

Activities at ORNL that Support BTO Mission but are Funded by Others

Presented to:

**Public Session at the
DOE Building Technologies Office
FY2017 Peer Review**

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Non-BTO funding mechanisms

- Strategic Partnership Projects (SPPs – formerly known as Work for Others)
- Cooperative Research and Development Agreements (CRADAs)
- User Agreements (we are a DOE-designated national user facility)
 - Lab Directed Research and Development (LDRD)
 - Seed (essentially small LDRDs)
- Internal funding from lab overhead

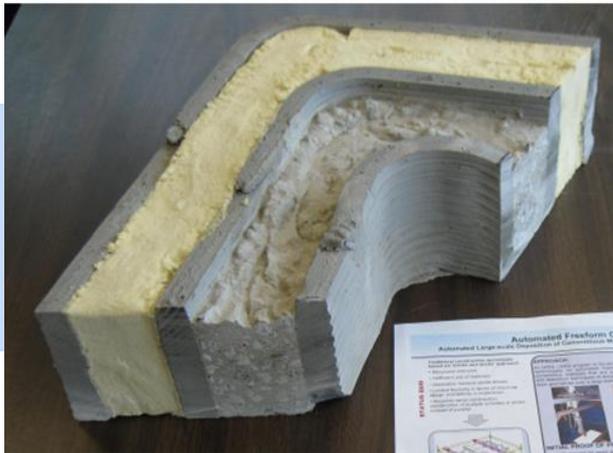


Options (in order of likelihood of IP creation)

- Internal funding (targeting applied energy programs)
 - ORNL internal R&D; ORNL funds the work and owns the IP
- CRADA (BTO funds ORNL, partner is self-funded)
 - Collaborative R&D; each party owns its own inventions; joint inventions owned jointly; partner has exclusive option in a field of use to license ORNL inventions (not for free); data protected up to 5 years
- Strategic Partnership Program (formerly WFO)
 - ORNL executes R&D scope; collaboration is permitted; industry funds the work and owns the IP (if US sponsor using corporate funds)
- Non-Proprietary User Agreement (BTO funds ORNL, partner self-funded)
 - Industry accesses ORNL facilities to execute R&D scope; collaboration is permitted; each party owns its own inventions; joint inventions owned jointly
- Proprietary User Agreement
 - Industry accesses ORNL facilities to execute R&D scope; not a collaboration; industry funds the work and owns the IP (if US sponsor using corporate funds)

Internally funded: materials and processes to 3D print building envelopes

FY2007-09



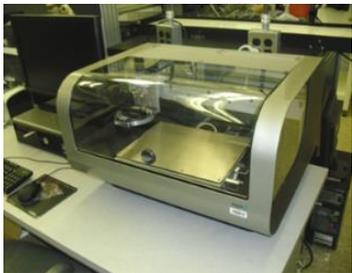
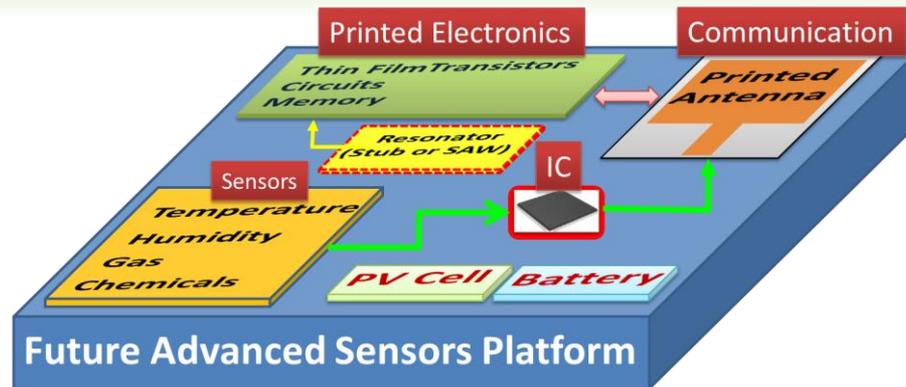
FY2014-16



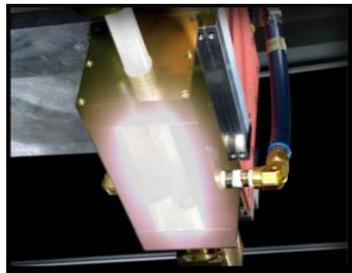
Internally funded: low-cost wireless sensor platform

FY2013-15

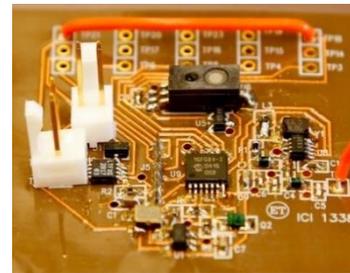
- Platform designed to leverage advanced materials/manufacturing, achieve low cost
 - Energy independent
 - Harvests
 - Stores
 - Ultra low use
 - Multi-sensor
 - T, RH, etc.
 - Penetrating wireless
 - Durable



Print components on flexible substrates



Low temperature photonic curing



Add what is unprintable, demonstrate platform

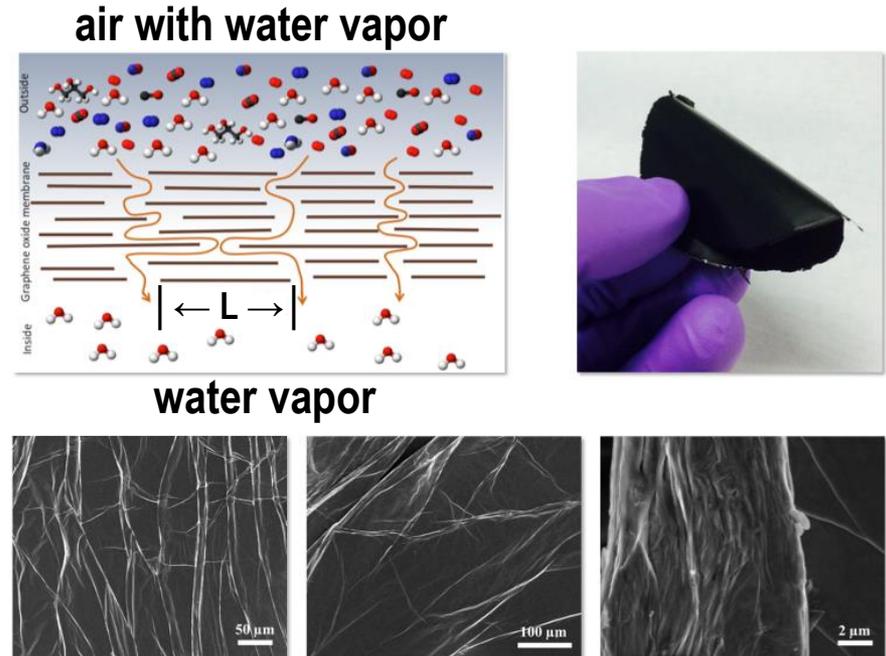


Engage industry partner to manufacture prototypes for OEMs

Internally funded: water vapor separation from air using graphene oxide membranes

FY2016-17

- Water vapor separation driven by modest water vapor partial pressure differential across the membrane
- Several orders of magnitude more permeable to water vapor than polymer-based membranes
- Essentially zero crossover of air (oxygen, nitrogen, CO₂)
- 4-inch diameter membranes were successfully fabricated and characterized



Stacked graphene oxide flakes with size $L = 1-10 \mu\text{m}$ in the form of a laminate of many layers of flakes, tightly bonded together by Van Der Waals forces

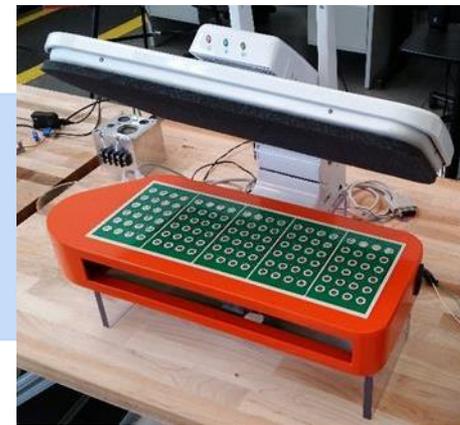
CRADAs: BTO resources are leveraged 2 for 1



Magnetocaloric refrigerator



Absorption water heater



Ultrasonic clothes dryer



Adsorption water heater



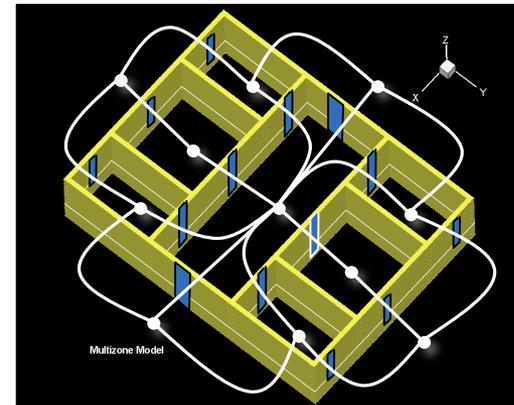
Air-source integrated heat pump



Thermoelectric clothes dryer

SPP: develop envelope airtightness savings calculator

- Credible, easy-to-use, free online calculator
- Calculator output → energy and cost savings
- Considers all HVAC, temperature, wind, and stack effects in a simultaneous solution for pressure at each node and airflow between them



Pre-Run Simulations of DOE Commercial Prototype Buildings

Max HVAC/ventilation airflow rates

EnergyPlus

- DOE prototype building
- Pre-determined city
- Envelope airtightness
- Weather

Hourly air leakage rates

CONTAM

- DOE prototype building
- Pre-determined city
- Envelope airtightness
- Weather

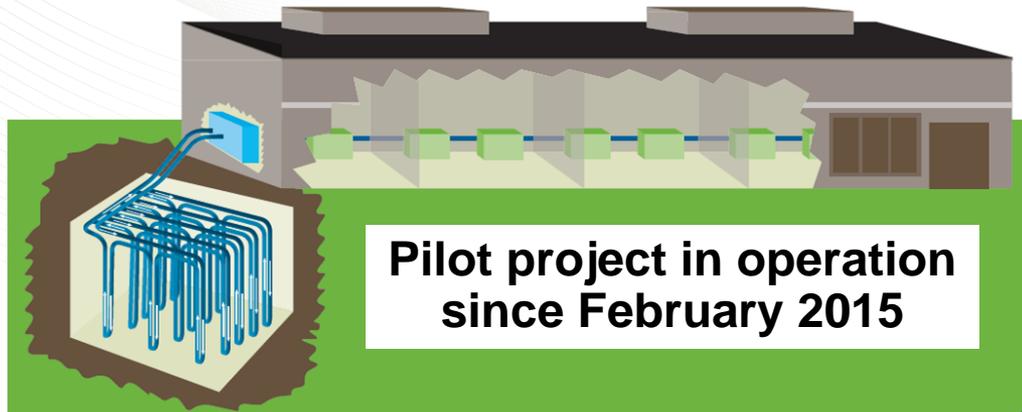
EnergyPlus

- DOE prototype building
- Pre-determined city
- Weather

Pre-Run Results

Energy use and cost as a function of envelope airtightness

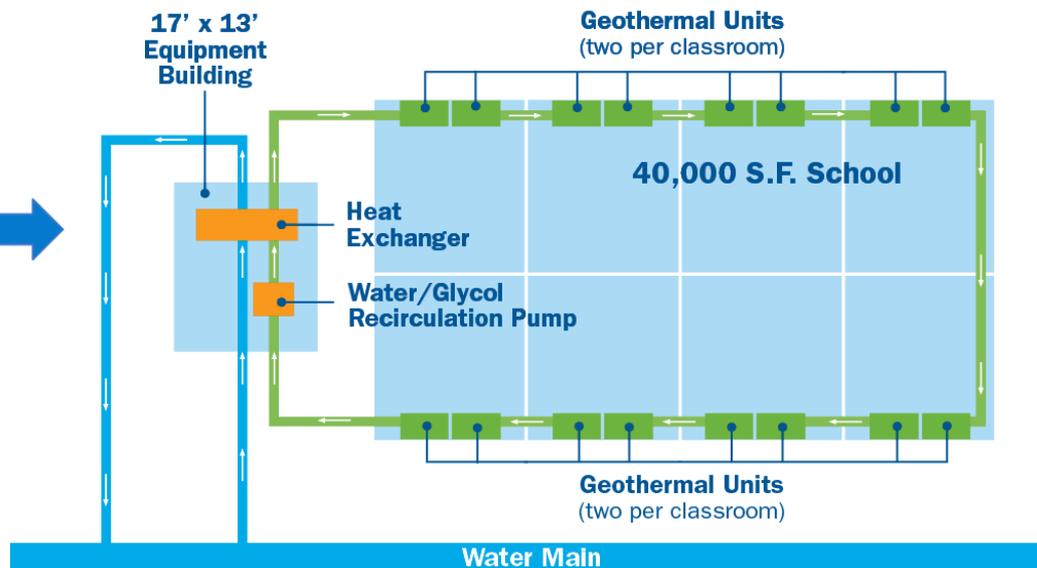
SPP: evaluate quality of public water supply when used as heat source/sink for GSHP systems



ORNL has decades of experience in water quality analysis, modeling and water chemistry in support of integrated environmental impact assessments



Replace bore field with food-grade stainless steel plate-frame heat exchanger



SPP: compare multiple HVACs installed in the same building, exposed to same occupancy and weather

- Flexible Research Platform (FRP):
 - Install multiple HVAC systems
 - Emulate occupant effect on energy use
 - Expose each HVAC to hottest, coldest, and mildest weather by rotating operation
 - Use data to calibrate models for full characterization of each HVAC system

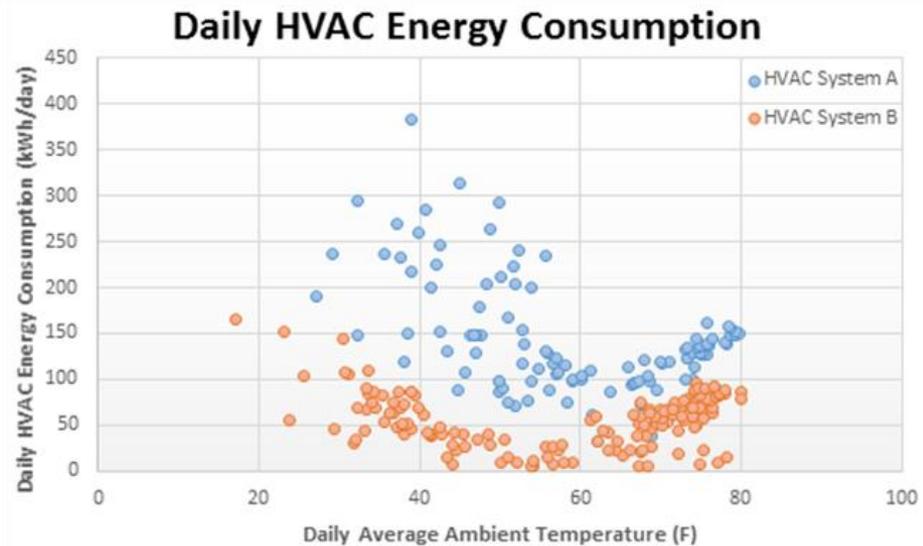


Cooling Season HVAC Energy Comparison (A vs. B)

	A	B
Total Energy Use (kWh)	5,635	4,517
% Difference (vs. A)	-	20%

Heating Season HVAC Energy Comparison (A vs. B)

	A	B
Total Energy Use (kWh)	31,104	7,715
% Difference (vs. A)	-	75%



Proprietary user agreements: envelope-related

- Typical scopes (*resistance to heat flow, airtightness, or moisture-durability):
 - Characterize performance* gain of wall assembly with new feature vs. baseline
 - Characterize performance* gain of low-sloped roof assembly with new feature vs. baseline
 - Characterize performance* gain of roof/attic assembly with new feature vs. baseline
 - Measure the hygrothermal properties of a new construction material

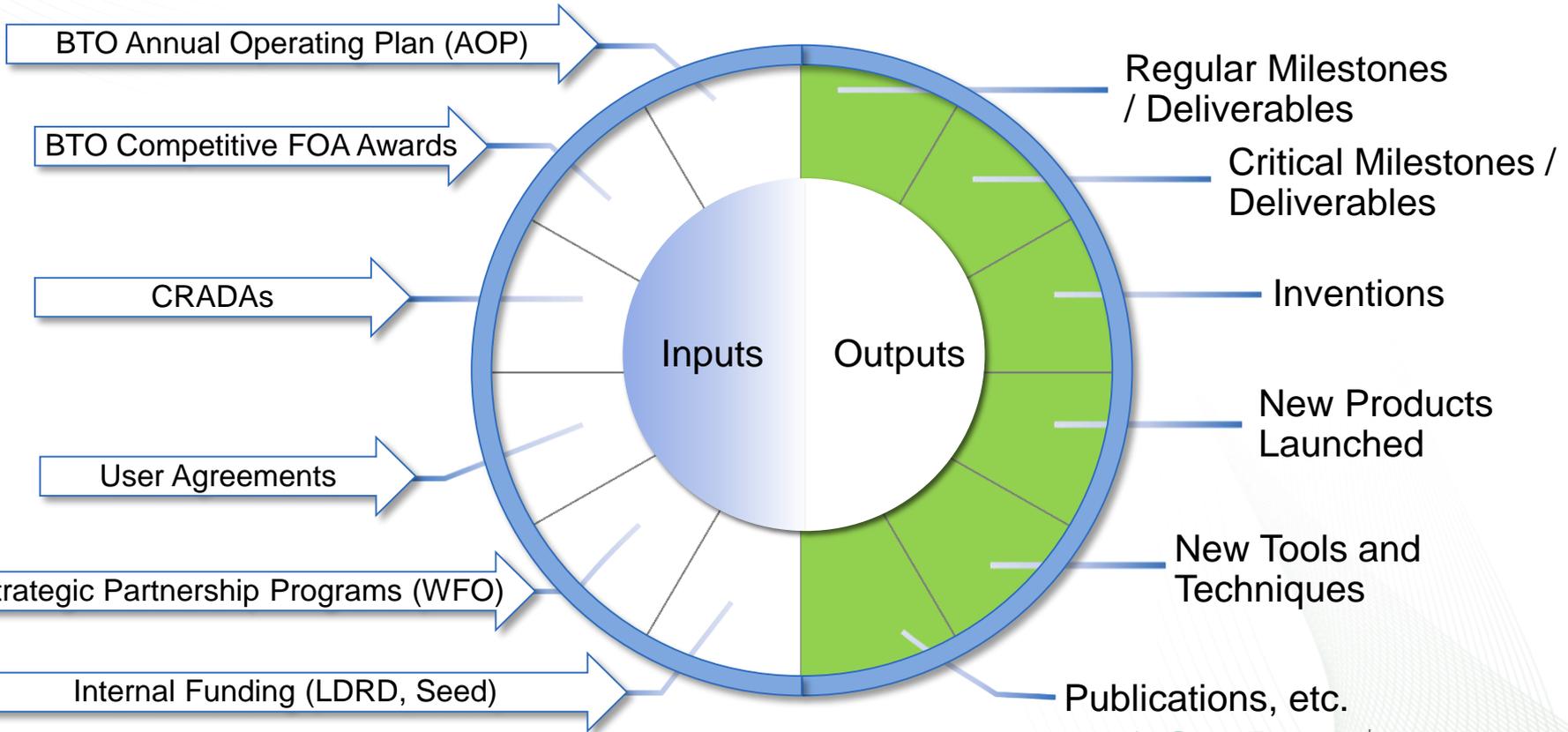


Proprietary user agreement: equipment-related

- Typical scopes:
 - Characterize performance of various types of heat exchangers vs. baseline
 - Characterize performance of various types of compressors vs. baseline
 - Characterize performance of various types of HVAC&R/appliance systems vs. baseline
 - Repeat above with various lower GWP alternative refrigerants



BTRIC user facility business model



Discussion

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