U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BUILDING TECHNOLOGIES OFFICE

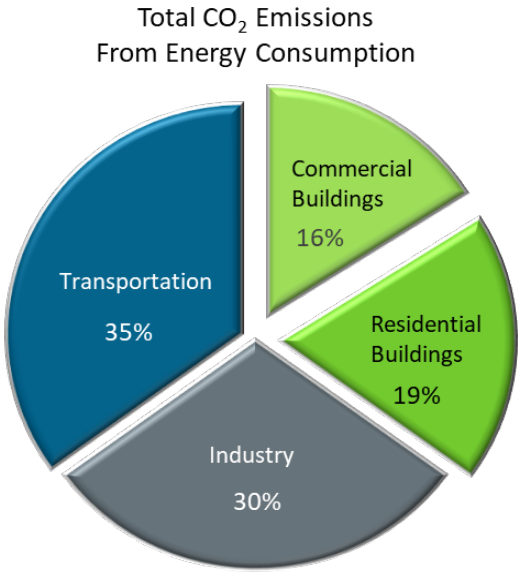
BUILDING
Technologies Office

PEER REVIEW

August 2021

DOE's Building Technologies Office

Today's U.S. building stock consists of nearly 130 million commercial and residential buildings. Collectively, these buildings consume 40% of U.S. energy and are responsible for about 35% of U.S. CO_2 emissions from energy consumption. The U.S. Department of Energy (DOE) Building Technologies Office (BTO) works to improve the energy performance of U.S. buildings and reduce the nearly $100 billion in energy that the sector wastes each year. Gains in the energy efficiency, demand flexibility, and electrification of U.S. building systems will deliver economic, environmental, health, and equity benefits to American families and businesses and help decarbonize the power grid.



EIA Monthly Energy Review, March 2021

BTO supports research by the DOE National Laboratories and other world-class research organizations and works with the private sector to develop and deploy cutting-edge, affordable, and energy-efficient building technologies and systems. These innovations reduce energy use intensity; improve indoor air quality, lighting, and temperature controls; enhance occupant comfort and productivity; and lower costs.

BTO conducts annual peer reviews to ensure that the projects in its research portfolios remain relevant, effective, and aligned with DOE priorities. This review is a formal, documented evaluation process that uses objective criteria and a panel of independent experts to assess BTO-funded projects. The assessments examine the projects in terms of their technical, scientific, or business merit; actual or anticipated results; productivity; and effectiveness. BTO uses its annual Peer Review to identify needed course corrections to its research, improve its program planning process, and inform future research activities.

BTO supports the Administration's energy, environmental, equity, and economic priorities

Shortly after taking office, President Biden announced a bold plan to transition the country to a carbon-neutral economy, mitigate climate change and environmental degradation, and improve energy and public health equity. Major goals include decarbonizing the electricity sector by 2035, achieving a carbon-neutral economy by 2050, and rectifying inequities in air and water quality. Supporting actions focus on increasing sustainable and affordable housing, modernizing energy codes, and reducing the carbon footprint of new building construction. A report by the Coalition for Green Capital and Rewiring America shows how these actions could save up to $750 per year for nearly 12 million low- to moderate-income American households and create nearly 700,000 good-paying jobs.


Energy Secretary Granholm

In May 2021, Secretary of Energy Jennifer M. Granholm identified building efficiency as a key component of the Biden Administration's energy and climate agenda. To support the Administration's priorities, DOE has announced several new programs to advance efficiency in heating and cooling, smart building technologies, and windows—all major BTO areas of focus.

Program and subprograms with projects under review

The 2021 BTO project review cycle includes 96 RD&D projects, all of which fit within the Emerging Technologies Program. Reviewers will evaluate each project assigned to them according to five criteria—approach, impact, progress, collaboration and coordination, and remaining project work. After developing a numerical score for each criterion, each reviewer will provide supporting comments. These reviewer scores and accompanying comments will inform decision making and future project planning by BTO. The Office will produce a final report on the peer review to summarize scores and comments.

Emerging Technologies Program

The Emerging Technologies (ET) Program supports technology research and development; validation; and effective integration of new energy-saving strategies, technologies, and analytical tools or services. ET projects involve collaboration among industry, national laboratories, academia, and others to develop and demonstrate novel technologies and scale them up to reduce energy use and costs in new and existing *residential and commercial* buildings. ET conducts research through the following subprograms:

Building Equipment – The Building Equipment subprogram works with national labs and industry partners to develop cost-effective, energy-efficient temperature control systems such as heat pumps, heat exchangers, and non-vapor compression technologies—as well as heating and cooling technologies used in many appliances. These technologies can expedite building electrification and cut in half the energy used by conventional HVAC equipment.
BTO contact: Ed Vineyard

Building Energy Modeling (BEM) – This subprogram develops physics-based software to simulate building energy use. Given a specific building's geometry, construction materials, and climate, BEM programs can calculate its electrical loads, energy use, and energy costs. These programs help to design more efficient new buildings and to assess and improve the energy performance of existing buildings. *BTO contact: Dr. Amir Roth*

Windows – The Windows subprogram advances key window technologies such as triple-pane insulating windows, dynamic solar control, daylighting, and shading. Windows are responsible for about 10% of energy use in buildings and influence end uses that account for up to 40% of building energy use. In 2021, DOE announced the Partnership for Advanced Window Solutions (PAWS) to accelerate the adoption of advanced window technologies.
BTO contact: Marc LaFrance

Technology-to-Market (T2M) – This subprogram works to accelerate broad commercial adoption of innovative R&D concepts. T2M funds efforts by businesses, universities, and national laboratories to overcome obstacles to the commercial uptake of new technology—ensuring that technologies with the potential to significantly improve building efficiency are deployed profitably and at scale. *BTO contact: Mary Hubbard*

Lighting R&D – The Lighting R&D subprogram fosters collaboration among researchers, industry, universities, and other stakeholders to drive advances in solid-state lighting (SSL) technology, including light-emitting diode (LED) lighting. The subprogram also researches advanced lighting controls. Lighting R&D has contributed greatly to the growth of these highly efficient lighting technologies, which are anticipated to save up to 78 quads of energy by 2035.
BTO contact: Dr. Brian Walker

Building Controls – Modern buildings use a network of sensors and device controllers to manage indoor climate, lighting, and other functions. By developing better building controls, this subprogram aims to give facility managers the tools they need to gather energy use data, improve efficiency, and respond quickly to changes in outdoor conditions.
BTO contact: Erika Gupta

Building Envelope and Thermal Energy Storage – This subprogram conducts research to improve building envelopes—the walls and other barriers that separate the building interior from the outside environment to maintain comfortable conditions for occupants. Advanced envelope technologies, such as ultra-high R insulation, diagnostic technologies and modeling tools, remediation measures, tunable transport materials, and thermal energy storage systems, can reduce building energy use by up to 25%—potentially cutting total U.S. energy use by 10%.
BTO contact: Sven Mumme

Building Electric Appliances, Devices, and Systems (BEADS) – This subprogram focuses on electric appliances, plug loads, and miscellaneous electric loads (MELs). These electrical end uses make up 20-40% of building electricity use today, and that share is likely to increase with broad uptake of technologies like electric vehicles (EVs). BEADS research explores a variety of technologies that help to characterize and reduce these electric loads.
BTO contact: Dr. Wyatt Merrill

Thank you for being part of our 2021 ***Peer Review***. We cannot succeed without the expertise, experience, insight, and partnership of researchers, practitioners, and stakeholders like *you*. Please continue to stay in touch after this Peer Review. You can reach out through buildings@ee.doe.gov or visit our website at www.energy.gov/eere/buildings/building-technologies-office. To contact an individual BTO staff member, use the format: first.last@ee.doe.gov.

Please join us for our 2021 ***Peer PReview*** on November 2–4.

BTO Peer Review Schedule

Project reviews are scheduled for the week of August 23 through August 27, 2021. The schedule below indicates which days each portfolio will be reviewed and specifies the beginning time of each individual project review. Registered attendees can navigate to project review sessions via the Attendee Hub on the day of the related review(s). All sessions listed in the schedule below are open, public sessions and are available for registrants to attend outside of assigned review sessions. Learn more about BTO's current and past Peer Reviews.

MONDAY

	Building Equipment	Building Energy Modeling
1:15 PM	BREAK	**Introduction: BEM Empirical Validation Projects** Amir Roth (BTO)
1:30 PM	**Membrane dehumidification as façade-integrated building screens for latent cooling** Forrest Meggers (Princeton University)	**Empirical validation-FLEXLAB** Christian Kohler (LBNL)
2:00 PM	**CRADA with Palo Alto Research Center in development and analysis of a liquid desiccant regeneration technology** Jason Woods (NREL)	**Empirical validation-FRP/iUNIT** Piljae Im (ORNL)
2:30 PM	**Wall embedded multi-functional heat pump with energy storage systems for grid-responsive and weather-transactive controls** Bo Shen (ORNL)	**Empirical validation-ETNA** Ralph Muehleisen (ANL)
3:00 PM	BREAK	
	Building Equipment	Building Energy Modeling
3:15 PM	BREAK	**Introduction: BEM Controls Projects** Amir Roth (BTO)
3:30 PM	**Implementing low global warming potential (GWP) and energy efficient refrigerant technologies-Part II: Heat transfer, properties and compatibility studies** Xudong Wang (AHRI)	**VOLTTRON** Jereme Haack (PNNL)
4:00 PM	**Grid resilient, self-powered, fuel flexible, high efficiency heating system** Sandeep Alavandi (GTI)	**Open building control** Michael Wetter (LBNL)
4:30 PM	**Next-generation desiccant-based gas clothes dryer systems** Sajjad Bigham (Michigan Technological University)	**BOpTest** David Blum (LBNL)
5:00 PM		**Co-Design of HVAC Systems, Controls, and Sensing** Veronica Adetola (PNNL)

TUESDAY

	Building Equipment		Building Energy Modeling
11:15 AM	BREAK		**Introduction: BEM Projects** Amir Roth (BTO)
11:30 AM	**Electrohydrodynamic enabled electrochemical membrane dehumidifier for separate sensible, latent cooling** Yunho Hwang (University of Maryland)		**ASHRAE 229P** Supriya Goel (PNNL)
12:00 PM	**NO vapor-compression, electrochemical looping heat pump (NOVEL HP)** Davide Ziviani (Purdue University)		**Simplified PRM** Supriya Goel (PNNL)
12:30 PM	**Highly efficient microemulsion-based absorption chillers for HVAC application** Bao Yang (University of Maryland)		**LFRT2030/BEM-ED** Cindy Regnier (LBNL)
1:00 PM	BREAK		
	Building Equipment	Windows	Building Energy Modeling
1:15 PM	BREAK		**Introduction: BEM Projects** Amir Roth (BTO)
1:30 PM	**Reduced AC loads using RAD-AC: an efficient electrochemical dehumidification cycle** Aaron Meles (PARC)	**VO2 thermochromic (Transparent Thermochromic Smart Window Film)** Jie Li (ANL)	**Sensor Data Integration** Tianzhen Hong (LBNL)
2:00 PM	**Electrostatic dehumidification** Ron Domitrovic (EPRI)	**Combining high thermal performance, switchability, and energy generation into a unified durable window platform** Lance Wheeler (NREL)	**EnergyPlus 10X** Tianzhen Hong (LBNL)
2:30 PM	**Separating sensible and latent cooling with electrically charged rotating vortexes and vapor capturing air handler** Lorenzo Cremaschi (Auburn University)	**Pulse-strengthened and laser edge sealed vacuum insulation glazing** Joshi Pooran (ORNL)	
3:00 PM	BREAK		

	Building Equipment	Windows	Technology to Market
3:30 PM	**Membrane-based ionic liquid absorption system for ultra-efficient dehumidification and heating** Saeed Moghaddam (University of Florida)	**Robust, large-scale dynamic windows using reversible metal electrodeposition** Michael McGehee (University of Colorado)	**IMPEL+** Reshma Singh (LBNL)
4:00 PM	**Thermoelastic active regenerators with giant deltaT** Ichiro Takeuchi (University of Maryland)	**Low-cost vacuum insulated glass for retrofit of single pane windows** Jungho Kim (University of Maryland)	
4:30 PM	**Novel framework for performance evaluation and design optimization of phase change material (PCM) embedded heat exchangers for the built environment** Vikrant Aute (University of Maryland)	**Low-cost, high-performance electrochromic devices** Anoop Agrawal (Polyceed)	

WEDNESDAY

	Building Equipment	Building Controls
11:30 AM	**High power density magneto- and elasto-caloric systems** Vitalij Pecharsky (AL)	**AFDD: Evaluation of fault prevalence in commercial buildings** Eliot Crowe (LBNL)
12:00 PM	**Hybrid HVAC with thermal energy storage R&D** Spencer Dutton (LBNL)	**AFDD: Test datasets and prioritization methods** Guanjing Lin (LBNL)
12:30 PM	**A natural gas-driven highly efficient thermo-vacuum clothes dryer** Kashif Nawaz (ORNL)	**Benchmark datasets** Tianzhen Hong (LBNL)
1:00 PM	BREAK	
	Building Equipment	Building Controls
1:30 PM	**Cast heat exchanger using the novel Ce-Al alloy** Kashif Nawaz (ORNL)	**Risk-based framework for dynamic assessment and prioritization of flexible building loads** Jared Langevin (LBNL)
2:00 PM	**Low-cost, high-perf. polymer composite HXs made by additive manufacturing** Kashif Nawaz (ORNL)	**Hierarchal model-free transactive control** Mohammed Olama (ORNL)
2:30 PM	**Separate sensible and latent AC system** Kashif Nawaz (ORNL)	**Scalable load management** Helia Zandi (ORNL)
3:00 PM	BREAK	
	Building Equipment	Building Controls
3:30 PM	**Drop-in, Retrofit Furnace with Maximum Efficiency – Self Powered System** Kyle Gluesenkamp (ORNL)	**Behind the meter storage analysis (with VTO and SETO)** Jason Woods (NREL)
4:00 PM	**Novel Compact Flooded Evaporators for Commercial Refrigeration** Kashif Nawaz (ORNL)	**Smart Neighborhoods** Teja Kuruganti (ORNL)
4:30 PM	**High efficiency flammable refrigerant leak event risk mitigation (CRADA with NAMA)** Viral Patel (ORNL)	**Connected Home Solution** Michael Brambley (PNNL)

THURSDAY

	Building Equipment	Lighting	Building Envelope	Building Controls
11:30 AM	**Cold climate integrated heat pump (ORNL, Emerson, Nortek, and Syracuse)** Bo Shen (ORNL)	**Multifunctional optical outcouplers for efficient and stable white OLEDs** Marc Baldo (MIT)	**Bio-based phase change materials (PCMs) for thermal energy storage** Patrick Hopkins (University of Virginia)	**Scaling of Building Transactive Control (aka Campus project)** Srinivas Katipamula (PNNL)
12:00 PM	**Liquid piston with spray cooling near isothermal compressor** Ahmad Abu-Heiba (ORNL)	**Spatially adaptive tunable lighting control system with expanded wellness and energy saving benefits** Bob Karlicek (Rensselaer Polytechnic Institute)	**Salt hydrate eutectic thermal energy storage for building thermal regulation** Patrick Shamberger (Texas A&M University)	**Data Driven Weather and Energy Forecasting** Zhi Zhou (ANL)
12:30 PM	**Low GWP for vending machine (McDonalds)** Vishal Sharma (ORNL)	**Integrated daylighting, electric lighting, and controls research** Sarah Safranek (PNNL)	**Multipurpose latent heat storage system for building applications - Development of low-cost, high-performance, easy-to-apply, non-flammable, inorganic phase change material (PCM) technology** Jan Kosny (University of Massachusetts, Lowell)	**Machine-Learning-Driven Site-Specific Weather Inference** Rui Yang (NREL)
1:00 PM	BREAK			

	Building Equipment		Building Envelope	Building Controls
1:30 PM	**Direct expansion HP for GWP <150** Bo Shen (ORNL)		**Stable thermochemical salt hydrates for energy storage in buildings** Sumanjeet Kaur (LBNL)	**Deep Reinforcement Learning for GEB** Andrey Bernstein (NREL)
2:00 PM	**Seamlessly fuel-flexible heat pump** Kyle Gluesenkamp (ORNL)		**A new approach to encapsulate salt hydrate PCM** Jaswinder Sharma (ORNL)	**Hot, Cold, or Just Right** Ronnen Levinson (LBNL)
2:30 PM	**Next generation transcritical CO2** Brian Fricke (ORNL)		**Cost-effective thermally activated building systems to support a power grid system with high penetrations of as-available renewable energy resources** Jialai Wang (University of Alabama)	**Building Intelligence with Layered Defense using Security-Constrained Optimization and Security Risk Detection (BUILD-SOS): A Probabilistic Approach** Qun Zhou (University of Central Florida)
3:00 PM	BREAK			
	Building Equipment		Building Envelope	Building Controls
3:30 PM	**Impact of leaks in commercial refrigeration using zeotropic refrigeration** Vishal Sharma (ORNL)		**High performance membrane heat exchangers for HVAC** Vince Romanin (Treau)	**Adaptive Cyber-Physical Resilience for Building Control System** Mustafa Dokucu (General Electric)
4:00 PM	**Flexible HP WH with embedded energy storage** Kashif Nawaz (ORNL)		**Air conditioner with integrated composite PCM** Jason Woods (NREL)	**Securing Grid-interactive Efficient Buildings (GEB) through Cyber Defense and Resilient System (CYDRES)** Zheng O'Neill (Texas A&M University)
4:30 PM	**A3 refrigerant sensor** Moonis Ally (ORNL)		**Smart Building Start (SBS)** Timothy Salsbury (PNNL)	

FRIDAY

	Building Equipment	Building Envelope	BEADS
11:30 AM	**Grid flexible, compact, efficient, indirect evaporative cooling integrated with sorption thermal storage, XL** Xiaobing Liu (ORNL)	**Scalable and Cost-Effective roll-to-roll additive manufacturing of Highly Durable and Thermal Insulating Silica-Carbon Aerogel** Shenqiang Ren (University at Buffalo, SUNY)	**Sensors impact evaluation and verification project** Piljae Im (ORNL)
12:00 PM	**NG blend with Hydrogen fuel cooking appliances/CRADA with SoCalGAS** Praveen Cheekatamarla (ORNL)	**Inexpensive and durable aerogel-based VIP cores** Massimo Bertino (Virginia Commonwealth University)	**Improving energy efficiency of wireless communication circuitry in MELs** Benton Calhoun (University of Virginia)
12:30 PM		**Preinstalled Sealant for Prefab Components** Diana Hun (ORNL)	**Reducing Plug Load Electricity Footprint of Residential Buildings through Low Cost, Non-Intrusive Sub Metering and Personalized Feedback Technology** Christoph Meinrenken (Columbia University)
1:00 PM	BREAK		
		Building Envelope	
1:30 PM		**Development of R-12/in Isocyanurate-based super insulation at atmospheric pressure** Massimo Bertino (Virginia Commonwealth University)	
2:00 PM		**Stationary concentrator daylighting system** Chirs Gladden (Glint Photonics Inc.)	
2:30 PM		**Field Study of modified atmosphere insulation technology for vinyl siding retrofit** Andre Desjarlais (ORNL)	

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