# Buildings of the Future Scoping Study
SEEING BEYOND THIS CENTURY

OVERVIEW

Scope

The Buildings of the Future Scoping Study will develop a vision for what U.S. mainstream commercial and residential buildings could become in 100 years. It will look across a number of essential performance metrics that can be measured or tracked to ascertain building quality: energy and water consumption, greenhouse gas emissions and other waste, material use, resilient design, occupants' health and productivity, and cyber and physical security. The study will also consider the actors and infrastructure that influence the way buildings are designed, built, and operated, such as utility infrastructure, real estate market dynamics, occupant needs, building control and communication, regulations, construction and procurement, and environmental concerns. It will investigate key design and technology trends and identify important knowledge gaps that, if remedied, could revolutionize the quality of the built environment. In shaping this vision, it will also consider topics that indirectly impact building design an planning, such as modes of urban transportation, grid modernization, and information technology development.
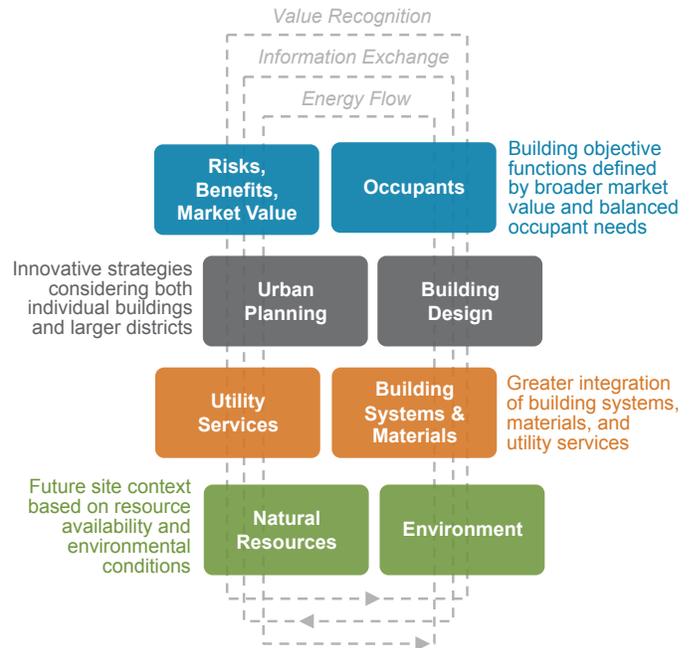
This vision will be defined in the context of environmental issues and resource availability. It will rely on knowledge of cutting-edge technologies and trends, incorporate innovative building design and planning strategies, and utilize occupants needs and markets to define objective functions and performance goals.
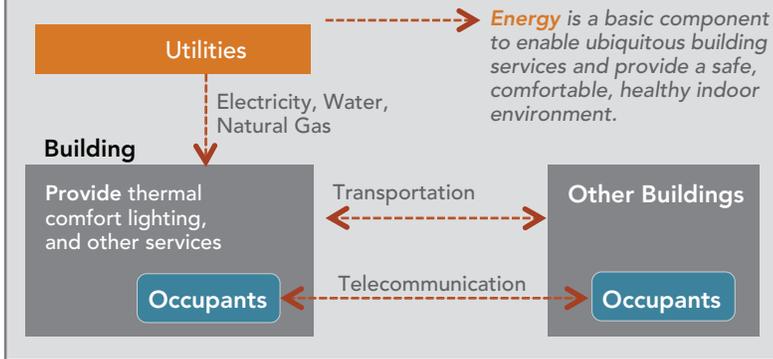
Critical Components of Our Visions for Future Buildings

» **An integrated vision.** Building stakeholder groups have developed various performance metrics (e.g. greenhouse gas emissions, energy use, water use) and corresponding quantitative goals and commitments; however, it is unclear how other important aspects of buildings, such as resilience to changing environmental conditions and occupant well-being can fit into the existing commitments to reduce energy use and greenhouse gas emissions. Moreover, buildings must be envisioned as active components of larger districts where urban transportation, utility service, and resource exchange are equally important.

» **A proactive, coherent paradigm.** A valuable vision is not intended to create solutions on a clean slate, but to shift buildings towards a more forward-looking process. The vision must acknowledge the known problems and current desires, foresee future conditions and anticipated needs, and respect the building evolvement process.

» **A scalable approach.** Many visions resulted in one-off case studies rather than evolutionary and scalable solutions for mainstream buildings, due to unforeseen technical complications, cost overruns, unclear public benefits, and lack of implementation strategies.

http://energy.gov/eere/buildings/building-technologies-office

ENERGY AND BUILDING SERVICES (TODAY'S MODEL)

One-way communication, mostly driven by occupant needs, is the dominant means of controlling energy and other resource use in the built environment.

Utilities

Electricity, Water, Natural Gas

Building

Provide thermal comfort lighting, and other services

Transportation

Other Buildings

Telecommunication

Occupants

Occupants

Energy is a basic component to enable ubiquitous building services and provide a safe, comfortable, healthy indoor environment.

This vision development will explore:

» the dynamic, multi-dimensional resource and information exchange within and between buildings, utility infrastructure, environment, and occupants;

» the 'value-added' opportunities that come from understanding the human/building interface;

» a full suite of comprehensive, transparent building performance metrics to describe the value proposition of future buildings.

PANEL DISCUSSIONS AND INTERVIEWS

Through a series of panel discussions and interviews with thought leaders, we aim to:

» Identify and describe the resource and information flows within and outside buildings (occupants, environment, utilities, building districts)

» Discuss how innovative technologies and strategies can resolve problems in buildings today and how well they might potentially work for tomorrow

» Explore future building attributes

Each panel is expected to focus on one topic and discuss the following, as appropriate, in the context of expected future conditions (see 'Future Context' callout box):

» Will building use types, functions, and ownership be the same or different? Why?

» How will societal needs (e.g. owner and occupant interests and activities) shape future buildings?

» How will climate change impact future buildings?

» How will potential changes in energy and material flow (e.g., different forms of energy, water, waste water, etc.) influence buildings?

» Compared to today's practice, will there be more efficient ways of developing buildings to meet needs and adapt to changes in the future? What aspects of the built environment need to be developed, enhanced, or changed? What could drive these changes?

» What are the most important future building attributes?

Future Context

Environment and Climate Change

According to the Intergovernmental Panel on Climate Change's Fifth Assessment Report (IPCC 2014), the global surface temperature is projected to rise over the 21st century under all assessed emission scenarios. *"Many aspects of climate change and associated impacts will continue for centuries, even if anthropogenic emissions of greenhouse gas are stopped."* It is very likely that:

• heat waves will occur with a higher frequency and longer duration;

• occasional cold winter extremes will continue to occur;

• mean precipitation will decrease in dry regions;

• sea level will rise in more than about 95% of the ocean area;

• climate change is projected to undermine food security and reduce renewable surface water and ground water resources in most dry subtropical regions.

Population Growth

Population in the U.S. is projected to increase from 321 million in 2015 to 420 million in 2060 (U.S. Census Bureau, 2014) and 462 million in 2100 (United Nations, 2012). In 2014, 81% of the population lived in urban areas; in 2050, 87% will live in urban areas (United Nations, 2014)

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UPCOMING EVENTS (subject to change)

Date	Event	Panelists (or Leads)	Focus
March 18 🟩	Webinar	Mary Ann Lazarus/HOK Chris Garvin/Terrapin Bright Green Thomas Knittel/HOK Nora Wang/PNNL (Moderator)	Resilience Biomimicry Biophilia
March 30 🟦	IEA EBC Annex 66 Expert Meeting (Berkeley, CA)	Clint Andrews/Rutgers Steve Selkowitz/LBNL Cary Chan/Swire Properties Hui Zhang/UC Berkeley CBE Led by: Jared Langevin/DOE	Occupants Behavior and Enabling Technologies
April 2 🟧 ⬜	Living Future unConference (Seattle, WA)	Panel Discussion (Morning) Nora Wang/PNNL Pat Phelan/DOE Steve Shankle/PNNL Workshop (Afternoon) PNNL partnered with ZGF Architects, New Building Institute, EcoDistricts	Building-Grid Integration Connected Building Districts Information Technologies Real Estate Market Dynamics
April 14 🟧 🟦 ⬜	DOE BTO Peer Review Meeting (D.C.)	Dave Rouse/APA Jason Christopher/DOE Jon Francis/Bosch Jonathon Herz/Department of Health and Human Services Nora Wang/PNNL (Moderator)	Urban Planning Security Internet of Things Health
May 4 🟩 🟦 ⬜	New York City Workshop	Led by: Edward Bogucz & Chetna Chianese/Syracuse CoE Jorge Gonzalez/CUNY Masoud Ghandehari/NYU William Worek/Stony Brook University	Occupants Smart City Urban Informatics Building Controls
June 23 🟦 ⬜	Webinar	Steve Nadel/ACEEE Duane Jonlin/City of Seattle Michael Rosenberg, Bing Liu/PNNL	Codes and Regulations
June 30 🟩 ⬜	ASME ES2015 (San Diego, CA)	Osman Ahmed/Siemens Yunho Hwang/UMD Agami Reddy/ASU Led by: Jorge Gonzalez/CUNY Pat Phelan/DOE	Building Technologies
July 13 & 15 🟦	Webinars	Led by: Centers for Disease Control and Prevention	Health, Well-being
July 14 🟧	Webinar	Philip Enquist/SOM Lonnie Love, Roderick Jackson/ORNL James Rose/Univ. of Tennessee	Additive Manufacturing and Construction
July 31 🟩 🟧 🟦 ⬜	Concluding Workshop (D.C.)	Led by: Nora Wang/PNNL (Partnered with AIA)	Future building characteristics, performance metrics, and long-term targets

Environment & Natural Resource	Utility Services & Other Supply	Occupants	Connected Built Environment