
- Support development and field testing of user-friendly, affordable integrated whole-building control and grid service delivery
- Develop and demonstrate integrated low-carbon building retrofit packages that leverage GEBs

RECOMMENDATION 2

Accelerate Technology Interoperability to Optimize Efficiency and Demand Flexibility Performance

- Accelerate adoption of existing open standards, particularly at the application layer
- Identify additional open standards needed at the application layer across grid services
- Streamline delivery of GEB applications and capabilities by providing standard solutions for data interpretability
- Provide system and device level reporting capabilities
- Enable users to provide control permissions to trusted third-party applications and services
- Field validate the benefits of enhanced interoperability
- Explore methods to rate or score interoperability of devices and buildings

RECOMMENDATION 3

Collect and Provide Data and Develop Methods for Benchmarking and Evaluating Demand Flexibility Technology & Whole Building Performance

- Develop standard methods for data collection and analysis, and measurement and verification of demand flexibility technologies and strategies.
- Expand energy efficiency benchmark datasets and benchmarking tools to incorporate demand flexibility

Pillar 2: Enhancing the Value of GEBs to Consumers and Utilities

RECOMMENDATION 1

Improve and Expand Innovative Customer Demand Flexibility Program Offerings

- Design and market demand flexibility programs with a focus on consumer preferences
- Package demand flexibility with other consumer offerings
- Consider additional value streams in incentive-based demand flexibility program compensation
- Review existing programs for opportunities to modernize design
- Develop partnerships between utilities and aggregators to help implement incentive-based demand flexibility programs
- Research and socialize data on innovative demand flexibility programs
- Encourage innovative demand flexibility programs and pilots

RECOMMENDATION 2

Expand Consumer Knowledge and Consideration of Price-based Programs

- Consider customer adoption of EE and demand flexibility measures as part of broader rate design objectives
- Understand customer enrollment and bill impacts
- Take an inclusive approach to marketing the new options to consumers
- Plan for full scale deployment

RECOMMENDATION 3

Introduce Incentives for Utilities to Deploy Demand Flexibility Resources

- Identify and evaluate the appropriate incentive mechanisms to encourage investment in demand side programs
- Assess whether and how the incentive mechanisms of interest may comport with existing laws and regulations
- Develop key design parameters and metrics for the adopted incentive mechanisms, as well as the process for setting specific program targets
- Evaluate customer impacts when estimating the cost-effectiveness of the new incentive mechanism
- Perform research studies and provide technical assistance
- Consider underserved communities when establishing performance metrics
- Identify opportunities for improving demand flexibility access to wholesale markets

RECOMMENDATION 4

Comprehensively Incorporate Demand Flexibility into Utility Resource Planning

- Ensure that a comprehensive list of demand side measures are considered in the analysis
- Account for all applicable value streams
- Develop robust representation of demand flexibility measure performance characteristics
- Account for interactions between demand side resources
- Increase consideration of Non-Wires Solutions (NWS)
- Research and socialize best practices for incorporating demand side resources into resource planning

Pillar 3: Empowering GEB Users and Operations

RECOMMENDATION 1

Understand How Users Interact with GEBs and the Role of Technology

- Understand user perceptions of the value of providing demand flexibility
- Openly document technology installation, configuration, and operation experiences
- Quantify user preferences for building service levels and availability
- Evaluate the relationship between prices, incentives, technology and load flexibility

RECOMMENDATION 2

Develop Tools to Support Decision Making on Design and Operation of GEBs

- Enhance capabilities of existing building performance tools to include demand flexibility and GHG emissions information
- Validate GEB decision support tools by comparing field data with simulation data
- Collect and publish data on the hard and soft costs of installing and configuring advanced sensing and control technologies needed for a fully optimized GEB and related DERs
- Develop advanced data-driven analysis methods to support GEB technology decision support, design and selection tools

RECOMMENDATION 3

Leverage Existing Building-Related Workforce Programs to Integrate Advanced Building Technology and Operations Education and Training

- Establish skill and credential standards relevant to advanced building technologies and operations
- Expand relevant curricula, training programs, and certifications
- Broaden relevant workforce development programs
- Develop resources and provide funding to facilitate outreach to students in K-12 schools, community colleges, and universities
- Establish building training and assessment centers

Pillar 4: Supporting GEB Deployment through State and Federal Enabling Programs and Policies

RECOMMENDATION 1

Lead by Example

- Integrate demand flexibility in initiatives for corporate partnerships
- Promote demand flexibility for ESPC
- Participate in demand response and energy efficiency programs and markets
- Broaden building energy tracking requirements in public buildings

RECOMMENDATION 2

Expand Funding and Financing Options for GEB Technologies

- Evaluate financing and funding mechanisms and determine if new financial assistance mechanisms are needed
- Identify how requirements of existing financing and funding mechanisms for EE can be modified to include demand flexibility
- Promote partnerships between utilities and entities that receive public funding

RECOMMENDATION 3

Expand Codes and Standards to Incorporate Demand Flexibility

- Determine aspects of demand flexibility that may be considered for codification
- Combine grid-interactive requirements and open standards for automated communication with energy efficiency requirements
- Provide technical assistance to government entities and professional organizations responsible for codes and standards development

RECOMMENDATION 4

Consider Implementing Demand Flexibility in State Targets or Mandates

- Conduct research to assess cost-effective and achievable demand flexibility potential for a given jurisdiction or service territory
- Consider implementing peak reduction standards
- Consider establishing statewide or utility-specific demand flexibility procurement requirements

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