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CONGRESSIONAL BRIEFING

Leveraging Grid Edge Integration for Resilience & Decarbonization

Briefing Series: Modernizing the U.S. Energy System: Opportunities, Challenges, and the Path Forward

Friday, June 25, 2021

About EESI…

EESI
Environmental and Energy Study Institute

NON-PROFIT

Founded in 1984 by a bipartisan Congressional caucus as an independent (i.e., not federally-funded) non-profit organization

NON-PARTISAN

Source of non-partisan information on environmental, energy, and climate policies

DIRECT ASSISTANCE

In addition to a full portfolio of federal policy work, EESI provides direct assistance to utilities to develop “on-bill financing” programs

SUSTAINABLE SOCIETIES

Focused on win-win solutions to make our energy, buildings, and transportation sectors sustainable, resilient, and more equitable

EESI
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…About EESI

BRIEFING WEBCASTS

Live and archived video recordings of public briefings and written summaries

CLIMATE CHANGE SOLUTIONS

Bi-weekly newsletter with all you need to know including a legislation tracker

SOCIAL MEDIA (@EESIONLINE)

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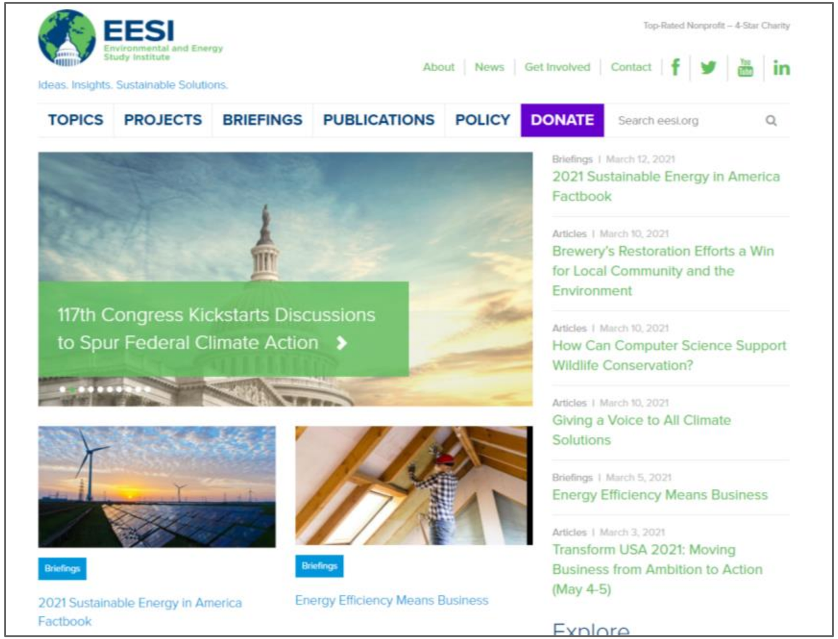
FACT SHEETS

Timely, objective coverage of climate and clean energy topics



A National Roadmap for Grid-Interactive Efficient Buildings

Available at: gebroadmap.lbl.gov

U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

BUILDING TECHNOLOGIES OFFICE

EESI MODERNIZING THE US ENERGY SYSTEM SERIES   JUNE 25, 2021

This work was funded by the U.S. Department of Energy Building Technologies Office under Contract No. DE-AC02-05CH11231.

Why GEBs?

Integrate the growing share of variable renewable energy

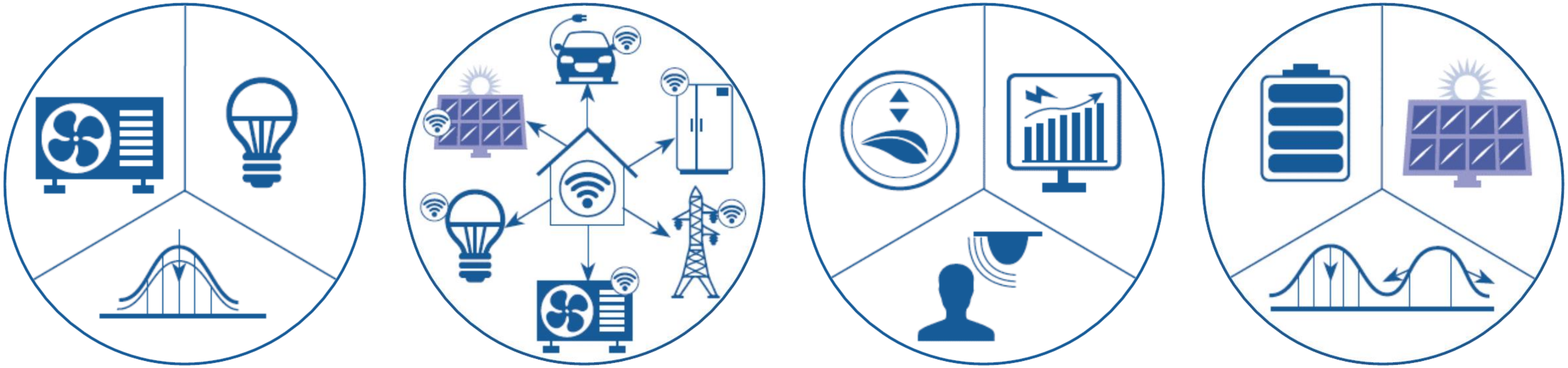
Reduce costs to replacing aging electricity system infrastructure and improve system reliability

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

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



EFFICIENT

Persistent low energy use minimizes demand on grid resources and infrastructure

CONNECTED

Two-way communication with flexible technologies, the grid, and occupants

SMART

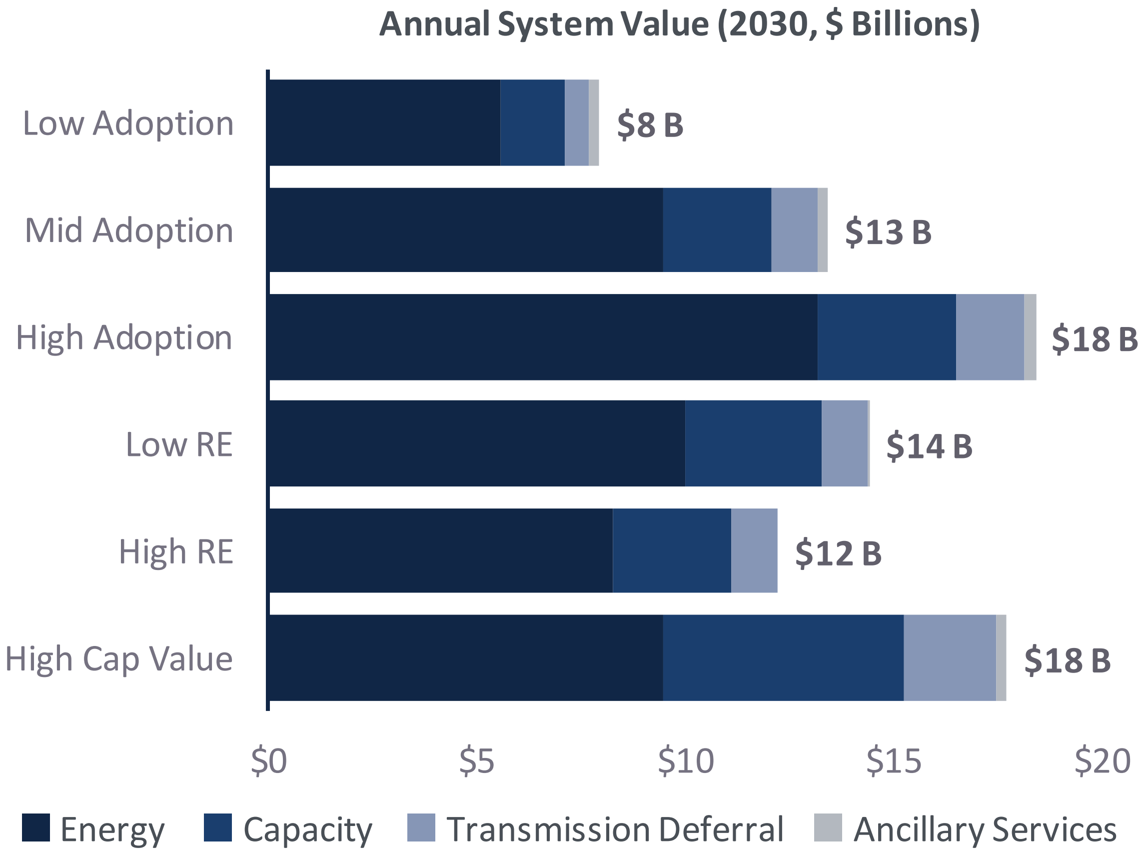
Analytics supported by sensors and controls co-optimize efficiency, flexibility, and occupant preferences

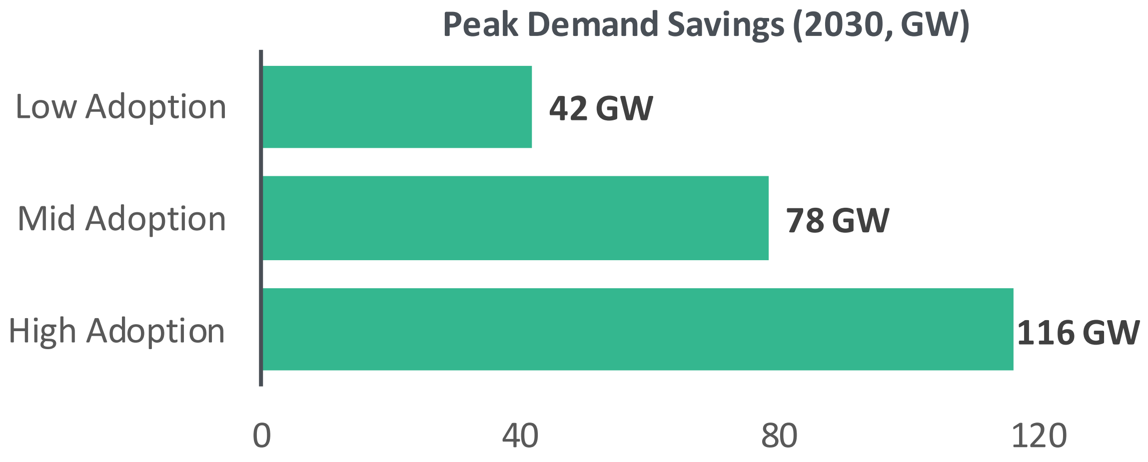
FLEXIBLE

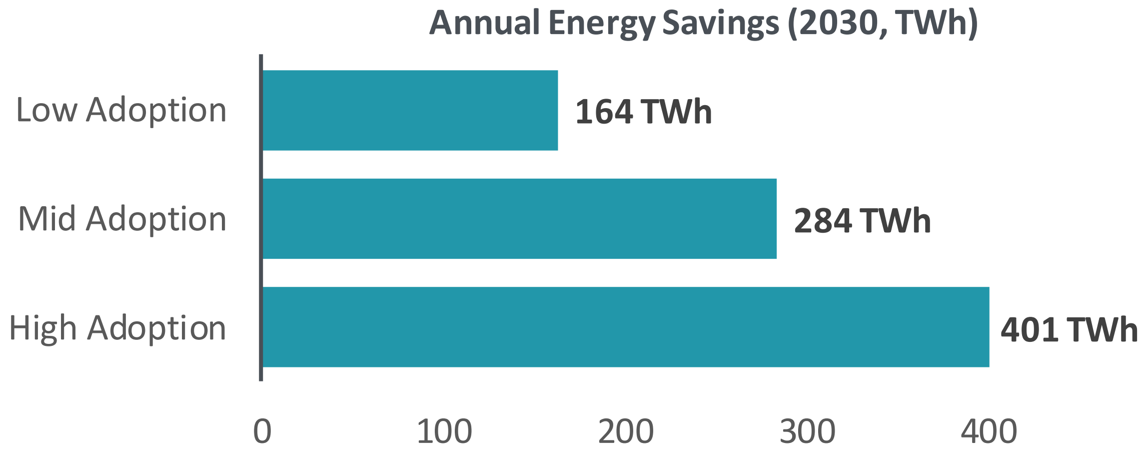
Flexible loads and distributed generation/ storage can be used to reduce, shift, or modulate energy use

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

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





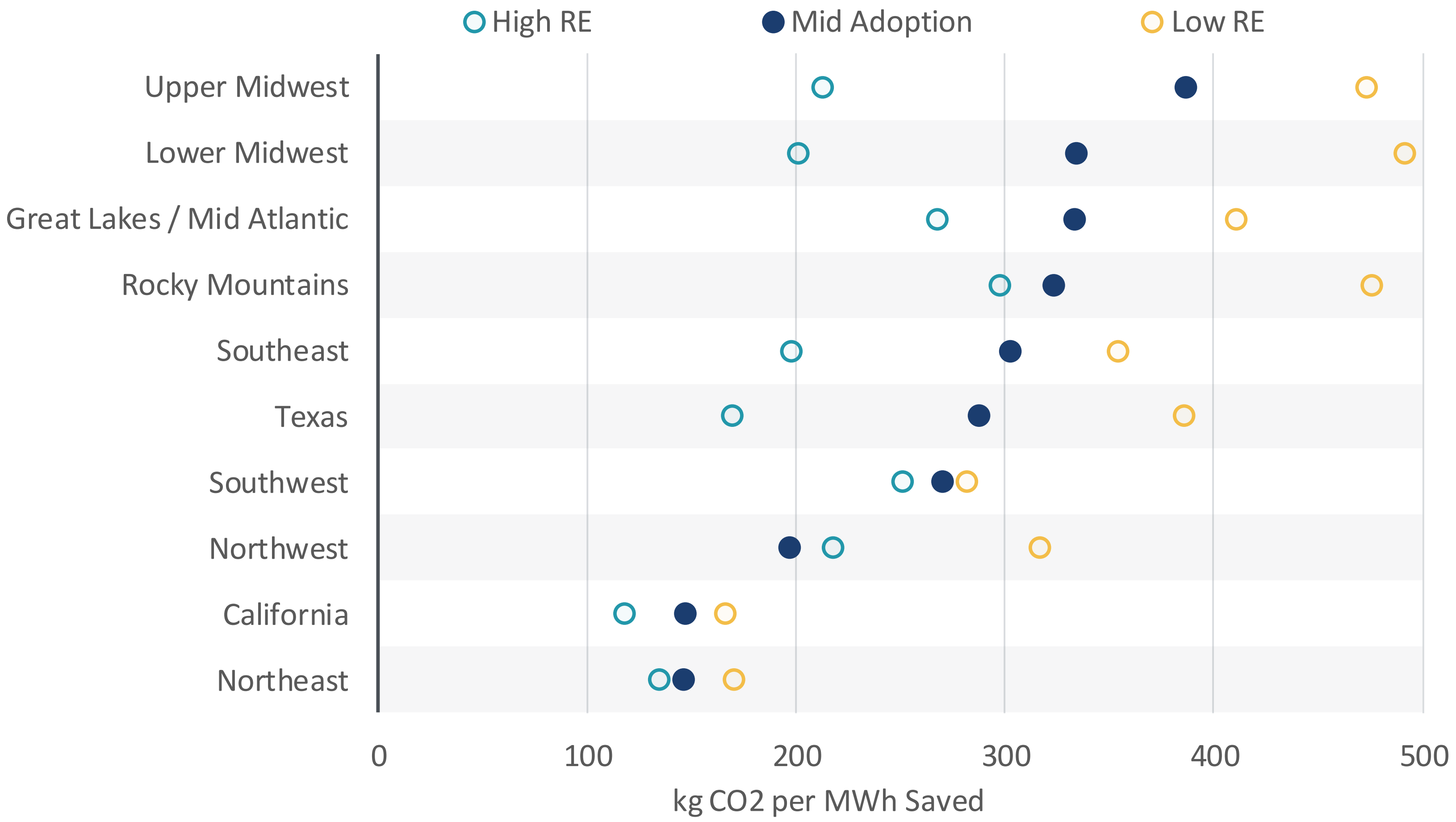


Notes: All in 2019 dollars. Peak demand savings are computed as the sum of impacts during each region's coincident peak hour. $100 - $200 billion reflects the NPV at a social discount rate of 4% nominal (2% real).

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)



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

Disclaimer

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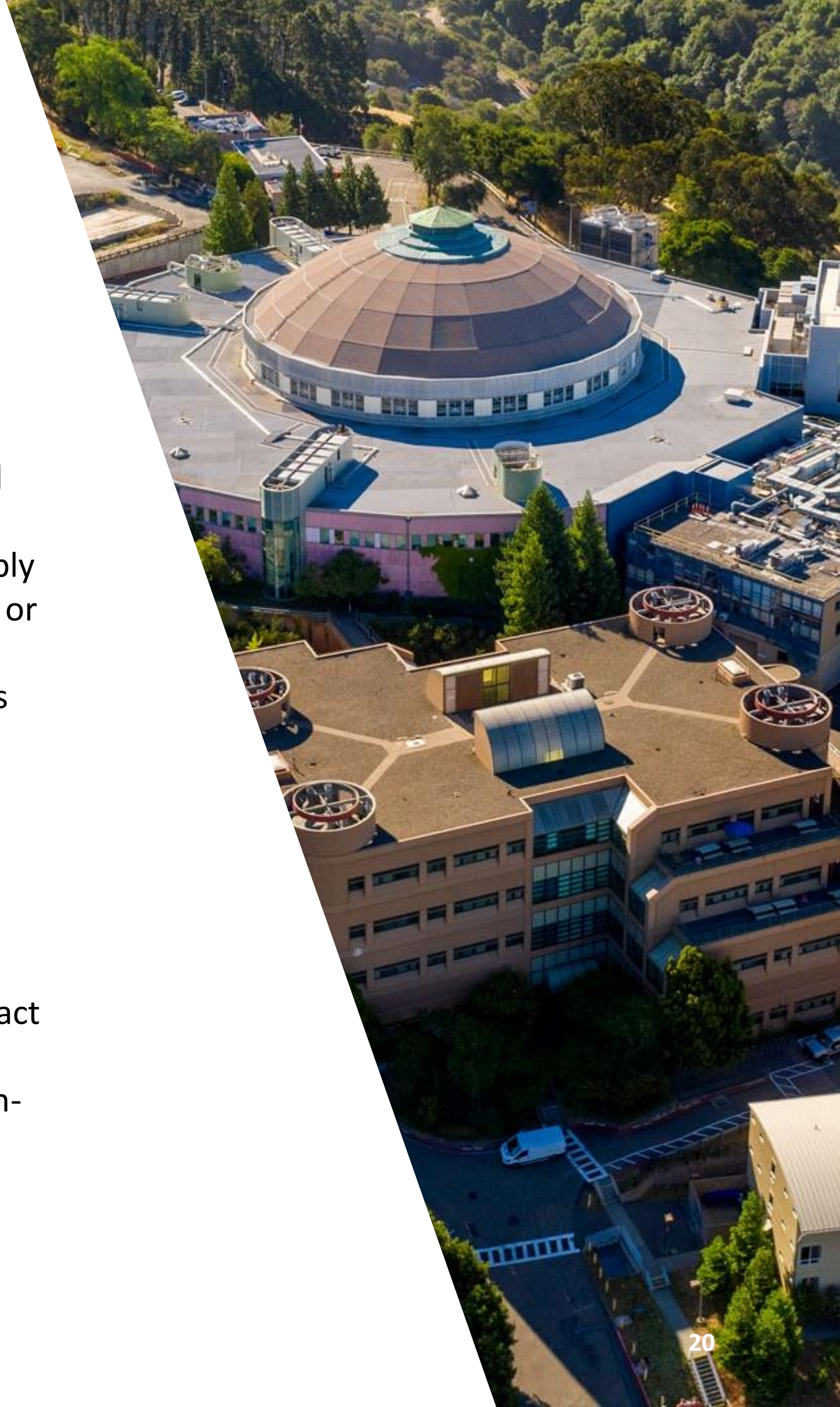

Unlocking the Value of Electric Vehicles as Grid Assets

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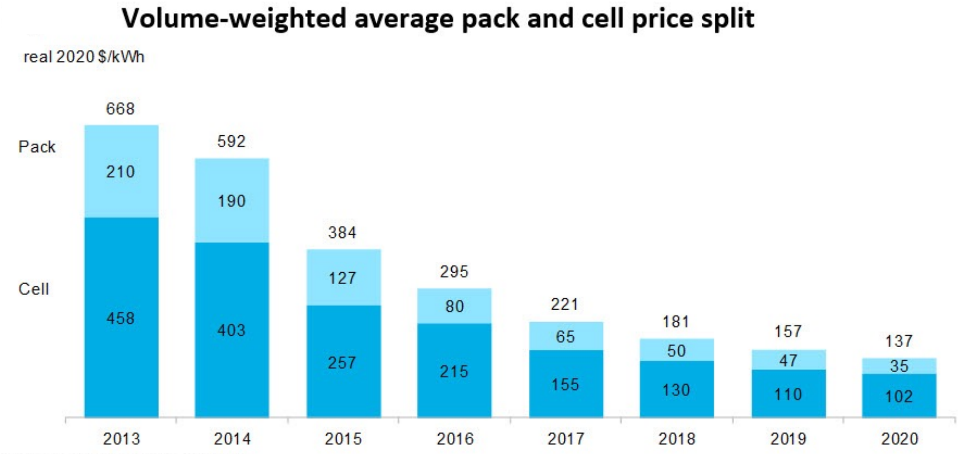
Atkinson Center for Sustainability
Cornell University

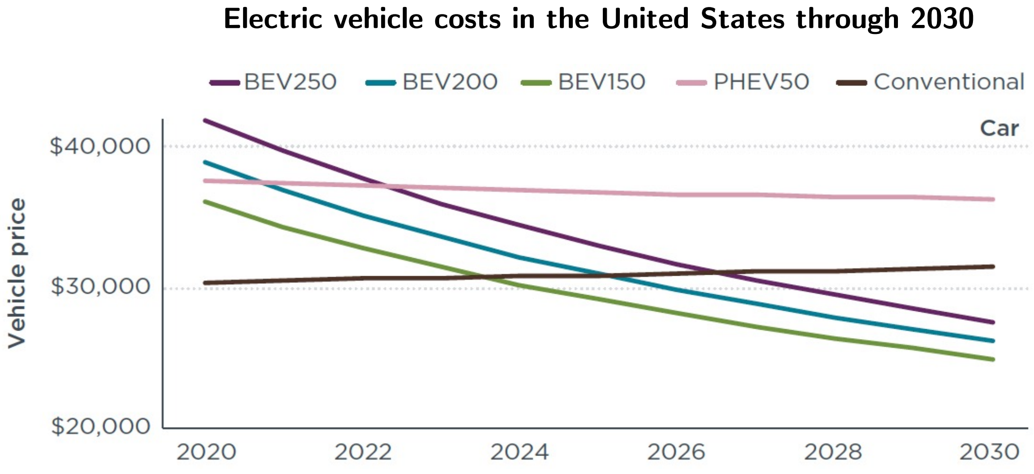
Electric Vehicles Are Coming

- Declining battery costs
- Progressive policy and incentives
- Automakers betting big on EVs
- Greenhouse gas emission reductions

But is the grid ready?



Source: BloombergNEF



Source: Lutsey et al. (2019)

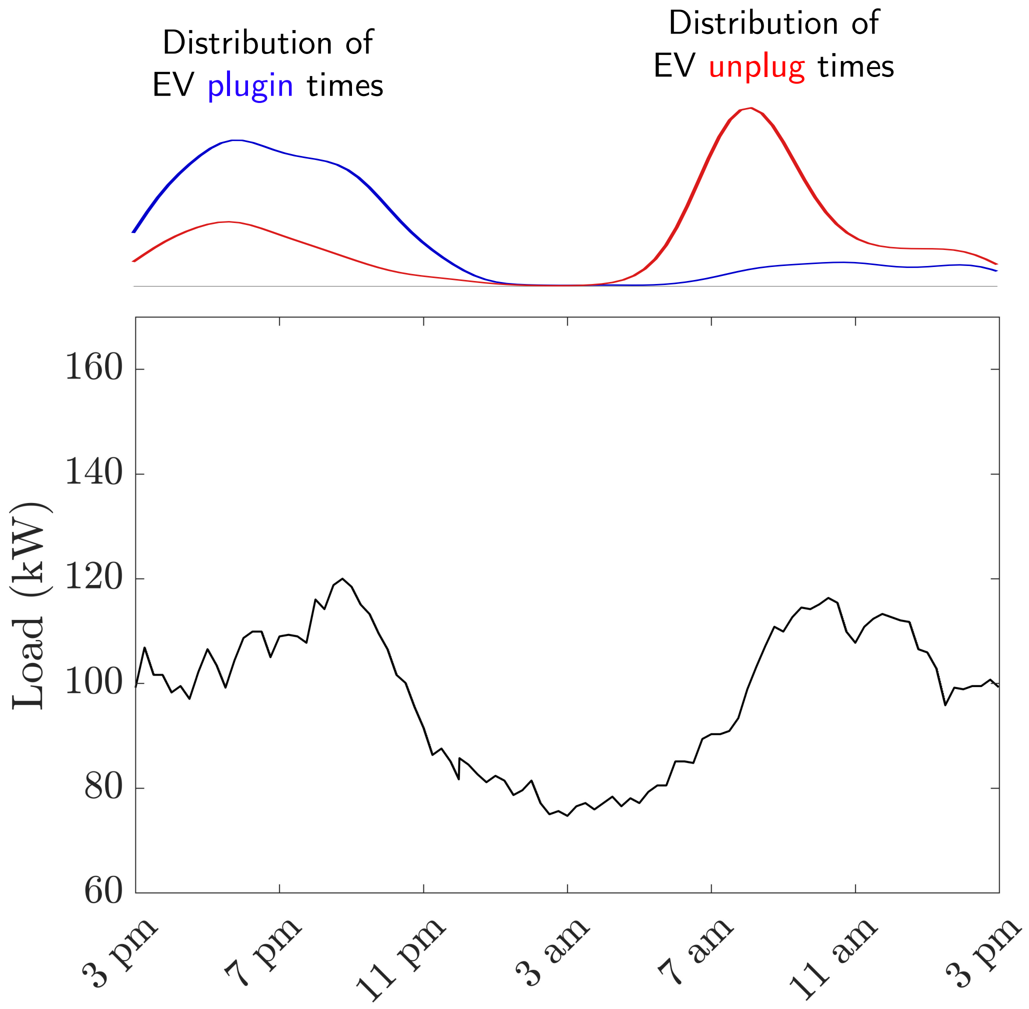
Outline

- A pilot study – OptimizEV (joint work with Polina Alexeenko)
- Grid impacts of unmanaged EV charging
- Harnessing the flexibility of EV charging to minimize strain on grid
- Decarbonizing the transportation sector (and why renewables need EVs)
- Other opportunities and risks...

A Real-World Pilot Study

- The OptimizEV pilot
  - Real-world study of residential EV charging patterns
  - 35 participants in Tompkins County, NY
  - Equipped with Level-2 chargers (7.7 kW max power)
  - Pilot ran from January 2020 – May 2021

- Three scenarios studied:
  1. Unmanaged EV charging
  2. EV charging based on time-of-use pricing
  3. Optimized EV charging



Impact of Unmanaged EV Charging

- The OptimizEV pilot
  - Real-world study of residential EV charging patterns
  - 35 participants in Tompkins County, NY
  - Equipped with Level-2 chargers (7.7 kW max power)
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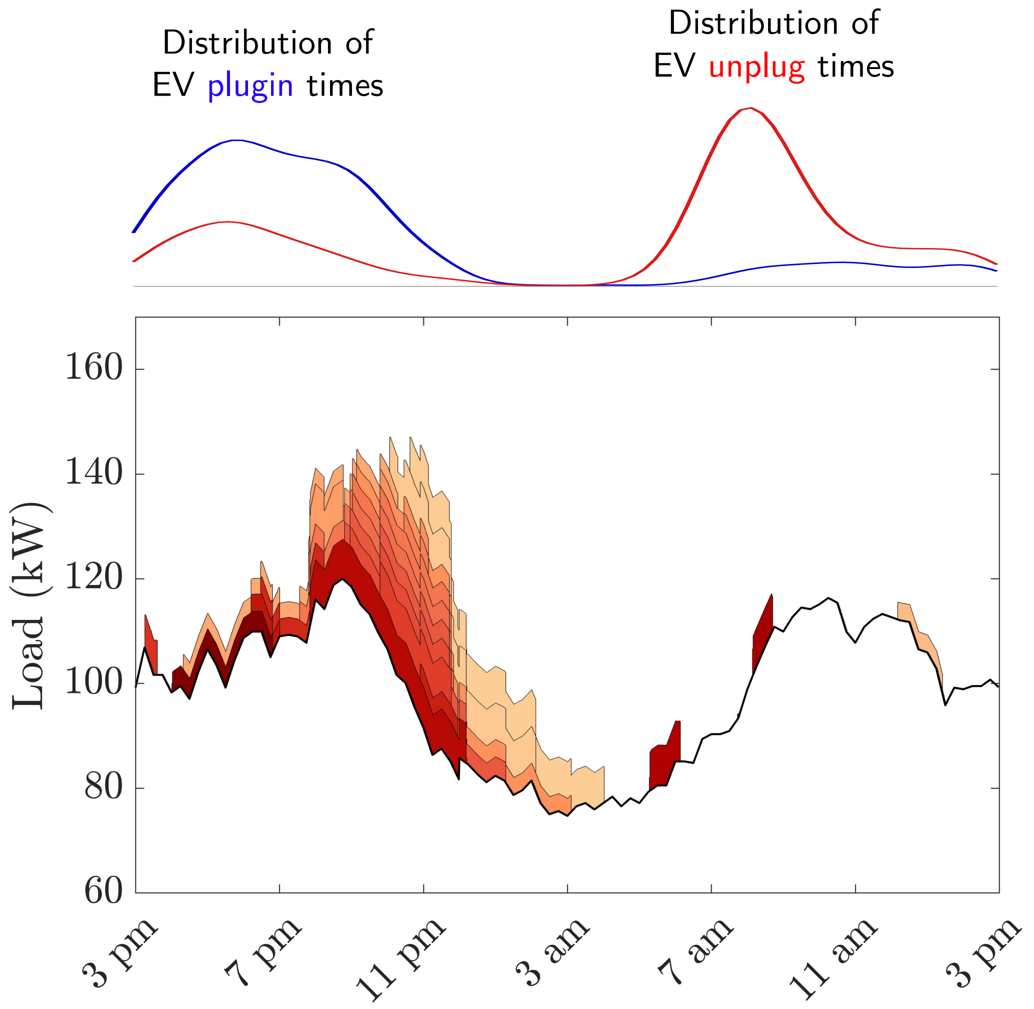

Unintended Consequences of Time-of-Use Pricing

- The OptimizEV pilot
  - Real-world study of residential EV charging patterns
  - 35 participants in Tompkins County, NY
  - Equipped with Level-2 chargers (7.7 kW max power)
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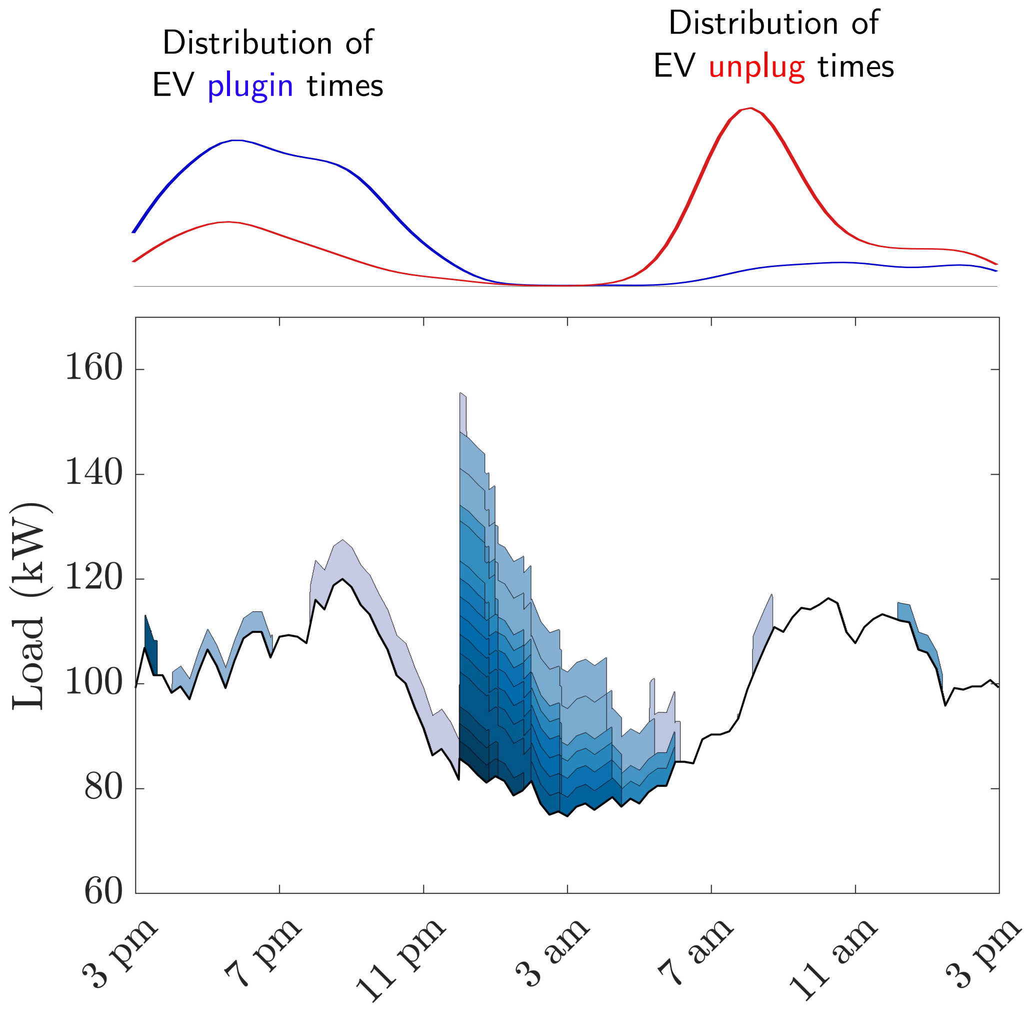
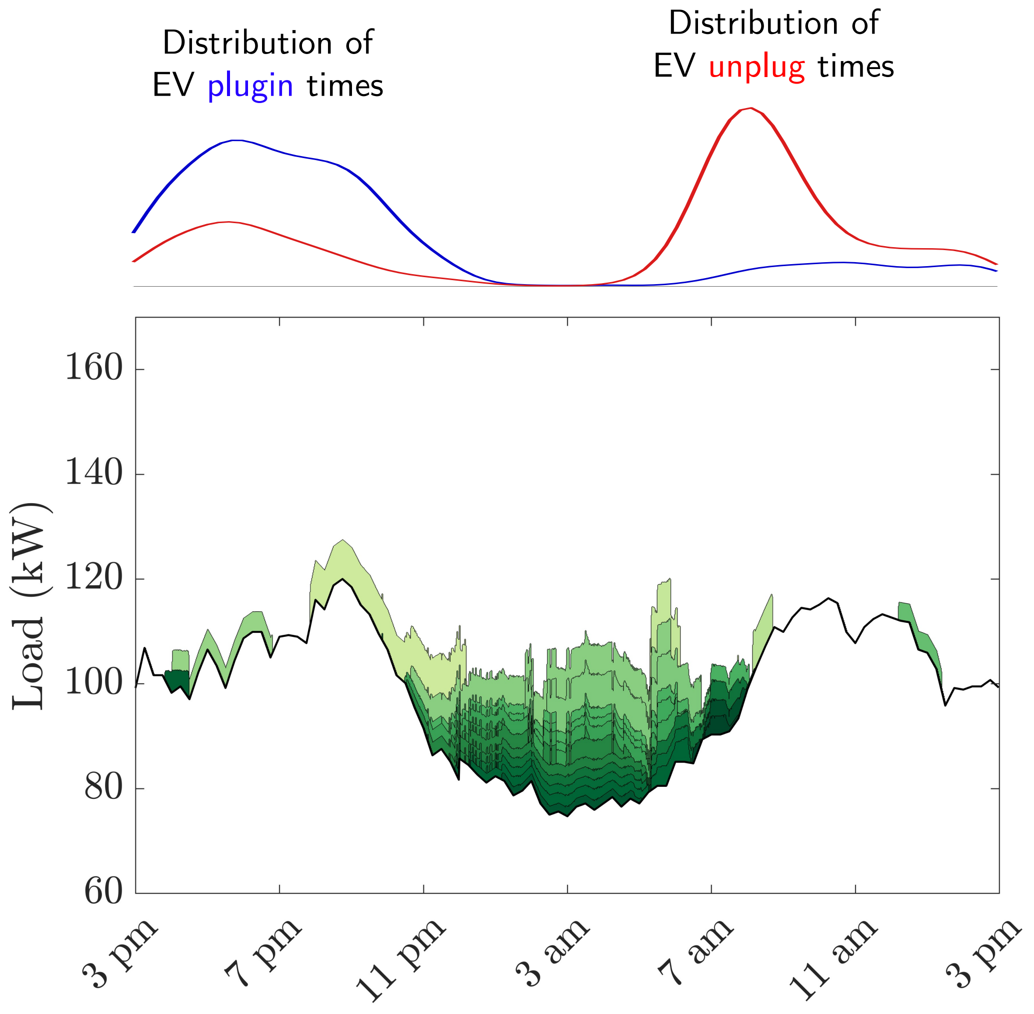


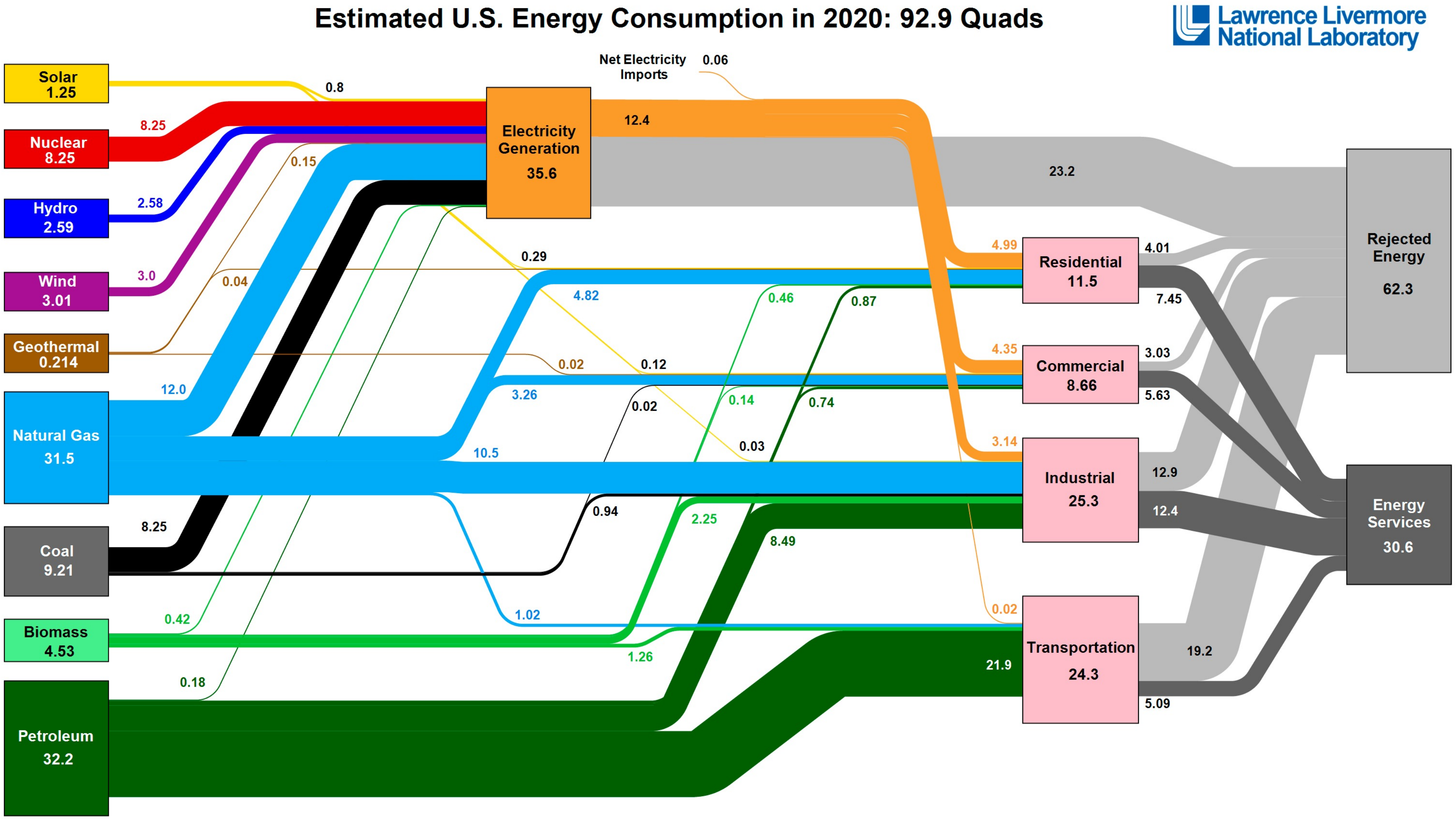
Optimized "V1G" Charging

- The OptimizEV pilot
  - Real-world study of residential EV charging patterns
  - 35 participants in Tompkins County, NY
  - Equipped with Level-2 chargers (7.7 kW max power)
  - Pilot ran from January 2020 – May 2021



- Three scenarios studied:
  1. Unmanaged EV charging
  2. EV charging based on time-of-use pricing
  3. Optimized EV charging

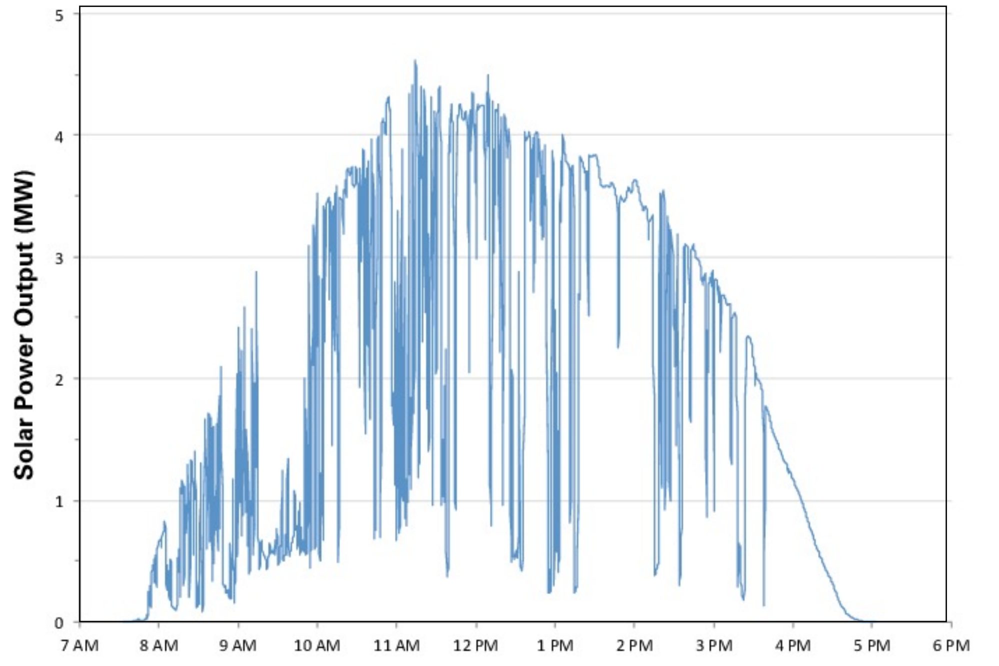
The Decarbonization Potential of EVs



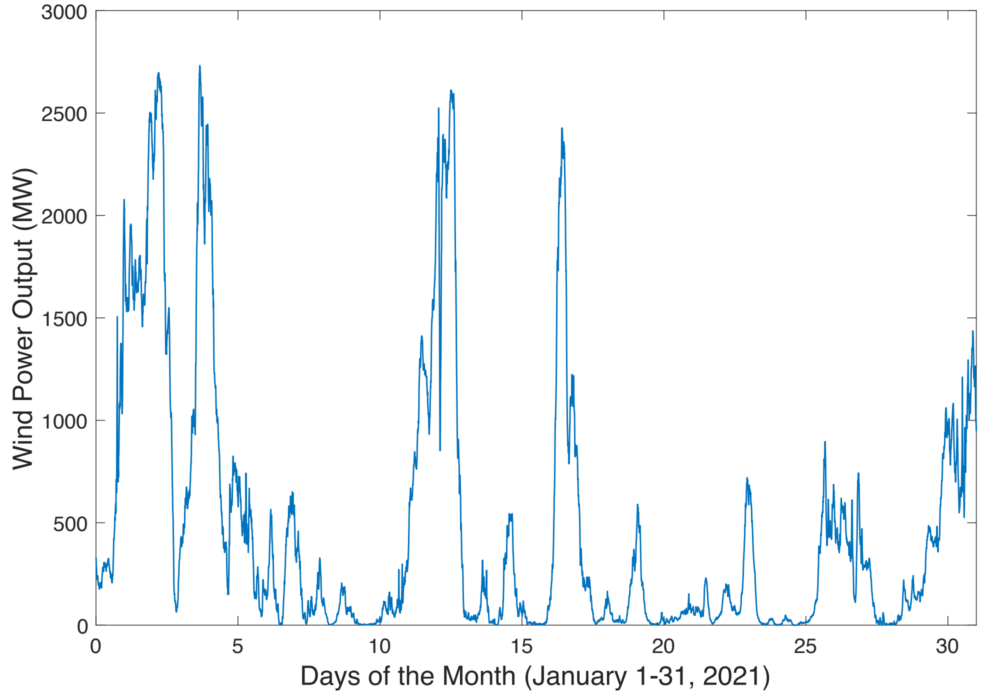
Source: LLNL March, 2021. Data is based on DOE/EIA MER (2020). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 21% for the transportation sector and 49% for the industrial sector, which was updated in 2017 to reflect DOE's analysis of manufacturing. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

A Symbiotic Relationship Between EVs and Renewables

Solar Power



Wind Power (BPA)



- Wind and solar power are highly variable and notoriously hard to forecast
- Through optimized charging, EVs can balance this variability by acting like a giant battery (by absorbing and suppling power to the grid – V2G)

Key Takeaways, Opportunities, and Risks

- If left unmanaged, EVs will stress grid, requiring costly infrastructure upgrades
- However, EVs are inherently flexible
- Smart charging technologies (V1G/V2G) can tap this flexibility to:
  - Increase utilization rate of existing grid infrastructure
  - Balance intermittency of renewables
  - Provide energy and ancillary services to the bulk power grid
- EVs can increase resilience by providing emergency backup power during outages
- Increased visibility/control at the grid-edge comes with increased risk of cyberattacks

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Reading Material

- E. Bitar, *Prepare Grid Now to Power EVs*. Albany Times Union, April, 9, 2021.
- P. Alexeenko and E. Bitar, *Harnessing the Flexibility of Plug-in Electric Vehicle Charging with Incentives and Real-time Control: A Pilot Study*. Preprint, 2021. (Email for copy)

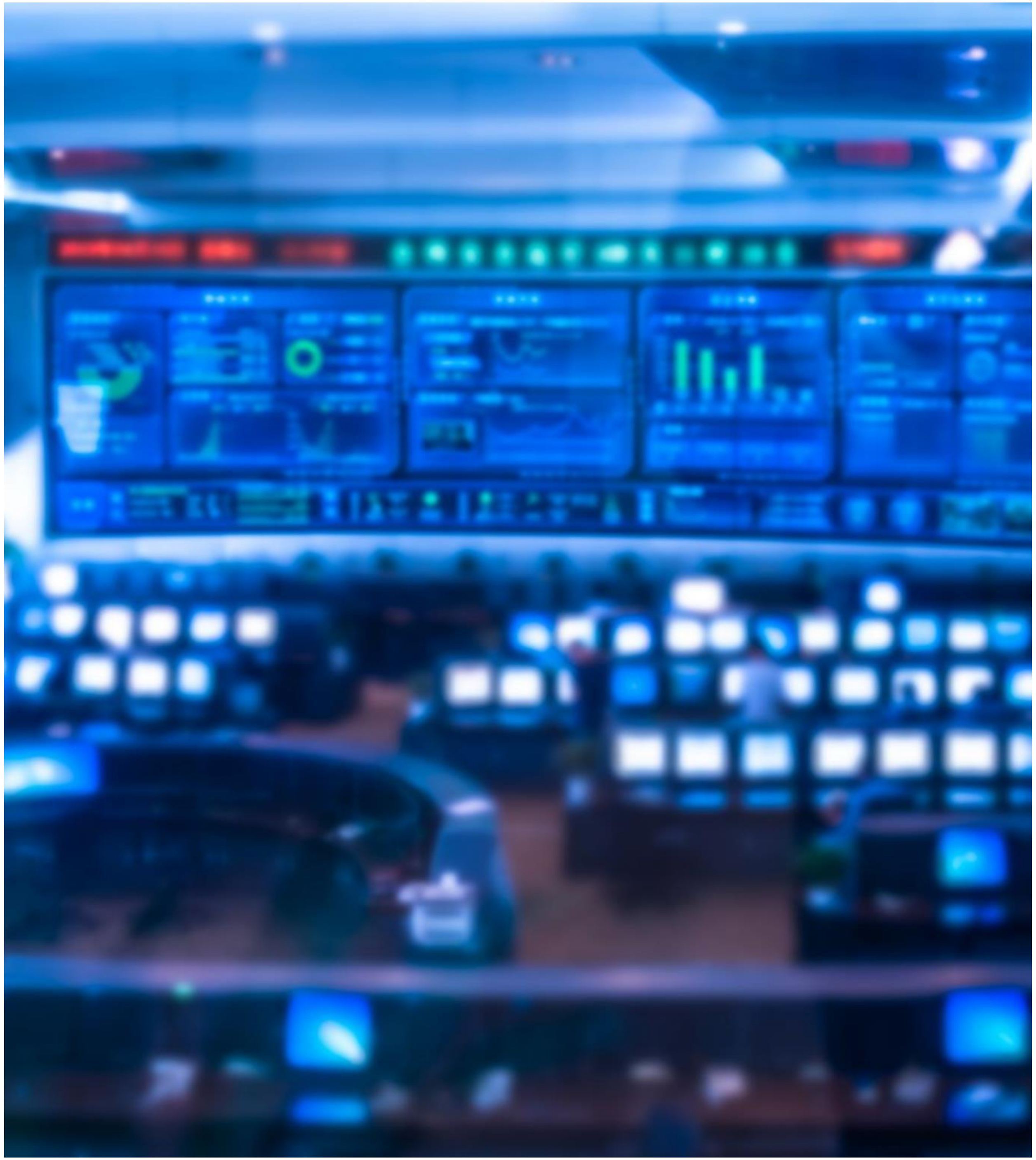
Smart Electric Power Alliance

SEPA Briefing on Leveraging Grid Edge Integration for Resilience & Decarbonization

June 25 2021

Clean + Modern Grid

Regulatory and Business Innovation | Grid Integration | Electrification



Smart Electric Power Alliance

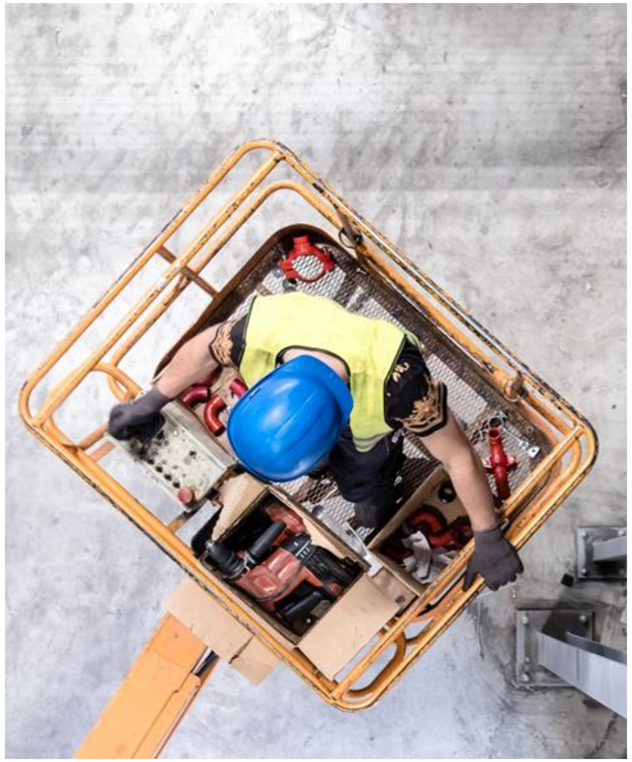
Smart Electric Power Alliance

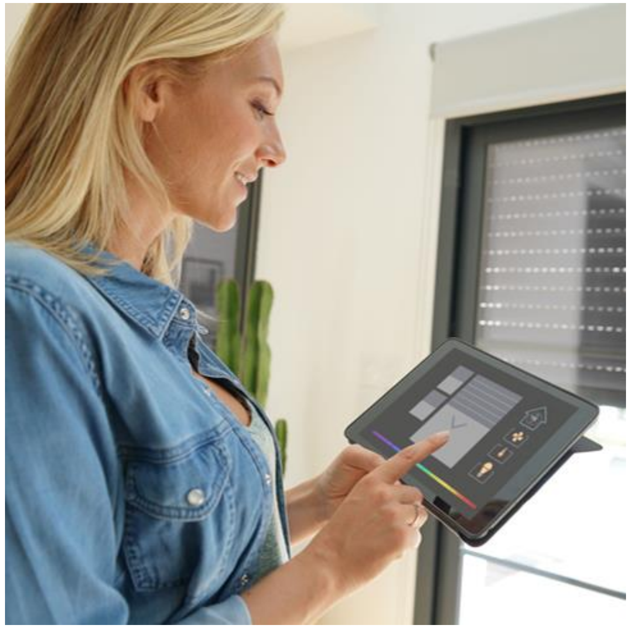
Vision

A carbon-free energy system by 2050

Mission

To facilitate the electric power industry's **smart transition** to a clean and modern energy future.



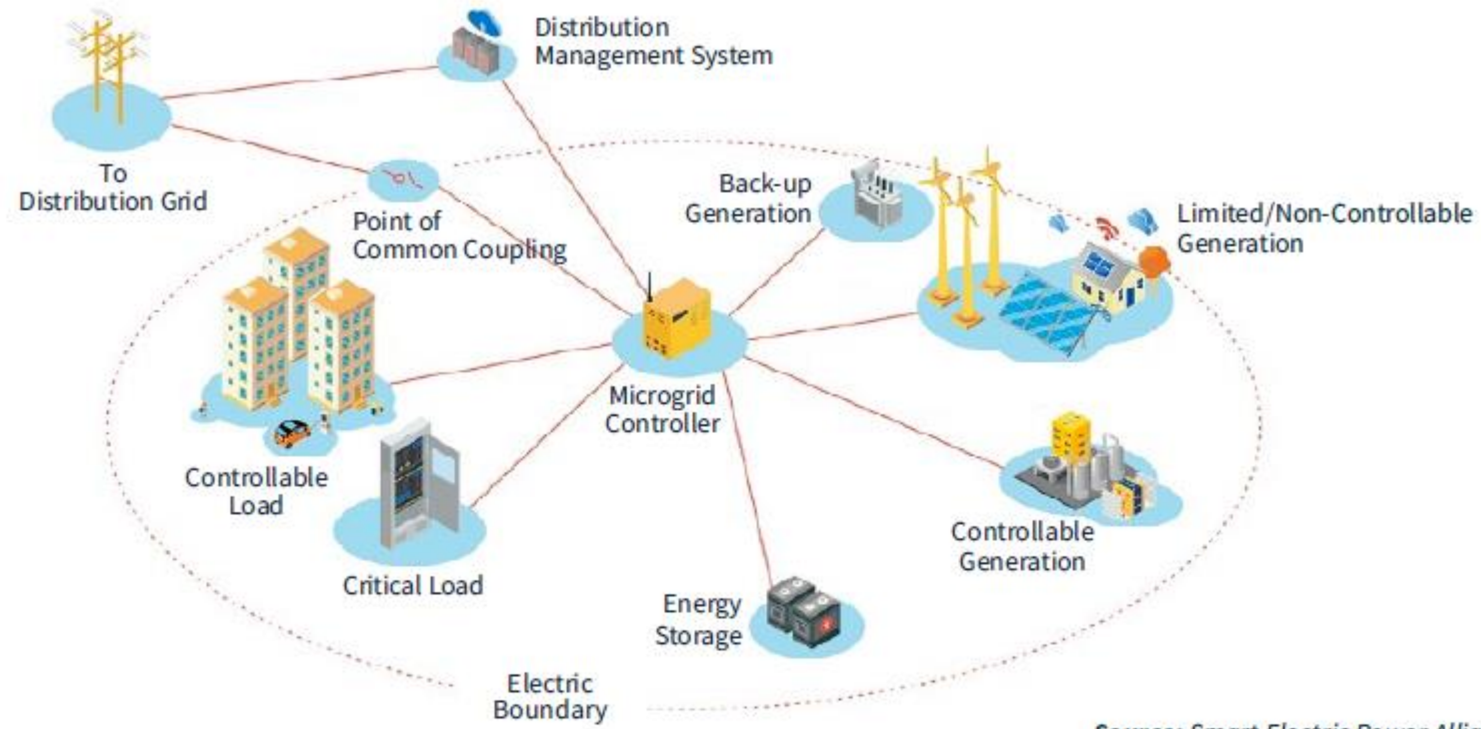


Who Are We?

Smart Electric Power Alliance

- A membership organization
- Staff of ~50
- Based in Washington, D.C.
- No Advocacy – 501c3
- Founded in 1992
- Research, Education, Collaboration & Standards
- Unbiased
- Technology Agnostic

Microgrid Overview



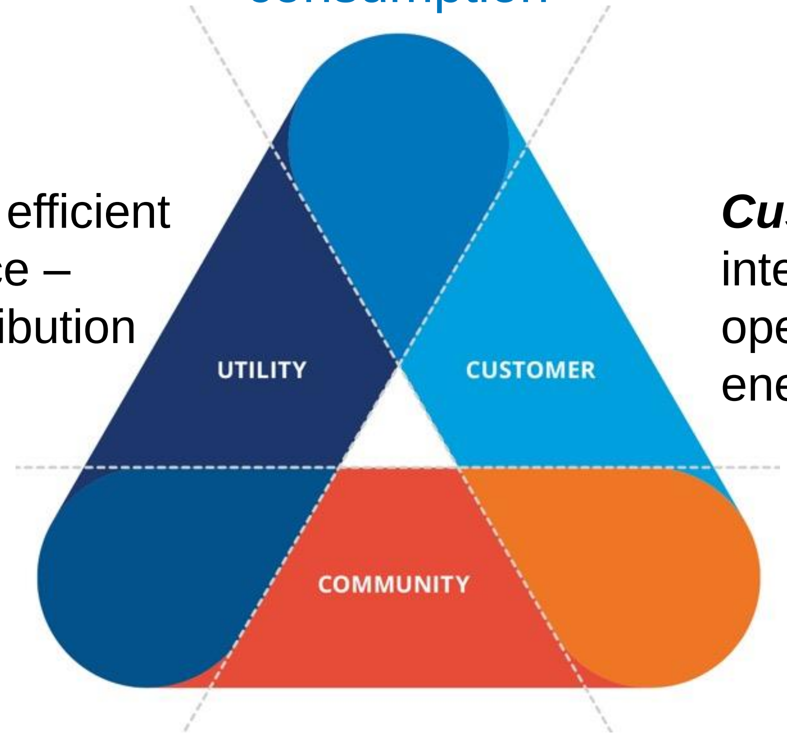
Source: *Smart Electric Power Alliance, 2020*

The ***DOE*** *defines the* ***microgrid*** *as "a group of interconnected loads and distributed energy resources within clearly* ***defined*** *electrical boundaries that acts as a single controllable entity with respect to the grid.*

Differing Perspectives on the Resilience Value Proposition

Reliability | continuity | lower consumption

Utilities value maintaining safe and efficient operations with highly reliable service – leveraging grid edge assets for distribution grid services.



Customers value avoiding power interruptions and maintaining critical operations and economic production – energy cost savings and energy efficiency.

National security | critical infrastructure | public institutions

Public health and safety | emergency preparedness

Communities value avoiding power interruptions and assuring critical services – access to clean and resilient power for all communities.

Areas that need continued focus…

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Gaps

- Lack of standards and terminology
- Siloed and proprietary systems
- Utility Business Models
- Microgrid Provider Compensation Mechanisms
- Regulatory Frameworks
- Equal access to clean and resilient power

Potential Solutions

- Standard Data Taxonomy
- Interoperability Frameworks
- Rate Recovery for Resilience Investments
- Contracts and Tariffs for Resilience Services
- Pilots and Demonstrations for Regulatory Sandboxes
- Stakeholder Informed Resilience Planning and Site Selection

SEPA Research on Microgrids and Resilience

Smart Electric Power Alliance

[Commonwealth of Kentucky Regional Microgrids for Resilience Study]

[MEA Resilient Maryland Newtowne Twenty Microgrid Feasibility Study]

[U.S. Department of Energy Voices of Experience: Microgrids for Resilience]

[SEPA Microgrid Playbook: Community Resilience for Natural Disasters]

Smart Electric Power Alliance

Questions?

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SCE's Pathway to a Reimagined Grid

Presenters:
Dana Cabbell, Director, Integrated System Strategy
Juan Castaneda, Principal Manager, Grid Technology Innovation

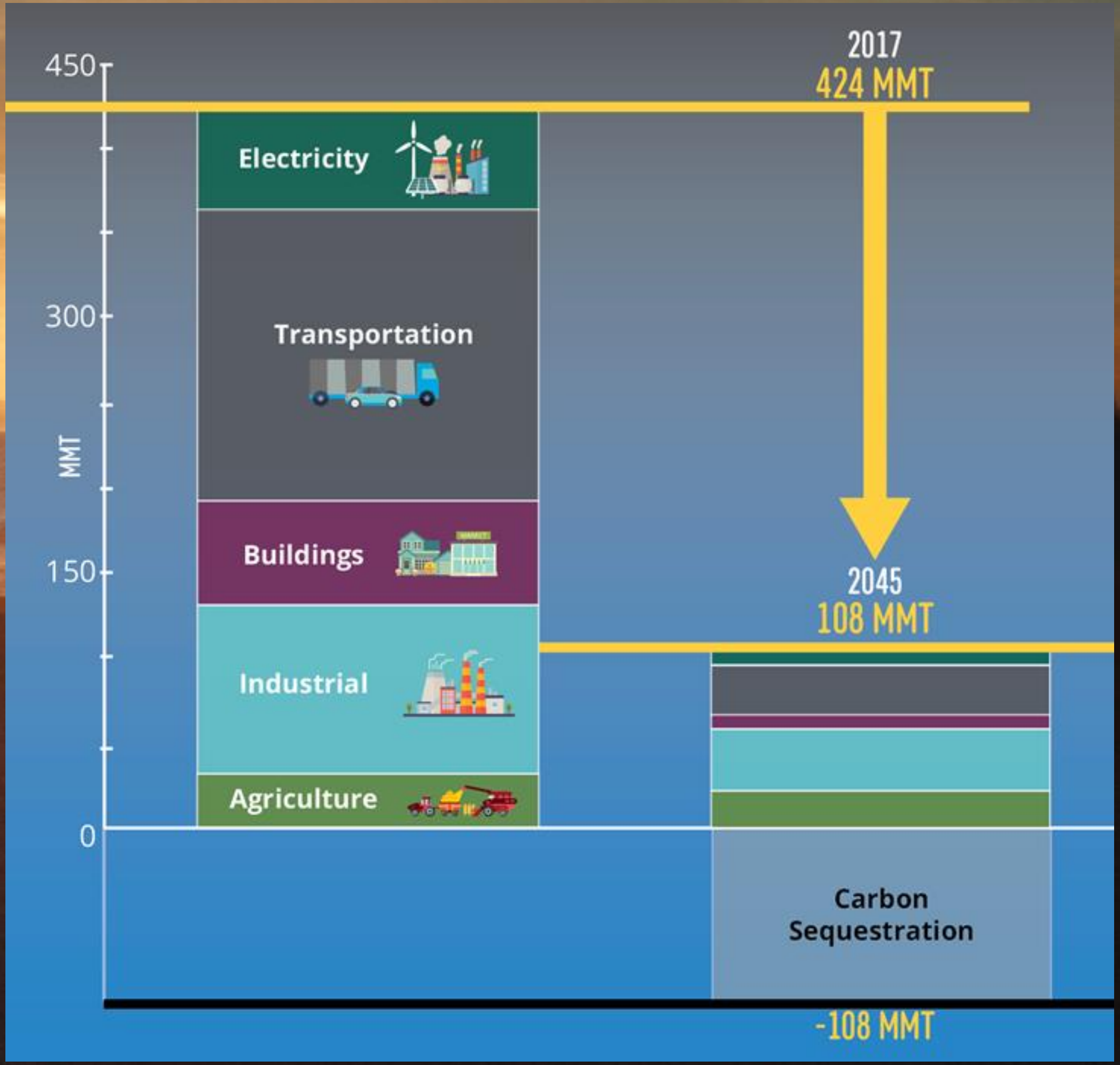
SOUTHERN CALIFORNIA EDISON®

Pathway 2045: Achieving 100% carbon neutrality

- Decarbonization of the **electric sector**

- Significant electrification of **transportation** and **buildings** and the use of **low-carbon fuels** for hard-to-electrify applications such as industrial and heavy-duty transportation

- Sequestration of remaining carbon through natural processes and engineered solutions



Our Reimagining the Grid approach

GRID CHALLENGES

Factors driving future grid uses, needs & evolution

- Customer
- Energy Supply
- Climate Impacts

Starting point for the grid

- Current SCE Grid
- Physical Topology

DEVELOPMENT OF GRID OPTIONS

SCE Regions
Geographic areas with unique attributes and needs (evolving over time)

- Unique needs & characteristics
- Local grid challenges

Region 1
Region 2
Region 3

Evolving SCE Grid
Grid design solutions with specific capabilities and technologies

- Required capabilities
- New grid technologies
- Specific grid architectures

ROADMAP

Future Grid Roadmap

- Near term
- Mid term
- Long term

Grid Challenges

CUSTOMER

- Supporting **large adoption of DERs** on distribution systems
- **Higher usage and load density** largely due to electrification
- **More end-uses that are sensitive to power quality** (e.g., power electronics)
- Overall, **increased reliance on electricity**

SUPPLY

- **Integrating very high levels of renewables** (far from load centers)
- **Ensuring Resource Adequate** with an evolving mix of resources
- Maintaining grid stability and resilience under **lower levels of inertia** with conventional generation retirements

CLIMATE

- Direct impacts to **performance of grid assets** from climate risks such as extreme temperatures, wildfires, and floods
- Climate-driven changes in **customer needs and electric service continuity**

Evolving SCE's Grid

Grid **planning, design, and operations** will need to shift from a focus on systemwide standards to one that meets multiple objectives based on localized needs. Changes in practice include:

- Strengthening our "forward radar"
- Moving from a deterministic planning approach to a risk-based, multi-scenario, and adaptive approach
- Greater integration of generation, transmission, distribution, and customer resources to optimize planning and operating decisions
- Recognizing the heterogeneity of different regional needs, moving from uniform grid architectures to region-specific, "modular" designs
- Incorporating flexibility into future grid architectures with technologies that can rapidly reconfigure and isolate portions of the grid while utilizing storage, DERs, and controllable loads

Reimagined Grid

to enable Pathway 2045 vision and meet location-specific needs

- Heterogenous and integrated T and D architectures
- Grid decisions more autonomous, flexible, and software/network-centric
- Common IT/OT platform deployed across the grid with advanced cybersecurity
- Tailored grid architectures with existing and next-gen technologies deployed for different regions

Achieving our vision for the reimagined grid will require rethinking various aspects of the grid

Increased technology focus and collaboration

Coordinated and adaptive grid planning

Reimagined approach to grid design

More efficient and integrated licensing/ permitting processes

Intelligent, more autonomous grid management and operations

Learn more at:

edison.com/pathway2045

edison.com/reimaginingthegrid

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