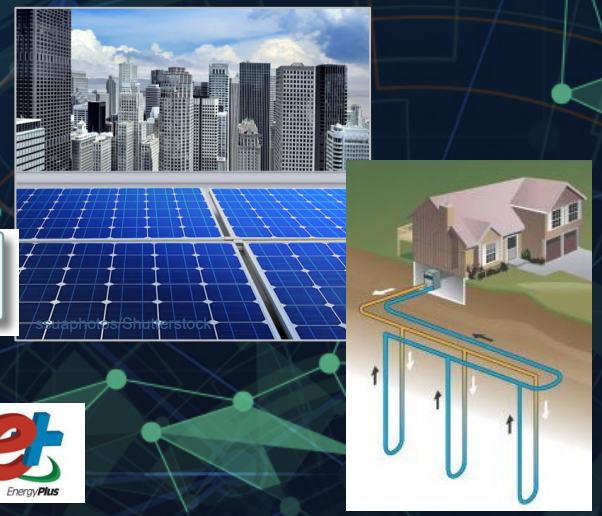
Emerging Technologies for Sustainable Buildings

David Yashar

Chief (Acting), Building Energy and Environment Division



VCAT

October 26, 2021

National Institute of Standards and Technology
U.S. Department of Commerce

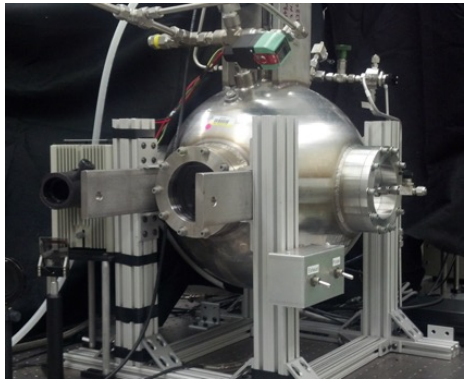
engineering laboratory

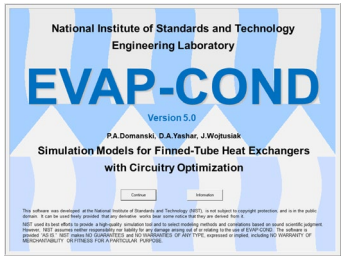
Motivations

- **US has 100 M dwellings and >5 M commercial/institutional buildings**
- **41 % of US energy consumption, 73 % of electricity and 14 % of potable water**
  - Annual cost of $230B - residential and $168B - commercial buildings
- **Energy efficiency industry employs 2.1 Million Americans** (2021 U.S. Energy and Employment Report)
- **GHG emissions associated with buildings**
  - Direct + indirect - 38% of total GHG emissions or 2B tons CO2e/yr
  - Leakage of high-GWP HFC refrigerants
- **Improved indoor environments could yield $20B to $160B in health and productivity benefits** (2002 Fisk)
- **Increased awareness of Indoor Air Quality and Ventilation (IAQ&V) issues due to COVID-19 pandemic and increasing number of wildfires**

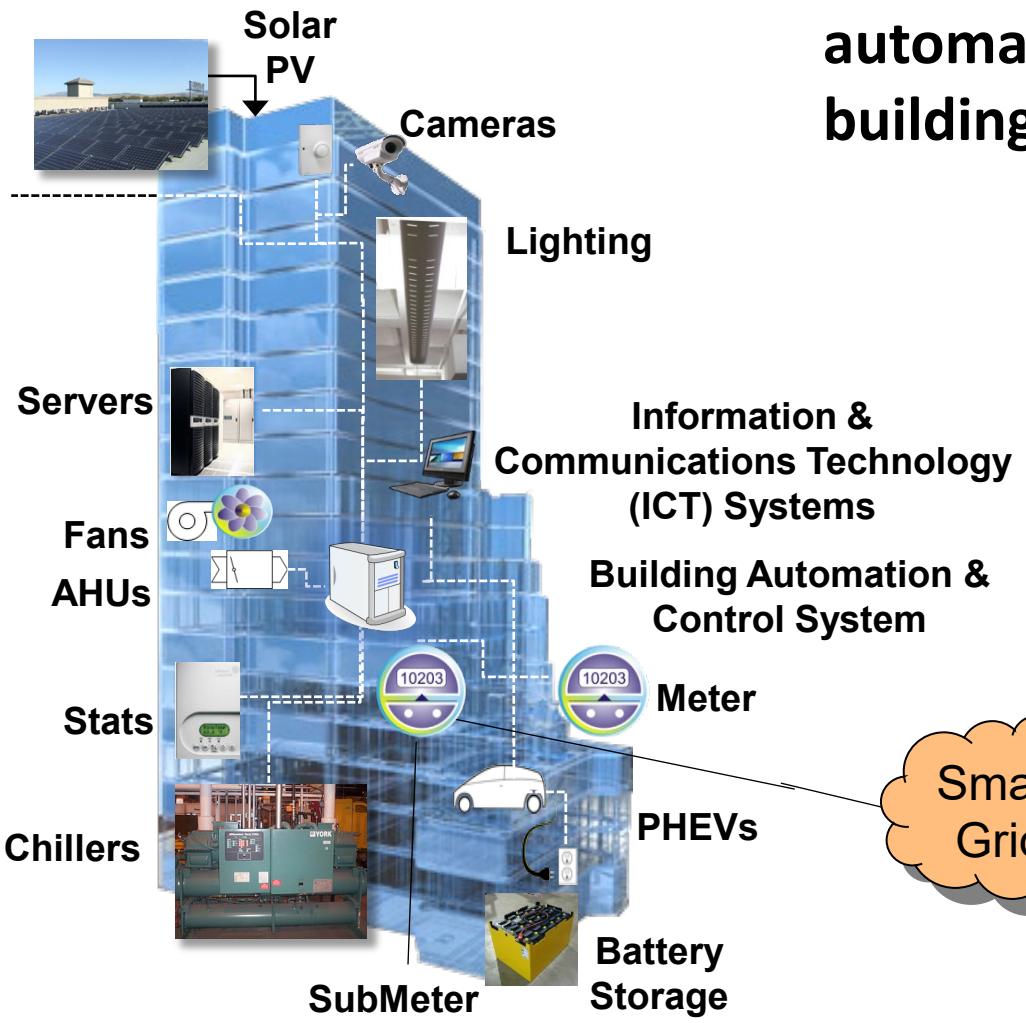
Meeting Industry Needs

- **Technical information**
  - Experimental work spanning system components to whole buildings
  - Typically, 40+ publications per year
- **Public Datasets**
  - Net-Zero Energy Residential Test Facility (NZERTF), PV arrays and weather, building airtightness, and HP fault/fault-free
- **Models/software**
  - CONTAM - building airflow and contaminant transport
  - Vapor compression system & heat exchanger software tools
  - BEES, BIRDS NEST, E3 & PV^2 software for sustainable design
- **Standard Reference Data/Material/Instrument**
- **National and International Standards Leadership**
  - SDOs (ASHRAE, ISO, IEC, SEPA, NEMA, OASIS)
  - Industry Associations (ABAA, AHRI, BACnet International)





Smarter Buildings

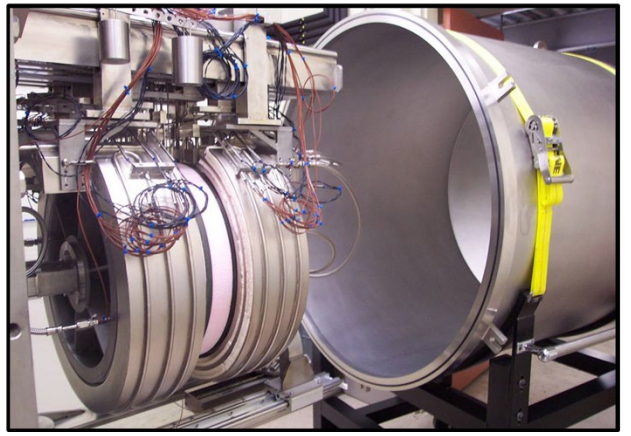


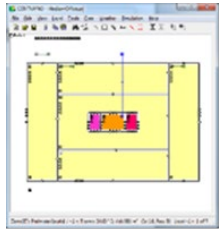
Enables utilization of the capabilities of networked automation and control systems to improve home and building operations through:

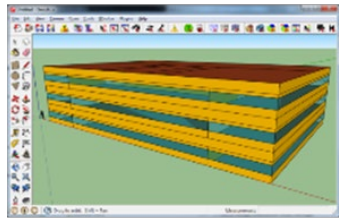
- Better system commissioning
- Automated fault detection and diagnostics
- Intelligent agent-based optimization
- Integration and interaction with a smart grid
- Semantic interoperability for building system data and information

Improving Indoor Environment in Energy Efficient Buildings

- **Reducing Heat Loss and Gain**
  - Insulation
  - Building Airtightness
- **Indoor Air Quality**
  - Coupled multizone building airflow and energy simulation tools
  - Contaminant control in low-energy buildings
  - IAQ-Related Disaster Response & Preparation (COVID-19, WUI smoke, CO, CBR, etc.)

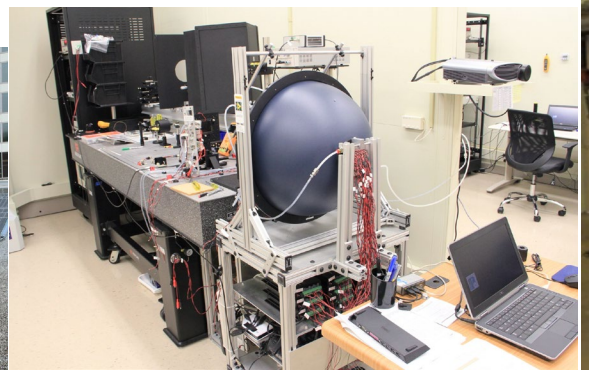






Lowering Demands in Energy Efficient Buildings

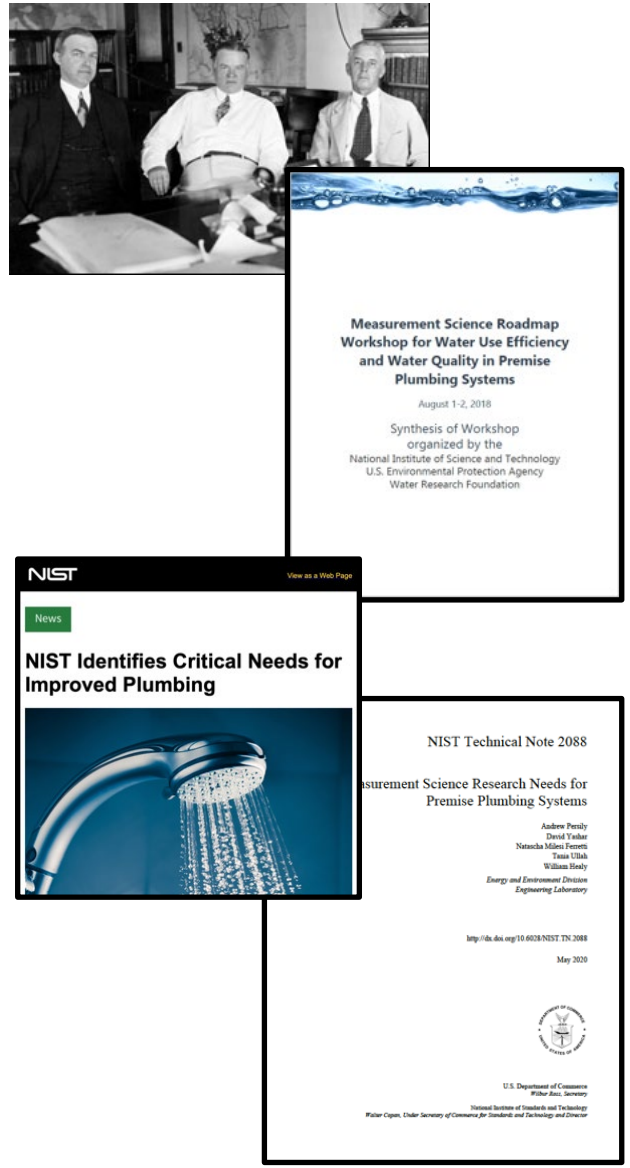
- **Improving Equipment Efficiency**
  - Space Conditioning Equipment traditional, novel, Low-GWP
  - Water Heating
  - Other Appliances
- **Onsite Renewable Energy Generation**
  - Characterizing performance of PV cells
  - Performance of PV arrays, aging
- **Whole Building Metrics**



BEES online

Water Use in Buildings

- **NBS/NIST plumbing research 1920s-1980s**
- **Modern systems, outdated design approaches**
  - Different usage patterns, lower water consumption
  - Water quality concerns, OPPPs, energy use
  - ICC, IAPMO and other stakeholders asking NIST to re-engage
- **2018 Premise Plumbing Roadmap workshop**
  - Organized with EPA Office of Water and WRF
- **May 2020, NIST TechNote: Measurement Science Research Needs for Premise Plumbing Systems**
- **FY20-FY22 Temporary NIST Funding**
  - Portfolio of research projects on premise plumbing system performance



Future Goals

- Safe and Efficient Premise Plumbing
- Energy-Efficient Heating/Cooling using Low-GWP Refrigerants
- Energy-Efficient Ventilation for Pandemic and Climate Change Risks
- Affordable and Efficient Photovoltaic and Energy Storage for Net-Zero Energy Buildings
- Application of AI Techniques to Improve Building Operation


Questions