



Office of Energy Efficiency
& Renewable Energy

Built Environment Innovation Roundtable

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Report for Emerging Technologies

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Comments

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Table of Contents

Introduction	1
Objectives	1
Participants	2
Agenda.....	3
Opening Remarks	4
Participant Introductions and Soapboxes.....	4
Participant 1, global climate innovator	4
Participant 2, multinational company	4
Participant 3, leading global heating, air conditioning, and refrigeration manufacturer	5
Participant 4, company serving over nine million customers	6
Paul Farnan, Principal Deputy Assistant Secretary of the U.S. Army for Installations, Energy and Environment, DOD	7
Alexis M. Pelosi, Senior Advisor for Climate, HUD	8
Participant 5, major organization	8
Participant 6, public corporation	9
Participant 7, nonprofit organization	10
Participant 8, venture capital firm.....	10
Roundtable Discussion.....	12
Key Takeaways.....	15

Introduction

On September 24, 2024, the Building Technologies Office (BTO) within the U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) hosted a roundtable on innovations in the built environment. The 90-minute stakeholder breakout session took place at the Google/X offices located in Manhattan's Chelsea neighborhood, as part of a larger energy technology commercialization workshop.

Ten high-level experts across the investor, technology development, utility, and public sector/non-government organization spaces were invited to present four-minute soapbox talks on their companies' partnerships with DOE and efforts to accelerate innovation to reduce energy use in the built environment. DOE leadership set the stage with opening remarks, and participants self-introduced and gave their talks. A question-and-answer session among participants and attendees followed.

Objectives

DOE's primary objective for the Built Environment Innovation Roundtable was to explore energy-related innovations for buildings and infrastructure — with a particular focus on energy efficiency, innovation, sustainable materials, resilience, and infrastructure. Secondary objectives were to promote the exchange of ideas and information among DOE partners, to establish stakeholder relationships, and to encourage future collaboration with one another.

Key questions for discussion included:

- How can we all collaborate to draw on the best innovation that is already happening, and to remove barriers for benefits to spread throughout the economy?
- How can innovation supported by DOE overcome the most important barriers to efficiency and affordability, beyond the narrower focus of improving what is already commercially available?
- How might the companies represented at the roundtable partner with each other and not just with DOE?
- For organizations that have recently reached the summit of one mountain, what have you learned from that climb, and how does it influence the view of what's next?

Participants

Jeff Marootian	Principal Deputy Assistant Secretary, DOE EERE
Brian Walker	Emerging Technologies Program Manager, DOE EERE Building Technologies Office (BTO)
Paul Farnan	Principal Deputy Assistant Secretary of the Army for Installations, Energy and Environment, Department of Defense (DOD)
Rachel Golden	Senior Principal of Carbon-Free Buildings, RMI (formerly Rocky Mountain Institute)
Robin Lanier	Managing Director of New Ventures, Southern Company
Holly Paeper	President of Commercial HVAC Americas, Trane Technologies
Alexis Pelosi	Senior Advisor for Climate, Office of the Secretary, U.S. Department of Housing and Urban Development (HUD)
Kelley Raymond	Senior Director of Sustainability and Environmental Advocacy, Daikin U.S. Corporation
Michael Reed	Acting Head of Large Buildings, New York State Energy Research & Development Authority (NYSERDA)
David Ribeiro	Director of Local Policy, American Council for an Energy-Efficient Economy (ACEEE)
Jeannie Salo	Chief Public Policy Officer, Schneider Electric
Alok Sindher	Climate Tech Investment Team Partner, Fifth Wall
Sarah Zaleski	Chief Products Officer, U.S. Green Building Council (USGBC)

Agenda

Opening Remarks

Jeff Marootian, DOE

Participant Introductions and Soapboxes

Paul Farnan, U.S. Army, DOD

Robin Lanier, Southern Company

Holly Paeper, Trane Technologies

Alexis Pelosi, HUD

Kelley Raymond, Daikin U.S.

Michael Reed, NYSERDA

David Ribeiro, ACEEE

Jeannie Salo, Schneider Electric

Alok Sindher, Fifth Wall

Sarah Zaleski, USGBC

Discussion and Q&A

Jeff Marootian, DOE (moderator)

Opening Remarks

Jeff Marootian, DOE EERE Principal Deputy Assistant Secretary, welcomed attendees to the roundtable. He stated the United States is embarking on an energy revolution that requires partnership between DOE and both the public and private sectors and described this roundtable as an opportunity to exchange ideas and information, and to assure DOE is doing all it can to collaborate with companies like those participating.

Marootian asked participants to introduce themselves and present their soapbox talks.



Jeff Marootian, DOE EERE Principal Deputy Secretary, welcomed attendees from investor, technology development, utility, and public sector/non-government organizations. Photo: DOE

Participant Introductions and Soapboxes

Participant 1, global climate innovator

- \$800 billion dollars a year is spent powering homes, buildings, and factories, and 20% to 30% of that is wasted, resulting in a significant carbon footprint.
- Across all its businesses, this company is focused on driving more efficient systems through electrification and has been partnering with DOE on initiatives including DOE's Residential Cold Climate Heat Pump Challenge.
- The company is also partnering with research organizations such as Purdue University and Texas A&M University specifically to look at embedding artificial intelligence in heat waste recovery and reuse, and it sees an opportunity to be at least 50% more efficient than today.
- Support and help with overall awareness is very much needed to inform customers of the technology solutions currently available. How can we collectively, as an industry, challenge existing norms and market to customers to show what is possible and what incentives are out there?

Participant 2, multinational company

- This participant represents a company focused on electrification of homes, buildings, and factories along with robotics and automation. Its fundamental

purpose is sustainability, and it consults with customers on how to decarbonize their buildings and supply chains.

- There are states and cities leading additional, bold building requirements that are driving action — how can we all lift them up and catalyze outcomes? What is their data, and how has their work reduced emissions?
- The definition of “net-zero building” from the White House is important but doesn’t go far enough. Grid interactivity and smart buildings must be factored in to achieve net zero.
- The Federal Sustainability Plan is very important, and the federal government and the U.S. Army have done trailblazing work leading by example and demonstrating what is possible.
- Digitization must be incented or required. Until buildings are digitized more widely, we won’t be able to manage the energy and digital insights, and we won’t be able to do smart controls or have grid interactivity. It all comes down to grid interactivity: we need to reduce pressure on the grid, and we need to integrate storage. Microgrids create resilient buildings with storage that reinforce stability of the grid.
- We all need to share outcomes and learn from each other. Federal buildings are a great place to start to demonstrate savings to the taxpayer and to repurpose funding. Even if people don’t believe in climate change, they do believe in the government saving money.
- We also must fix fragmented jurisdiction at the state level. There are states that aren’t passing updated codes.
- Military installations should be prioritized. They are the most critical infrastructure we have, and they can provide the best example of success because they are essentially small cities, with homes, residential buildings, commercial buildings.

Participant 3, leading global heating, air conditioning, and refrigeration manufacturer

- Consumers both understand and dramatically misunderstand heat pumps. “Heat pumpification” is a huge part of decarbonizing and being more grid resilient, but one survey from 2020 found that only 5% of the world’s heating and hot water is from heat pumps.
- DOE has proven heat pumps are three times more efficient than furnaces. While furnaces can achieve 90–95% efficiency, a heat pump, for the energy it makes versus what it takes, can make five times that efficiency.

- In September 2024, DOE announced this company's achievement as one of eight competitors to pass all its field testing and move to the final stage of the Cold Climate Heat Pump Challenge. Partnership with DOE and its labs has been invaluable to prove that heat pump technology is something people can use and trust.
- Demand response programs, in general, have not been very popular and less successful than hoped, but demand flexibility could be different. Instead of operating at a single, dual, or three speed, a heat pump can operate at a continuous percentage of whatever capacity is needed for a home, thus using less energy. Load balancing like this can be very important to achieve decarbonization.
- The company believes air-to-water heat pumps will be the vanguard of the next heat pump technology in the United States because of their versatility and performance in extreme conditions.
- The company recently received a grant under the Defense Production Act to advance affordable air-to-water heat pumps and the associated American workforce.

Participant 4, company serving over nine million customers

- This participant represents a company heavily focused on sustainable solutions, from the vertically integrated electric side to the customer demand side; raising the intelligence of and modernizing its infrastructures; and making sure customers have very personalized engagement.
- The company is also focused on parity between demand-side and supply-side resources, which cannot be done without intelligent buildings. The effects of heat pump usage on the grid during winter storms have caused the company to think about its supply side for quick ramp rates along with investment and deployment of technologies that can help smooth that curve.
- In lab-set use cases, the company has worked with DOE and others to deploy smart communities and smart homes. While it has learned a lot, it needs to get them to mass market. It has deployed smart technology in communities in multiple Southeast states and has also partnered with Habitat for Humanity, because home connectivity and flexibility should reach all customers, not just those with higher incomes.
- Partnerships and collaboration are critical, and the company is heavily focused on deployment for our customers — it encourages everyone at this roundtable to band together.

- Through a partnership with a major, multinational technology company, the company is working to use technology to get residential homeowners more energy insights so they can make better decisions. About 70% of customers own a device from the partner in their home, and the participant believes it can reach customers in a different and more meaningful way to help them with their energy usage.
- The participant urges investing in the demand side as much as the supply side.



Attendees discussed their companies' partnerships with DOE and efforts to accelerate innovation to reduce energy use in the built environment. *Photo: DOE*

Paul Farnan, Principal Deputy Assistant Secretary of the U.S. Army for Installations, Energy and Environment, DOD

- Over the last three years, the Army has been reimagining and rethinking its approach to energy on its installations.
- The Army has a vested interest in resiliency, especially during emergencies. It needs fully self-contained generation on its bases, and that means renewables. If there is a national emergency and the grid goes down for days, weeks, or months, it needs to be able to operate. The Army partners with utilities all around the country to put massive amounts of solar and battery storage on bases. The grid powers communities day to day, and in the event of a national emergency, the Army can tap into a microgrid for resilience. This is a win-win for utilities, who can lease not only a lot of land, but a lot of secure land, at a reduced cost.
- Currently, the Army operates around 100 small cities and is always looking for more pilot projects. If you have a pilot technology, let the Army try it out for you.
- The Army also has a new building policy to change how construction is done on its installations. It has around 160,000 buildings, which are its largest source of emissions. New construction and major renovations must incorporate steps to move buildings toward net zero: electrification, energy efficiency, envelope, storage. The less energy we need, the closer we get to resilience. The challenge, however, is cost.
- The Army needs you to share your expertise — tell us how we can save energy and, in turn, save money.

Alexis M. Pelosi, Senior Advisor for Climate, HUD

- HUD supports and assists around 4.5 million properties in the United States.
- HUD has made a concerted effort to reach out across federal agencies for awareness that funding opportunities prioritize and reach affordable housing. It is looking across its entire portfolio for ways to reduce emissions, costs, and impact on residents.
- Building energy codes need to be universal. HUD has adopted the latest energy codes, but homebuilding feedback indicates that it's far more challenging to align them with affordable housing versus market-rate housing. How can HUD partner with homebuilders and others to move forward with new technology to reduce emissions and reduce costs?
- When we all think about solutions, we need to design with affordable housing in mind. If we can solve for affordable housing, we solve for the broader housing marketplace overall.
- Affordable housing has led the way in energy efficiency and resiliency out of necessity — developers look for every opportunity to extend the life cycle of a property to reduce operating costs.
- One challenge with affordable housing is digitization. HUD is challenged with utilities providing information on utility usage, especially in the multifamily space, which makes it difficult to digitize buildings.
- It is critical we all make investments in a smart and resilient way over the long term to preserve affordable housing.
- To reiterate, solutions need to be cost effective and designed with affordable housing in mind, and they need to be simple and accessible. HUD definitely sees smart technology as a solution, but the digital divide is real, and we all need to consider those challenges.

Participant 5, major organization

- This participant's organization and others have laid groundwork to build awareness of what can be achieved and what's possible for buildings, make best practices more widely available, and create demand drivers for technology. They also build broader literacy of next-generation building concepts (embodied carbon, electrification, equity assessment, carbon planning) — how do we embed these in standards to make them more commonplace?
- To date, this organization's certification has been widely adopted by 180 countries in over 120,000 buildings.

- Its latest version will be released in 2025 and have a large focus on decarbonization. Projects pursuing the new certification must complete assessments in climate resiliency and social impact along with a 25-year projected carbon assessment that includes onsite combustion, grid supplies, electricity, refrigerants, and embodied carbon.
- The organization is looking for ways to partner with roundtable attendees not only to adopt enhanced codes and create demand drivers for technology, but also to spread workforce awareness: How do we deal with these new technologies? How do we integrate them into design? How do we maintain them? The organization also welcomes partnership to help shape its next round of certification, which will include communities, campuses, and homes.
- In addition, to help meet building decarbonization goals, the organization is launching a new platform to help track, set goals, improve, and verify performance. It sees the platform as a framework to link efforts and research and provide a broader one for buildings and portfolios to engage.



The roundtable was an opportunity for attendees to share ideas and foster collaboration with one another. Photo: DOE

Participant 6, public corporation

- As stated by others, affordable housing does play a critical role in building transformation, as does the ability to prioritize housing and deliver material benefits to all Americans. If we can design solutions that work for affordable housing, it will scale.
- This corporation has worked with local and state government organizations and utilities for many years to develop solutions that work for housing properties.
- In response to inefficiencies identified with windows and boilers, these partners are challenging the manufacturing community to develop an efficient window heat pump. The corporation also wants to work with manufacturers on a similar solution for packaged terminal air conditioners, noting the private sector is desperate for these types of solutions.
- There has been a focus on how to convert heating from natural gas to electric. In some areas, however, the operational costs of gas are so much cheaper than electricity that converting is not a viable solution. There is a lot to be said about partial electrification and figuring out how to deploy heat pumps instead of air

conditioners at the time of replacing air conditioners. It's possible to empower consumers to make decisions based on what their energy costs look like. As part of the green energy transition, we have to avoid raising the cost of living.

Participant 7, nonprofit organization

- It's important to acknowledge the success of building codes over the last few decades. A building that is built to the 2021 International Energy Conservation Code is 50% more efficient than it would have been before. Tech commercialization has moved markets along.
- One area where there needs to be acceleration is moving toward net-zero codes. This organization recently received federal funding to work with six states and one city to develop net-zero codes. It has also launched a nationwide collaborative to help cities and states implement building codes.
- When discussing commercialization for existing buildings, Building Performance Standards (BPS) are a very intriguing policy for cities to set caps for energy use and greenhouse gas emissions and letting innovation happen.
- Affordable housing is the most difficult aspect of the housing stock required to comply with BPS — what kinds of resources can be set up so those who live in affordable housing can see these benefits?
- As we all think about partnerships, consider engaging with local governments on pilot projects or program development. Local governments are innovative by nature and want to create partnerships by nature, because they generally work with few resources.

Participant 8, venture capital firm

- This company focuses on the built environment for its investments and is dedicated to climate and decarbonization strategies. It has investors who are real estate corporates, with approximately 60 billion square feet represented in its investor base.
- The built environment offers a carrot and stick scenario. First, the sticks: When legislation like New York Local Law 97 [a building performance standard] is passed, major players pay attention despite any hoopla surrounding it, and even if it's overturned. Once these companies do their homework and see it saves money, they think about how to apply these actions themselves: How can we implement them regionally? How can we support the jurisdictions that are interested and help them avoid reversal?

- Next, the carrots: Startups and small companies don't have the ability to lobby like larger corporations. Incentives that include lifetime savings are needed. Initial product costs are high but over time, customers will save money.
- Education, however, is not ubiquitous. When talking to installers and those who are "boots on the ground," they say that usually, the cheapest thing sells. Let's all think about how we can help deployment drive down the cost over time.

Roundtable Discussion

Marootian kicked off the roundtable discussion by summarizing DOE's perspective, acknowledging that existing technology will not get us "all the way there," but that exciting things are happening, and government capital from multiple DOE offices can help advanced shared goals.

One thing that has come up repeatedly is the balance between comfort, consumer preference, and efficiency. The specific challenge we hear about with heat pumps is discharge air temperature — folks are unhappy that the temperature coming out is cooler than their body temperature. How do you think about that balance?

Participant: Our solutions are consistently 110 degrees Fahrenheit in terms of what our customers are feeling and seeing. We only hear from a narrow band of customers that have an issue but regardless, it is on our radar and from a technological standpoint, we see a short path to solving this issue in a way that makes things comfortable for all.

[Directed to a specific participant] You mentioned a fragmented world of patchwork codes at the city and state levels. What do you see as the solution to that?

Participant: Federal preemption of some kind, though I know it would be incredibly controversial. But sometimes the time comes, and everybody gets mad for a time, but then they change their tune. I've seen it in many industries. We can't deal with buildings when we have states that won't update to basic codes and building safety. Maybe there is a better approach than total preemption — maybe a subset of buildings that demonstrate significant impact, or states that are leading on this can get assistance to show how successful it is so that other states follow.

My company is developing an underground supergrid coast to coast, and we just raised a billion dollars in project capital. If the focus is on deployment, is there a consortium to help get district heating going, or get heat pumps to buildings that need more power, or to DOD facilities?

Farnan, DOD: I would love to have a discussion about that for Army bases.

Walker, DOE: If you're not connected with the Vehicle Transportation Office, or some of the other sub-surface folks like the Geothermal Technologies Office, let's follow up.

What is missing in the early stage right now in terms of technology, or things you'd like to deploy that aren't there yet, or almost there?

Participant: There are a lot of companies that say they can modernize buildings, but not a lot of companies that are doing it well. We have a number of energy efficiency and demand-side management programs, but we need a view of those buildings to make the right recommendations. We don't have enough people, ourselves or our partners, to cover that landscape. I think there's a critical role for artificial intelligence, but I have not

seen many who can do it well and at scale. Let's figure out what the model is to build it in a better way. If you know somebody, get them in touch.

Another participant: For all different kinds of building upgrades, there's no place for a smaller building to go, for a reasonable price, to figure out how they can decarbonize and the right solutions for them. Talking to one contractor is not enough; they need a system. They're big enough to do something about sustainability but too small to afford the assistance they need to decarbonize their building. It's a missed market there to connect them with the right solutions.

One of the big opportunities in climate innovation is with financing. Shifting the return on investment seems to be a big need, and financing innovation seems to be a big opportunity. When you think about the intersection of standards, and getting standards deployed, and the ability to drive adoption, are there any examples of interesting creative capital or financing mechanisms?

Pelosi, HUD: Award recipients from the U.S. Environment Protection Agency's \$27 billion Greenhouse Gas Reduction Fund briefed HUD's senior leadership about the technologies they plan to create. Any new affordable housing or retrofits inevitably include HUD funding targeted toward decreasing emissions, so it's important to understand what those products are. Another big issue is bridging the appraisal gap with new homes – when homebuilders put in energy-efficient products, it is not factored into how a home is appraised. A high appraisal could mean qualifying for a higher loan amount, which becomes an equity issue: HUD does not want to put people in homes they can't afford. How do we bridge that gap until the technology gets where it needs to go? One creative idea could be a pool of funds to help cover that gap for low-income homeowners. There are a lot of potential opportunities out there, but I haven't seen anything new to the marketplace that excites me yet.

Participant: Underwriting is also great for disruption. I was involved in some research years ago at DOE's Lawrence Berkeley National Laboratory looking at the decreased default rate of commercial mortgages that are more efficient too, but that hasn't gotten to underwriters yet. How do we start to integrate climate resilience and decarbonization into underwriting insurance?

To build on the comment of education, I'd like to underscore not underestimating the role of the trades and the education of the trades. At the end of the day, they are the ones installing the products.

Participant: That value is a key piece of the decarbonization workforce. It's not just the policy works. It's the boots on the ground.

Another participant: There are very unique challenges in a residential market versus a commercial market. Installation costs can really vary in a residential market and there are barriers to installation as well. There are also issues finding people who are trained in and can maintain new technologies for the long term. It's especially tough for those who work in affordable housing, who may not have the ability to easily maintain or have

access to many contractors — there are so many models out there, so many different kinds of parts. Training is so key to that.

Walker, DOE: And meetings like this are great, but what we do afterwards is really what matters most. It's not just talking to the right folks, it's redefining what success means: being a technology that is easy to use. How do we make sure the time to get somebody qualified, to install that new high-efficiency heat pump or that variable-speed unit, is as short as possible?

Key Takeaways

- Affordable housing must be included when designing solutions for decarbonization. Innovation and equity need not oppose each other; solutions for affordable housing are also solutions for the broader housing marketplace.
- Artificial intelligence is still nascent but has potential to play a critical role in efficiency and to fill the decarbonization modeling gap.
- Digitization remains a challenge for utilities, and the dearth of data available impacts optimizing solutions for the grid.
- Heat pumps remain a very efficient means for heating and cooling and help balance grid demand, but many consumers are unaware of their benefits or concerned their utility bills will increase with their use. Focusing on partial electrification could be a way for consumers to make the shift and empower them to make decisions based on their known energy costs.
- Building codes and standards have made great strides in the last few decades but moving toward net-zero remains small scale.
- Increasing consumer awareness of existing energy-efficient solutions and balancing consumer needs with efficiency should be prioritized more than they are currently.
- Workforce education and training are not ubiquitous. Technologies should be straightforward and easy to use to reduce the time it takes to qualify tradespeople to install and maintain.
- Federal programs and incentives like DOE's Cold Climate Heat Pump Challenge are examples of existing work where the process and results can be amplified.
- Partnerships create the groundwork for accelerating decarbonization. The U.S. Army operates about 100 self-contained cities around the country that are excellent sites for pilot technologies and welcomes new partnerships. Many local governments without access to or funding for resources also welcome the opportunity for pilot projects.

For more information, visit: energy.gov/eere

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