

Better Buildings Residential Network Peer Exchange Call Series

The Potential of Whole-Home Lighting Systems and Low-Voltage Homes

December 14, 2023



#### **Agenda and Ground Rules**

- Moderator
  - Jonathan Cohen, Better Buildings Residential Network, U.S. DOE Residential Buildings Integration Program (RBI)
- Agenda Review and Ground Rules
- Residential Network Overview and Upcoming Call Schedule
- Opening Poll
- Featured Speakers
  - Wyatt Merrill, U.S. Department of Energy (DOE)
  - Michael Poplawski, Pacific Northwest National Laboratory (PNNL)
  - Ann Collier, Smart Electric Power Alliance (SEPA)
- Open Discussion
- Closing Poll and Announcements

#### **Ground Rules:**

- 1. Sales of services and commercial messages are not appropriate during Peer Exchange Calls.
- 2. Calls are a safe place for discussion; **please do not attribute information to individuals** on the call.

The views expressed by speakers are their own, and do not reflect those of the Dept. of Energy.





#### **Better Buildings Residential Network**

#### Join the Network

#### **Member Benefits:**

- Recognition in media, social media and publications
- Speaking opportunities
- Updates on latest trends
- Voluntary member initiatives
- One-on-One brainstorming conversations

#### **Commitment:**

 Members only need to provide one number: their organization's number of residential energy upgrades per year, or equivalent.

#### Upcoming Calls (2<sup>nd</sup> & 4<sup>th</sup> Thursdays):

- 1/11: Diversity, Equity, Inclusion, and Residential Energy Efficiency Right Now, A Snapshot
- 1/25: <u>TBA</u>

Peer Exchange Call summaries are posted on the Better Buildings <u>website</u> a few weeks after the call



For more information or to join, for no cost, email <u>bbresidentialnetwork@ee.doe.gov</u>, or go to <u>energy.gov/eere/bbrn</u> & click Join





Wyatt Merrill U.S. DOE



# **Electrifying with existing infrastructure** and clever storage

Wyatt Merrill

Technology Manager – Solid-State Lighting R&D and Building Electric Appliances, Devices, and Systems (BEADS) U.S. DOE Building Technologies Office (BTO)



Office of ENERGY EFFICIENCY & RENEWABLE ENERGY



### The Building Technologies Office approach

BTO invests in energy efficiency & related technologies that make homes and buildings more affordable and comfortable, and make the US more sustainable, secure and prosperous. Activities include:



R&D Pre-competitive, earlystage investment in next-generation technologies Integration Technology validation, field & lab testing, metrics, market integration Codes & Standards

Whole building & equipment standards technical analysis, test procedures, regulations

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#### **Energy-Storage Equipped (ESE) Appliances**

Reduced electrical work: No need to run new circuits, 120-V outlets already in most kitchens to power oven clock







Ranges 45MM

Service Addressable: difficult to electrify homes, 22.5MM Market Value: \$135 Billion at \$6000 per/ home

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### **Towards ESE networks**



A newly selected BTO FOA project is targeting ESE 120-V HPWHs and mini-splits

What could a home (or neighborhood) do with coordinated ESE appliances?



#### ESE appliances are part of a bigger electrification/resilience opportunity



### **Technology adoption can be FAST**



Source: Mai, Trieu, Paige Jadun, Jeffrey Logan, Colin McMillan, Matteo Muratori, Daniel Steinberg, Laura Vimmerstedt, Ryan Jones, Benjamin Haley, and Brent Nelson. 2018.Electrification Futures Study: Scenarios of Electric Technology Adoption and Power Consumption for the United States. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-71500. wyatt.merrill@ee.doe.gov



Michael Poplawski *PNNL* 



# Low-voltage lighting ... and more

### U.S. DEPARTMENT OF

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Michael Poplawski

Chief Engineer & Team Lead

Pacific Northwest National laboratory



#### Where to start?



### Low-voltage lighting has been around for 50ish years



Reference: https://www.alconlighting.com/blog/home/history-function-track-lighting/

### There are many commercially available AC alternatives...



### **Low-Voltage Emerge Alliance Standards**



https://www.emergealliance.org/standards/occupied-space-2/ https://www.emergealliance.org/standards/occupied-space-2/standard-faqs/ https://www.emergealliance.org/about/vision/ https://www.emergealliance.org/dc-revenue-grade-metering-standard/

### Low-Voltage Power Over Ethernet ... Standardized by IEEE



### Here is where it starts to get messy...



### **Electrical engineering basics**



**TLDR** 

#### Low voltage $\neq$ Low power

DC system efficiency is typically more dependent on system architecture and design than AC system efficiency (and we didn't even get into cable types and losses)

DC systems are more likely to be more energy efficient than AC systems if AC/DC conversions are ELIMINATED, not just MOVED

AC/DC conversions can only be eliminated if DC generation sources (e.g., PV) are used to DIRECTLY (not through an inverter) power DC loads

Low-voltage DC systems installation and maintenance costs MAY be lower than comparable AC system costs, and MAY depend on locality ... and control considerations

#### **Other considerations**

Atypical electrical distributions technologies are highly disruptive to existing practices: marketing, installation, electrical safety codes, energy codes

Lighting customers demand broad choices and easy replaceability: fixture type, output, color temperature, housing color/style

DC light sources (i.e., LED) are here to stay, building loads are increasingly inherently DC, building DC generation (i.e., PV) and storage (i.e., batteries) deployment is growing...

Low-voltage DC systems with integrated control/data MAY bring electrification and resilience advantages

Interoperability, standards, and standards certification processes/bodies are key

# Top three value proposition choices for DC lighting and building microgrids from RFI and interview respondents



https://www.pnnl.gov/publications/dc-lighting-and-building-microgrids

# DC systems have potential building microgrid advantages, but product availability and maturity is still evolving...



#### **Opportunity: Low-voltage DC systems with integrated system-level power management, facilitating electrification and resilience**



#### **Opportunity: Low-voltage DC systems with integrated neighborhood-level power management, facilitating electrification and resilience**



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Ann Collier SEPA







## **Grid-Interactive Efficient Buildings**

Ann Collier, Senior Manager – Emerging Technology DOE Better Buildings Residential Network Peer Exchange: The Potential of Whole-Home Lighting Systems and Low-Voltage Homes. December 14, 2023

# What SEPA Does



SEPA is a **membership organization** comprised of ~1,100 utilities, industry partners, regulators and other stakeholders.

We Accelerate the Transformation to a Carbon Free Energy System through:



# The Evolving GEBs Opportunity





Source: U.S. Department of Energy, A National Roadmap for Grid-Interactive Efficient Buildings, 2021.

#### DOE Building Technology Office's GEB Definition

Energy-efficient buildings— with smart technologies— characterized by the active use of distributed energy resources (DERs)— to optimize energy use for grid services, occupant needs and preferences, and cost reductions— in a continuous and integrated way.

#### DOE Goal: Triple energy efficiency & demand flexibility in residential & commercial buildings by 2030 (2020 baseline)

# **GEBs Value to the Electricity Grid**

Buildings account for over 70% of all U.S. electricity consumption and at least one-third of U.S. economy-wide emissions.

As noted in DOE's A National Roadmap for GEBs, GEBs can provide value to the grid via diverse measures and technologies that also co-optimize across customer preferences and energy costs.

Coordinating residential & commercial building electricity consumption with grid needs and resources could:

- Save between \$100-200 billion in U.S. electric power system costs nationally
- Decrease CO2 emissions by 80 million tons per year nationally by 2030 (6% of total power sector CO2 emissions).



Smart Electric Power Alliance

Source: U.S. Department of Energy, A National Roadmap for Grid-Interactive Efficient Buildings, 2021.

### **Smart Efficiency is a Core Component of GEBs**



#### Customer energy programs must evolve to support GEBs development



Source: SEPA, 2022

# **Getting from Residential EE to GEBs**





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Customer energy programs must evolve to support GEBs development



Source: ACEEE, in U.S. Department of Energy, A National Roadmap for Grid-Interactive Efficient Buildings, 2021.

# **Smart Efficiency is a Step Towards GEBs**



GEB-capable technologies exist for many building systems– but integration tools are still in development and pilot phases.





FIGURE 9: TECHNOLOGY PIPELINE EXAMPLES FOR EACH GEB LAYER

Note: TES integrated with HVAC is available in large commercial buildings but rare in small commercial or residential buildings.

#### FIGURE 5: ENERGY AND PEAK DEMAND SAVINGS BY MEASURE TYPE (2030)

Notes: Values shown correspond to the Mid Adoption case. Regional detail is provided in Appendix B. "CAC" is central air-conditioning. Water heating impacts are primarily driven by heat pump adoption. Each type of measure has some element of demand flexibility, except for refrigeration, which was modeled strictly as providing EE benefits. Measure types are defined in Figure 15. The Residential Preconditioning measure results are excluded as they do not map exclusively to CAC, ASHP, or Envelope.

# Assembling Components in a GEB Program



#### Ingredient

#### Funding

**Smart Electric Power Alliance** 

#### Components (Examples)

Energy-efficient products	HVAC, water heaters, LED lighting, shell, etc.
Renewable energy	Behind-the-meter solar PV, utility wind or solar
Behind-the-meter DERs	Electric vehicles, EV chargers, battery storage
Sensing & controls for products	Smart thermostat, occupancy sensor, daylighting sensor, automated dimming, etc.
Sensing & controls for buildings	Smart home energy management, building automation systems
Control software	DRMS, DERMs, vendor-specific platforms
Program manager or aggregator	Utility, aggregator, third-party administrator
Grid-to-building control strategy	Implementation guidelines, aggregation rules, cost-effectiveness guidelines
Funding	Utility investments, system benefit charge, grants
Administration & coordination	Time & effort across many teams

#### Grid-Interactive Efficient Buildings Program Source: SEPA

# **Report & Case Studies**





#### What's in the report?

- Practitioner perspectives on challenges to and potential solution strategies for the building energy program transition
- Identifies challenges of deploying effective coordinated energy efficiency, demand flexibility, and demand response utility programs
- Provides solution strategies to support all stakeholders looking to unlock a GEBs future
- Includes 8 case studies

Supported by the U.S. Department of Energy and Lawrence Berkeley National Laboratory

# **Current State & Coordinated Program Types**

#### Current Program State

- Fully optimized and coordinated programs are still nascent
- Continuum of current program activity (investigation, piloting, full deployment)
- Majority of study participants currently operate traditional EE and DR programs, with a few also providing DF offerings
- Program integration early successes primarily due to supportive regulatory environments combined with internal drivers
- **Type 1 Programs** represented the majority of activity

Characteristics	Program Types			
	Type 1 EE+DF: Programs Promoting Customer End-use Technology Adoption	Type 2 Integrated EE+DF(+DR): Programs Promoting Customer End-use Adoption with Potential to Provide Grid Services	Type 3 Coupled EE+DF(+DR): Programs Promoting Customer End-use Adoption Linked to Dispatchable Grid Services	
E & DF Approach	Integrates EE and DF program offerings to customers			
R Approach	Not coupled with DR (i.e., not tied to grid services)	Integrates with non-dispatchable DR (e.g., includes the potential to provide grid services by pairing with time-varying rates)	Couples with dispatchable DR (i.e., includes the potential to provide grid services through dispatchable programs)	
	Promotes GEBs by increasing the efficiency and adoption of EE+DF technologies in buildings			
EBs Promotion		Promotes GEBs by offering opportunities to co-optimize across energy cost, grid services, and customer preferences		



# **Case Studies**



#### SMUD 2030 Zero Carbon Plan and Coordinated Programs

SMUD adopted its 2030 Zero Carbon Plan in April 2021. Year 1 priorities include the following actions relevant to coordinated EE+DF(+DR) programs:

- Perform information technology system upgrades to enable distributed energy resources (DERs) and VPPs.
- Include DERs in operations, distribution and grid planning processes.
- Launch new customer-partner pilot programs for VPPs, involving thermostats, (EVs), rooftop solar and batteries.
- Launch pilots for behavioral DR ("Flex Alert"), EV managed charging and vehicle-to-grid (V2G) demonstrations.

### Successful Strategies for Eversource and National Grid

- House EE+DF and DR teams under one umbrella
- Coordinate with other departments/teams early in the program development process.

#### **Potential Solutions to Cost-Effectiveness Challenges**

- Program administrators can analyze AMI data, when and where available, to help utilities, regulators, customers, and solution providers better understand or measure program value and cost-effectiveness.
- Regulators and program administrators can collaborate regionally (especially in areas with regional organized wholesale markets) to help utilities and participants assess value.
- Regulators can review existing cost-effectiveness requirements for potential enhancements and alignment with national best practices.

# **Contact Us**



#### **Ann Collier**

Senior Manager, Emerging Technology acollier@sepapower.org

#### SEPA

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#### **Team Leads and Locations:**

Team Lead: Frontier Energy – Building Research and Consulting Business Unit Location: Southwestern U.S.

**Team Lead:** Center for Energy & Environment **Location**: Midwest U.S.

**Team Lead:** Enterprise Community Partners Inc. **Location**: Western and Central U.S.

Team Lead: Steven Winter Associates Location: Northeastern U.S.

Team Lead: EXP Location: Eastern U.S.

**Team Lead:** Cycle Architecture, PLLC **Location**: Northeastern U.S.

Team Lead: Syracuse Center of Excellence in Environmental & Energy Systems Location: Northeastern U.S.

Team Lead: Earth Advantage Location: Pacific Northwest U.S.

**Team Lead:** Southeast Energy Efficiency Alliance **Location**: Southeastern U.S.

# **Announcement:** Building America Retrofit Solutions Teams!





#### Nine Multi-Disciplinary Teams Each Consisting Of:



Scan QR code to learn more about the teams!

# **Building America Retrofit Solutions Teams**

A portfolio of field demonstration projects leading to de-risked, equitable, and scalable technical retrofit solutions in the existing U.S. housing stock

#### **Key Objectives:**

- **Reduce risk** of retrofits to end-user, utilities, contractors, financiers.
- **Improve value proposition** of retrofit improvements to end-user, utilities, regulators.
- Develop, disseminate, and promote use of best retrofit practices.
- **Inform** technology development to meet enduser/contractor needs.



Teams will engage directly with communities to identify retrofit needs and develop best practice guidance for broader, scalable retrofit implementation (timeline: 1–3-year projects)





### **Smart Tools for Efficient HVAC Performance (STEP) Campaign**





Scan this QR code to visit our website Contact: christian.valoria@pnnl.gov

The STEP Campaign aims to increase adoption of smart diagnostic tools to streamline HVAC system performance testing and troubleshooting, reducing energy-wasting faults and improving occupant comfort.

#### 



#### **HVAC Contractors and Technicians**

- Reduce callbacks, improve consistency and quality, streamline processes
- Find out where to get training on smart diagnostic tools
- Be recognized for successful adoption of smart diagnostic tools!



#### **HVAC Training Organizations**

- Offer qualified training on System
  Performance with smart diagnostic tools
- Promote your training events
- Be recognized for providing training!



#### **Utilities and Program Implementers**

- Streamline quality installation and quality maintenance programs
- Improve engagement with your contractors
- Be recognized for programs that utilize smart diagnostic tools!



#### Weatherization Organizations

- Ensure your ASHP/CAC installations are operating at optimized efficiency
- Develop pilot with PNNL team
- Be recognized!



ORGANIZING PARTNERS













#### **Explore the Residential Program Guide**

Resources to help improve your program and reach energy efficiency targets:

- <u>Handbooks</u> explain *why* and *how* to implement specific stages of a program.
- <u>Quick Answers</u> provide answers and resources for common questions.
- <u>Proven Practices</u> posts include lessons learned, examples, and helpful tips from successful programs.
- <u>Technology Solutions</u> NEW! present resources on advanced technologies, HVAC & Heat Pump Water Heaters, including installation guidance, marketing strategies, & potential savings.
- <u>Health + Home Performance Infographic</u> spark homeowner conversations.



https://rpsc.energy.gov





#### **Health + Home Performance Infographic**

#### **Do You Have a "Healthy Home?"** A qualified contractor can help you assess and address indoor air quality, improve your comfort, and cut your utility bills. Answers to a few basic questions can help you get started: · How old are your heating and cooling systems? Ensuring your system is updated and well maintained can save money and improve health and comfort. Is your home insulated? Properly installed insulation in your walls and attic, at levels recommended for your home's climate, will cut bills, and improve comfort. ▦▦ · Have you ever noticed mold in your home? Visible mold likely means humidity levels need to be better addressed or indicates a potential leak or water damage. · Are your windows caulked and doors weather-stripped? These relatively simple fixes reduce air leaks and help maintain indoor temperature levels. • Are your appliances ENERGY STAR<sup>®</sup> rated? ENERGY STAR appliances are energy efficient and help you save money. . Do you know if your home's heating and cooling systems include proper levels of ventilation? Effective ventilation is important for both health and safety. Ventilation, along with frequently replaced air filters, can help make sure your home is bringing in fresh air as needed, and keep out pollutants when outdoor air quality is poor due to ozone, fire, or other factors. **GET** started FIND A OUALIFIED CONTRACTOR . Home Performance with ENERGY STAR® at ENERGYSTAR.gov/HomePerform Building Performance Institute at bpi.org/locator-tool ENERGY A RENEWABLE ENERGY

DOE's Health + Home Performance Infographic reveals the link between efficiency and health – something everyone cares about. Efficiency programs and contractors can use the question-and-answer format to discover a homeowner's needs.

The infographic is ideal for the "kitchen table" conversations where people decide what to do – and who they want to do it. It also has links for homeowners to find a qualified contractor if they do not already have one.

<u>Download</u> this infographic from DOE's Better Buildings Residential Network.

Looking for photos to help tell your energy efficiency story? Visit our image libraries: <u>https://www.energy.gov/eere/better-buildings-residential-network/articles/image-libraries</u>

## **Thank You!**

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