NREL
NATIONAL RENEWABLE ENERGY LABORATORY

NREL Buildings Program Overview

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Transforming Energy
through Building Science and Integration

foresee™ Home Energy Management Software

Automating connected appliances and systems in a choreographed way saves energy, reduces strain on the grid, and could save homeowners up to $9 billion on their energy bills.

R&D 100
2018
WINNER

Multibuilding Energy Simulation and Optimization

ResStock™ is helping states, municipalities, utilities, and manufacturers identify which home improvements save the most energy and money

ResStock

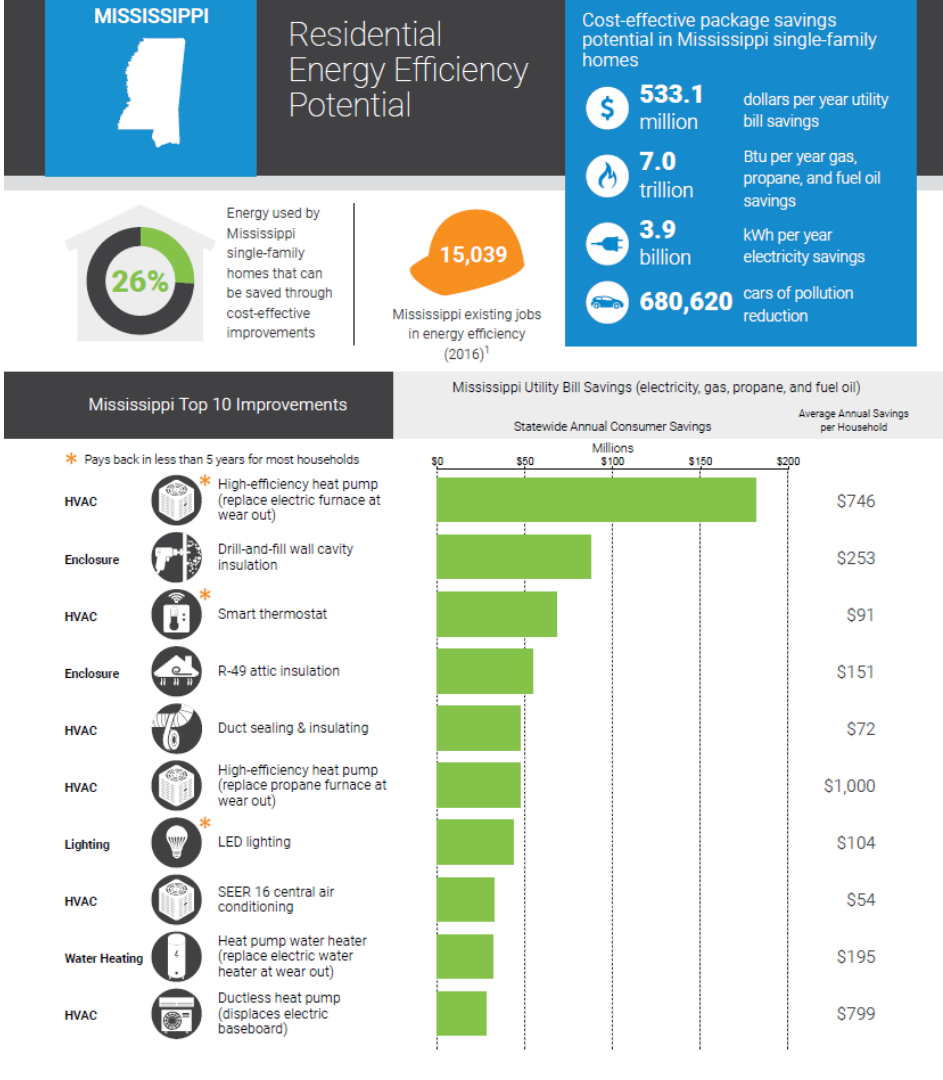
R&D 100
2019
WINNER

ResStock Website

Interactive web visualizations

- Housing characteristics
- Baseline consumption by end-use, fuel
- Savings and cost-effectiveness for upgrades

https://resstock.nrel.gov/



Analytics Targeting Commercial Energy, Cost Savings

ComStock produces data-driven, physics-based simulation of the U.S. commercial building stock to achieve **unprecedented granularity in modeling** building energy use and demand

ComStock

Urban Energy Modeling

NREL's **URBANopt platform** and its underlying **physics-based analytics engine** support the design and optimization of urban districts and help plan the integration of high-efficiency, sustainable energy technologies community-wide.

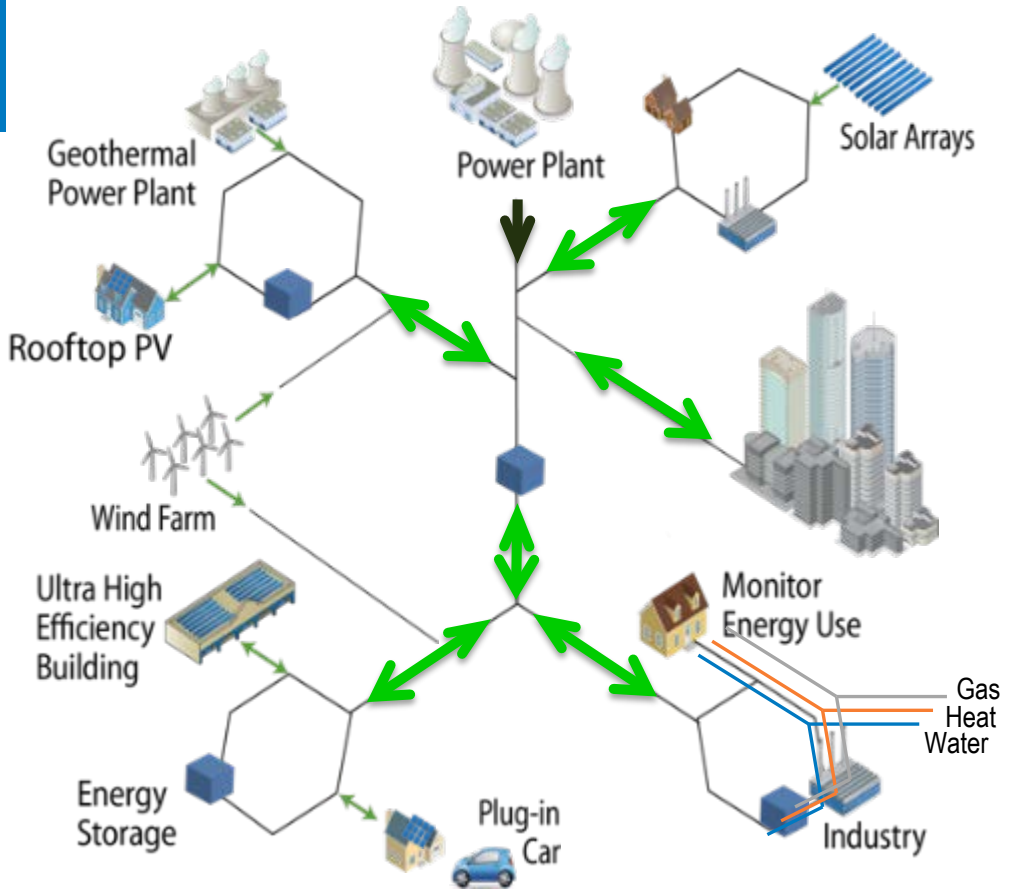

The Future Is
Grid-Interactive Efficient Buildings

The Energy Grid of the Future is Changing

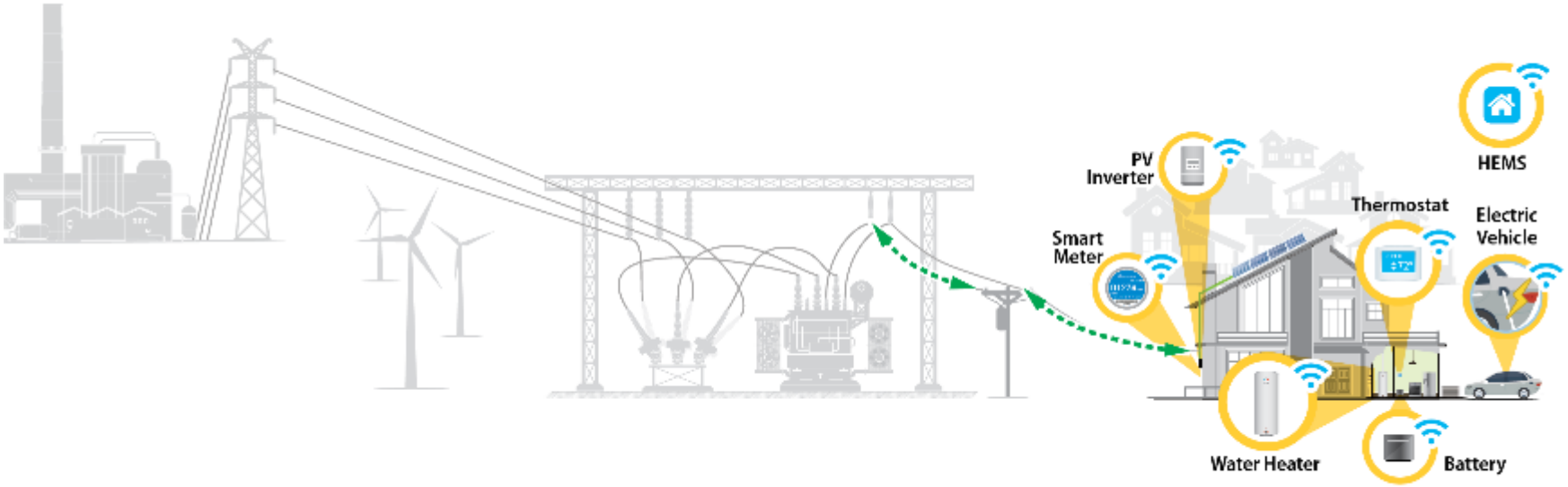
Buildings comprise

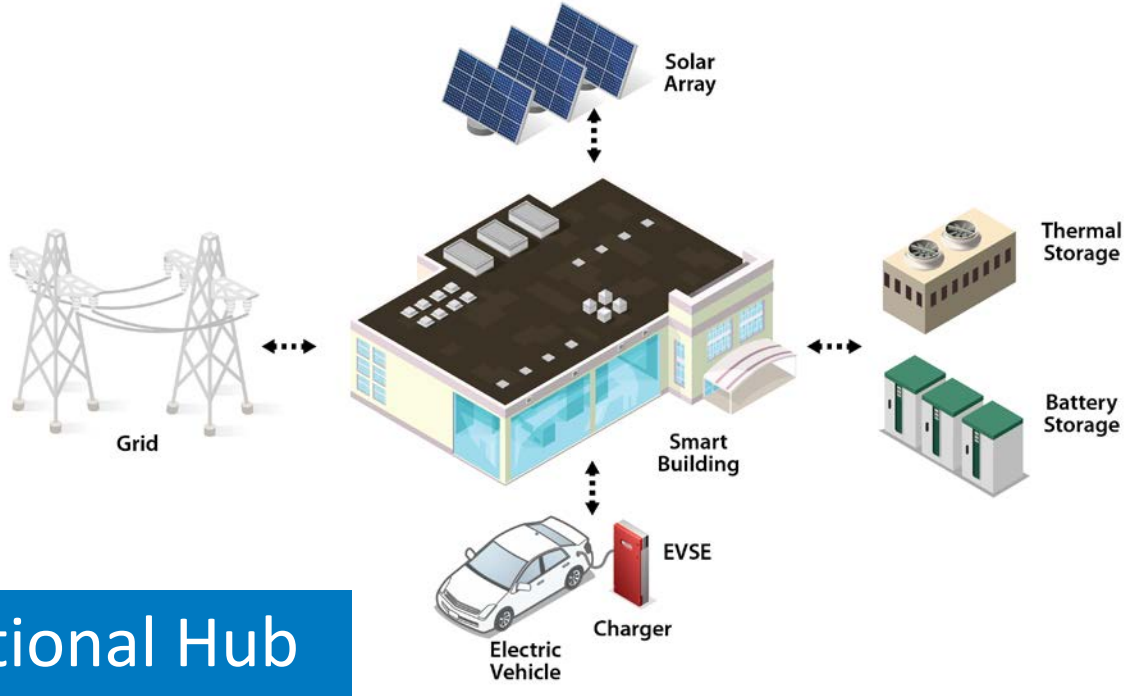
75%

of current electrical demand



How We Use Electricity is Changing





Buildings: The Foundational Hub

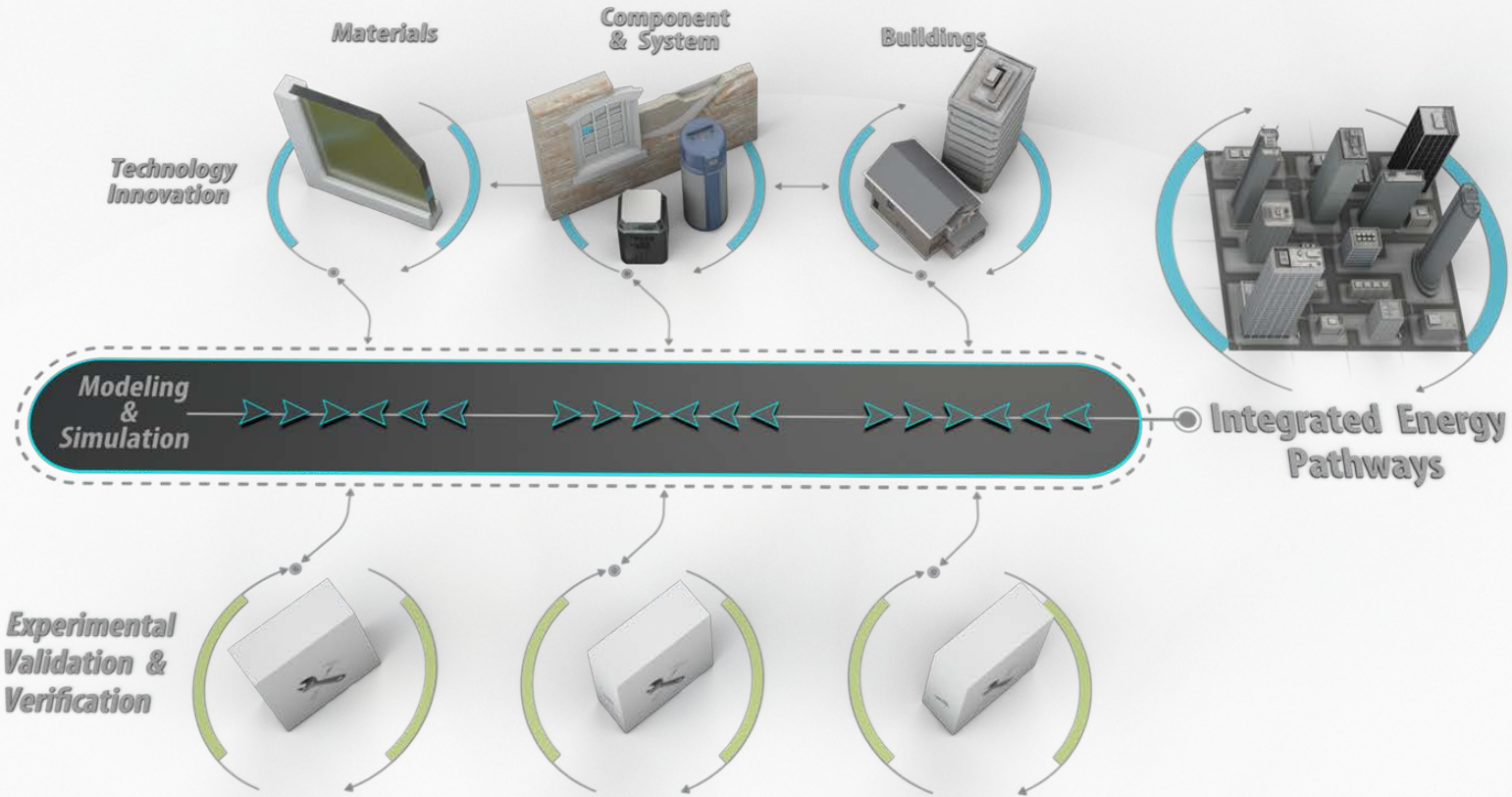
Integrated systems with optimal design and operation.

- Smart buildings, electric vehicles, solar energy, battery storage, thermal storage, can be optimized to address current industry needs.
- New materials and controls can enable optimal integration for the future

Opportunities & Challenges

- Buildings can provide grid services such as reduced generation operation, generation capacity, transmission and distribution upgrades, and contingency reserves.
- Supply and demand diversity, which vary by climate, location, generation resource, market, and building type, drive spatial and temporal imbalances in the energy grid.
- “Behind the meter” solutions can be developed and optimized to provide grid services that reduce spatial and temporal energy imbalances; however, solutions must be integrated across diverse technologies, controls platforms, and systems.

Integrated Strategy Enables Impactful Innovation




Beyond Efficiency:
Grid-Interactive Efficient Buildings Research

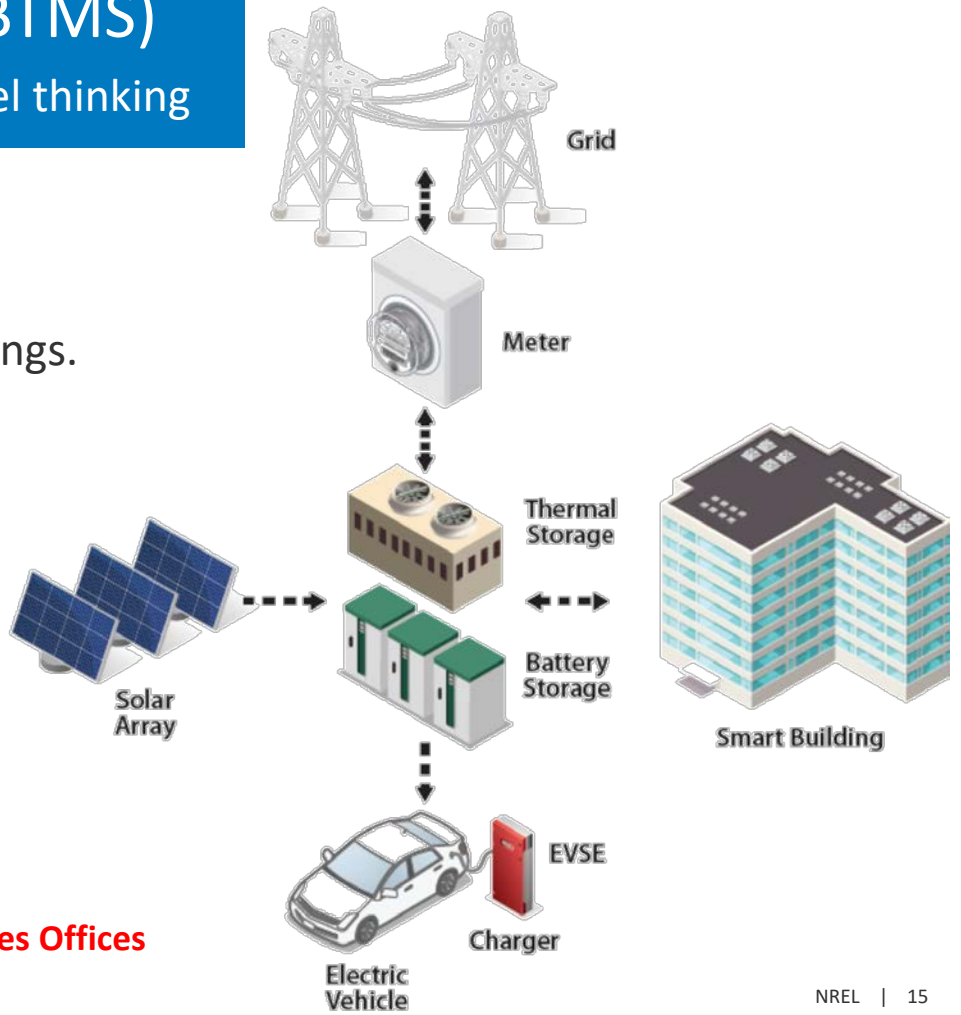
Behind-the-meter storage (BTMS)

Early-stage research guided by system-level thinking

- **Buildings** are largest electrical load.
- **Electric vehicles** will be charged at buildings.
- **Photovoltaics** will be everywhere.

To mitigate the impact of these on the electric grid, we need flexibility:

- More intelligent controls
- **Thermal energy storage**
- **Electrochemical energy storage**



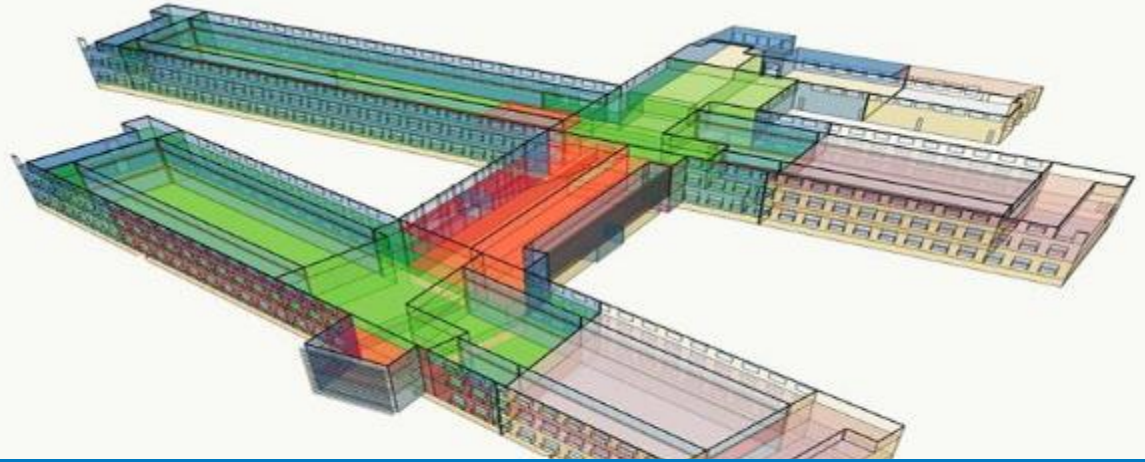
A partnership between the Buildings, Solar, and Vehicles Offices

NREL | Oak Ridge National Laboratory | INL Idaho National Laboratory | Sandia National Laboratories | Argonne National Laboratory

Innovative Thermal Storage

Optimizes integration of advanced building-scale thermal energy storage technologies with other forms of:

- Energy storage
- Renewable energy
- Loads.

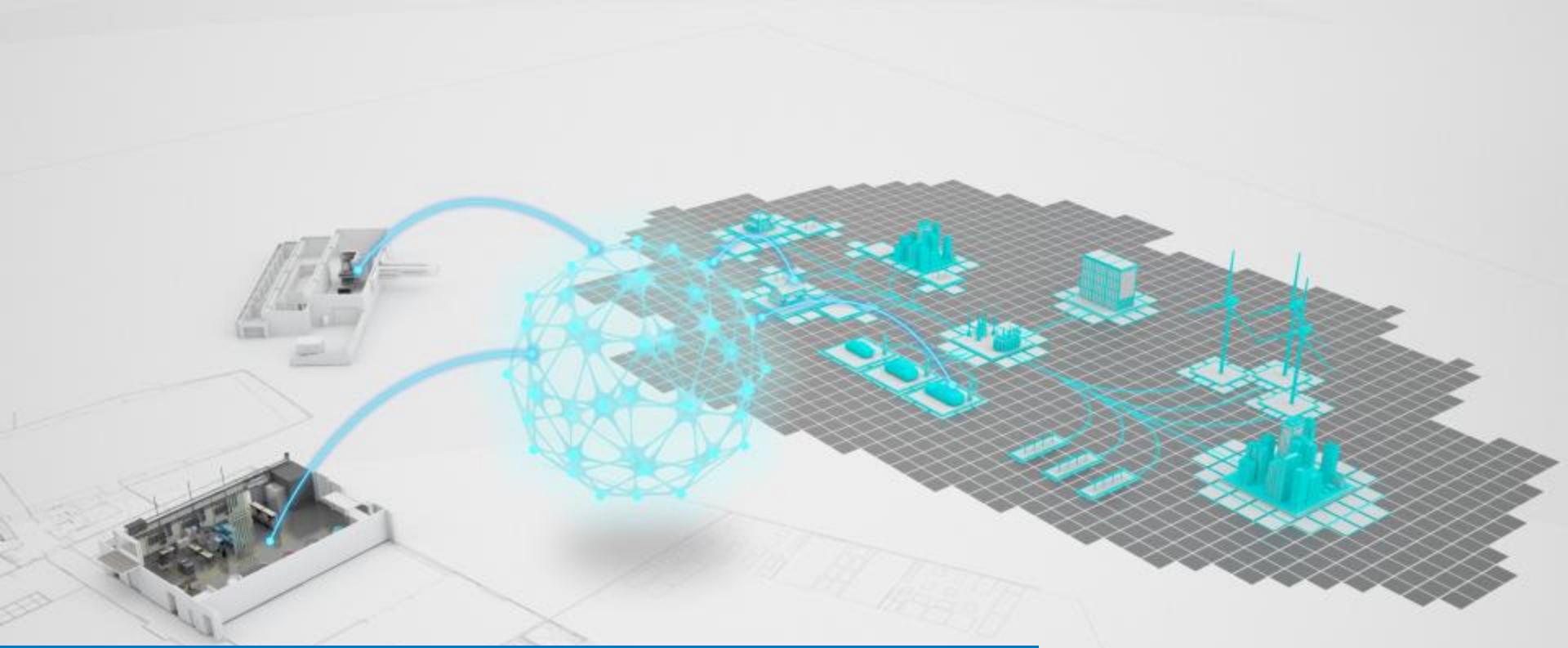


Building Energy Simulation and Optimization

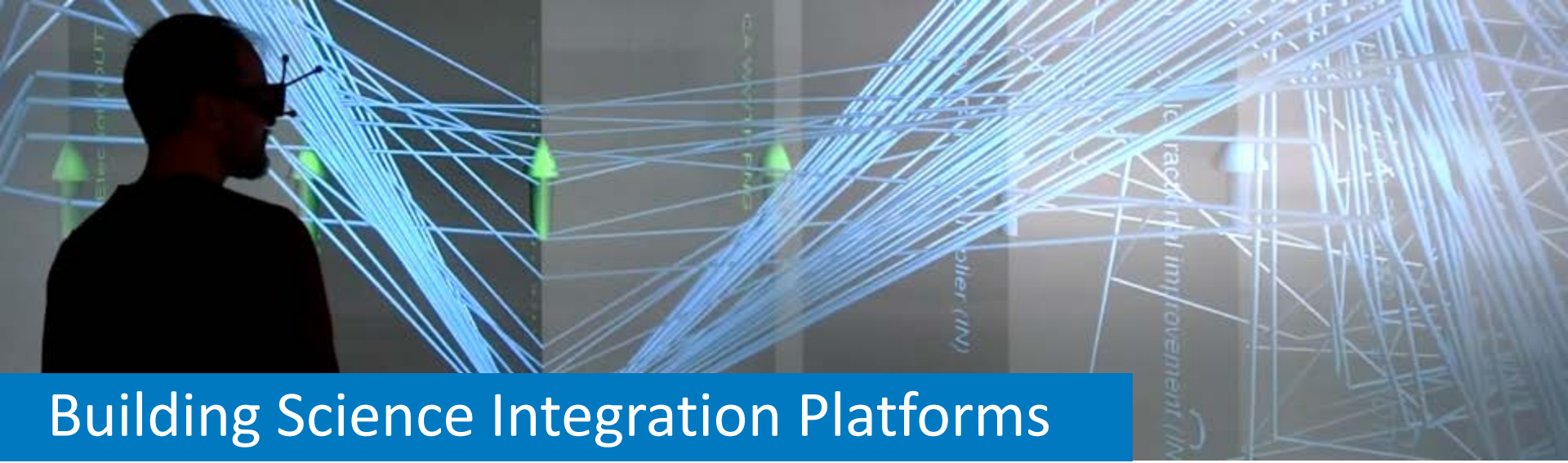
- Time Resolution
- Geo-spatial Resolution and Scale
- Operational versus Design Planning
- Technology and Building Scale

Building Simulation

Coupling the Virtual and the Physical



Connecting the Virtual and Physical



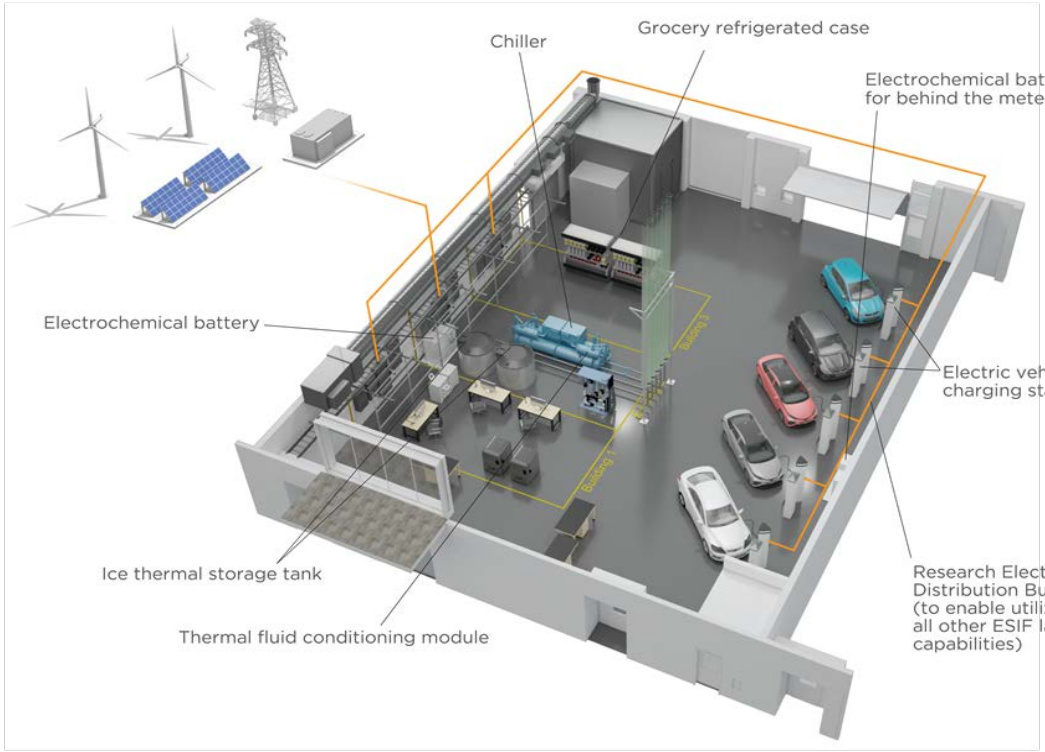
Building Science Integration Platforms

"System-in-the-loop" R&D prove the science and scale of building energy:

- Flexibility
- Efficiency
- Interoperability with the grid.

Energy Systems Integration

- Hardware-in-the-loop functionality for grid-interactive efficient buildings R&D
- Four key focus areas:
  - behind-the-meter energy storage,
  - flexibility for demand-side management,
  - intelligent efficiency
  - interoperability (connectivity, controls, communication).



Building System Hardware in the Loop

End-to-End Energy Ecosystem

- Residential loads hub that contains two residential electrical systems with associated smart home appliance suites
- Small commercial load hub that includes building electrical infrastructure with common outlets and mounting infrastructure for appliances and distributed energy resources
- Power-hardware-in-the-loop test bays for multi-inverters, small-scale commercial equipment, and cyber security networks
- Demonstration and testing of commercial PV inverters

Energy Efficiency at Scale through Advanced Data Science

Unprecedented granularity in building simulation and modeling identifies residential and commercial building energy efficiency opportunities.

Res Stock

Com Stock

End-Use Load Profiles: The Critical Link to the Future

Building stock characteristics database

+

Physics-based computer modeling

+

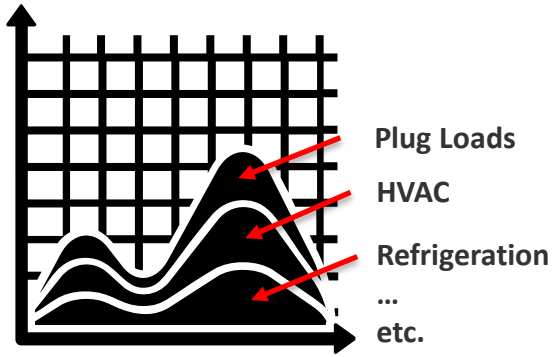
Calibration

Aggregate AMI

End-use profiles

BAS Trend logs

End Use Load Profiles:
Allows for evaluating the impact of future scenarios and technologies



- Multi-regional with national coverage
- Sub-hourly time resolution

NREL advances the science and engineering of energy efficiency, sustainable transportation, and renewable power technologies and provides the knowledge to integrate and optimize energy systems.

Thank you

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NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.