Grid-integrated Efficient Buildings and Connected Communities

KEYNOTE FOR CALFLEX HUB SYMPOSIUM

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

BUILDING TECHNOLOGIES OFFICE

2022

The U.S. is pursuing ambitious climate mitigation goals

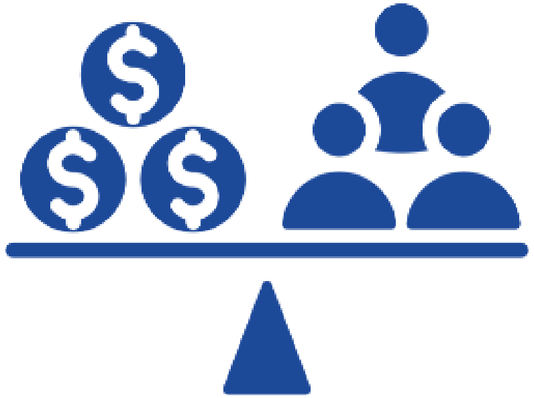
Greenhouse gas emissions reductions

50-52% reduction by 2030 vs. 2005 levels

Net-zero emissions economy by 2050

Power system decarbonization

100% carbon pollution-free electricity by 2035



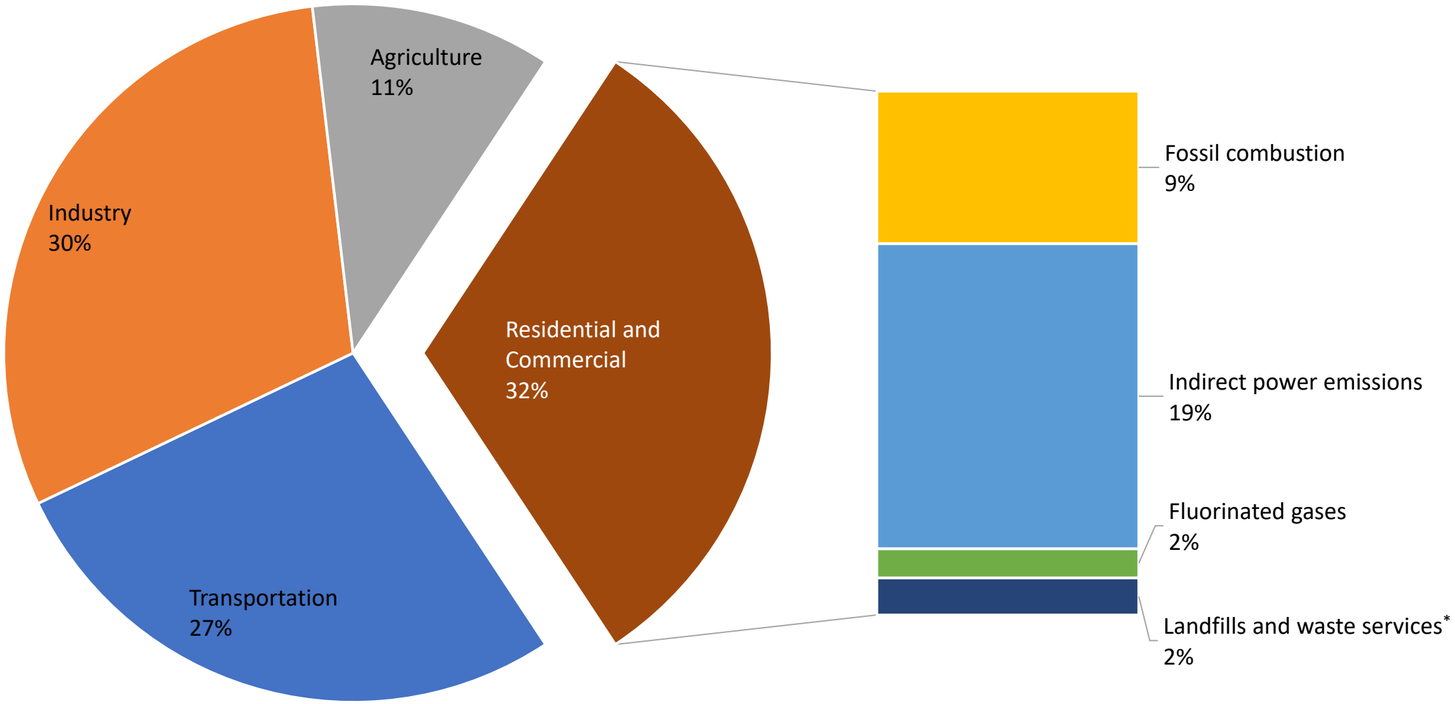
Energy justice

40% of benefits from federal climate and clean energy investments flow to disadvantaged communities

Source: National Climate Task Force

Buildings are a key source of U.S. emissions

Total U.S. Greenhouse Gas Emissions by Sector with Electricity Distributed



- Building material and construction emissions estimated to be an additional 2–11% (allocated to Industry and Transportation)
- EPA estimates methane leakage in natural gas systems contributes ~3% of total (165 $MtCO_2e$; allocated to Industry)

Source: U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-20

* EPA classifies emissions from landfills and waste services under the Commercial sector

Buildings are central to multiple decarbonization pillars

Reduce fossil-fired demand through electrification of heating, water heating, and cooking

Connect EVs, distributed generation and storage to the distribution grid

Limit scale of required electricity infrastructure needed under deep grid decarbonization

Improve people-centric outcomes such as energy justice, community resilience, air quality and public health, and energy security

Recognize buildings have a purpose while decarbonizing them

People-centered

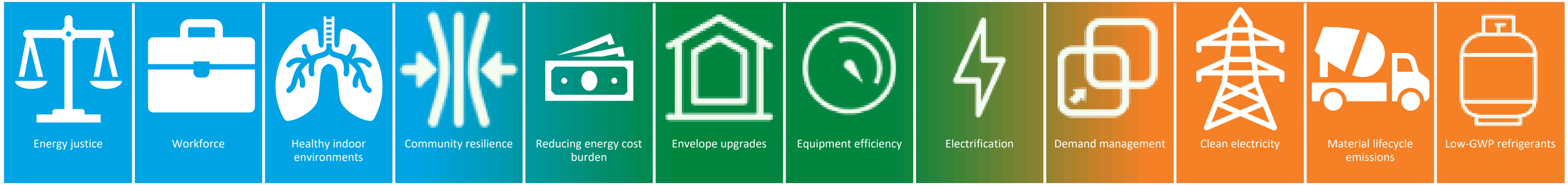
Healthy, comfortable, and resilient buildings for living and working are foundational to communities that underpin the human experience

Efficient

Efficiency helps us reduce waste and save money in healthy buildings

Clean

Decarbonization makes healthy, efficient buildings better for the environment and enhances societal good



Buildings serve a function first. Focus on performing this function efficiently, and then aim for societal benefits such as decarbonization and grid enablement.

A vision for a net-zero U.S. building sector by 2050

Support rapid decarbonization of the U.S. building stock in line with economy-wide net-zero emissions by 2050 while centering equity and benefits to communities

Increase building energy efficiency

Reduce onsite energy use intensity in buildings 30% by 2035 and 45% by 2050, compared to 2005

Accelerate building electrification

Reduce onsite fossil-based CO_2 emissions in buildings 25% by 2035 and 75% by 2050, compared to 2005

Transform the grid edge at buildings

Increase building demand flexibility potential 3X by 2050, compared to 2020, to enable a net-zero grid, reduce grid edge infrastructure costs, and improve resilience.

Prioritize equity, affordability, and resilience

Ensure that 40% of the benefits of federal building decarbonization investments flow to disadvantaged communities

Reduce the cost of decarbonizing key building segments 50% by 2035 while also reducing consumer energy burdens

Increase the ability of communities to withstand stress from climate change, extreme weather, and grid disruptions

Transform the grid edge at buildings

Demand-side management through building energy efficiency and demand flexibility can reduce the cost and scale of grid transformation to meet decarbonization goals

KEY ISSUES

Lack of demand-side resource valuation

Efficiency and demand flexibility are often not valued alongside conventional generation resources in utility planning and power markets

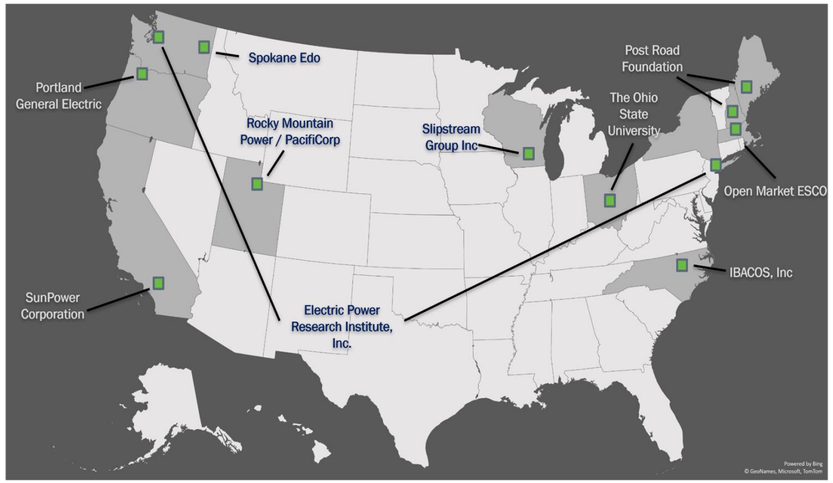
Lack of incentives

Insufficient economic and regulatory motivations for utilities, aggregators, and consumers to develop and participate in demand flexibility programs

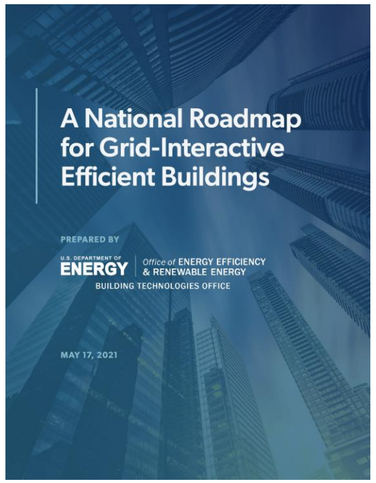
Uncertainty about performance

Lack of trust in the actual performance of demand-side management resources among utilities and system operators

EXAMPLE INITIATIVES



Connected Communities



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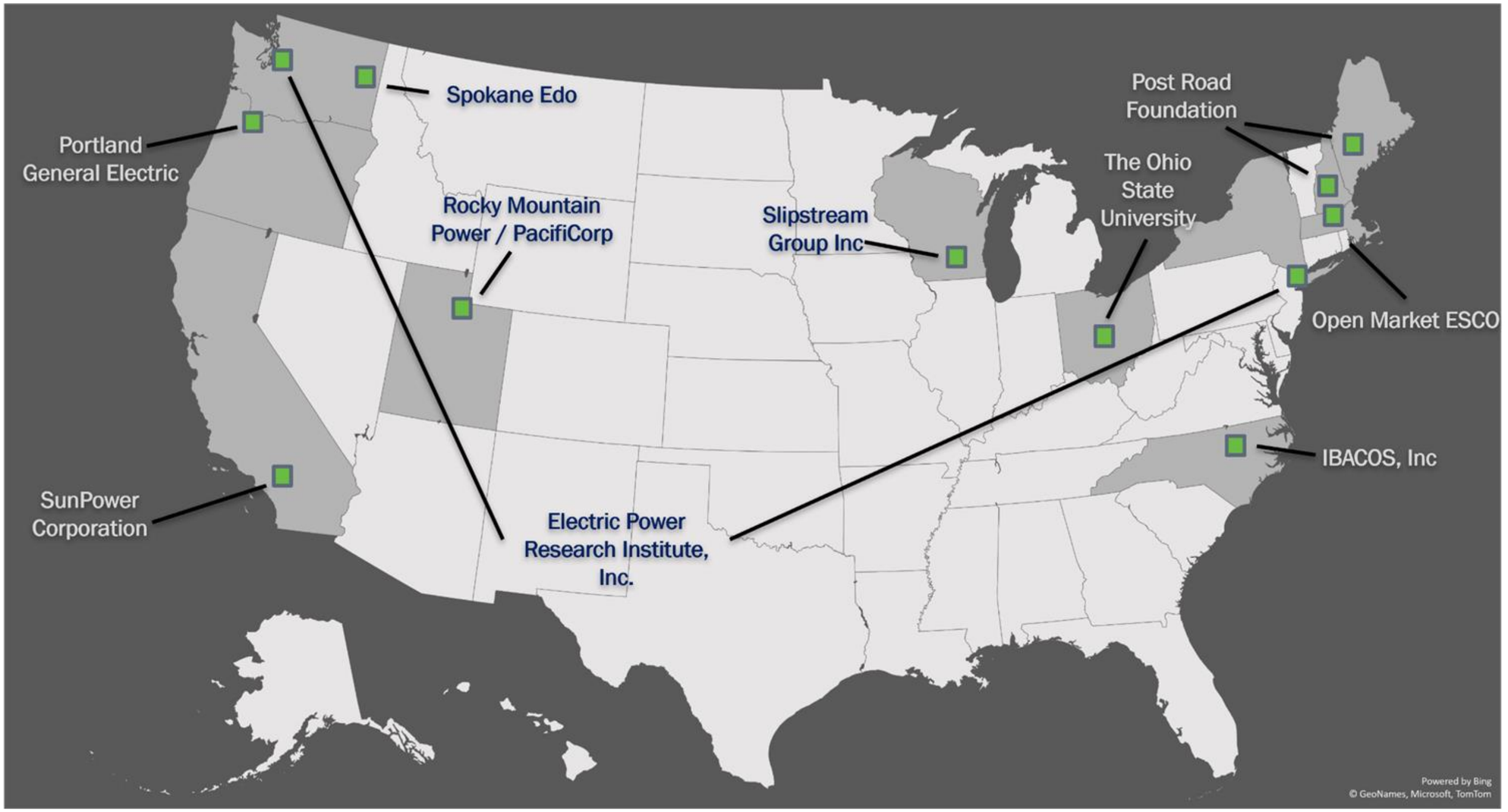
Location of *Connected Communities* Projects Selected for Negotiations

10 Selected Projects

- $61 Million Total funding
- Final Awards expected May 2022.



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

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Edo Energy

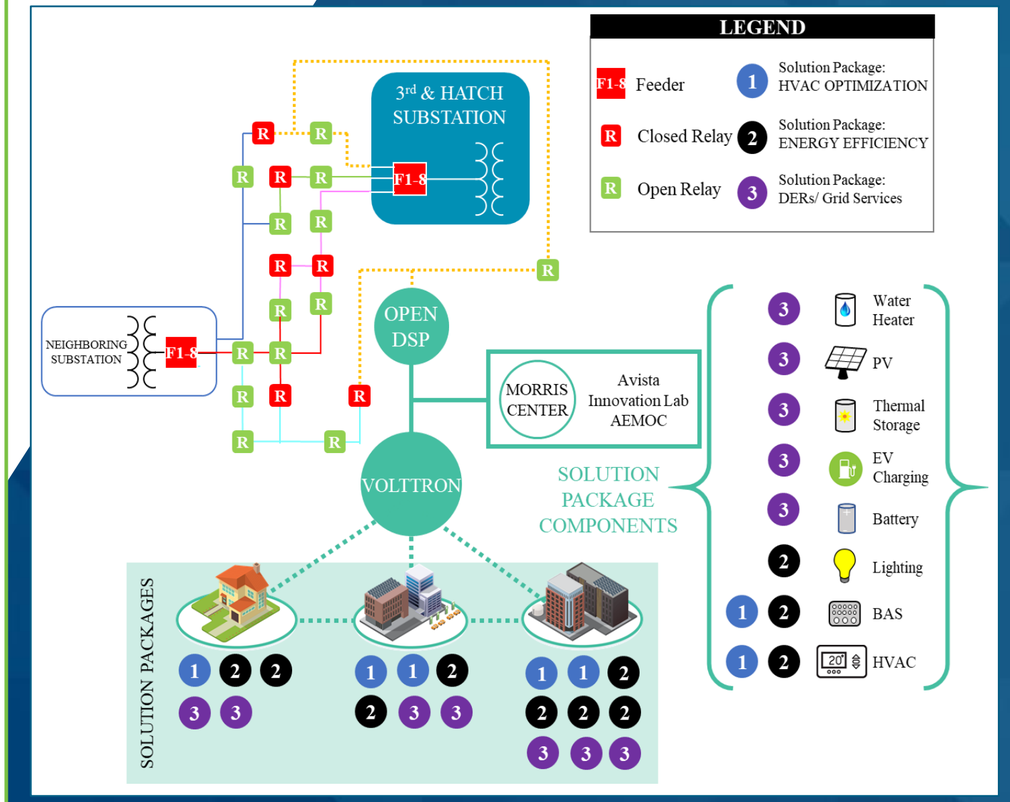
with Avista Utilities, McKinstry, PNNL, and Urbanova

Community Description

This project will demonstrate non-wires alternatives that support deferring or avoiding major capital investments in a 55MW-peak distribution substation by creating targeted (locationally specific) virtual power plants (VPP) from existing buildings, while optimizing power quality and supporting adjacent feeder needs. 75 to 125 participants will be recruited from existing single and multi-family residential and commercial buildings, and building flexibility will be augmented by DERs to demonstrate 1–2.25 MW of flexible load. EE measures are realized by improving small and large commercial building operations and retrofitting for single and multi-family homes. The project includes the Spokane EcoDistrict with an existing battery, thermal storage, onsite PV, and an all-electric central plant.

KEY INNOVATION:

- ✓ Developing an integration platform to systematically deploy VOLTTRON in multiple building types and optimizing VPP dispatch with OpenDSO.
- ✓ Coordinating VPP scheduling and dispatch of building resources using Avista Utility's Active Energy Management Operations Center.
- ✓ Demonstrating a novel utility and private sector partnership with a shared-value business model for building-to-grid integration services.
- ✓ Demonstrating multi-year operation of buildings and DERs as VPPs to provide insight on their dependability and load flexibility as dispatchable utility resources.
- ✓ Developing a Connected Communities Playbook that details project design (prices, incentives), market potential and behavioral research to enable reaching scale and replicability.



SunPower Corporation

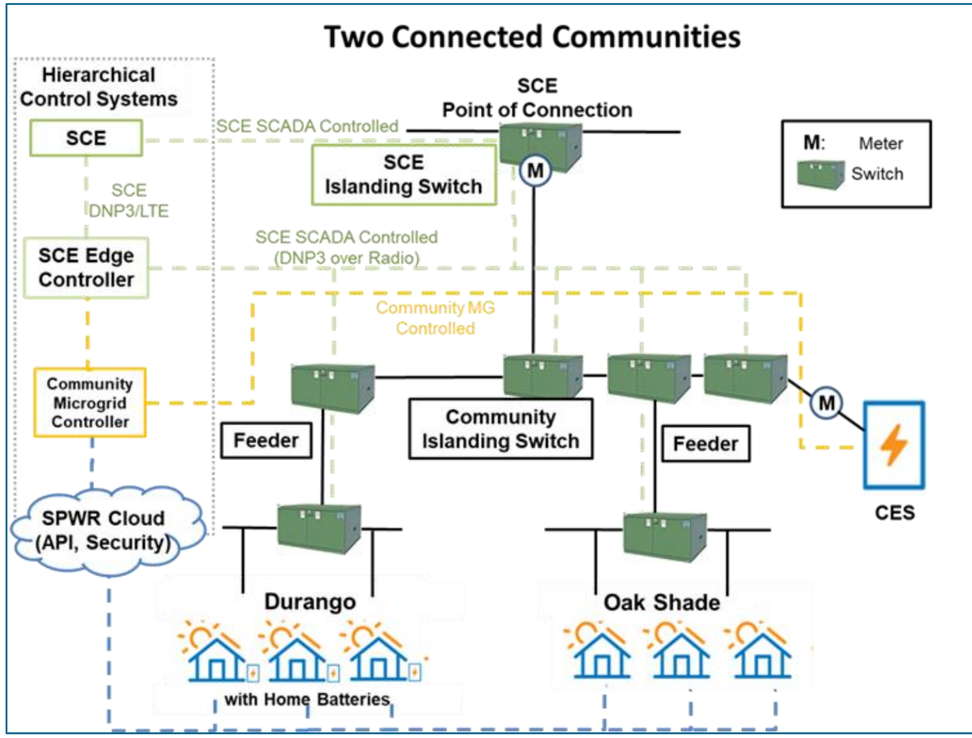
with KB Home, University of California Irvine, Schneider Electric and Southern California Edison

Community Description

Two new home neighborhoods in California connected with microgrids equipped with distributed energy resources, load flexibility, energy efficiency, and reliability and resiliency measures. Homes will be all-electric, meet DOE zero energy ready homes criteria with PV and home energy management systems. Both neighborhoods (200+ homes) will have in home-batteries and be connected by a community battery which will power a microgrid in the event of a grid outage. The connected communities will be able to share resources as needed and provide grid services to the local utility.

KEY INNOVATION:

- ✓ Integration of existing commercial technology including nested microgrids.
- ✓ Evaluate value of community battery, residential batteries, and home energy management systems.
- ✓ Shifting natural gas fuel end-uses to high efficiency all-electric technology and utilizing controllable HVAC, water heaters and ENERGY STAR labeled appliances.
- ✓ Utility distribution SCADA and automation system edge controller w/close coupled community nested microgrid



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Portland General Electric

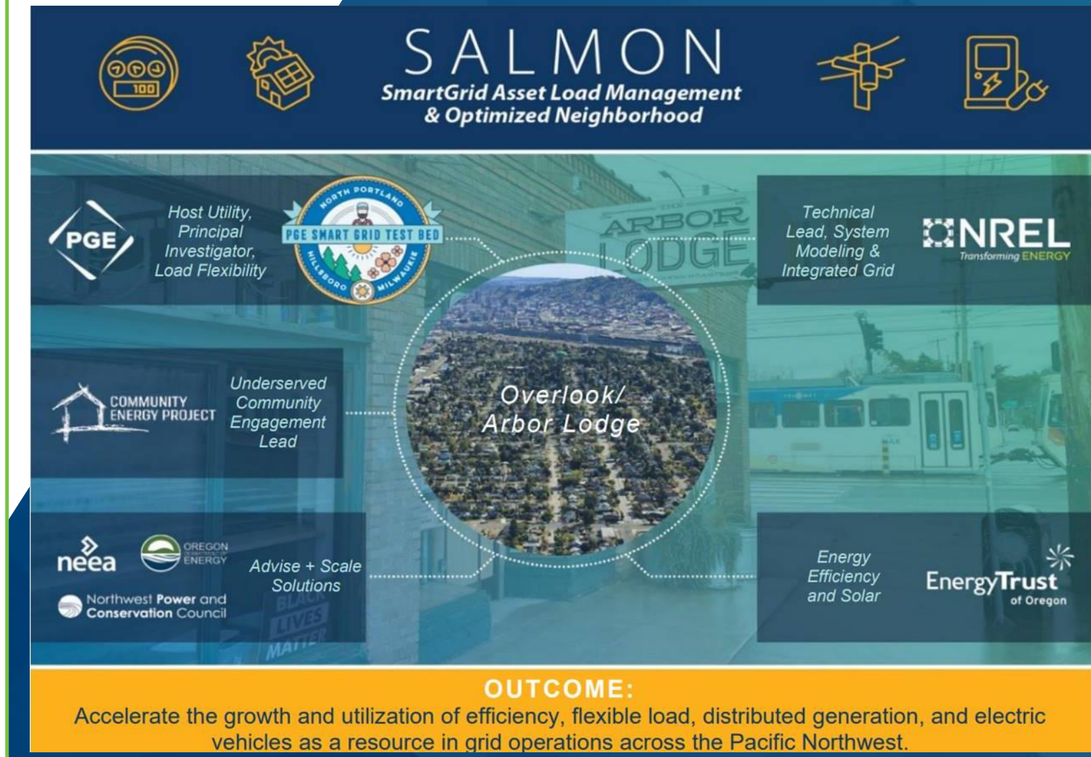
with Energy Trust of Oregon, NEEA, Community Energy Project, NREL, Open Systems International, Inc.

Community Description

A mix of residential and commercial buildings in Portland's Overlook/Arbor Lodge neighborhood will be encouraged to participate. The project goal is to demonstrate 1.4 MW of flexible loads through retrofitting approximately 580 (~21%) buildings with various measures including smart thermostats, smart water heaters, shell measures, high efficiency HVAC, solar with smart inverters, storage, and managed electric vehicle charging. Measures will be integrated into PGE's Advanced Distribution and DER Management Systems, and optimized by NREL to demonstrate multiple grid services.

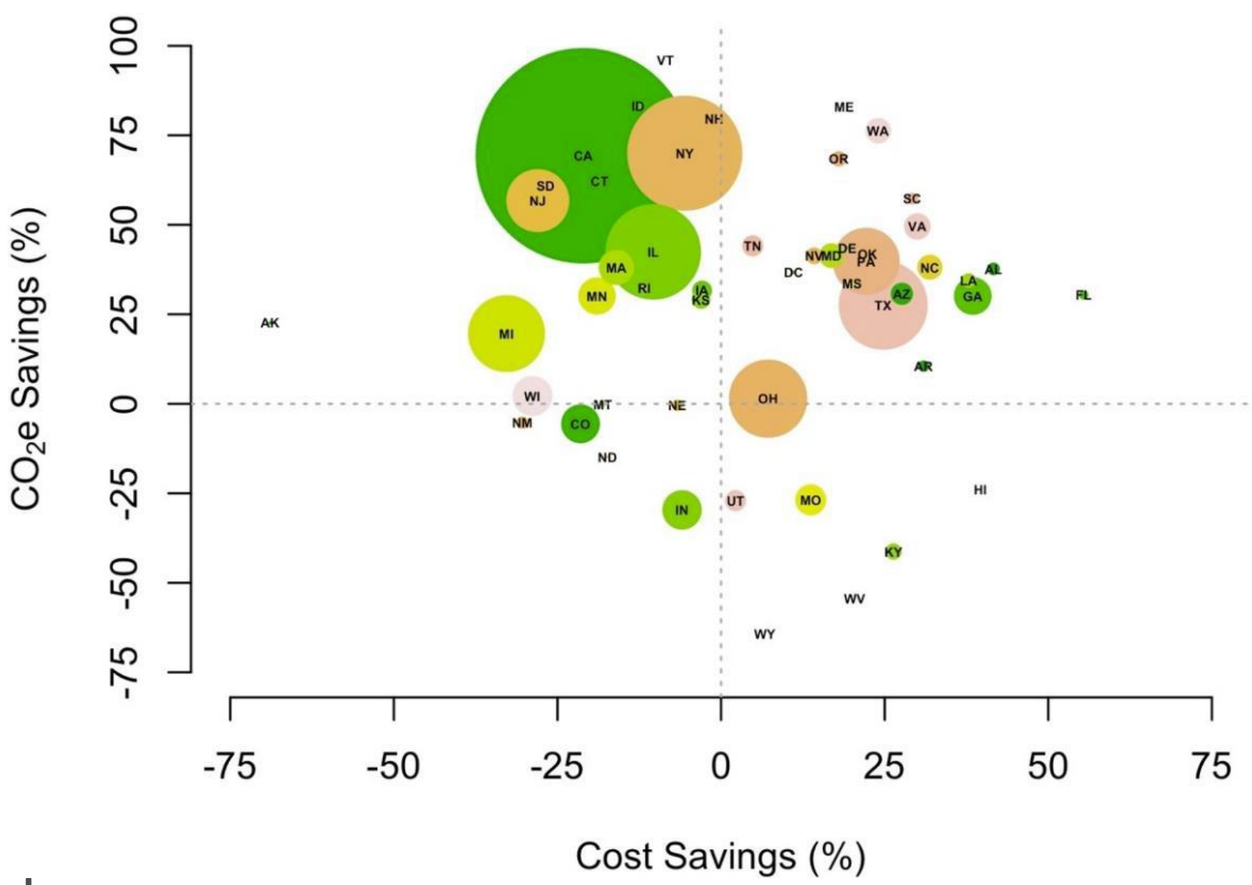
KEY INNOVATION:

- ✓ Community engagement with a special focus on low-income and traditionally underserved residents facing gentrification
- ✓ Demonstrates a range of grid services
- ✓ Strong market transformation activities that leverage existing utility programs and distribution channels and works with national organizations to disseminate findings



For discussion - sequencing affordability, decarbonization and flexibility

- Customer energy costs, energy affordability and energy security shoul all be key considerations
- Improve affordability while decarboniz
  - This will require more weatherization and more efficient equipment
  - Areas with lower electric rates are more amenable to electrification
- Customer energy security can be improved through less variability in energy costs
  - e.g., SRP fixed bill program
- Should we have higher fixed charges that reflect our infrastructure costs and support electrification?



Percent savings for CO2e and energy cost in each US state, when replacing a 95 AFUE furnace with a COP 3 heat pump. Points are scaled according to the count of natural gas space heating appliances in each state. Color coding is for visual separation only , (Walker, Less, and Casquero-Modrego 2022)