ACEEE Testimony

American Council for an Energy-Efficient Economy

Testimony for Building Technologies Research for a Sustainable Future

To the Subcommittee on Energy of the U.S. House Committee on Science, Space, and Technology

BY NORA WANG ESRAM, PH.D.
SENIOR DIRECTOR FOR RESEARCH, AMERICAN COUNCIL FOR AN ENERGY-EFFICIENT ECONOMY
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Introduction

Thank you for the opportunity to testify on the topic of building technologies R&D. The American Council for an Energy-Efficient Economy (ACEEE), a nonprofit 501(c)(3) organization founded in 1980 by researchers at universities and national laboratories, acts as a catalyst to advance energy efficiency policies, programs, technologies, investments, and behaviors. We produce more than 30 reports and other resources each year on technologies, programs, and policies to reduce energy consumption, mitigate climate change, and advance an equitable and just clean energy system. We have a long history of providing testimony to Congress, as well as state and local policymakers, based on our research findings.

Summary

Both the public and private sectors have historically viewed investments in building energy efficiency technologies as win-win strategies to reduce energy costs and create local jobs. As we shift more attention to combatting climate change and promoting clean energy, energy efficiency technologies are sometimes perceived as less-transformative or less-aggressive approaches to meeting ambitious climate goals. This perception fails to recognize the interconnectivity of building systems with other fundamental aspects of society. Buildings interact with the energy network and are critical to meeting other needs, such as health and resilience. For example, a house with lower internal thermal loads (thanks to efficient lights and appliances) and lower external thermal loads (thanks to improved envelope insulation) needs a much smaller heating and cooling system to keep occupants comfortable. Such a house would need a smaller onsite photovoltaic or battery system to become zero-energy. In addition, an efficient house is healthier, more comfortable, and can better shelter its occupants in place during extreme weather conditions.

Our research finds that building energy efficiency has the potential to reduce U.S. greenhouse gas emissions by nearly 20% by 2050[1]. However, slow uptake of building retrofits and insufficient private investment in building efficiency improvements demonstrate that existing barriers—such as the lack of consumer demand and value proposition for efficiency-oriented

[1] Nadel, S., Ungar, L., (2019). Halfway there: Energy efficiency can cut energy use and greenhouse gas emissions in half by 2050. American Council for an Energy-Efficient Economy. Available at www.aceee.org/research-report/u1907

businesses—need to be addressed in a more accelerated and innovative fashion. Energy efficiency is shifting from product efficiency to process and system efficiency. More research and innovation must focus on the processes through which building technologies are deployed and the context in which they are applied.

We strongly support a broad range of building technologies programs to achieve urgent carbon reduction while also equitably benefitting communities. This testimony focuses on specific recommendations to enhance the impact of the Department of Energy's (DOE) Building Technologies Office (BTO). BTO's programs are highly capable and well positioned to play a pivotal role in advancing low-carbon building technologies, expediting energy efficiency retrofits, and driving enduring transformation of the building industry, all while achieving equitable outcomes. BTO should expand its research, development, and demonstration (RD&D) efforts as follows: **(1) Accelerate deep energy retrofits through innovative processes, such as manufacturing-inspired mass production; (2) Retool the workforce and inspire a new generation of leaders in the building sector; (3) Drive enduring market transformation through integration with health, resilience, and other societal goals. In pursuing these three goals, BTO should collaborate with state and local governments and community-based organizations to create proactive, replicable, equitable solutions.**

Congress should clarify that BTO has the authority to expand its scope to include construction, health, resilience, and financing. Congress should also direct BTO to work collaboratively with other DOE offices and federal agencies to create foundational programs and establish self-sustaining mechanisms for lasting impacts.

Increase productivity in building construction industry to promote deep retrofits and job growth

Improving productivity in the building construction industry can simultaneously expand the reach of deep energy retrofits and create jobs. Since 1945, productivity[2] in U.S. manufacturing, retail, and agriculture has grown by as much as 1,500%, while productivity in construction has barely increased at all.[3] Compared to large-scale players in heavy construction and large-scale housing development, many of the fragmented specialized trades—which mostly work on small real estate and retrofit projects—have even lower productivity.[4] Low productivity translates to higher costs for owners, lower profitability for contractors, and lower wages for workers. This situation contributes to slow uptake of retrofits and stagnation in energy efficiency improvements to existing buildings**.** Almost 80% of the nation's 124 million homes (as of 2019) are at least 20 years old, and more than 50% are at least 40 years old.[5] Less than 0.02

[2] Labor productivity is defined as value added by construction workers per hour of work and its growth over time, adjusted for inflation.

[3] Sveikauskas, L., Rowe. S., Mildenberger, J., Price, J. & Young, A. (2016). Productivity growth in construction. *Journal of Construction Engineering and Management*, 142 (10). DOI: 10.1061/(ASCE)CO.1943-7862.0001138.

[4] Barbosa, F., Woetzel, J., Mischke, J., Ribeirinho, M. J., Sridhar, M., Parsons, M., & Brown, S. (2017). Reinventing construction: A route to higher productivity. McKinsey Global Institute. Available at www.mckinsey.com/business-functions/operations/our-insights/reinventing-construction-through-a-productivity-revolution

[5] U.S. Census Bureau. (2019). American Housing Survey. Available at www.census.gov/programs-surveys/ahs.html

percent of homeowners reported home remodeling in 2017; less than half of these remodeling projects included residing, reroofing, insulation, or HVAC replacement[6]. The vast majority of commercial buildings are small—about half of buildings are 5,000 square feet or smaller, and nearly three-fourths are 10,000 square feet or smaller[7]—and are an underserved market sector. Unfortunately, most individual players in the building construction industry lack incentives, information, and tools to combat these challenges in the construction industry.

To meet the Biden administration's goal of upgrading 4 million buildings and weatherizing 2 million homes[8] over four years, the construction industry needs to be reinvented. McKinsey & Company has already identified seven ways[9] to improve construction productivity by 50%–60%.[10] Many of these identified areas will benefit greatly from federally funded R&D. **We suggest that BTO focus on two areas: (1) creating innovative solutions using a manufacturing-inspired mass production platform and processes and (2) retooling the workforce and inspiring a new generation of leaders in the building sector.**

Accelerate deep energy retrofits through innovative processes

Some on-site construction can be moved to a manufacturing-inspired mass production platform and process. This includes off-site manufacturing of building components for both new and existing buildings and using lean manufacturing principles to cluster and streamline retrofits to reduce variable costs. BTO's Advanced Building Construction (ABC) Initiative has taken the first step to create highly productive construction practices that integrate energy-efficient solutions. We applaud BTO's endeavor and urge Congress to support BTO in expanding and scaling up its efforts.

To ensure that the ABC Initiative can successfully industrialize and modernize U.S. construction and renovation, BTO needs to work with a variety of partners on supply- and demand-side interventions, such as establishing manufacturing capacity, creating financing mechanisms, and

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[6] Joint Center for Housing Studies of Harvard University. (2019). Improving America's Housing. Available at www.jchs.harvard.edu/sites/default/files/reports/files/Harvard_JCHS_Improving_Americas_Housing_2019.pdf

[7] U.S. Energy Information Administration. 2012. Commercial Buildings Energy Consumption Survey. https://www.eia.gov/consumption/commercial/reports/2012/buildstock/.

[8] According to Ariel Drehobl's Testimony before the Subcommittee on Energy of the U.S. House Committee on Energy and Commerce (October 01, 2020), the Weatherization Assistance Program (WAP) currently serves about 100,000 homes per year through DOE funding and leveraged funds from the Low-Income Home Energy Assistance Program (LIHEAP) and other sources. This number is far below the 15.7 million severely energy burdened households in the United States. At the current rate, it would take 360 years to weatherize all eligible households through WAP.

[9] They are (1) reshape regulation and increase transparency, (2) rewire the contractual framework, (3) rethink design and engineering processes, (4) improve procurement and supply-chain management, (5) improve on-site execution, (6) infuse the construction industry with digital technology, new materials, and advanced automation, and (7) reskill the workforce.

[10] Barbosa, F., Woetzel, J., Mischke, J., Ribeirinho, M. J., Sridhar, M., Parsons, M.… & Brown, S. (2017). Reinventing construction: A route to higher productivity. McKinsey Global Institute. Available at www.mckinsey.com/business-functions/operations/our-insights/reinventing-construction-through-a-productivity-revolution

increasing procurement of ABC technologies in various market segments. The partners include, among others, other DOE offices (e.g., Advanced Manufacturing Office, Office of Weatherization and Intergovernmental Programs, Office of Economic Impact and Diversity, Loan Office); other federal agencies (e.g., Department of Housing and Urban Development, Department of Agriculture, Federal Emergency Management Agency, Economic Development Administration, NIST/Manufacturing Extension Partnership); government-sponsored enterprises (e.g., Fannie Mae, Freddie Mac); state and local governments; trade associations; and stakeholders focused on equity and justice concerns.

Many of these interventions need building R&D support. For example, **BTO should develop consistent data collection and performance evaluation methods, build knowledge infrastructure for cost comparison and carbon emission calculations, and quantify and verify energy equity and justice-related benefits provided by the ABC approaches. BTO, working with other relevant federal agencies, should assess the impact of integrating ABC technologies with local economic development plans and carbon reduction goals on local economies, communities, and workforces. BTO should explore how ABC can improve quality of life for marginalized communities[11] across the United States, such as through lower energy bills, improved home health and comfort, and the creation of local workforce opportunities.**

Retool the workforce and inspire a new generation of building leaders

Workforce development is inseparable from increased productivity and innovation. Federal R&D support is needed to create a skilled, diverse workforce—and a pipeline of young workers—who can speed up retrofits and maintain and operate the buildings of the future.

First, innovative construction processes, as discussed above, require training a workforce to use the latest equipment and digital tools to assemble pre-framed building components onsite and to streamline retrofits. Specialty trades and contractors are the first line of support for building owners. They play a significant role in implementing energy efficiency solutions. Helping them gain a competitive edge will, in return, accelerate uptake of retrofit solutions by leveraging existing markets for building renovations.

Second, advanced building technologies and systems (e.g., building submetering, building energy management systems (BEMS), automated fault detection and diagnostics (AFDD)) require building managers to gain new skills, such as data management. This creates a challenging learning curve for building managers, which has hindered the adoption of sensor and control innovations. The market penetration of BEMS and AFDD each was only about 4% in 2018.[12] As BTO is advancing grid-interactive buildings, there is a critical need for building

[11] Marginalized communities are those most affected by community decision making and whose life outcomes are disproportionately affected by societal structures. These groups can include people of color, low-income residents, youth, the elderly, recently arrived immigrants, people with limited English proficiency, people with disabilities, and people experiencing homelessness. In some contexts, marginalized communities may be referred to as disadvantaged or underserved communities.

[12] U.S. Energy Information Administration. (2020). Trends in commercial whole-building sensors and controls. Available at www.eia.gov/analysis/studies/buildings/commercial/sensors/pdf/sensors_controls.pdf

managers to gain new knowledge and skillsets to operate complex building systems that can provide grid services without compromising occupants' needs. As more building managers become familiar with these new technologies, wider adoption could have benefits beyond building operators. For example, AFDD could help ensure the proper performance of building systems in public housing, where operation and maintenance resources are sparse.

Third, the sustainable buildings of the future will rely on a new generation of innovators and entrepreneurs. The jobs that attract millennials tend to be occupations dealing with software, data, or management.[13] Transformation of the building and construction industry requires rethinking the building profession (which is typically narrowly defined as architects, builders, or contractors, but can be expanded to include data scientists, software engineers, etc.) to attract the younger generation and cultivate our future building workforce starting as early as in K-12 schools. For example, BTO's Solar Decathlon has created an environment that inspires and trains tomorrow's buildings leaders outside of the classroom. As a Solar Decathlon alumna, I have personally benefited from my Solar Decathlon experience and have witnessed the energy of thousands of young Solar Decathlon graduates who want to work in the clean energy sector. Many of us have chosen to devote our careers to energy efficiency and renewable energy, thanks to Solar Decathlon.

Last but not least, a vibrant workforce needs diversity. The building industry has historically been too homogeneous, made up of only 11% women and 11.4% non-white individuals.[14] The pressing labor shortage in energy efficiency and building construction creates an ideal opportunity for workforce development programs to reach out to groups of people who may have been ignored in the past. Diversifying the construction workforce not only fills the talent gap that continues to grow as baby boomers retire, but also boosts creativity and invites those with new perspectives to develop energy efficiency solutions that will be more applicable to and more successful in diverse communities.

Congress should direct BTO to lead and support workforce development in the above four areas. BTO should develop new initiatives beyond training curriculums and certificates. Successful workforce development requires consistent commitment and creativity. BTO should leverage its R&D capabilities to reinvent traditional training and education in the buildings professions, ultimately creating more interactive processes, deepening civic engagement, and incubating leadership.

Drive enduring market transformation through integration with health, resilience and other societal trends and goals

The direct economic benefits of reduced energy consumption have traditionally been the primary criteria used to evaluate energy efficiency technologies and solutions. However, it is crucial to recognize that many energy efficiency projects have significant non-energy benefits,

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[13] Renzulli, K.A. (2019). The job millennials want most pays $98,500. CBNC. Available at www.cnbc.com/2019/02/21/the-10-jobs-millennials-most-want.html

[14] U.S. Bureau of Labor Statistics. (2020). Labor Force Statistics from the Current Population Survey. Available at www.bls.gov/cps/cpsaat18.htm

such as improved occupant productivity, decreased illness from indoor air quality problems, and reduced environmental pollution. These non-energy benefits can have large indirect economic benefits, which energy efficiency project valuation methodologies often ignore. For example, a recent report by Stok found that owner-occupants and tenants could gain $115 per square foot 10-year net present value from personnel savings and $14 per square foot from utility and maintenance savings through office retrofits that enhance indoor environments.[15] The societal impacts of low-quality, inefficient buildings are not captured in the cost-benefit analysis typically performed for building upgrades. Rather, these costs of inefficient buildings are borne elsewhere, such as through catastrophic property damage during extreme weather events or by populations with illnesses exacerbated by sub-optimal housing. Energy efficiency can support community resilience by strengthening local energy systems and delivering more-reliable, more-affordable energy for local governments, households, and businesses.[16]

Currently, even with significant public financial assistance and utility incentives, progress in energy retrofits is extremely slow, and many energy efficiency projects are limited in scope and impact. Some one-off demonstrations or pilots are incapable of scaling up after financial assistance is depleted or their lower-hanging fruits are picked. Utility energy efficiency programs have achieved large savings from efficient lighting, such as light-emitting diodes (LED); now, they need other technology opportunities because LED technology has achieved substantial market penetration.[17] Many known barriers to market transformation, such as lack of capital, uncertainty in predicted savings, and split incentives between owners and tenants, boil down to the fact that, in many cases, energy efficiency has not yet been fully integrated into the products and processes that consumers want and businesses value. Decades of scientific research have proven the impact of the built environment (e.g., lighting, comfort, and air quality) on human circadian rhythm, the immune system, cognitive function, and task performance. A review of 63 high-quality studies shows a 5.7% average improvement in productivity and a 37% reduction in absenteeism when indoor air quality and thermal comfort are improved.[18] Unfortunately, this knowledge has yet to be fully utilized to guide technology and strategy development in the building energy sector to promote positive human outcomes—the most valuable, desirable outcomes for business owners and individuals. **To drive market transformation and produce lasting impact, BTO should consider broader, public-good impacts of integrated energy and building services and invest more in cross-sector R&D to align energy and carbon reduction goals with other societal goals, such as health and social equity. Three recommendations are discussed below.**

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[15] Attema, J. E., Fowell, S. J., Macko, M. J., & Neilson., W. C. (2018). The financial case for high performance buildings. San Francisco: stok, LLC. Available at stok.com/research/financial-case-for-high-performance-buildings

[16] Ribeiro, D., Mackres, E., Baatz, B., Cluett, R., Jarrett, R., Kelly, M., & Vaidyanathan, S. (2015). Enhancing community resilience through energy efficiency. American Council for an Energy-Efficient Economy. Available at www.aceee.org/research-report/u1508

[17] U.S. Energy Information Agency. (2020). Utility energy efficiency spending and savings declined in 2018. Available at www.eia.gov/todayinenergy/detail.php?id=42975#

[18] Wang. N., Rotondo, J. A. (2020). Energy and health nexus: Making the case for building energy efficiency considerations of occupant health and productivity. Pacific Northwest National Laboratory. Available at www.pnnl.gov/sites/default/files/media/file/EED_0831_BROCH_HealthyBuildings_v4.pdf

First, Congress should direct and support BTO in conducting more research on the non-energy benefits of efficiency technologies to building occupants and the broader economy. The complexity of human health and behaviors increases the uncertainty of measuring and verifying non-energy outcomes. BTO is in a unique position to lead development of consistent methods to quantify the non-energy benefits of building systems and services. Some states (e.g., MA, CA) have started studies to identify and investigate these non-energy benefits. A consistent approach supported by an interoperable platform across vendors and service providers is vital to establish credibility and accumulate knowledge and evidence at a faster pace. BTO should support public- and private-sector building owners to build business cases to advance human-centered building systems and develop crosscutting strategies to fully leverage resources beyond the energy sector. A 2020 ACEEE study identified at least six sources of health-related federal funding that could be used to support residential energy efficiency programs (via the departments of Health and Human Services, Housing and Urban Development, and Treasury), representing $2 billion that could be used to provide weatherization and/or complementary services to households in need.[19] For example, Johns Manville and its installation contractors have been working in conjunction with the South Coast Air Quality Management District (AQMD) to implement a residential energy efficiency retrofit program for groups of homes in disadvantaged communities located in Coachella Valley in California, leveraging environmental mitigation funds established by Assembly Bill No. 1318[20] and utility incentives. With an average cost of approximately $4,000 per home, the program reduces household energy use by 18% while improving home comfort and helping the AQMD achieve its air quality goals.[21] Johns Manville also uses lean manufacturing principles to minimize the project's overhead cost and significantly increase the productivity of its contractors. BTO could help develop replicable models to help scale up similar solutions nationwide. It is important for BTO to partner with community-based organizations and environmental justice organizations to identify non-energy benefits, ensure that those benefits reach marginalized communities, and involve community organizations in accelerating building retrofits while also creating jobs.

Second, BTO should anticipate changes in the building sector and incorporate energy efficiency into what businesses and consumers will need in the near future. In the commercial sector, the amount of space devoted to scientific laboratories in the United States has increased 70% in the past 10 years.[22] The race to develop coronavirus therapies and vaccines has further ramped up investment in lab space. In many areas, building owners have been converting offices to life science facilities[23] and apartments[24], or turning empty stores into e-

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[19] Hayes, S., Gerbode, C. (2020). Braiding energy and health funding for in-home programs: federal funding opportunities. Available at: www.aceee.org/research-report/h2002.

[20] AB-1318 South Coast Air Quality Management District: emission reduction credits: California Environmental Quality Act. Available at leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=200920100AB1318

[21] Rowan, D. (2020). South coast air quality management district residential energy efficiency retrofit project (Coachella Valley). ROWAN Engineering, Inc.

[22] Session, P. (2020). Here comes the life sciences land rush. Available at www.bloomberg.com/news/articles/2020-09-15/life-sciences-labs-are-hot-covid-era-real-estate?srnd=citylab

[23] Ibid.

commerce fulfillment centers[25]. The upcoming wave of adaptive reuse presents huge building retrofit opportunities beyond normal tenant buildouts; there are many emerging opportunities to develop more affordable housing at a faster pace[26]. BTO should embrace these solutions that not only reduce building energy use but also help building owners become flexible enough that they can better adapt to unforeseen future changes. For example, the pandemic has accelerated the demand for more flexibility in office space. In the short term, some offices have been redesigned for the new reality of social distancing. In the long term, more agile office spaces are needed to support the transformation of the office from a place where individuals spend an entire day working to a place where staff visit occasionally to collaborate, meet with clients, or retreat.[27] Uncertainties about and fluctuations in occupant density make building operation challenging if a building is not equipped with energy management technologies and strategies. A few studies, such as those by the University of California at Davis,[28] Carbon Lighthouse,[29] and Hatch Data,[30] show that empty office buildings have been consuming a significant amount of energy during the COVID lockdown (up to 100% of usual). In a more-competitive real estate market where fewer tenants are willing to pay a hefty utility bill for a half-empty office, there will likely be more appetite for modular and more-efficient HVAC equipment, miscellaneous load-management technologies, and building automation.

Third, lifecycle carbon in buildings constitutes another R&D gap. The increasing societal interest in and policy support for "Buy Clean" policies provides a unique opportunity to reduce lifecycle carbon in buildings. The building construction industry accounts for 5% of global energy use and 10% of global greenhouse gas emissions.[31] A primary source of these emissions is the manufacture of building construction materials such as steel, cement, and glass. These Buy Clean proposals have focused on the materials approach (e.g., specifying materials with low embodied carbon). Perspectives on whole-building performance (e.g., selecting alternative

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[24] Orton, K. (2019). A man worked at the IRS for 10 years, then he came back to live where his cubicle was. Available at www.washingtonpost.com/realestate/what-once-was-your-cubicle-can-now-be-your-home/2019/10/16/6f12cafe-f01a-11e9-8693-f487e46784aa_story.html

[25] Reonomy. (2020). Repurposing retail in the wake of COVID-19. Available at www.reonomy.com/blog/post/recycling-empty-retail-spaces

[26] HUD User. Adaptive reuse in suburban housing markets. Available at www.huduser.gov/portal/pdredge/pdr-edge-featd-article-030518.html

[27] Rubin, C. (2020) The office is dead. Available at marker.medium.com/the-office-is-dead-16be89f25d01

[28] Meier, A. (2020). Saving energy in buildings when nobody is in them. Available at www.ase.org/blog/saving-energy-buildings-when-nobody-them

[29] Carbon Lighthouse. (2020). COVID shows that even empty buildings must use energy. Available at www.carbonlighthouse.com/covid-building-occupancy-energy-use/

[30] Hatchdata. (2020). How is U.S. office building energy use being affected by the coronavirus crisis? Available at hatchdata.com/assets/Hatch-Data-Research-Report-2020-04-06.pdf

[31] United Nations Environment Program (2020). 2020 Global Status Report for Buildings and Construction: Towards a Zero-emission, Efficient and Resilient Buildings and Construction Sector. Available at https://globalabc.org/sites/default/files/inline-files/2020%20Buildings%20GSR_FULL%20REPORT.pdf.

materials, reducing waste, considering the trade-off between embodied carbon and operational carbon emissions) haven't yet been integrated. Furthermore, the building sector has not yet made significant efforts to consider lifecycle carbon in building standards. **Congress should direct and support BTO in creating initiatives to drive low lifecycle carbon in building materials, equipment, and construction processes.** This focus will create market pull for low-carbon products that are better for occupant and enviornmental health, thereby improving the business case for the manufacturing industry. Such a focus will also drive innovations in building design, construction, and manufacturing processes. In collaboration with DOE's Advanced Manufacturing Office, BTO should engage industry leaders and innovators to develop business cases for transformative technologies that enable new buildings to meet low-carbon standards with little cost burden or even with added value. BTO should lead or support the development of lifecycle carbon calculations in buildings. Finally, BTO should develop strategies for expanding and accelerating the market demand for and availability of low-carbon alternatives through near- and medium-term voluntary market strategies. These can include labeling and certification programs, technical assistance, incentives, purchasing and procurement guidelines, voluntary codes, and education/awareness activities.

Conclusion

Federal R&D focusing on buildings can accelerate the deployment of advanced energy efficiency and clean-energy technologies in the existing buildings stock, which would normally take a century to undergo a complete turnover. Expeditious building retrofits are critical to decarbonizing the U.S. building sector. A highly efficient retrofit model comprises high productivity in building construction, a skillful and inclusive workforce, expanded value propositions beyond energy cost savings to attract wider public interest and private-sector investment, and multiple sources of public-sector funding. **Congress should direct and support BTO to use its RD&D capabilities to do the following:**

- **Spur modernized strategies that increase construction productivity, accelerate deep retrofits, and create local jobs.**
- **Grow and diversify the building-sector workforce. This workforce includes specialty trades and contractors, building and facility managers, and a new generation of innovators and entrepreneurs.**
- **Create the knowledge infrastructure needed to quantify the non-energy benefits of building efficiency technologies and integrate these benefits with local economic development plans and carbon reduction goals.**
- **Integrate energy efficiency into the products that consumers and businesses value, and develop innovative solutions that help building owners achieve greater flexibility and resilience.**
- **Reduce lifecycle carbon in buildings through standardization and a whole-building approach that drives innovation.**

The advancement of building technologies is not only about materials, equipment, and products; it also includes processes, systems, and workforce development efforts. Ambitious

carbon reduction goals require that BTO apply bold ideas and innovative approaches to revolutionize the fragmented and misaligned building construction industry. Efficiency is a means to achieve other societal goals, such as improved health, social equity, and economy prosperity. Market transformation for sustainable buildings requires a holistic view that integrates all these goals. BTO should expand its R&D efforts to develop integrated approaches that can yield environmental, economic, and health benefits, particularly for marginalized communities. Such approaches can also help building efficiency programs increase funding opportunities (e.g., by weaving together resources from health and resilience programs), expand services, and reach more households. To achieve broader success, BTO should collaborate with other DOE offices, other federal agencies, state and local governments, trade associations, and stakeholders focused on equity and justice concerns. The building sector is facing a paradigm shift. As the global building and construction industry seeks to increase productivity and decrease lifecycle carbon, our U.S. construction industry could be left behind. We must be proactive by taking bold action. Congress should support BTO in building a solid foundation that sustains a successful transformation of the building industry

Dr. Nora Wang Esram is the Senior Director for Research of the American Council for an Energy-Efficient Economy (ACEEE). Dr. Esram oversees ACEEE's research programs on buildings, transportation, industry, and behavior. Prior to joining ACEEE, Dr. Esram worked at the Pacific Northwest National Laboratory as a chief engineer and a team lead in the Electricity Infrastructure and Buildings Division for ten years, where she received Director's Award for Exceptional Engineering Achievement. Dr. Esram holds a Ph.D. in architecture from the University of Illinois, Urbana-Champaign. She is a licensed architect in Washington.