

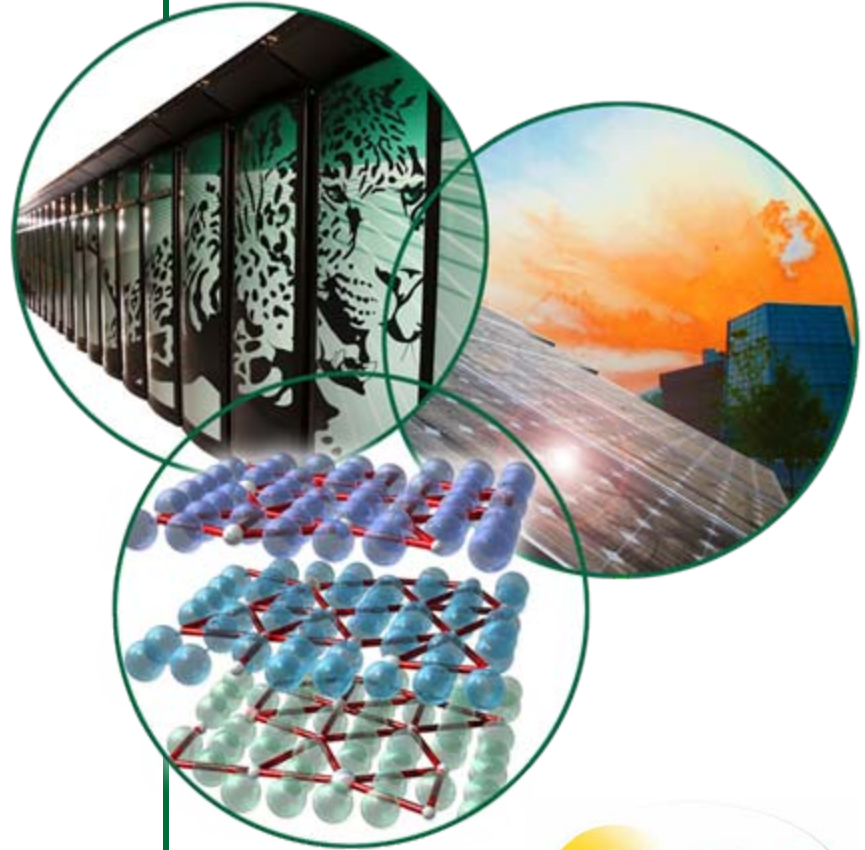
ORNL's Greatest Challenges Achieving Low Energy Buildings

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for

Joint ARPA-E/EERE Workshop on
"Advanced Building Energy
Technologies"

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ORNL Buildings R&D User Facilities

- **EXISTING: advanced component R&D**
 - Envelope and equipment
 - Residential and commercial
 - New construction and retrofit
- **EXISTING: residential system/building-level R&D**
 - Unoccupied research houses with simulated occupancy
- **COMING SOON: commercial system/building-level R&D**
 - Unoccupied “test buildings” with simulated occupancy

Systems Lab Tests



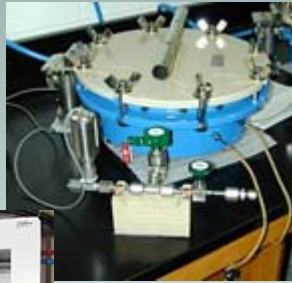
The only large-scale, 3-D climate simulator (for attic systems, etc.) in the U.S.



World's only guarded hot box doing dynamic wall testing daily

Exterior Insulation Finish System (EIFS) Case Study

Hygrothermal Properties Labs for Building Materials



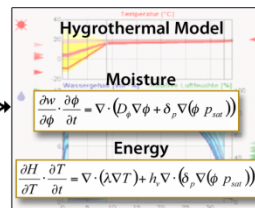
Material & System Characterization

Field Research

Advanced Hygrothermal Modeling

Indoor Conditions

Hygrothermal Material Properties



Climate

Construction Type & Details

Tacoma WA



Natural Exposure Test Facilities



Syracuse NY

Charleston SC



ORNL

Wärme Und Feuchte Instationär (WUFI)



"Self-Drying" EIFS Available (Multi-Sources)



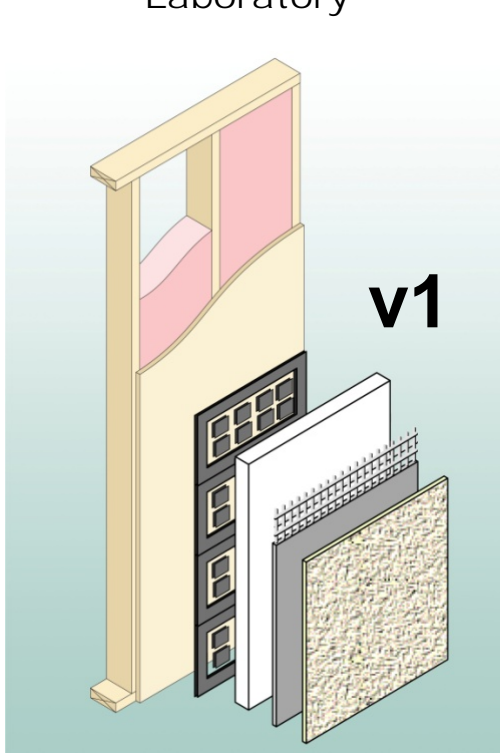
Laboratory



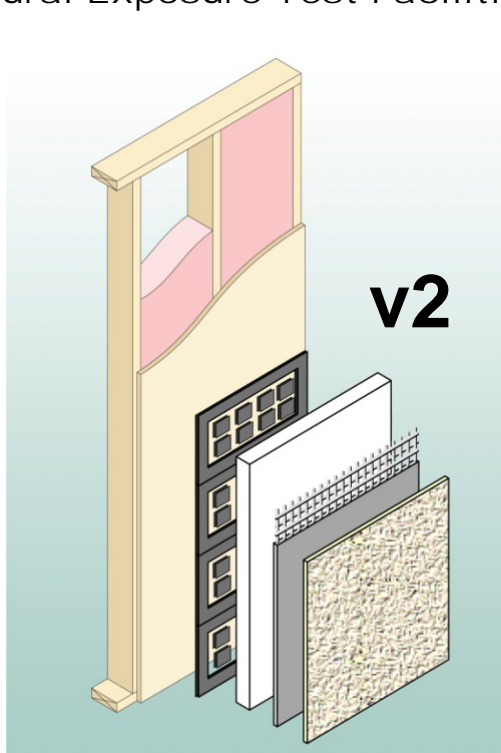
Natural Exposure Test Facilities



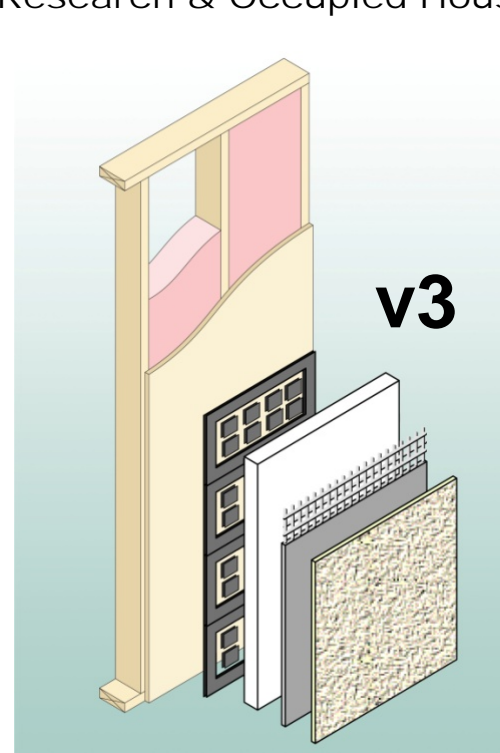
Research & Occupied Houses



v1



v2

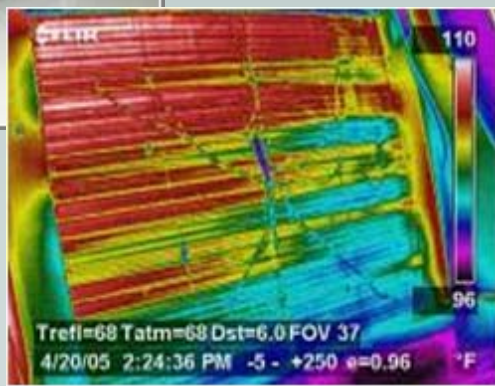


v3

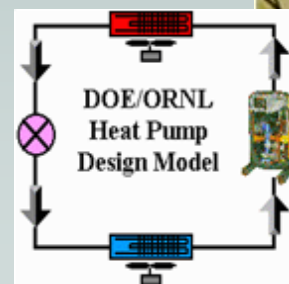
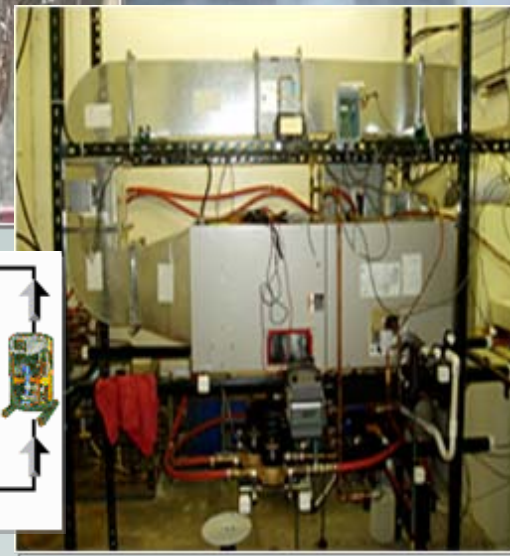
Heat Pump Water Heater Case Study



Advanced Heat Transfer Test Facilities



Prototyping Labs, Environmental Chambers



HPWHs Available (Multiple Major Sources)



Models, Labs, Chambers



Accelerated Durability Testing



Research & Occupied Houses



v1



v2



v3

Other Outcomes With Contributions From ORNL Buildings R&D User Facilities

- Data used to develop or revise more than 100 standards pertaining to various aspects of building envelopes
- Hygrothermal models for understanding heat, air, and moisture flow through envelope assemblies; storage within; and failure thresholds
- “Cool colored” roofs and walls (infrared blocking pigments)
- Thermal storage insulation (PCM-enhanced) for light frame construction
- Unequal parallel compressor systems for supermarket refrigeration
- Rooftop units with cascaded vapor compression/desiccant cycles
- Triple-effect absorption chillers
- Several types of small to mid-sized gas heat pumps
- Packaged cooling, heating and power (CHP) systems
- Ground-source heat pump systems

System/Building-Level R&D

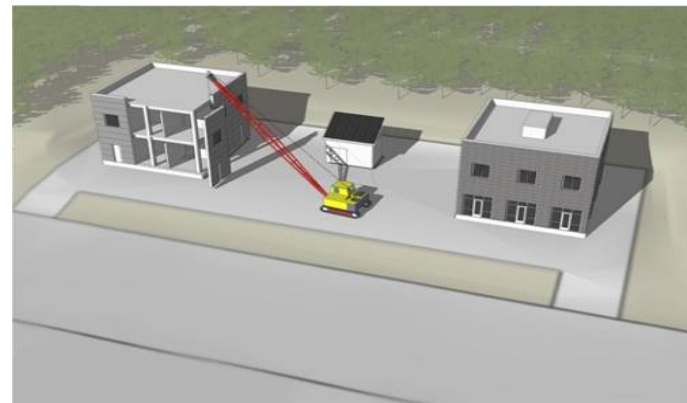
- **Residential**: partners willing to bear risk of carrying charges for land/bricks/mortar of actual houses



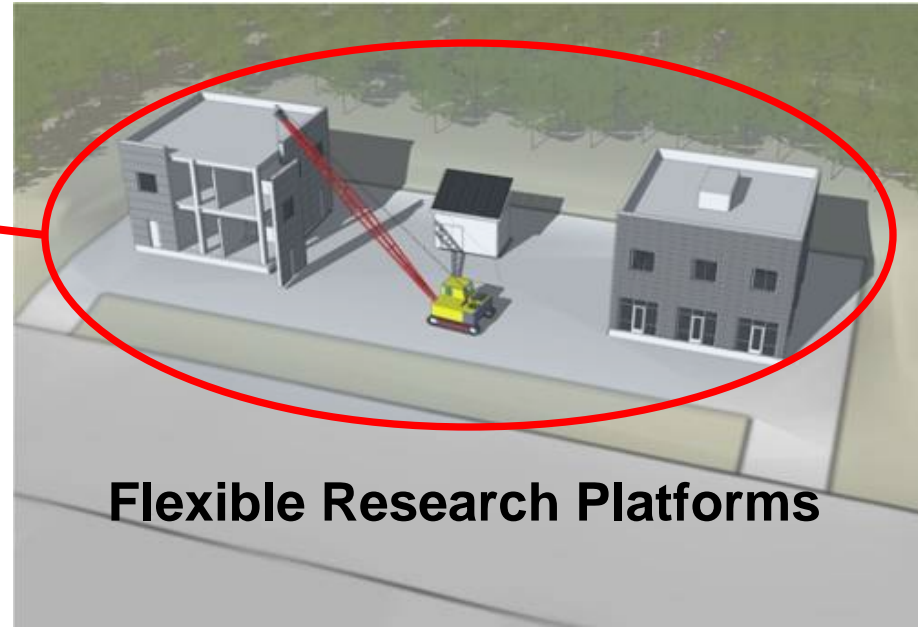
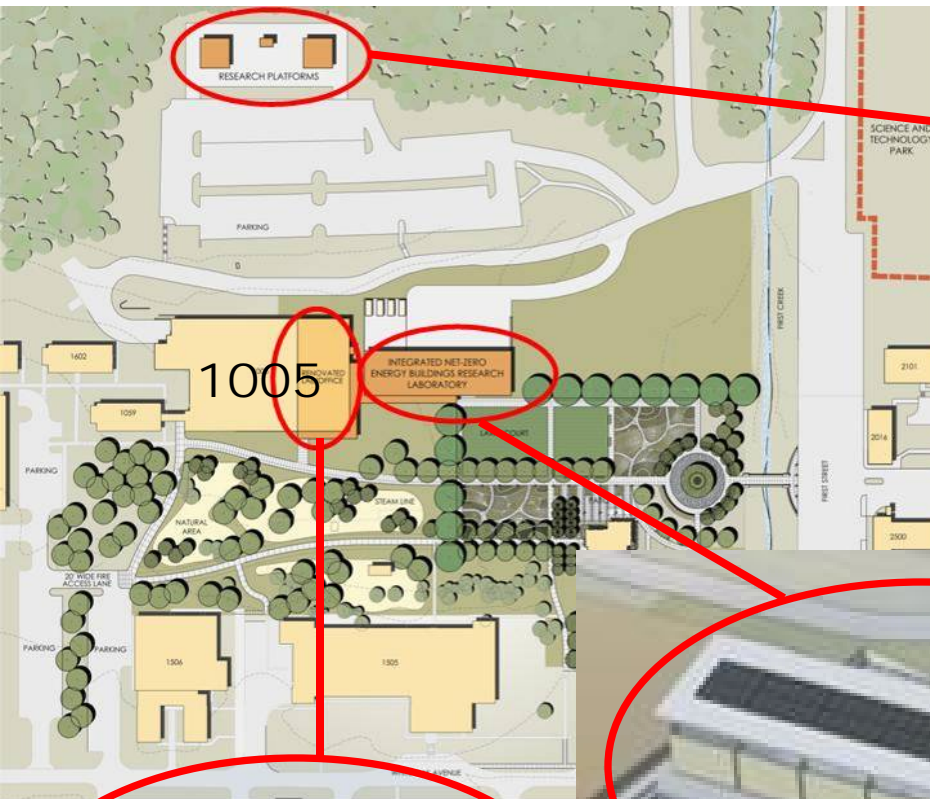
1. Plan R&D on 1 envelope strategy (new, retrofit) per house
2. Plan R&D on several generations of equip/appliances/controls
3. Build research houses
4. Exclusive use leases for R&D period (simulated occupancy)
5. After R&D period houses are released for sale
6. Build additional research houses as needed

- **Commercial**: requires dedicated lab-based facilities to generate solutions supported by sufficient rigor that next steps will be feasible in actual commercial buildings

1. Plan R&D on “test buildings” applied to skeletons
2. Design, construct, and commission “test buildings”
3. Operate “test buildings” (simulated occupancy)
4. Decommission and demolish “test buildings”
5. Repeat 1. through 4.



Buildings R&D User Facilities Coming Soon as a Result of ARRA Lab Call #09-002



Flexible Research Platforms



New High Bay

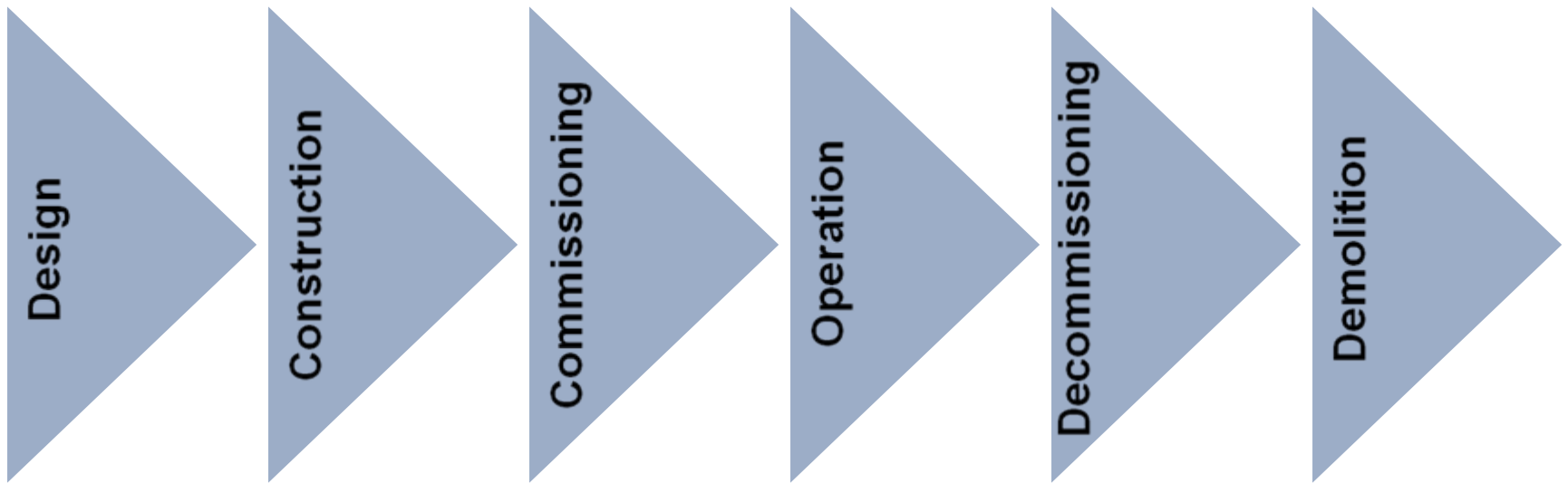
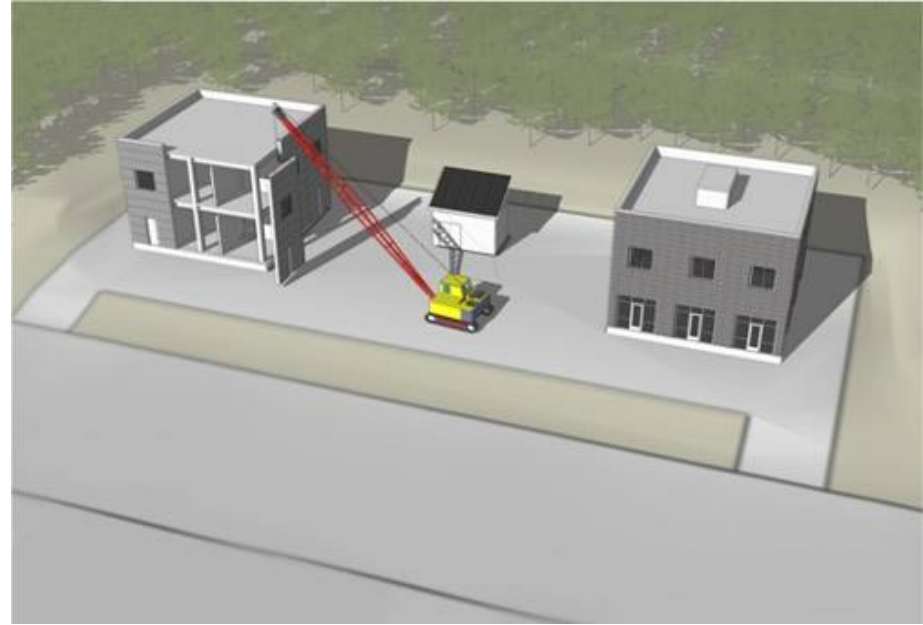


High Bay Interior

**Renovate East End
of Building 1005
Into Low Bay Labs
and Offices**

Flexible Research Platforms

Using the flexible research platforms, two “test buildings” can transition through their entire life-cycles in a year



Show how BIM can be used to manage buildings throughout their life cycle as a single integrated asset

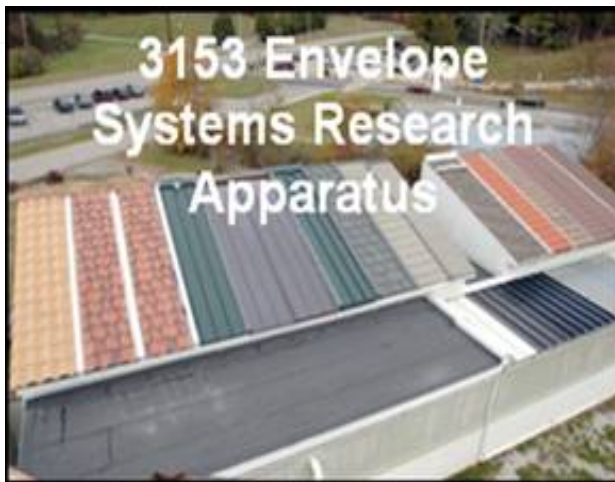
High Bay Laboratory

Using the High Bay, the systems and components of the two “test buildings” will be developed and prepared for integration on the flexible research platforms



- High bay laboratory will include four major sections:
 - (1) the Multifunctional Envelope Laboratory (MFEL),
 - (2) the HVAC Refrigeration and Equipment Laboratory (HVACRE),
 - (3) the Advanced Construction Technology Evaluation Laboratory (ACTEL), and
 - (4) the Buildings-to-Grid Integration Laboratory (B2GIL).

Project Also Upgrades Process Control and Data Acquisition Systems on Existing



Great Strides Toward Low Energy Buildings Will Require

- Building envelopes that are multifunctional.
- Building-information modeling (BIM) that is ubiquitous.
- Construction and retrofit processes that are more automated and economical.
- Buildings that are “more intelligent” and manage themselves.
- Integration of intelligent buildings with on-site power (renewable energy, CHP), smart grid, and EV/PHEVs.
- Emergence of transformational cooling, heating, water heating, and humidity control technologies.

Greatest Challenges

- Finding sponsors/collaborators for “great stride” initiatives
 - Historically most of them want success tomorrow at minimal risk
- Finding core program funding for operating user facilities
- Achieving the utilization potentials of all facilities assets
 - Facilities operational plans
- Creating opportunities for seasoned staff to mentor a new generation of building scientists