



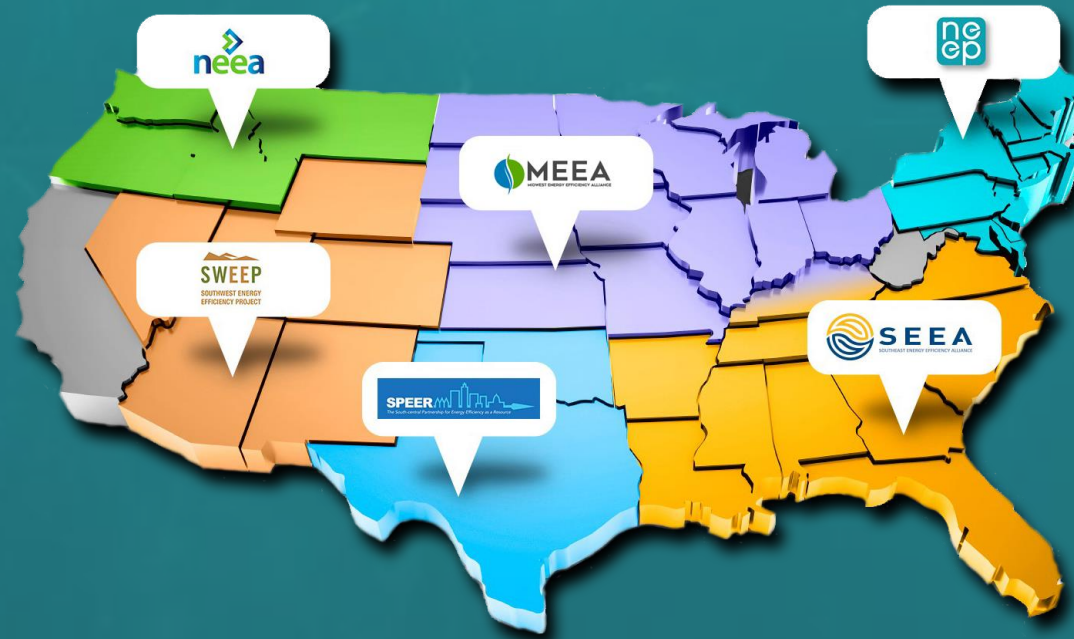
WELCOME!

Northeast Energy Efficiency R&D Connector Workshop

Dave Lis
Giselle Procaccianti

About NEEP

A Regional Energy Efficiency Organization



One of six REEOs funded in-part by U.S. DOE
to support state and local efficiency policies and programs.

Northeast Energy Efficiency Partnerships



“Assisting the Northeast & Mid-Atlantic Region in Reducing Total Carbon Emissions 80% by 2050”

Mission

Accelerate energy efficiency as an essential part of demand-side solutions that enable a sustainable regional energy system

Vision

That the region embraces next generation energy efficiency as a core strategy to meet energy needs in a carbon-constrained world

Approach

Overcome barriers and transform markets through *Collaboration, Education, and Enterprise*



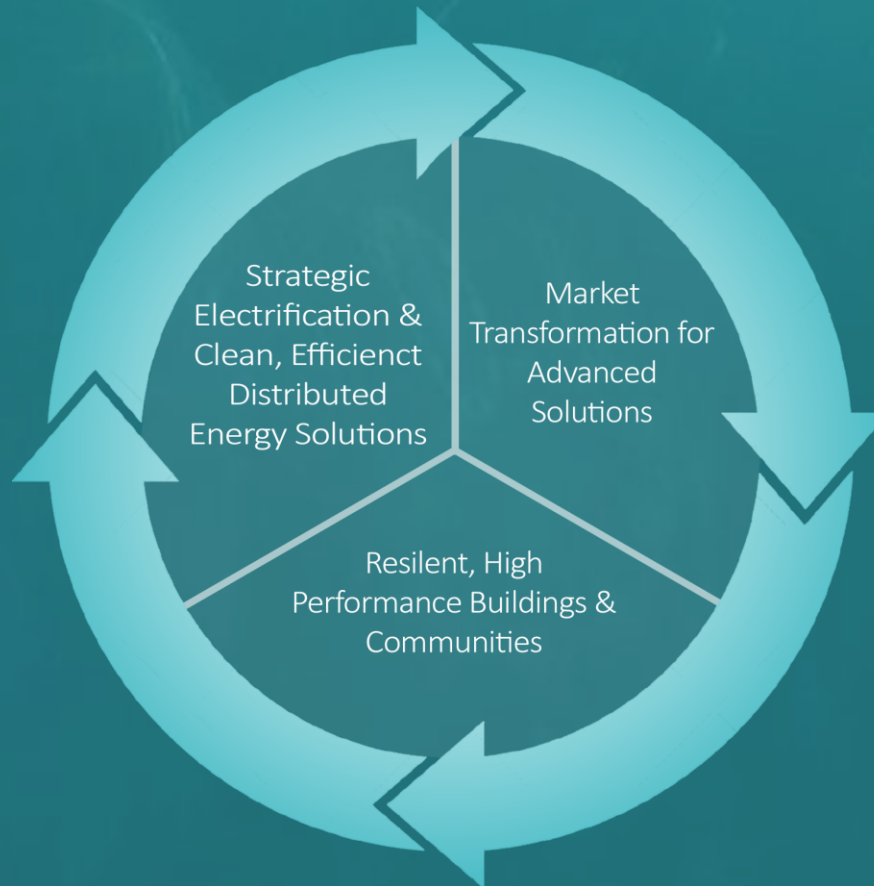


NEEP's Next Generation Efficiency Strategic 2017-2019 Agenda



Advanced Efficiency Leadership Network

For 80% Carbon Reductions by 2050



NEEP Products & Services

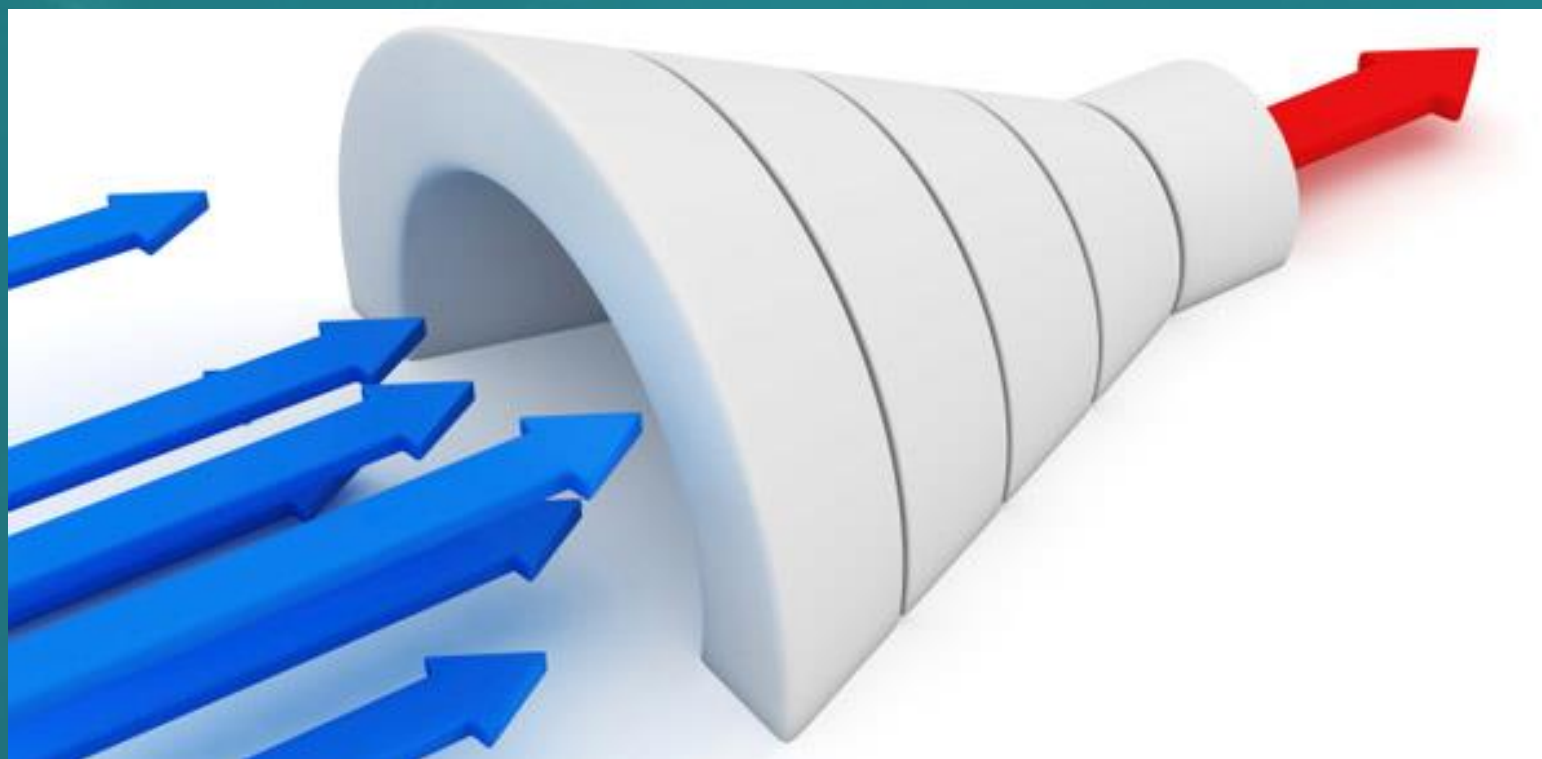
**Events & Stakeholder
Engagement**

**Research, Analysis,
Reports, Case
Studies**

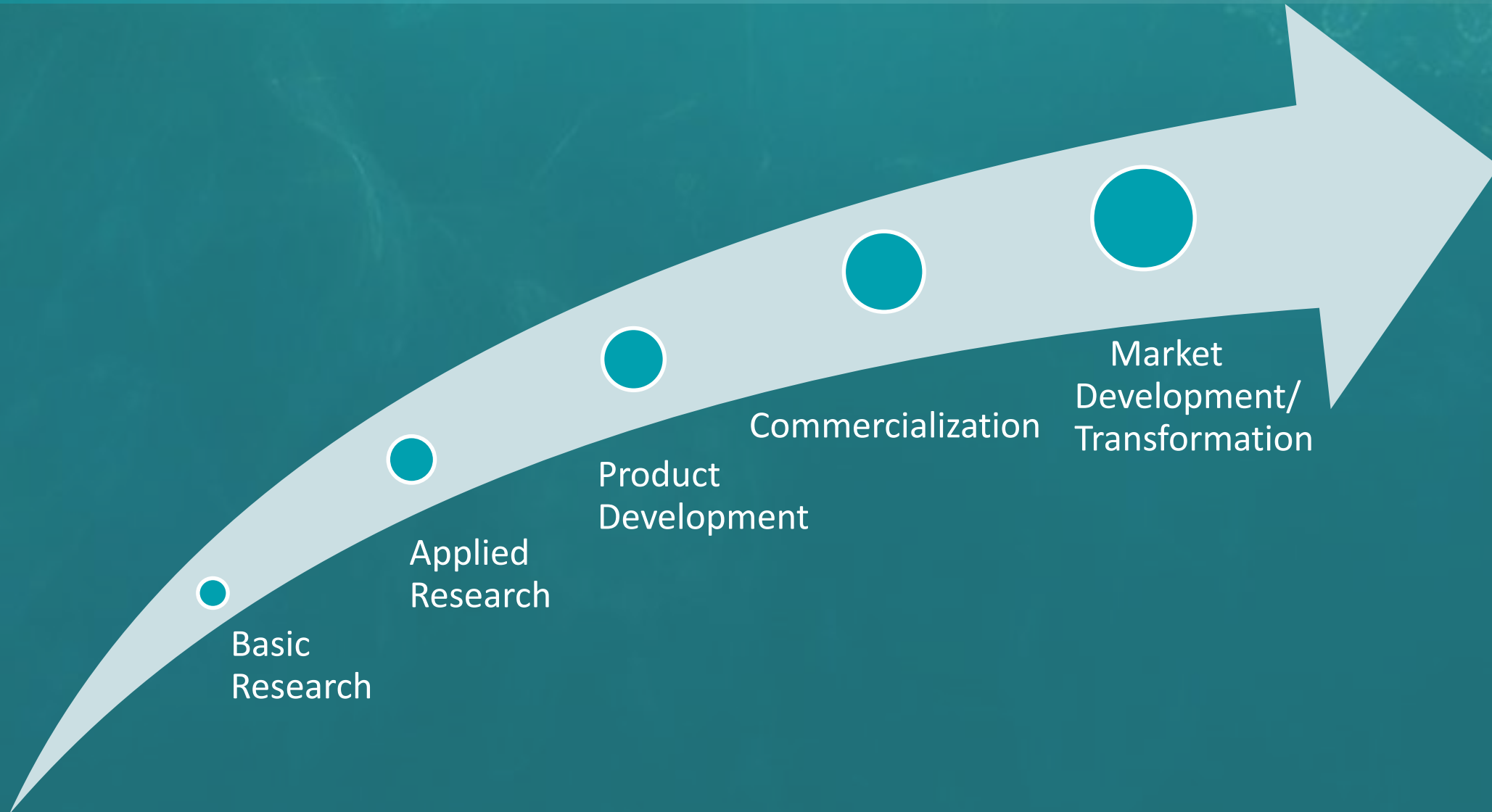
**Regional Market
Transformation
Strategies**

**Technical Assistance
& Web-based
Resource Centers**

Filling the Energy Efficiency Pipeline



Research and Development Continuum



Research and Development Connector



- Project Launch: Q3, 2017
- Objectives:
 - ▶ Identify current Energy Efficiency research efforts in the Northeast Region
 - ▶ Identify the major challenges associated with the energy efficiency R&D eco-system
 - ▶ Gain insight into current collaborations
 - ▶ Recommend an effective ongoing framework for the advancement of promising energy efficiency solutions

Connector Project Activities



- ▶ Assessment of regional R&D players and funders
- ▶ Convene in-person Workshop
- ▶ Compile findings, recommendations into Report

Based on data from 12 R&D institutions

4 main topics were discussed with each institution:

- ▶ What are your current areas of energy efficiency research?
- ▶ What are the challenges encountered by your R&D institution during the laboratory-to-market process?
- ▶ Where project funding comes from?
- ▶ Existing R&D partnerships?

Key research topics based on Connector study (1)



1.The Building Envelope

2.Building Performance

3.Building Modeling and Simulation

4.Evaluation, Measurement and Verification (EM&V)

Key research topics based on Connector study (2)



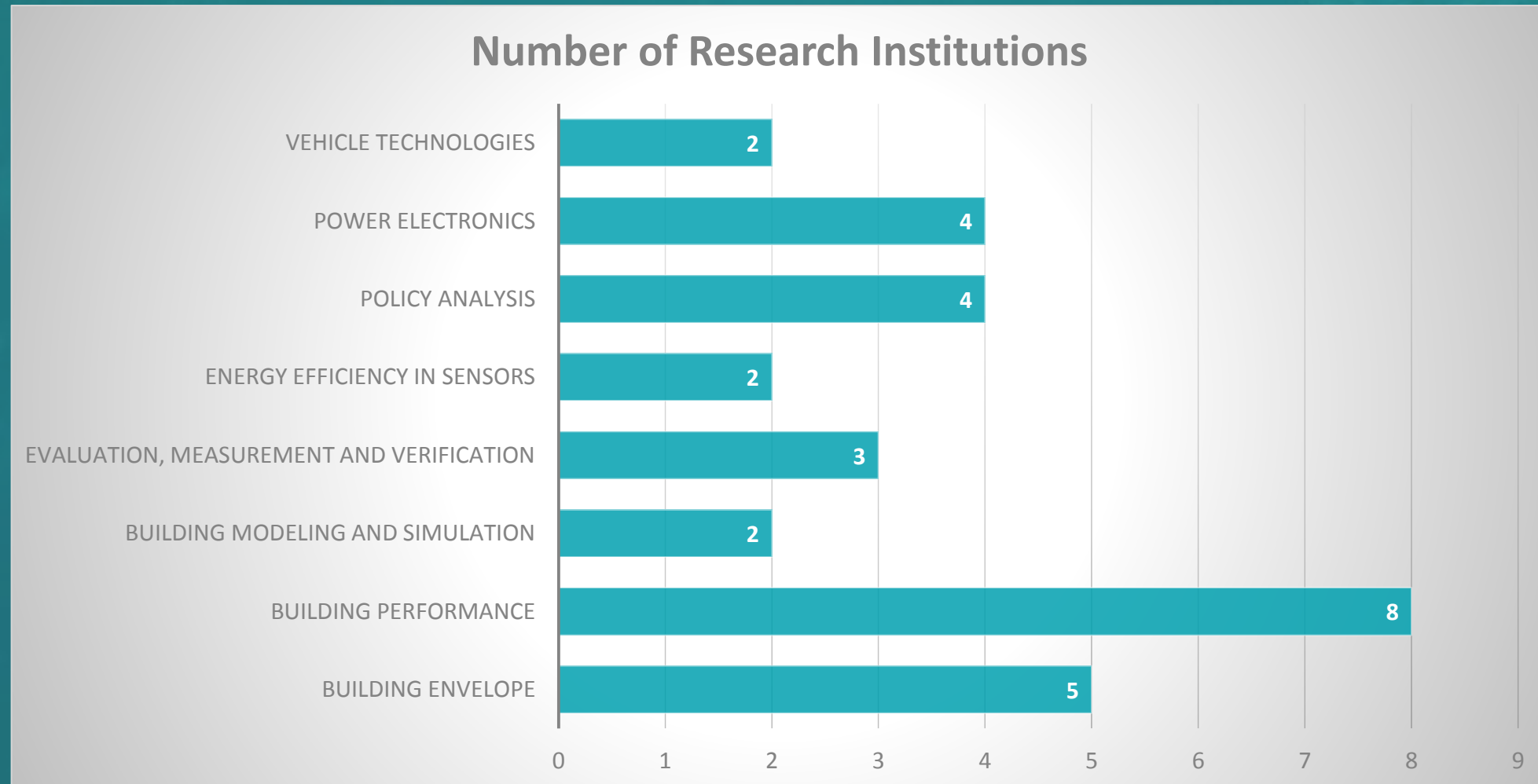
5. Energy Efficiency in Wireless Sensor Networks

6. Policy Analysis

7. Power Electronics

8. Vehicle Technologies

Energy Efficiency Topics by R&D Institutions



Challenges Associated with the Commercialization of Energy Efficiency Technologies



- Achieving commercialization without huge financial losses
- Increasing the number of R&D Institution-Industry interactions
- Acquiring support in terms of incentives and rewards

Why overcome these challenges?

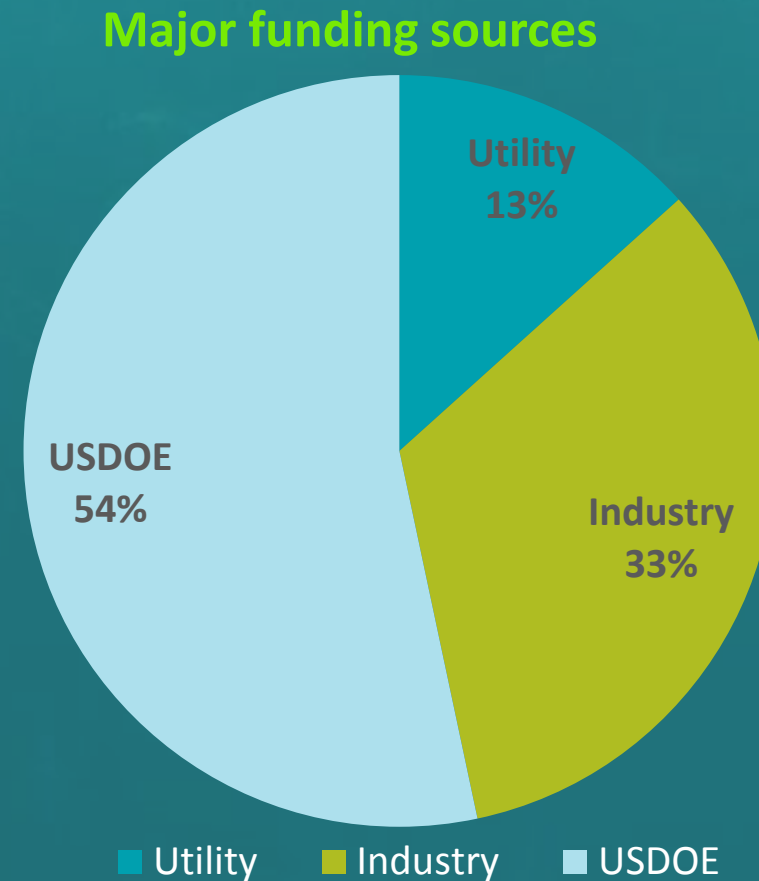


MORE FUNDING

Every research organization is in need of more funding. There is always a new type of research or a next stage of research to be funded.

Types of funding sources highlighting the 3 major sources

- Internal Seed Funding
- Local Government
- State funding
- **Utility**
- **Federal Funding**
- **Industry**



Types of Research Collaborations at R&D Organizations in the Northeast



Broader research shows that R&D collaborations can have the following benefits:



- Improve access to funding
- Increase knowledge pool
- Share research costs
- Increase productivity
- Encourage parties to think beyond
- Develop priceless relationships
- Move researchers away from a false sense of security

Main Question for Breakout Session

Can R&D collaborations within the field of Energy Efficiency lead to more funding and expedited technology transfer?

Types of collaborations

- Researcher/s-researcher/s
- Funder/s-funder/s
- Researcher/s-funder/s

NEXT STEPS

1. Gather information from this conference on how regional collaborations can help with the R&D commercialization process
2. Produce a report that showcases the R&D connector- findings from previous interactions with R&D Institutions in the Northeast region and from this workshop
3. Based on feedback, seek further funding to help R&D institutions expedite the R&D commercialization process through collaborative efforts

Thank you
from
NEEP



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The Research Tracker – Connecting Research Across the Country

CHERYN METZGER

Regional R&D Connector Workshop

Wednesday, March 1st, 2018



PNNL-SA-131169


Overview

- **Helping to make research coordination *EASIER***
 - Motivation
 - Research Tracker tutorial
 - Current coordination opportunities
- **Feedback on capabilities and use cases**

Motivation for the Research Tracker

- Not accidentally funding similar work without knowing it.
- Unknown budgets - benefit in leveraging other funds to get the work done that you want to
- Quick access to projects from multiple organizations
- Better grasp on what is getting funded

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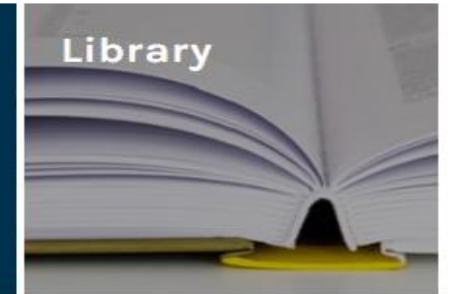
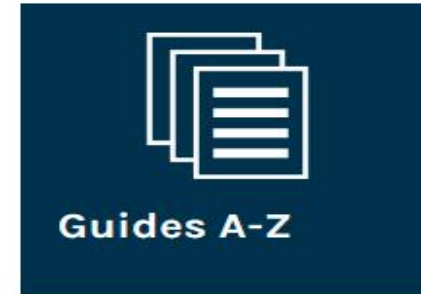
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[Library](#)

[Research Tracker](#)


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Research Tracker

This tool is intended for researchers and program managers to quickly find research projects around the country that are relevant to their work. The four organizations who provided content for this purpose represent the largest energy efficient buildings research portfolios in the country. These organizations each provided the content that they were comfortable sharing publically. Therefore, upon clicking on a particular project, it is possible that certain pieces of content are not present. Where possible, a point of contact is provided so that specific questions can be directed to that person. We welcome your comments! If you would like to provide any feedback on this tool (positive or constructive) please email basc@pnnl.gov .

Items per page

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Apply

[A "Plug-n-Play" Air Delivery System for Low-Load Homes and Evaluation of a Residential Thermal Comfort Rating Method](#)

IBACOS will investigate a simplified residential air delivery system to resolve comfort issues reported in low-load, production-built homes. This project could result in state-of-the-art comfort distribution systems, as well as a thermal comfort metric that helps builders and HVAC contractors measure and communicate the value of improved comfort delivery systems.

[A Constructible and Durable High-Performance Walls System: Extended Plate and Beam](#)

Home Innovation Research Labs, Inc. will work to make the extended plate and beam system of incorporating insulation more accessible to builders through demonstration projects, technical documents, and code compliance assistance. Findings from these activities could play a critical role in improving the efficiency of home heating and cooling, which typically account for 40% of a home's energy consumption.

[A Revolutionary Cold Climate Heat Pump Water Heater](#)

This proposal responds to BPA TIFO Interest Area 7, Cold Climate Heat Pump Water Heaters (HPWH). We propose to develop and demonstrate a novel integrated HPWH customized for demand response (DR) and

CURRENT SEARCH

235 Items

FILTER BY FUNDING ORGANIZATION



GRID, WHOLE BUILDING, OR TECHNOLOGY

[Technology \(153\)](#)[Whole Building \(66\)](#)[Grid \(9\)](#)

FILTER BY TECHNOLOGY TYPE




FILTER BY BUILDING TYPE




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ORGANIZATIONGRID, WHOLE BUILDING,
OR TECHNOLOGY[\(-\) Technology](#)BUILDING,
LOGY[\(3\)](#)
[g \(66\)](#)FILTER BY TECHNOLOGY
TYPE[HVAC \(66\)](#)[Lighting \(19\)](#)[Water Heating \(19\)](#)[Enclosure \(18\)](#)[Controls \(12\)](#)[MELS \(11\)](#)[Other \(5\)](#)[Storage \(4\)](#)[Appliances \(2\)](#)[IAQ \(1\)](#)

CHNOLOGY




ILDING TYPE




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[Advanced Rooftop Controls \(ARC\) Verification Protocol](#)

The goal is to develop a standard protocol to verify site-based savings for advanced rooftop unit (RTU) control (ARC) retrofits, based on manufacturer variable frequency drive (VFD) data. This will streamline the acquisition of 1 aMW of ARC retrofits and lower the cost of the impact evaluation. This project will draft a standard protocol to verify ARC retrofit site-based savings using Catalyst controller data. The project will compare best practice (unit-level, true-power over one-year with daily baseline cycling, as reported in Pacific Northwest National Laboratory (PNNL) study) and four simplified savings methods, to determine a simplest-reliable method. Deliverables include a draft protocol and presentations to the RTUG and, if appropriate, to the RTF. Once approved, the standard protocol would allow the streamlined acquisition of ARC retrofits

CURRENT SEARCH

66 Items

[\(-\) Technology](#)[\(-\) HVAC](#)

FILTER BY FUNDING ORGANIZATION

[Bonneville Power Administration \(26\)](#)[New York State Energy Research and Development Authority \(19\)](#)[Department of Energy \(14\)](#)[California Energy Commission \(6\)](#)

GRID, WHOLE BUILDING, OR TECHNOLOGY


[\(-\) Technology](#)

FILTER BY TECHNOLOGY TYPE


[\(-\) HVAC](#)

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[Best Practices for Linkage-less Burner Retrofits for Steam Boilers](#)

Steven Winter Associates (SWA) will conduct the retrofit installation and commissioning of (2) steam boiler burners with linkageless burner controls at demonstration sites in NYC. The project will use remotely monitored measurement and verification equipment to provide data collection of the systems pre and post-retrofit. SWA will oversee the installation and commissioning of the systems to ensure optimization of energy performance at demonstration sites. SWA will then develop a best practices strategy for the retrofiting process and the collected data will be analyzed for cost analysis, energy savings, metrics, and payback over both heating and non-heating seasons. The results of the project will be shared with building owners, management firms, building operators, and representatives from municipal and state organizations who are responsible for the evaluation of boiler upgrades in their respective organizations.

[Market evaluation and detailed energy analysis of the NextAire variable refrigerant volume natural gas-fired heat pump](#)

Gas Technology Institute will develop and conduct advanced modeling of the GHP system in order to provide a detailed assessment of the technology using regional weather data and detailed utility information for several New York locations and building types. The project will include a market assessment of the

CURRENT SEARCH

19 Items

[\(-\) Technology](#)[\(-\) HVAC](#)[\(-\) New York State Energy Research and Development Authority](#)

FILTER BY FUNDING ORGANIZATION

[\(-\) New York State Energy Research and Development Authority](#)


GRID, WHOLE BUILDING, OR TECHNOLOGY

[\(-\) Technology](#)

FILTER BY TECHNOLOGY TYPE

[\(-\) HVAC](#)

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Market evaluation and detailed energy analysis of the NextAire variable refrigerant volume natural gas-fired heat pump

Gas Technology Institute will develop and conduct advanced modeling of the GHP system in order to provide a detailed assessment of the technology using regional weather data and detailed utility information for several New York locations and building types. The project will include a market assessment of the competitiveness of the variable refrigerant volume (VRV) GHP, including energy and economic benefits, the value of resiliency, and the value of self-powered heating and cooling systems for customers in New York. The Proposer will take into account the energy savings, operating costs, lifecycle costs, and greenhouse gas emissions in order to determine any energy, economic, or environmental merits of GHPs over standard HVAC equipment

[DOI Project Web](#)

Scope

Funded Performer:	Gas Technology Institute
Link to Partners List:	View Partners
Agreement Total:	\$0
Match Total:	\$0
Project Start Date:	September 14, 2015

Project Details

Ongoing Initiative or Research Project:	Research Project
Grid, Whole Building, or Technology:	Technology
Technology Type:	HVAC

Program Information

Funding Organization:	New York State Energy Research and Development Authority
Program Area:	R&D - Buildings Research
Program Email:	Michael.Genovese@nyserda.ny.gov
Project Manager:	Michael Genovese

Locale

BA Climate Region:	Cold/Very Cold
State:	New York

Research Project Search

Research Project Summary Information

[Return to Search](#)
[Return to Search Results](#)
[Generate PDF](#)

Market evaluation and detailed energy analysis of the NextAire variable refrigerant volume natural gas-fired heat pump(61734)

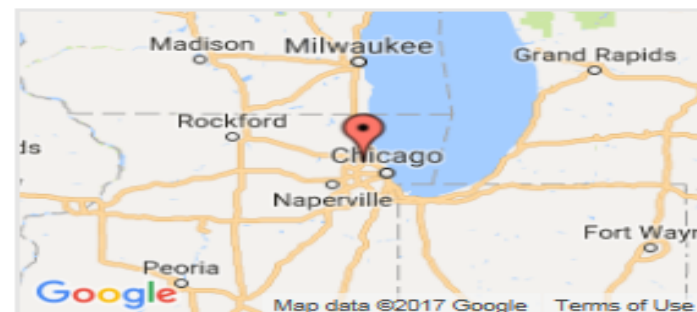
Gas Technology Institute

Background

The peak electric demand in New York is encountered between June and August each year, driven by a call for air conditioning, most commonly supplied by electric compressor-based technology. Gas engine-driven heat pumps (GHPs) are an important option for reducing this peak demand. A GHP system has the ability to provide self-powered heating and cooling without the need for utility power, making it a viable resiliency option for multi-zoned commercial buildings.

Project Description


Gas Technology Institute will develop and conduct advanced modeling of the GHP system in order to provide a detailed assessment of the technology using regional weather data and detailed utility information for several New York locations and building types. The project will include a market assessment of the competitiveness of the variable refrigerant volume (VRV) GHP, including energy and economic benefits, the value of resiliency, and the value of self-powered heating and cooling systems for



Specific Examples of Opportunities

Filter: Single Family; HVAC

Research Tracker

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[A "Plug-n-Play" Air Delivery System for Low-Load Homes and Evaluation of a Residential Thermal Comfort Rating Method](#)

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[Assessing the Market and Space-Conditioning Needs of Low-Load Homes](#)

High performance, low-load homes face unique space conditioning challenges that are not adequately addressed by HVAC design practices and equipment offerings. Equipment manufacturers have yet to include a diverse set of low-capacity equipment in their product offerings due to a lack of understanding of (1) where the low-load home market is headed and (2) the load profiles typical to low-load homes. This project looks to address both of these information gaps and ultimately send the necessary low-capacity equipment market signals to manufacturers, enabling them to design better products to meet production builder needs. The team will develop a technical whitepaper and presentation on the performance and cost tradeoffs of various equipment types/systems at meeting the comfort requirements of low-load homes, and forecasting the market penetration and equipment needs for these low-load homes.

[Bench Test for Inverter Driven Package Terminal Heat Pump](#)

CURRENT SEARCH

36 Items

[\(-\) Technology](#)

[\(-\) HVAC](#)

[\(-\) Single Family](#)

FILTER BY FUNDING ORGANIZATION

[Department of Energy \(14\)](#)

[Bonneville Power Administration \(10\)](#)

[New York State Energy Research and Development Authority \(7\)](#)

[California Energy Commission \(4\)](#)

GRID, WHOLE BUILDING, OR TECHNOLOGY

[\(-\) Technology](#)

FILTER BY TECHNOLOGY TYPE

[\(-\) HVAC](#)

[Water Heating \(1\)](#)

Filter: Single Family; HVAC

Skimming for Cold Climate Heat Pump Work

- Case Study on Cold Climate Heat Pump Performance – DOE, ORNL
- Cold Climate Air Source Heat Pumps: Market Assessment and Guidance for Trades – DOE, NEEP
- Evaluation of Cold-Climate Air-Source Heat Pumps – NYSERDA, SWA

Filter: Multifamily; HVAC

12 Results at DOE

- Variable Capacity Comfort Systems for Low Load Homes – DOE, FSEC
- Ventilation Integrated Comfort System (VICS) – DOE, SWA
- Sensitivity Analysis of Humidity in Low Load Homes – DOE, NREL and ORNL
- Assessing the Market and Space-Conditioning Needs of Low-Load Homes – DOE, NREL

9 Results at NYSERDA

- Development of supersonic nozzle to improve effectiveness of steam heating and reduce pumping requirements – NYSERDA, HFC
- Linkage-less Burner Retrofits for Steam Boilers – NYSERDA, SWA
- Improving Steam Distribution Systems – NYSERDA, USGBC
- Market Focused Commercial and Multi-Family Water Heating and Power – NYSERDA, GTI

Feedback – Additional Features?

What features might be more useful?

- Export function?
- Strategic plan/future project comparison?
- Number of test buildings?
- Plan to add other organizations that fund research:
 - PG&E
 - CEE
 - BC Hydro
 - NRCan
 - CSA
 - Other Entities Inside DOE (ARPA-E, OWIP)
- General search bar?

Feedback – Use Cases

- Is this something you think you might use?
- USE CASES:
 - Strategic planning
 - Upon starting a new project topic
 - Proposing to new funding opportunities
 - Before publishing report
- USERS:
 - DOE program managers
 - Other entity's program managers
 - PI's/Researchers
 - REEOs
- Useful to add other entity's portfolios?

Thank you!

CHERYN METZGER, PE, PMP

Pacific Northwest National Laboratory

Cheryn.metzger@pnnl.gov

707-623-7091





Challenging the Innovation Community

Regional R&D Connector Workshop

March 1, 2018

Joseph Borowiec, Program Manager – Advanced Buildings
Bryan Berry, Assistant Director – Technology and Business Innovation

Technology and Business Innovation

Invest in cutting-edge technologies that will meet increasing demand for clean energy

- Five key opportunity areas:
 - Smart grid technology
 - Renewables and distributed energy resources
 - High performance buildings
 - Clean transportation
 - Cleantech startup and innovation development



Current Building Priorities

NextGen HVAC

- ☐ 25% of the State's Energy Use
- ☐ 36% of the State's GHG Emissions
- ☐ Unique NYS challenges

Smart Buildings

- ☐ Potential to reduce energy costs 10 to 30%
- ☐ Facilitate integration of on-site generation and storage
- ☐ Enable a robust electric market & grid (demand response, transactive energy)
- ☐ Non energy benefits – customer experience, operational efficiency & reliability

- Major use of energy in NYS & GHG emissions, large stock of existing buildings, majority of energy use associated with HVAC, short duration cooling demand of Buildings a disproportionate burden on system and rate payers, and Buildings are dumb.

		<div> <div>Higher potential (>250TBtu)</div> <div>Medium potential (100– 250TBtu)</div> <div>Lower potential (<100TBtu)</div> </div>		
	Innovation Area	2030 End Usage	2030 Achievable Potential	Addressable Market for Innovation
Commercial	Lighting	291	98	193
	Cooling	141	57	84
	Space heating	308	8	300
	Water heating	148	8	140
Residential	Comfort & cooling	212	22	190
	Space heating	321	56	265
	Electronics & appliances	291	28	263
	Lighting	69	32	37
	Water heating/SHW ¹	185	116	69

Efficiency Innovations							
Technology	Market	Addressable Mkt for Innovation (TBtu)	Native Assets	Carbon Reduction	Efficiency Gain	Demand Reduction	Impact
Lighting	Residential	37	No	Low	Low	Low	Low
	Commercial	193	Yes	Medium	Medium	Low	Medium
Space Conditioning	Residential	455	Yes	High	High	Medium	High
	Commercial	384	Yes	High	High	High	High
Water Heating	Residential	69	No	Low	Low	Low	Low
	Commercial	140	Yes	Low	Medium	Low	Medium
Plug Loads	Residential	263	No	Medium	Low	Low	Low
	Commercial		No	Low	Low	Low	Low

HVAC systems account for the largest proportion of energy used in buildings. HVAC solutions need to be regional appropriate. Systems designed for full load efficiency but operate at partial load (reduced efficiency) most of the time, current vapor compression refrigerants harmful to the environment, Cooling demands of buildings have a huge impact on system peak and reliability, Native Assets

Problem (opportunity): Fossil fuels predominately used heating, High distribution loss, Space conditioning and ventilation coupled, Short duration cooling demand of Buildings a disproportionate burden on system and rate payers, Need for HVAC technologies to address Low Load Buildings

Technology Opportunities And Barrier Addressed

- ☐ Centralized HVAC Systems have high distribution losses
- ☐ There is need for improvements to cold climate heat pumps
- ☐ Energy consumption for air conditioning is dominated by the use of compressors
- ☐ Lack of advanced controls for HVAC for small to medium size buildings
- ☐ Need for integration of renewables/storage with conventional HVAC
- ☐ Coupling of space conditioning and ventilation limits cooling efficiency improvements
- ☐ Short duration cooling demand negatively impacts grid reliability and energy bills
- ☐ Effective solutions for heating electrification not available

Innovation Challenges

- ☐ Addresses a define need
- ☐ Successfully used in the past – L Prize
- ☐ Challenge Requirements
 - Identification and definition of the specific challenge
 - Setting the challenge level
 - Target Audience



Round 1 – Heat Pump Challenge

Challenge Requirements:

1. New York State Residential Applications;
2. Use standard vapor compression cycle, as described;
3. Projected HSPF, SEER, and EER, based on ANSI/AHRI Standard 210/240 testing conditions;
4. Proposed system has a SEER greater than or equal to 15; and
5. Proposed system has an EER greater than or equal to 12.5.

Challenge Targets:

HSPF and installed costs paid by the homeowner are presented in the following table.

Capacities	HSPF	COP at 5°F delivering maximum capacity	Installed cost (\$/kBtu/hr)
0 to < 12,000 Btu/hr	16	≥ 2.2	<100
12,000 to <36,000 Btu/hr	15	≥ 2.2	<100
36,000 Btu/hr and above	14	≥ 2.1	<75

Round 1 – GHEX Challenge

Challenge Requirements:

1. Breakdown of costs
2. Installations should conform to industry standards or less noted
3. Projects must adhere to all relevant local and NYS laws and ordinances or a statement must be made noting the requirement for a variance.

Challenge Targets:

1. Demonstration of a solution that is repeatable, sustainable, and scalable in attaining a 30% or greater cost reduction in the installation of a ground source heat exchanger

❑ Challenges – multi-rounds

❑ Procurement

- Two step process: Concept Paper, Full Proposal
- Full Proposal
 - Form fillable narrative, TRL/CRL Calculator
 - Statement of Work & Budget from current stage thru (pre) commercialization
 - No funding limit except for feasibility stage

❑ Awards

- Contracts – Entire scope, Up to amount, Staged funding
- Leveraging – more commitments than funds available

❑ Management

- Reviews: strategic fit, leverage, probability of technical & commercial success, impact
- Exit Ramp for Projects not going forward

New York State

- ❑ **11 Centers of Excellence** to foster collaboration between academic research community and business sector to develop and commercialize new technologies
- ❑ **7 Clean Energy Incubators, Proof of Concept Centers**
- ❑ Various **Industry Focused Organizations** (ex. Lighting Research Center, Building Energy Exchange)
- ❑ **Consortiums** (NY Best, NYS Smart Grid)

Beyond

- ❑ Organizations (NEEP, ACEEE, ASE, CEE, ASERTTI, NASEO, GTI,)
- ❑ National Laboratories
- ❑ ARPA-e, Department of Energy

Old Approach & Driver for Change

Past

- ☐ Opportunistic, board areas of interests and shallow in specifics, developed with limited stakeholder engagement, heavy focus on technology development, and activity funded in stages.
- ☐ Good results: 1 out of 4 development projects initiated resulted in a commercialized product
- ☐ Going Forward - Building on Best Practices (ex. form fillable narrative, TRL/CRL calculator)

Reforming the Energy Vision

REV 2030 Goals

**40% reduction in greenhouse gas emissions
from 1990 levels**

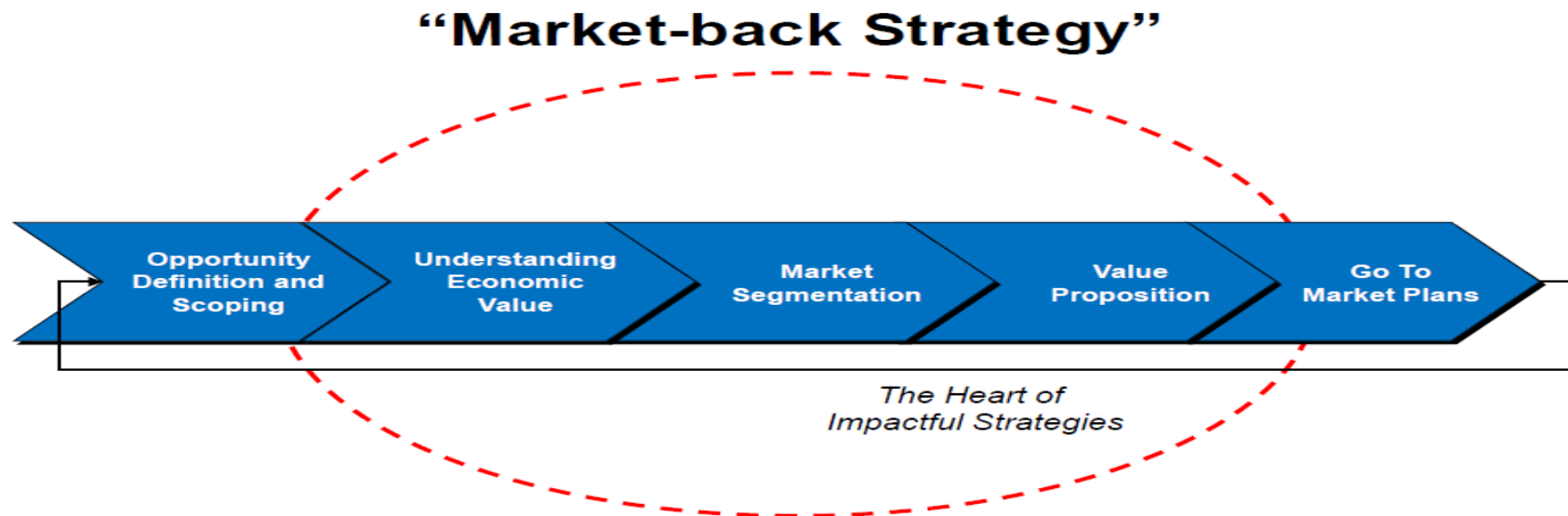
**50% of electricity must come from
renewable sources**

**23% reduction in energy consumption of
buildings from 2012 levels**

BACK UP SLIDES

At NYSERDA, we strive to develop high impact initiatives that are responsive to customers and markets – or designed “from the market back.”

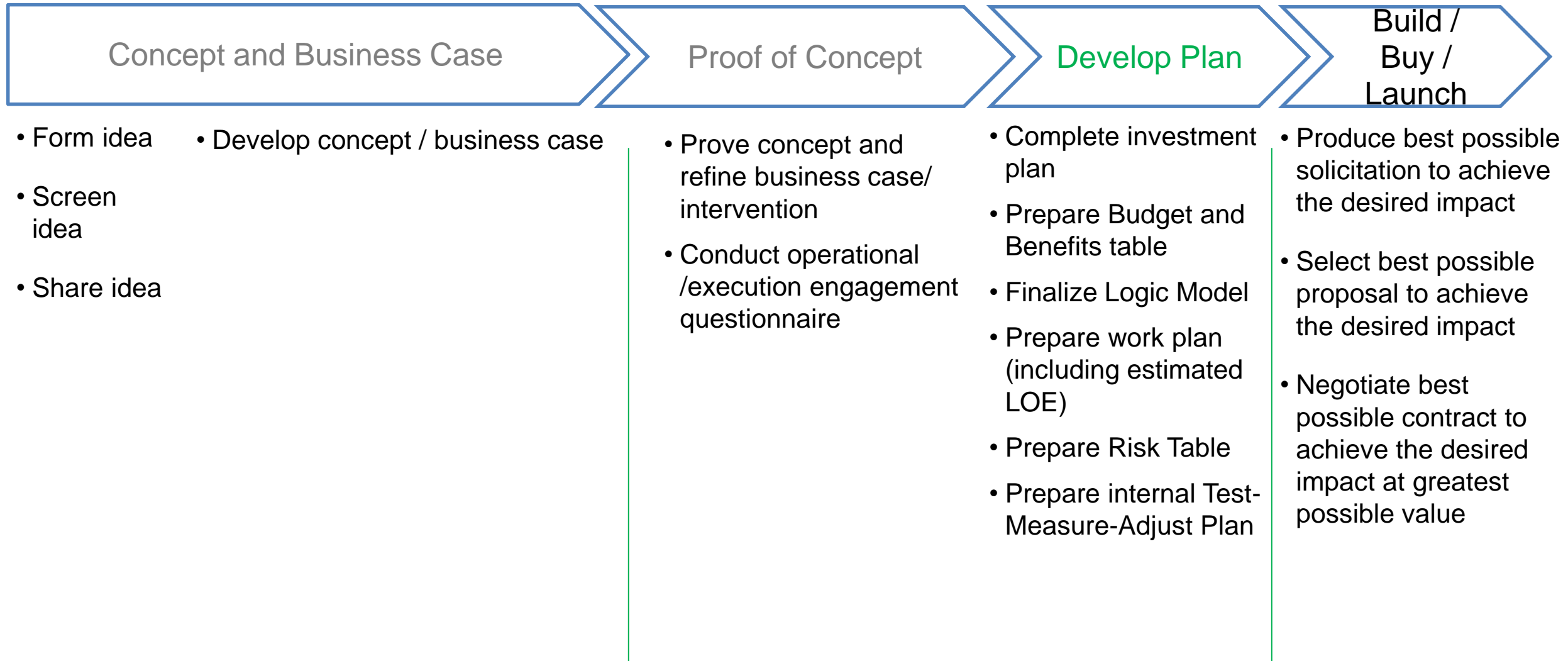
Strategic Marketing for Impact provides a framework for thinking about the economics and needs of the markets we are seeking to impact and NYSERDA’s potential actions in impacting these markets.



Guiding Priorities

- ✓ Size of the Prize
- ✓ We can move the needle (given our resources)
- ✓ We have Partners in NYS





Greenlight Gate 1 (Business Case/Strategy Review)
- compare to alternatives across NYSERDA

Greenlight Gate 2 (Investment Plan Review) - before DPS pre-review



NYSERDA

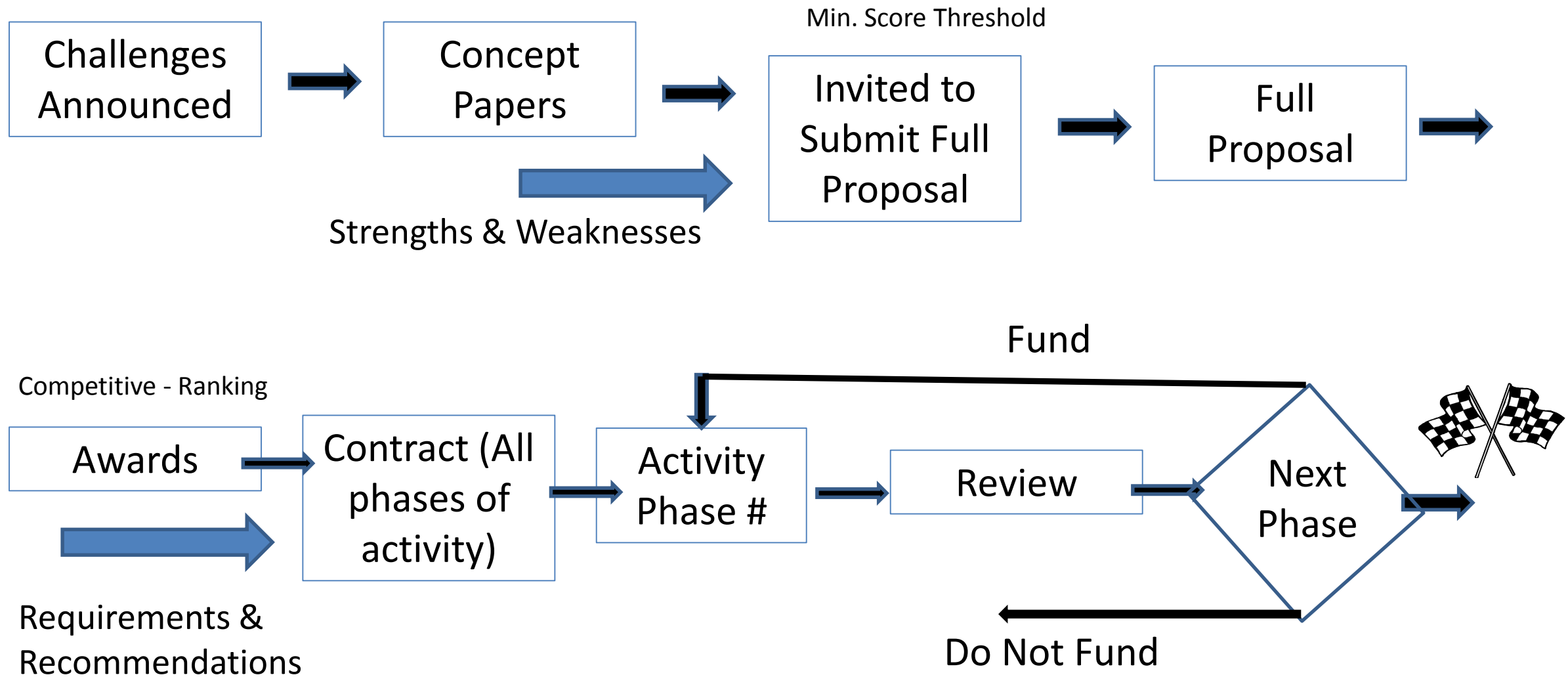
"NextGen HVAC Innovation Challenges"
 Program Opportunity Notice (PON) 3519
Up to \$15 Million Available
Round 2 of 4

NYSERDA reserves the right to extend, and/or add or reduce funding to this solicitation

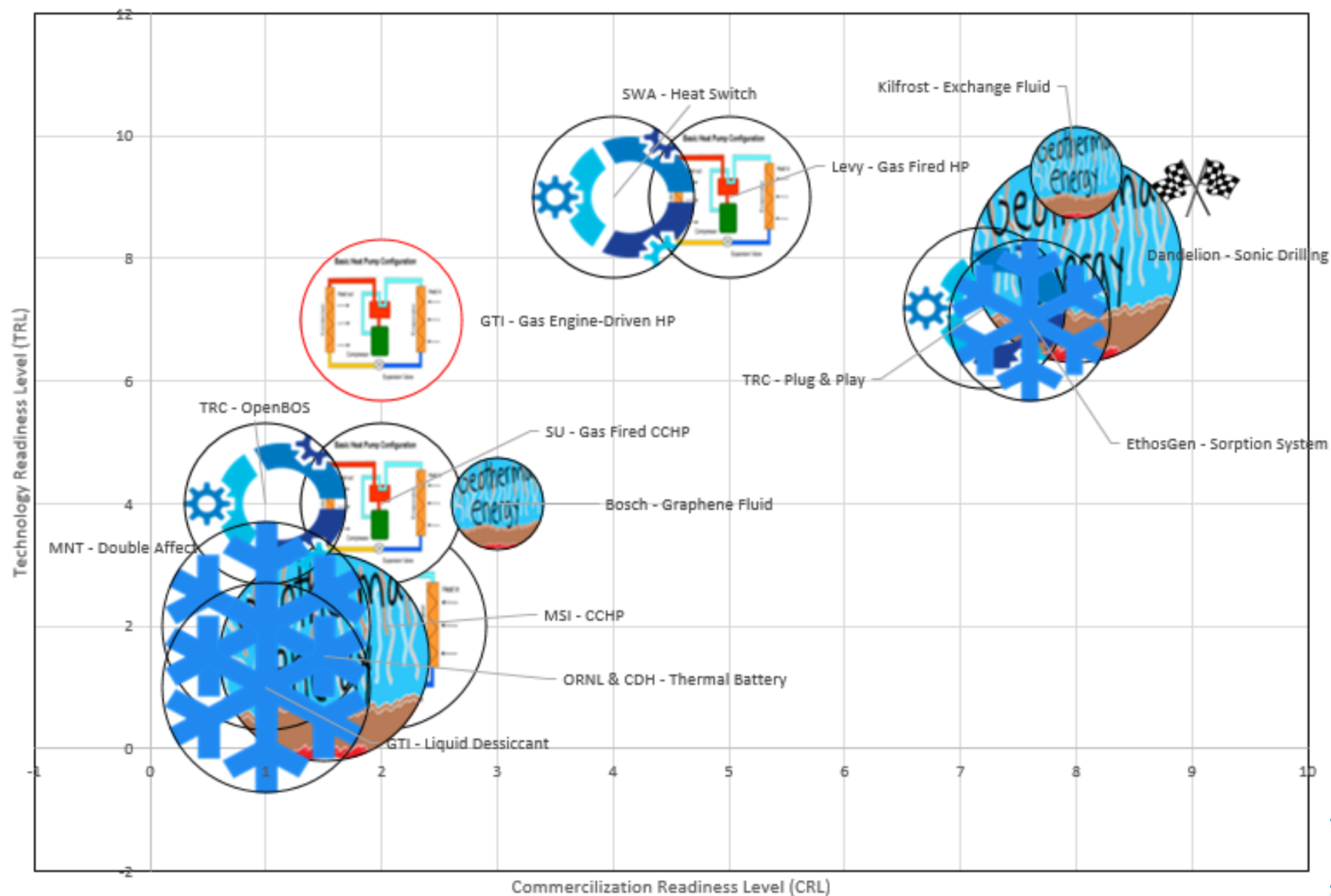
Important Dates* by 5:00 pm Eastern Time				
Round	Challenge Areas	Challenge Announcement	Concept Paper Due Date(s)	Full Proposal Due Date(s) (Tentative)
1	Heat Pumps, HVAC Controls, Compressorless HVAC, GHEX	June 29, 2017	August 3, 2017	November 16, 2017
2	Heat Pumps, HVAC Controls, Compressorless HVAC	March 22, 2018	April 26, 2018	August 2, 2018
3	TBD	November 29, 2018	January 10, 2019	April 11, 2019
4	TBD	July 25, 2019	August 29, 2019	December 5, 2019
*Dates are subject to change. Proposers should check NYSERDA's Funding Opportunity webpage (https://www.nyserdera.ny.gov/Funding-Opportunities) for the latest updates and revisions to PON 3519.				



NYSERDA

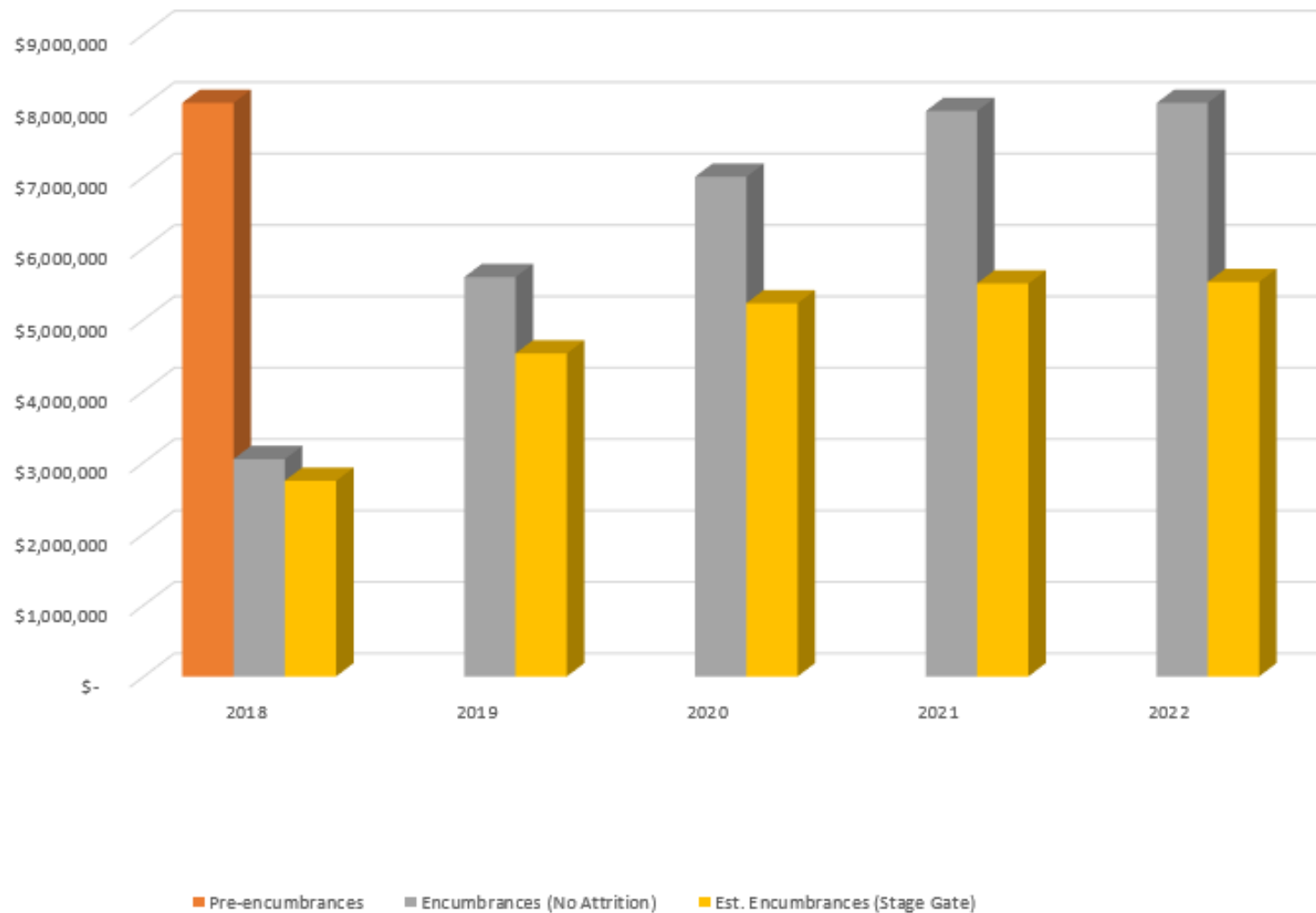


NextGen HVAC Round 1 Portfolio



PON	Concept Papers Received	Invited Full Proposals	Received Proposals	Awards Made	%
2606 - All Categories			342	80	23%
2606 - Heating			99	21	21%
3519 - Rnd 1	62	36	21	13	21%
Concept to Invited		58%			
	Invited to Received		58%		
		Received to Awarded		62%	
Concept to Award					21%

PON 3519 NextGen HVAC Round 1





U.S. DEPARTMENT OF
ENERGY

Office of
**ENERGY EFFICIENCY &
RENEWABLE ENERGY**

DOE Building Technologies Office Overview for R&D Connector Workshop

Mary Hubbard

March 1, 2018



BTO At-a-Glance: Structure, Budget, and Labs

U.S. Department of Energy,
Office Energy Efficiency &
Renewable Energy (EERE)

Office of Energy Efficiency

Building Technologies Office
(BTO)

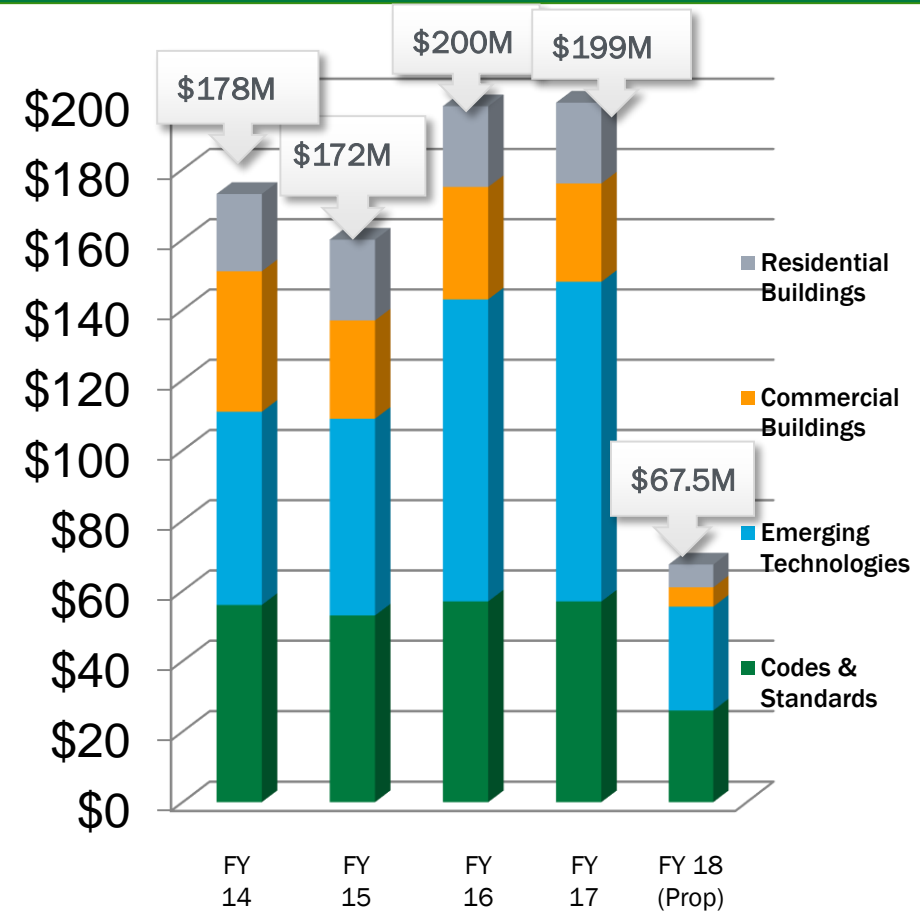
Emerging
Technologies

Residential
Buildings
Integration

Commercial
Buildings
Integration

Building
Energy
Codes

Appliance
Standards



DOE Research Has Saved Energy

Past



- \$1,200 purchase
- \$200/year to operate
- 18 cubic feet



- \$8/year
- 60 Watts
- 1,000 hour life



- Single-pane
- High heat loss

Present



- \$550 purchase
- \$50/year to operate
- 22 cubic feet



- \$2/year
- 15 Watts (or less)
- Up to 25,000 hours



- Double-pane & low-e
- Low heat loss
- 3x more efficient

Due to appliance standards alone, a typical household saves about **\$320** per year off their energy bills today, and as people replace their appliances with newer models, they can expect to save about **\$530 annually** by 2030.

BTO Programs Innovate, Reduce Energy Waste

Building America has produced...

>**100** energy efficient housing innovations

\$54 billion saved for American homes

R&D funded by BTO has resulted in more than 25 commercial products since 2010. One former partner has raised **over \$500 million** in private equity since BTO funding concluded.

High-Impact Technology

assistance from BTO has helped partners save more **\$200 million** in lighting and air conditioning energy costs since 2013.

Building Energy Codes from 2010 to 2040 are project to result in...

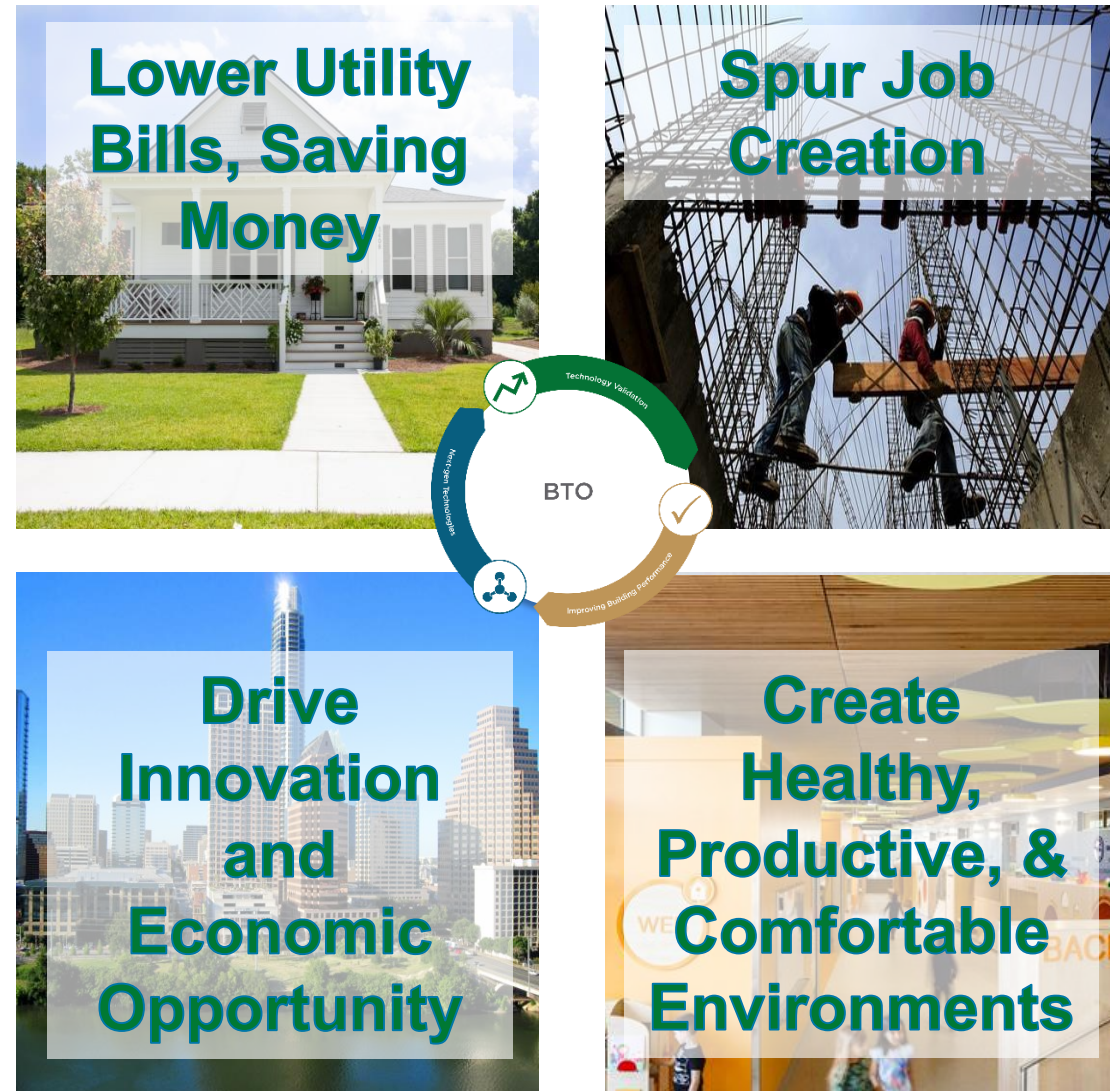
\$126 billion in energy savings to consumers

12.82 quads of primary energy savings



Appliances Standards implemented since 1987 saved American consumers **\$64 billion** on their utility bills in 2015 alone.

BTO At-a-Glance



BTO's 2016-2020 Multi-Year Program Plan



BTO Goal:

- **2030 goal:** Reduce average energy use per square foot of U.S. buildings by **30%** below 2010 levels
- **Long-term goal:** reduce average energy use per square foot of U.S. buildings by **50%**



National Goals:

- By 2030, double energy productivity relative to 2010

<http://energy.gov/eere/buildings/downloads/multi-year-program-plan>

Goal

Develop cost-effective technologies capable of reducing a building's energy use per square foot by **45%** by 2030, relative to 2010.

Strategy

- Use **Scout** to analyze building energy efficiency technology potential impacts
- **Fund R&D** through competitive solicitations and National Lab technical capabilities

Technology Areas



R&D Areas of Interest to BTO

Grid-interactive
Efficient
Buildings

Advanced HVAC

Solid State
Lighting

New Materials

Building
Envelopes

Building Energy
Modeling

Valuation of EE,
DSM

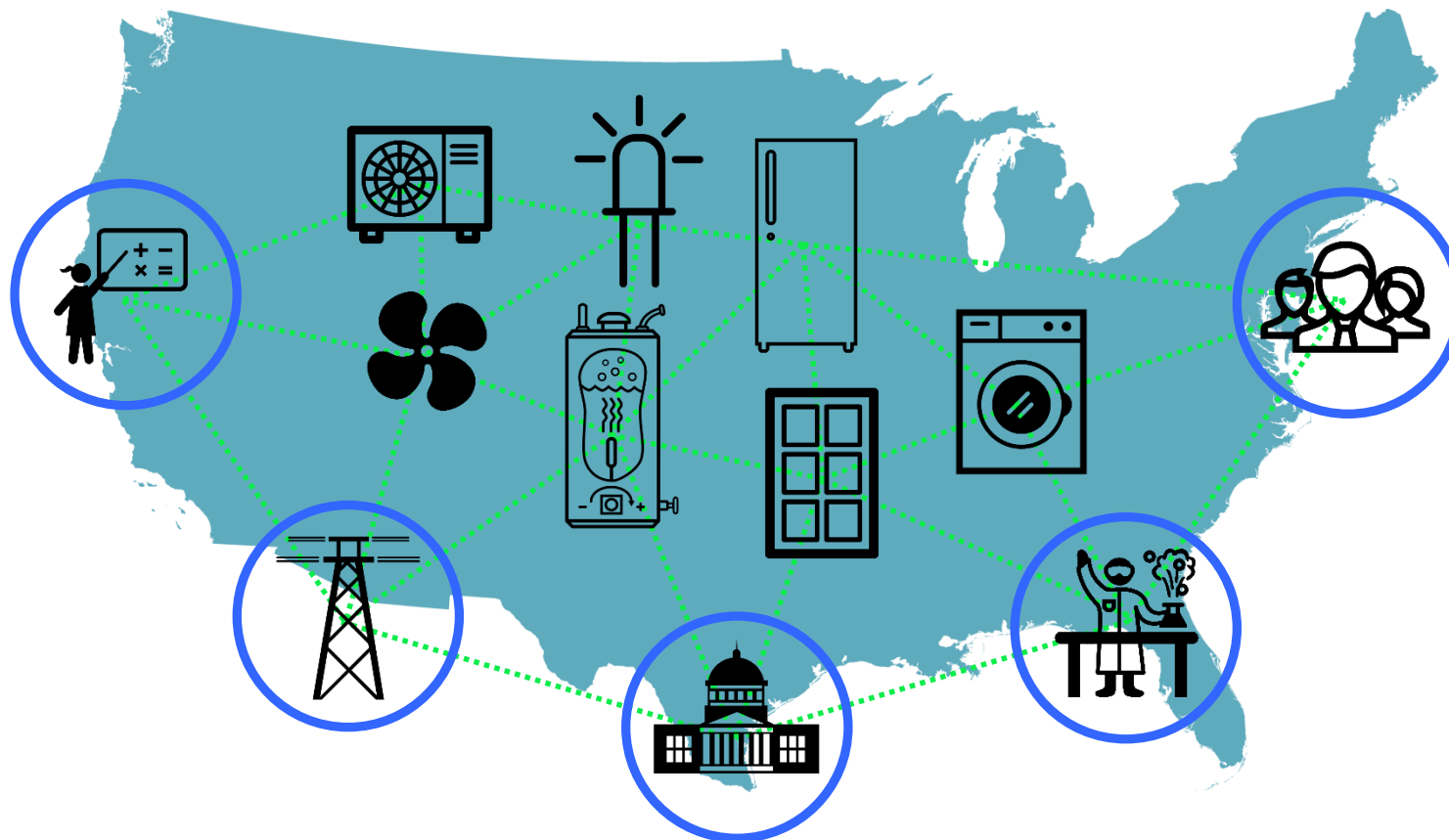
MELs

Integration into
systems, bldgs.,
communities

Evaluating Potential Impacts from Energy Efficiency R&D

BTO developed Scout to serve as a platform for energy efficiency impact analysis

- Estimates the national impacts of energy conservation measures (ECMs)
- Impacts examined include primary energy, CO₂ emissions, and operating costs
- Provides common analysis approach across multiple technologies/perspectives



Occupancy Counts & Thermal Comfort Preferences in Controls

Summary

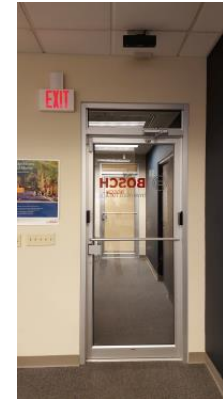
- Depth-based sensing technology utilized to perform fine-grained occupancy estimation in an area with little training and non-invasive setting that works in even in a completely dark environment.
- Design, implement, and evaluate a human-in-the-loop sensing and control system for energy efficiency of HVAC and lighting systems, which takes into account occupant comfort.

Anticipated Results

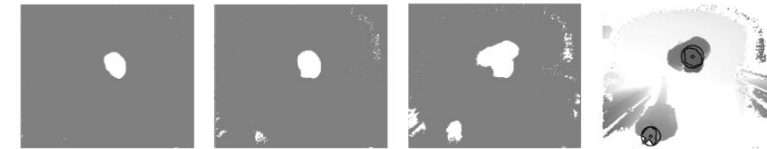
- Comfort model integration with human-in-the-loop control, embedded prototype development, and VOLTTRON integration
- Hardware prototype that is low-energy consuming and has average accuracy above 97%.
- Context aware human-in-the-loop controller that can switch between different modes depending on occupancy context and weather condition.

Impact

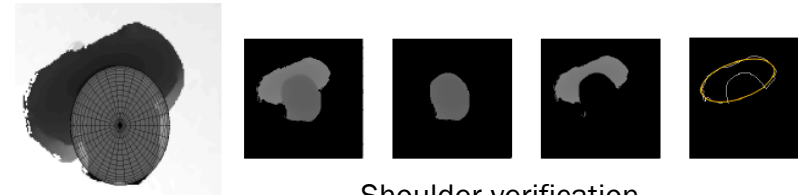
- Reduce significant energy waste (i.e. target 20% energy savings) by accurately estimating occupants in an area to overcome current HVAC systems operation which assumes maximum occupancy in each room.



Placement of a Kinect at a ceiling, Kinect for Xbox One, Embedded computer Odroid-XU4

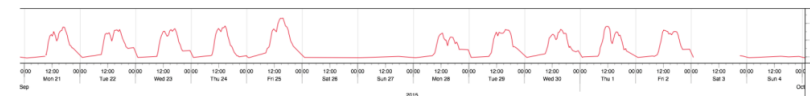


Head detection by multilevel scanning



Head verification

Shoulder verification

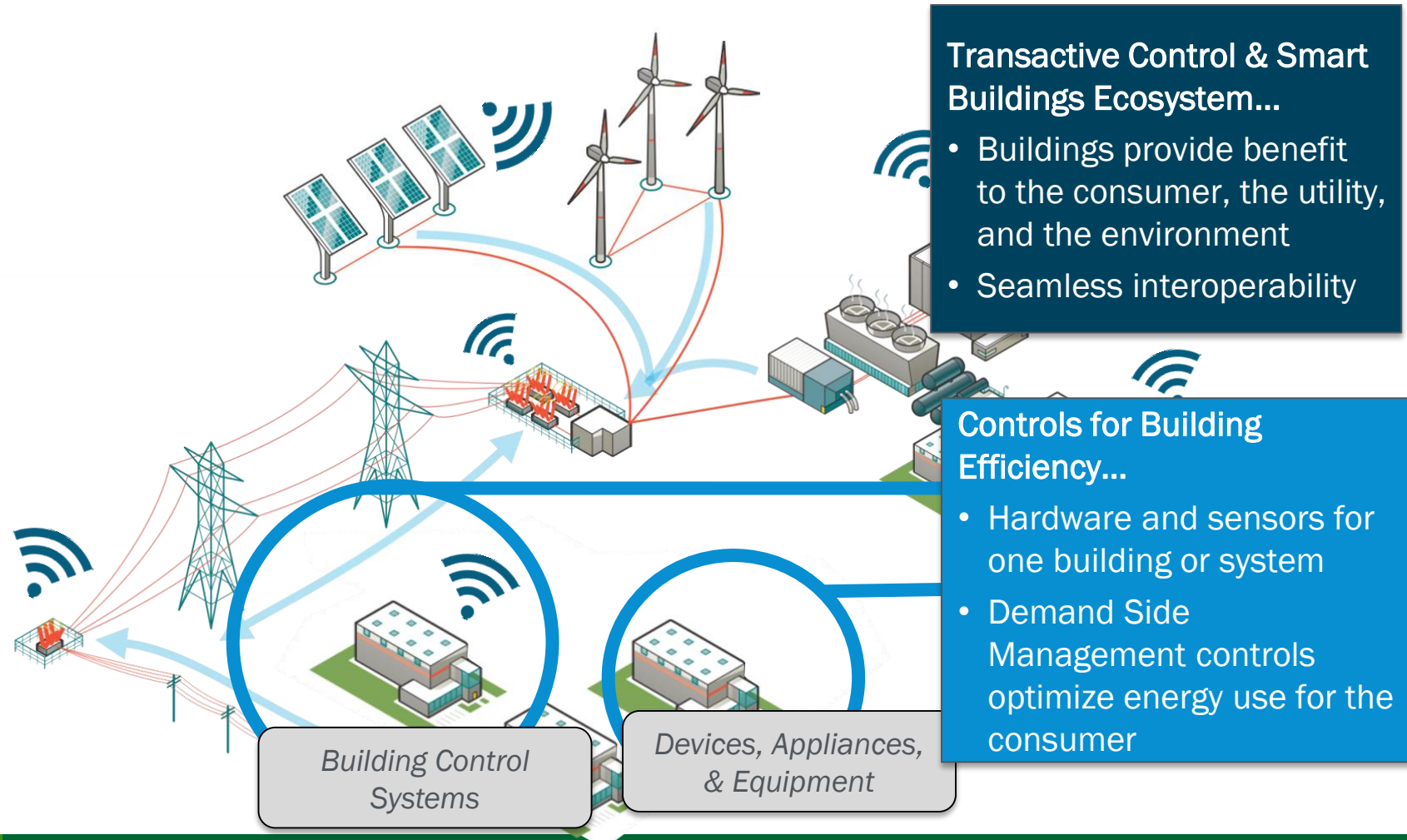


Occupancy estimation of two weeks at a Bosch office



Smart Buildings Are Key to Grid Flexibility

Seamlessly integrating emerging technologies into the grid in a safe, reliable, and cost-effective manner is critical to enable grid flexibility. Connecting buildings to the grid in a responsive, bidirectional manner is a crucial.



Grid-Interactive Efficient Buildings (GEB)

- A significant portion of BTO's current activities contribute to a more efficient and interactive electric grid, all united around the concept of “grid-interactive efficient buildings”
- These activities support DOE's larger Grid Modernization Initiative, which works across DOE to create the grid of the future

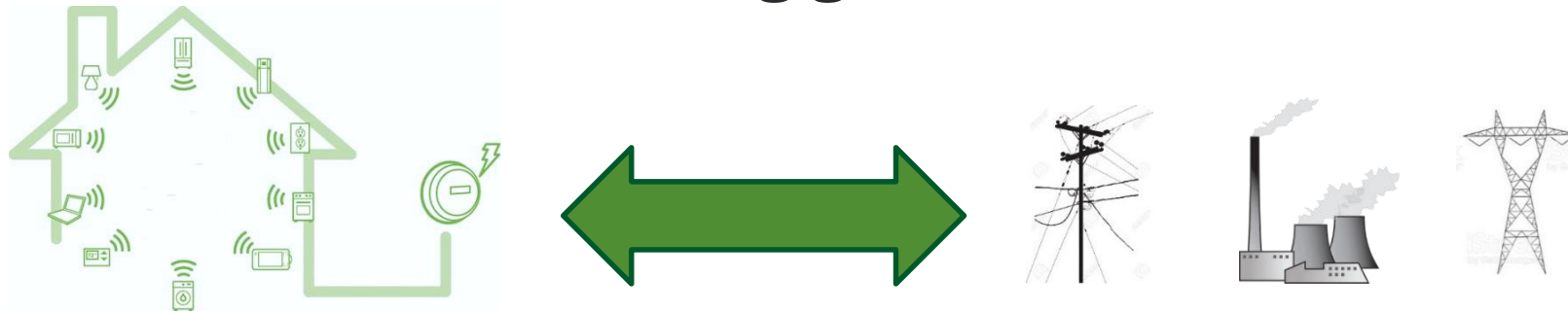
DOE Grid Modernization Initiative: Characteristics of a Modern Grid

A modern grid must have:

- Greater RESILIENCE to hazards of all types
- Improved RELIABILITY for everyday operations
- Enhanced SECURITY from an increasing and evolving number of threats
- Additional AFFORDABILITY to maintain our economic prosperity
- Superior FLEXIBILITY to respond to the variability and uncertainty of conditions at one or more timescales, including a range of energy futures
- Increased SUSTAINABILITY through energy-efficient and renewable resources.

Coming Soon: BTO's GEB Strategy

BTO is currently developing a new GEB strategy that will outline specific technical challenges and goals related to building-grid interaction.



GEB Focus Areas

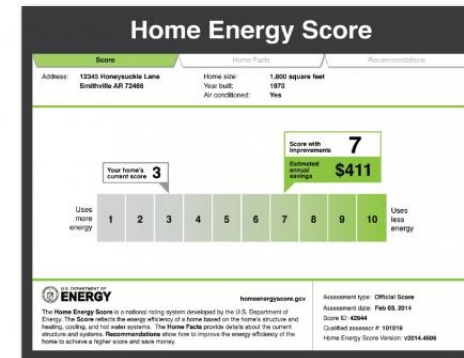
- Building Energy Management Cyber-Physical Systems to Enhance the Provision of Grid Services, including Advanced Building Controls, Sensing, Metering, and Data Analytics
- Energy Efficient Component-Based Technologies that Interact with the Grid
- Advancement of Building Energy Modeling to Support Design, Planning, and Valuation
- Systems Integration to Validate GEB Technologies and Verify Benefits

Public-Private Partners Reduce Uncertainty

BTO works with

- builders
- trade contractors
- building owners and operators
- finance experts
- product retailers
- regional energy efficiency organizations
- non-profits
- real estate professionals
- state and local governments

... to reduce barriers to the adoption of energy efficiency.



SEE Action
STATE & LOCAL ENERGY EFFICIENCY ACTION NETWORK



BTO Merit Review & Peer Review Process

- **Merit reviews are intended to provide an independent assessment of the technical/scientific merit of a proposal prior to the funding decision by senior BTO program staff**
 - Conducted for both national laboratory projects and Funding Opportunity Announcements (FOAs)
 - Merit Review of Core Lab Projects will occur May 3 – 4, 2018, overlapping with the last two days of the BTO Peer Review
 - Competed Lab Projects (May 21 - 25); FOAs (May – June - July)
- **The annual BTO Peer Review provides an objective evaluation and assessment of ongoing projects**
 - April 30 – May 3, 2018 at the Double Tree Crystal City, VA

Interested in becoming a reviewer?

Contact BTOPeerReview@ee.doe.gov

All reviewers that apply will be considered for all review needs

Thank You, Please Keep In Touch

- Visit our website: buildings.energy.gov
- Read the BTO newsletter: <https://energy.gov/eere/buildings/bto-digest-office-newsletter>
- Email us:
 - David Nemtzow, Director, David.Nemtzow@ee.doe.gov
 - Karma Sawyer, Program Manager for Emerging Technologies, Karma.Sawyer@ee.doe.gov
 - Mary Hubbard, Mary.Hubbard@ee.doe.gov



Fraunhofer CSE: The State of collaboration across the energy-efficiency R&D ecosystem



NEEP 2018 Northeast Regional R&D Connector Workshop

Kurt W. Roth, Ph.D.

March 1, 2018



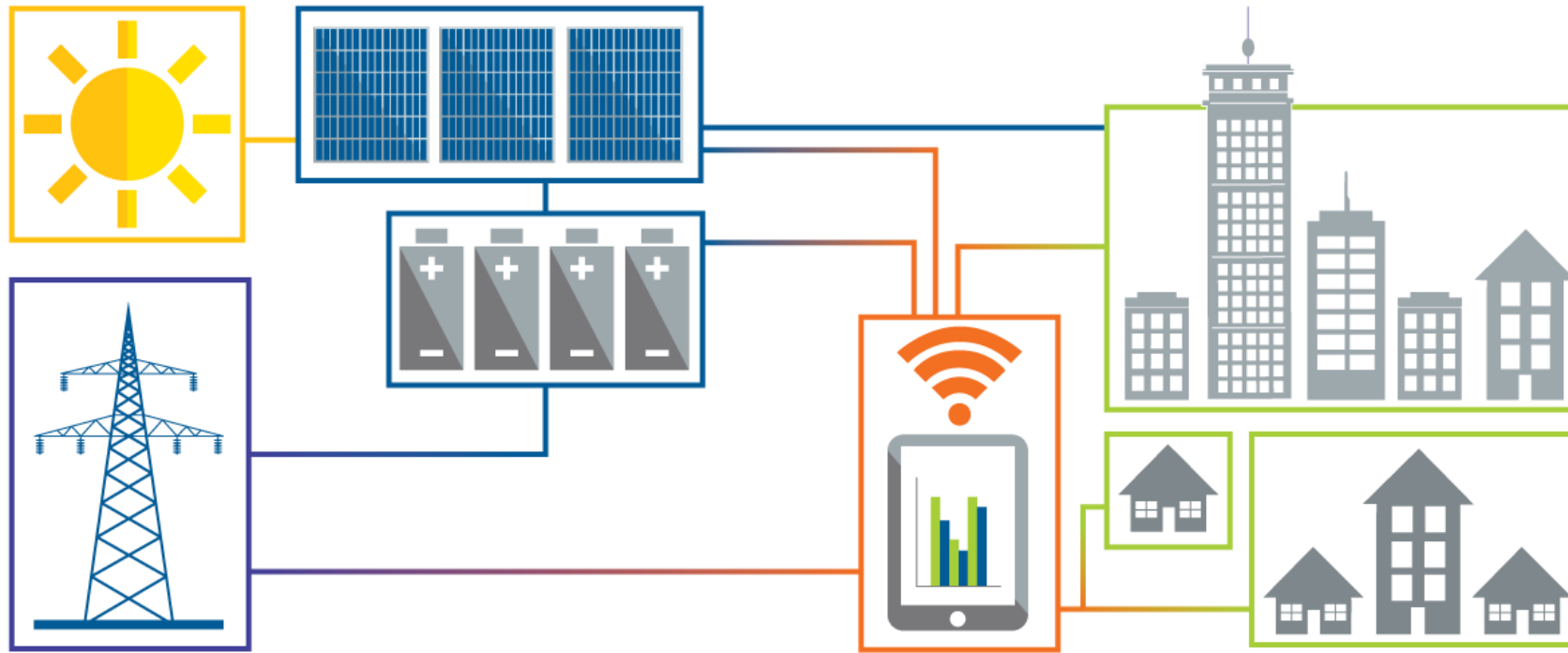
Building tomorrow's energy future today:

The Fraunhofer Center for Sustainable Energy Systems CSE accelerates the development and adoption of sustainable energy technologies through scientific research and engineering innovation.

- Non-profit, applied R&D laboratory
- Located in Boston (MA), additional field testing in Revere (MA) and Albuquerque (NM)
- Founded in April 2008
- ~ 35 employees

An aerial night view of a city skyline, likely New York City, featuring a prominent skyscraper (Empire State Building) illuminated against a dark blue sky. The city lights are visible, and the water is in the background.

HOW WILL WE SUPPLY, DISTRIBUTE, & USE ENERGY IN 2050?



Energy Systems Integration – The Key to 80%+ Greenhouse Gas Reduction

RENEWABLE GENERATION

With over 23k TW/y of solar energy available, **photovoltaic technologies** are the key to driving renewable energy goals and attaining a sustainable energy future.

BUILDING ENERGY EFFICIENCY

Buildings account for >40% of U.S. primary energy consumption. Therefore, increasing **building energy efficiency** has a significant impact on energy use.

SMART INTEGRATION

Achieving the goal of 80%+ renewables in 2050 will require dynamic energy systems that **smartly integrate renewable sources and intelligent loads**.

Fraunhofer performs *contract applied research and development* for private and public enterprises for the benefit of society.



- Basic business model: Contract R&D
 - 70% from competitively-won contracts with industry and government
 - Significant industry funding/role key
 - 30% in the form of “base funding” – government and other financing



We create strong partnerships to effectively address sustainable energy RD&D challenges.

- Direct industry projects
- Government-funded projects
 - DoE, DoD, NSF, NYSERDA, etc. funding Opportunities
 - Small Business Innovation Research (SBIR)
- TechBridge
- Technology Licensing



Working with Industry: Developing a New Generation of Bio-Based, Non-Corrosive Phenolic Foams

Key Challenges:

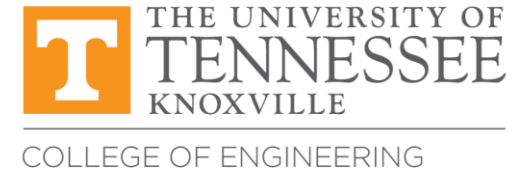
- Earlier phenolic foams had high R-value but high acidity (due to catalyst), resulting in metal roof corrosion and failure

Project Goals:

- Eliminate corrosion potential by developing a bio-based chemical formulation and new foaming and post-foaming curing processes
- Maintain high R-value, improve mechanical strength and durability, without increasing cost

Current Project Results:

- Developed no-VOC, foam that uses wood or agricultural bio-waste
- Foam pH >4.5, metal corrosion level ~tap water
- Looking to further develop and commercialize product



The Fraunhofer TechBridge Program

The Fraunhofer TechBridge Program is an open innovation and technology validation platform for investors and industry sponsors

TechBridge identifies and de-risks promising technologies by leveraging the [extensive resources of Fraunhofer CSE](#) and the Fraunhofer network of more than 60 institutes, including the [Fraunhofer Energy Alliance](#).

At the core of TechBridge is the design and execution of industry-grade development and demonstration projects that:

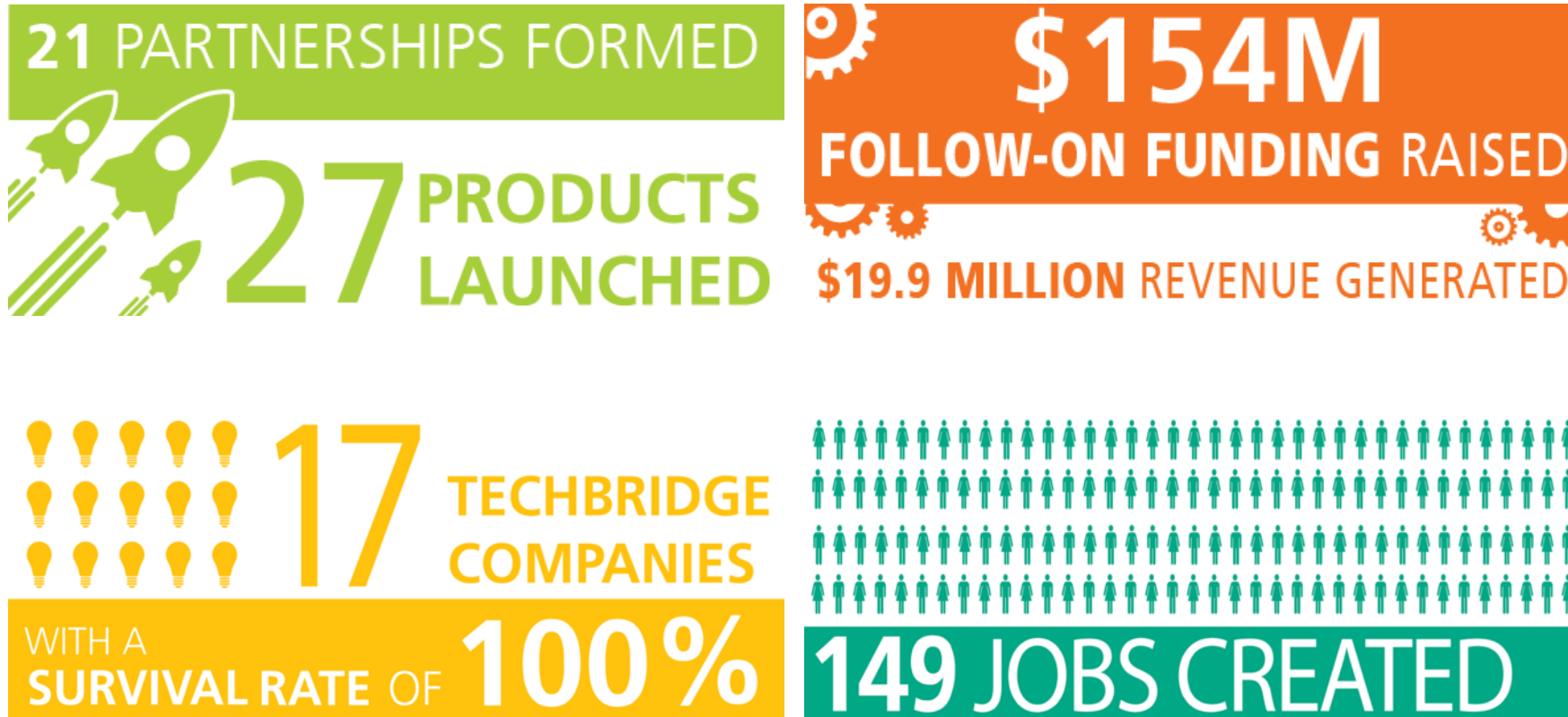
- Optimize and test prototypes
- Provide third-party validation
- Perform field demonstrations

Past TechBridge Sponsors



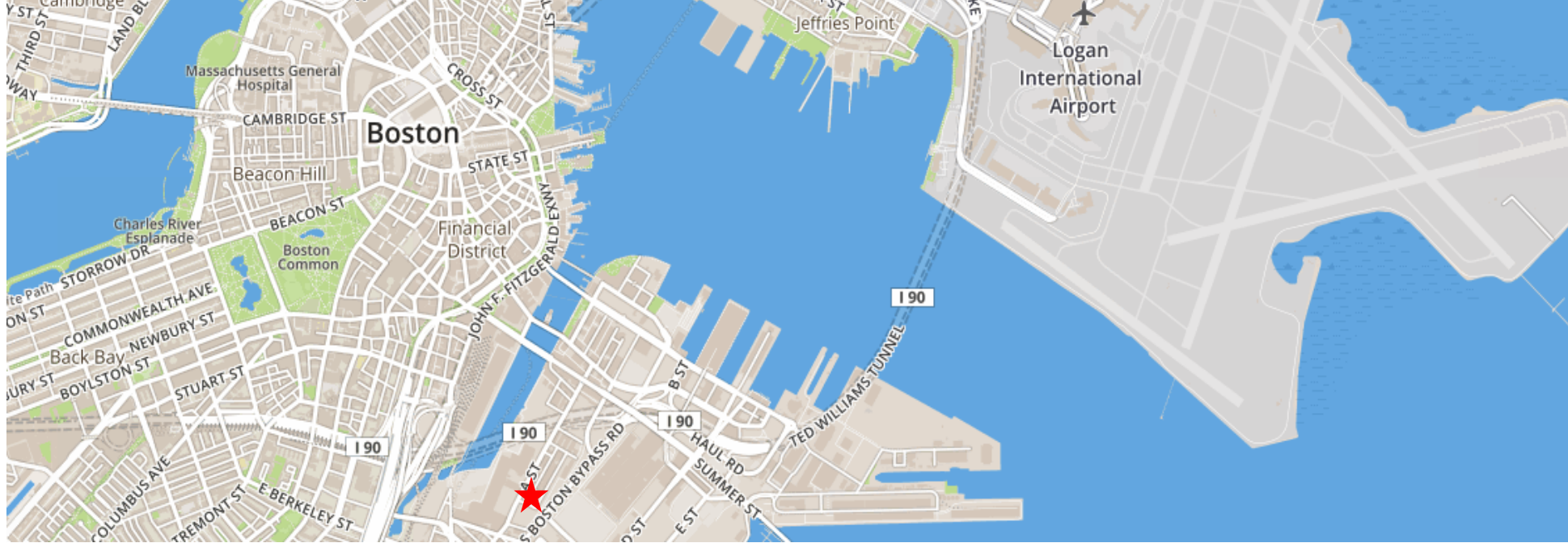
Fraunhofer TechBridge™ Program Supports Startups

- Impact Since its Founding in 2009



Fraunhofer has trained more than 150 engineers and scientists through its Fellows program.





Contact

Kurt Roth

Director, Building Energy Systems

e: kroth@cse.fraunhofer.org

Working with Industry:

SUNDIAL

An Integrated PV + Energy Storage + Load Management System
Enabling High-Penetration Feeder-Level PV



nationalgrid



Project Objectives

- Use demand-side load shaping and energy storage to support high-penetration of solar PV
- Test and pilot business models and market mechanisms that can facilitate exchange of load-shaping services within local distribution grids
- Year-long field demonstration on the National Grid distribution system with a portfolio of C&I Customers: 1.5MW PV, 0.5MW/1.0MWh battery, 1.5-3.8MW of load



The Department of Energy Plug & Play PV Project: Partners





Needs-Driven Building System Research



Steven Winter Associates

Robb Aldrich, PE

Principal Mechanical Engineer

raldrich@swinter.com

© Steven Winter Associates, Inc. 2018

Steven Winter Associates, Inc.

NEW YORK, NY | WASHINGTON, DC | NORWALK, CT

CALL US 866.676.1972 | SWINTER.COM

Locations: NYC, DC, CT

Approx. 125 employees

Improving Buildings:

- Residential, Commercial, Institutional

Focuses:

- Energy, Sustainability, Accessibility,

Services:

- Consulting
- Certification
- Compliance
- Research, Evaluation, R&D

Research driven by **gaps, challenges, needs** in building design, construction, operation.



Chicago: Basement Insulation



Basement Insulation (DOE)



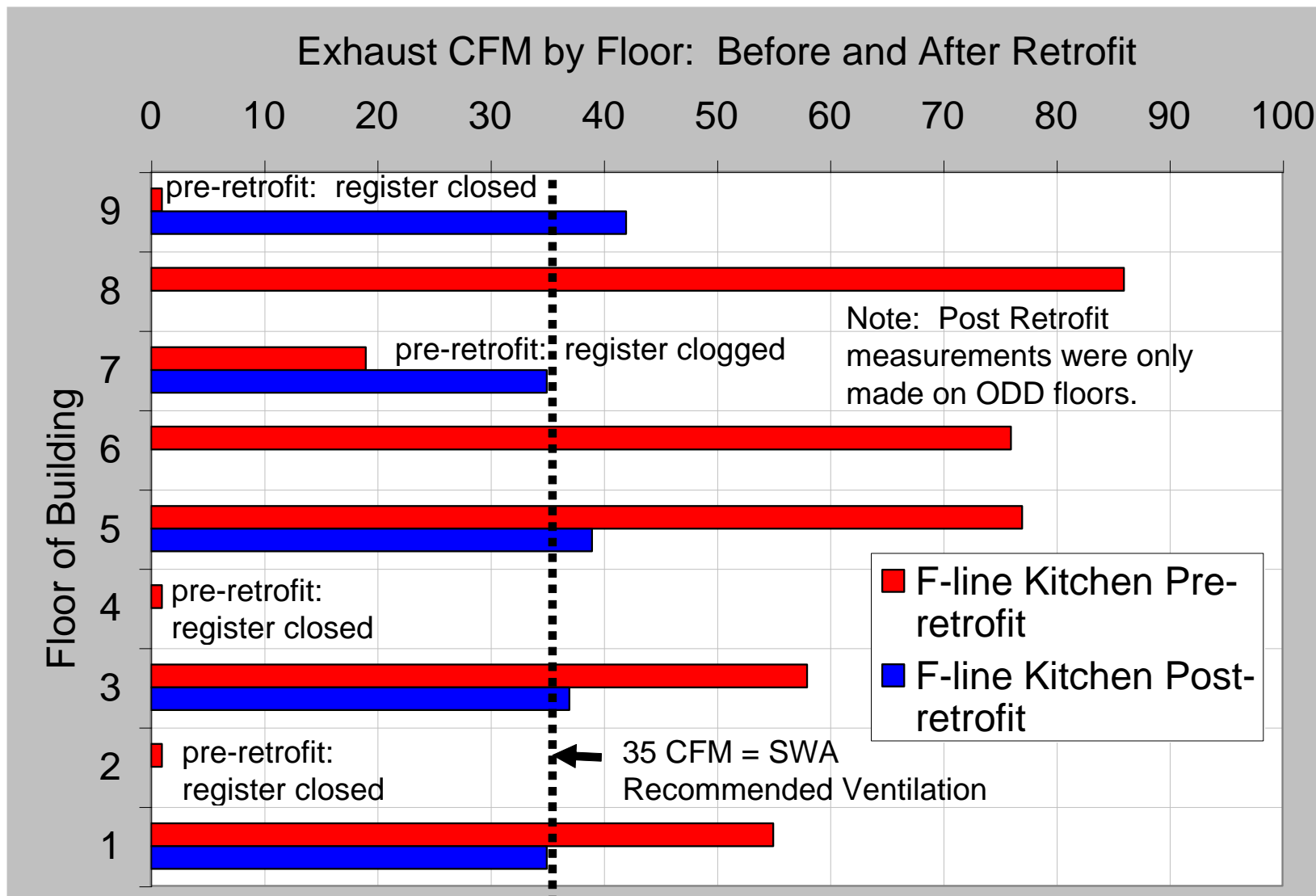


Ventilation Shafts (NYSERDA)

- Staggering leakage
- No consistent exhaust flow rates in apartments
- Tested several sealing methods, flow control dampers
- Fan power often reduced by 50+%
- Now common practice



Ventilation Shafts



Sealing Shaft Vents (NYSERDA)



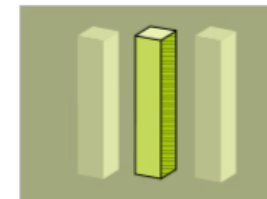
<http://urbangreencouncil.org/spending>

1. HOW TALL IS YOUR BUILDING?

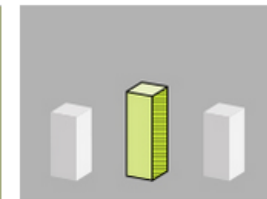
6



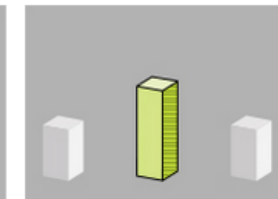
2. HOW WOULD YOU DESCRIBE YOUR BUILDING'S SURROUNDINGS?



DENSE CITY CENTER
Nearby buildings 80 feet or taller

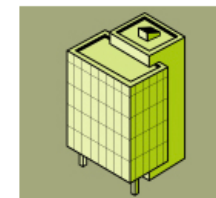


URBAN/SUBURBAN
Nearby buildings 20-80 feet tall

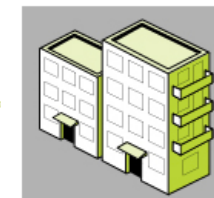


SUBURBAN
Nearby buildings below 20 feet

3. IS YOUR BUILDING TIGHT OR TYPICAL?



TIGHT (WELL-SEALED)
No major penetrations through majority of walls (usually constructed 2000 or later)



TYPICAL (DRAFTY)
Walls have openings for AC units, ventilation, etc., that are not well sealed (usually constructed before 2000)

Ventilation: HRV/ERV



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NEW YORK, NY | WASHINGTON, DC | NORWALK, CT

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Integrating H/C, H/ERV (DOE)





Communication, Collaboration

- SWA platforms:
 - web site
 - Blog
 - newsletters
- DOE:
 - Building America publications library
 - Solution Center
- Conferences:
 - ASHRAE, NESEA BE, HPC, Zero Energy, IEPEC, ABX, Energy & IAQ, GreenBuild, Passive House, BEST, Buildings, ACEEE, EEBA, RESNET, etc...
- Other org's: NEEP, NEHERS, etc.



Funding

- Government Agencies
 - Federal
 - State
 - City
- Utilities (tech. evaluation)
- Manufacturers
- Organizations
- **Partnerships**



Thank you!



kWh

Northeast Regional R&D Connector Workshop

Thomas Trabold, Nenad Nenadic

March 1st , 2018



Rochester Institute of Technology at a Glance



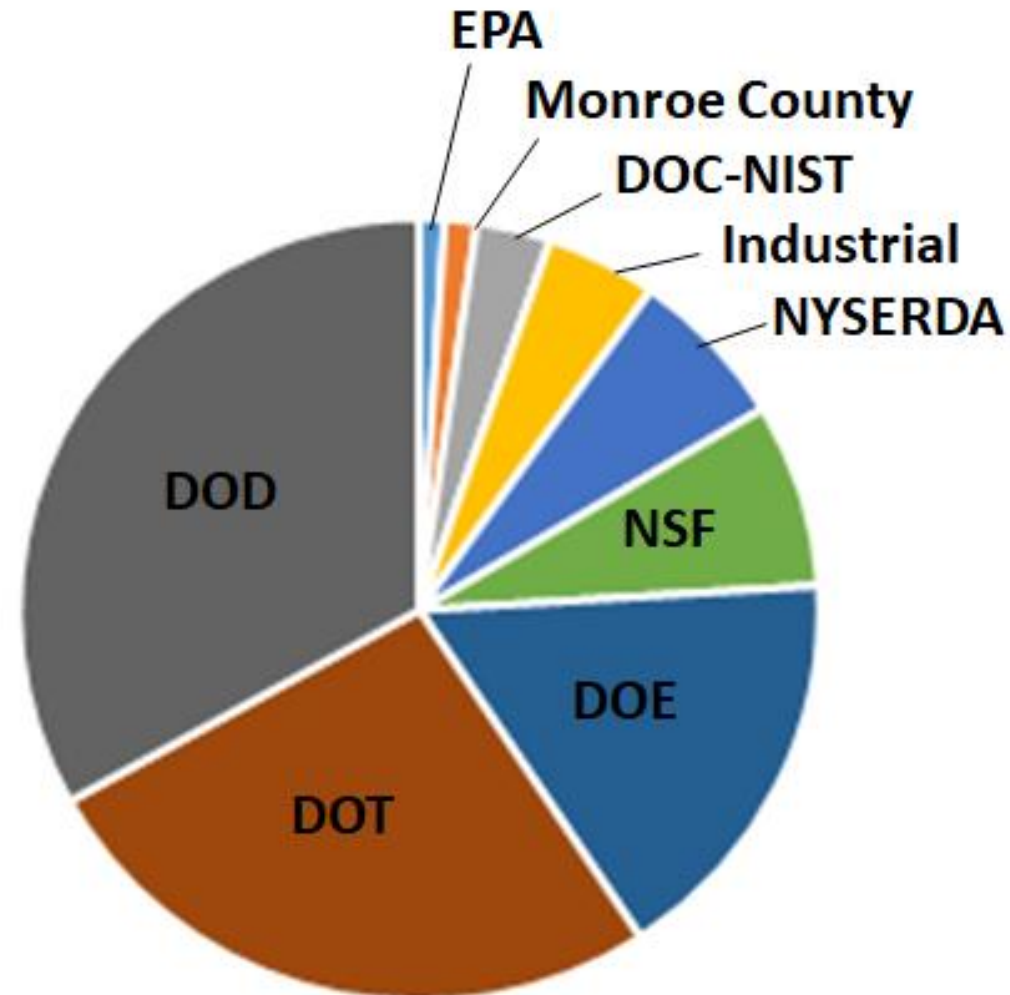
- ▲ **18,600 Students**
- ▲ **Unique technical, fine arts education & National School for Deaf**
- ▲ **Career & experiential learning - one of the oldest cooperative education schools in US**
- ▲ **#3 US in STEM degrees granted by a private university**



- ▲ **Applied manufacturing R&D – “industrial system optimization”**
- ▲ **120+ full-time, industry-experienced professional staff**
- ▲ **Academic unit with 10 core faculty offering 3 graduate degrees (~100 students)**
 - / Sustainability M.S., Ph.D.
 - / Sustainable Architecture M.Arch.
- ▲ **Highly collaborative with external partners in strategic focus areas**
- ▲ **225,000 ft² state-of-the-art manufacturing and LEED platinum building infrastructure**

Energy-Related Research Funding

GIS funding since 2010 is ~\$17M



Recent Energy R&D Activities

- National Science Foundation (\$310K) – “Simulating Build-Out of the U.S. Electricity Grid” (E. Williams and E. Hittinger)
- NYSERDA (\$280K) – “Using Local Storage and Generation to Achieve Flexible Demand for Charging Electric Vehicles” (M. Thurston and N. Nenadic)
- NYSERDA (\$108K) – “Microgrid-Grid Cooperation for Improving Economic and Environmental Cost and Grid Resilience” (N. Nenadic and M. Thurston)
- STAPLES (\$75K) – “Hydrogen Infrastructure for Product Distribution Centers - Phase 1: Fuel Cell-Powered Material Handling Equipment” (T. Trabold)
- COE (\$100K) – “Building monitoring”, (M. Thurston)
- NYSERDA/NEXUS (\$40K) – “Active Power Management for Small Business” (N. Nenadic, M. Thurston)
- NYSERDA/NEXUS (\$40K) – “Fuel Cells for Unmanned Aerial Systems” (M. Walluk, T. Trabold)
- NIST (\$287K) – “Fuel Cells for Residential Power Applications” (T. Trabold, M. Walluk)
- NYS P2I and NYSERDA (\$50K, \$150K) – “Secondary Applications for Transportation Batteries” (with BAE Systems) (N. Nenadic, G. Gaustad, M. Thurston)



USDOE funded manufacturing center led by RIT to enable early stage applied R&D of technologies that could dramatically reduce the embodied energy and carbon emissions associated with industrial-scale materials production and processing.

Applications

Microgrids

- Operation / co-operation
- Fuel cells
- [Battery EOL / secondary use](#)
- [Solar](#)
- Peak shaving
- Bio-based distributed gen

Built Environment

- Smart buildings
- Industrial efficiency
- Building retuning
- Lean energy & environment
- Smart buildings

Mobility

- EV and fuel cell vehicles
- APUs for heavy-duty trucks
- Material handling equipment
- Unmanned aerial systems
- Biofuels

Capabilities

Energy Policy

Data analysis

Grid modeling

System health monitoring

Demand modeling

Statistical inference:

Data → Knowledge → Decisions

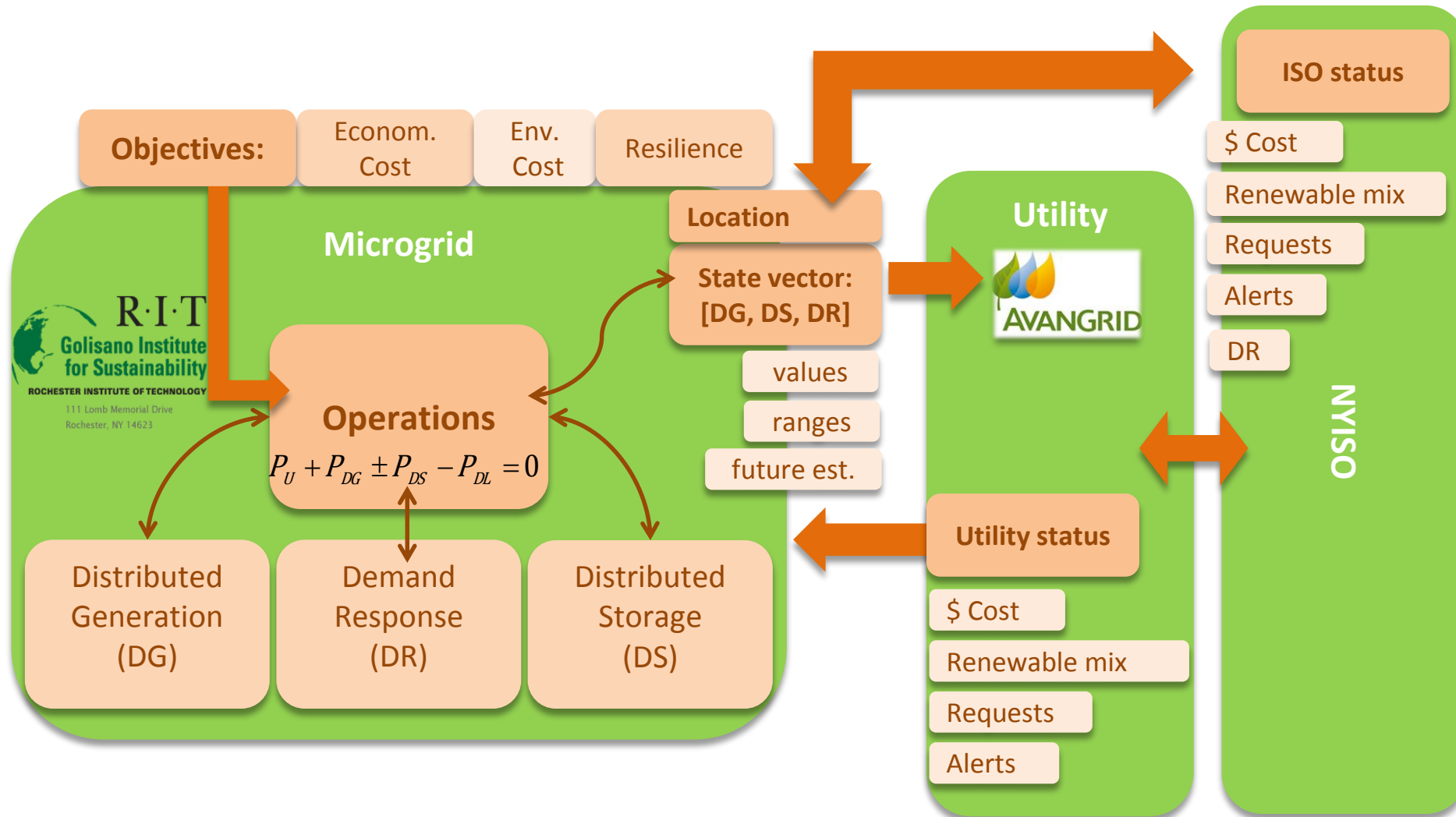
Test and measurement

Approach

Applied research

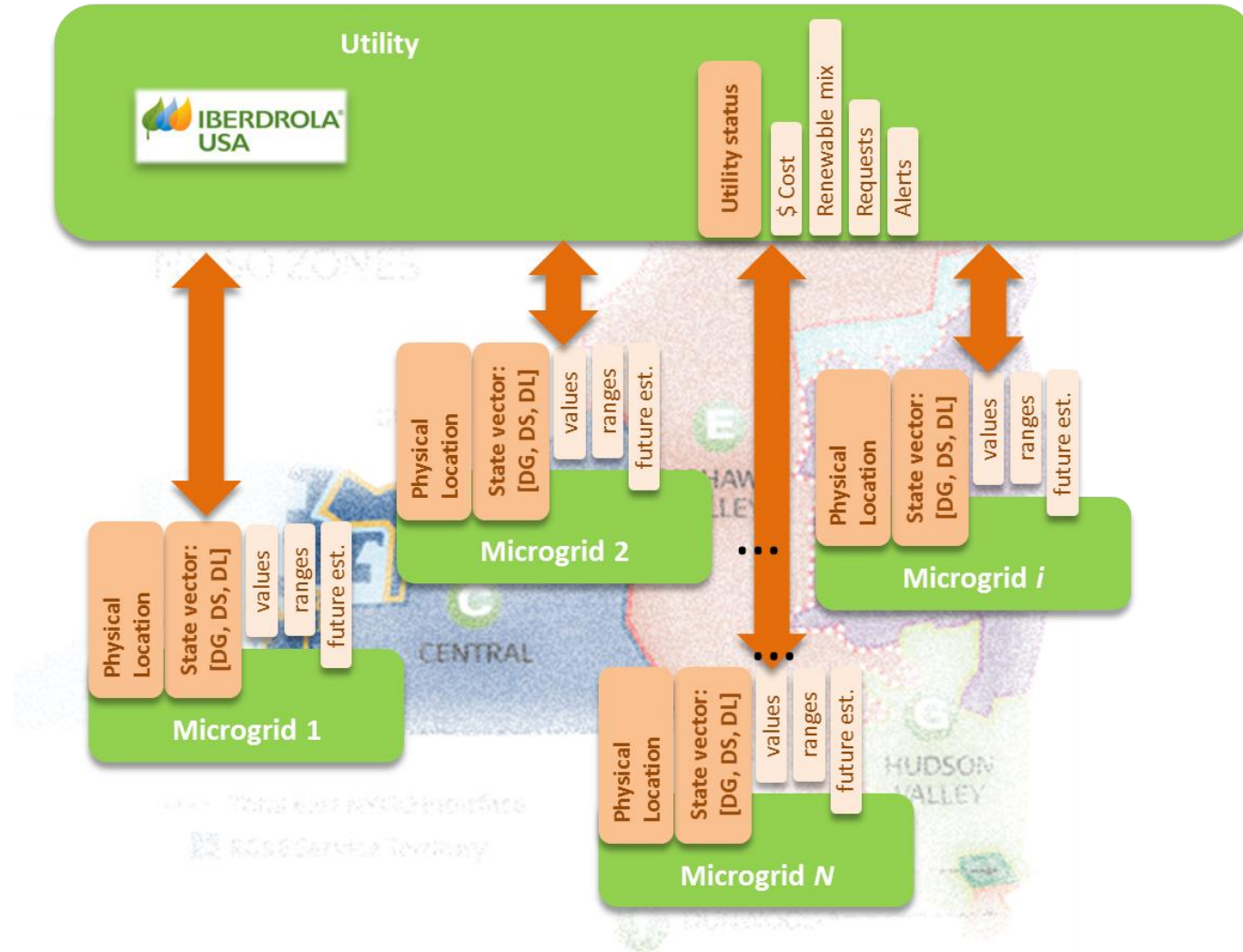
- Grounded within the scope and practicality of real-world problems
- Employ state-of-the art solutions and tried-and-true technologies
- Focus on system-level solutions
- Collaboration with fundamental researchers

Microgrid – Grid Interaction (NYSERDA) 1/3

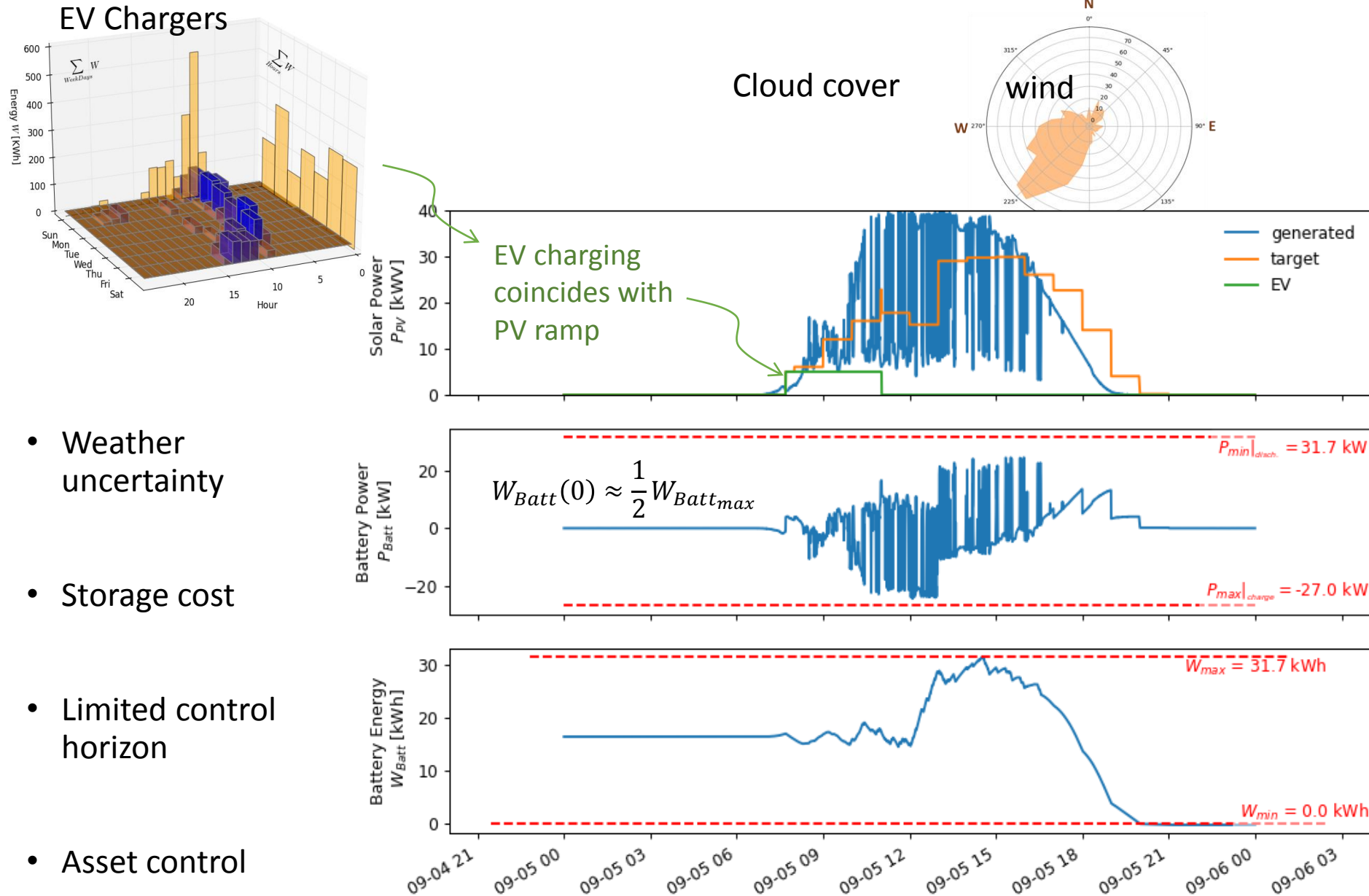


Microgrid – Grid Interaction (NYSERDA) 2/3

GRID Point of View: Virtual Power Plant



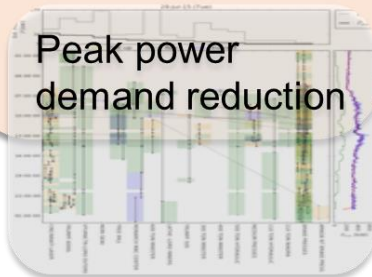
Microgrid – Grid Interaction (NYSERDA) 3/3 Firming Renewables



Shop Floor Power Monitoring (COE)

Motivation

- Monitor power of individual machines
- Many machines on a manufacturing floor
- Power meters are expensive



Approach

- Power estimations
- Wireless communications
- Interfaces
- Firmware customization



Asset and process anomaly detection



Benefits

- Data-driven decisions
- Vendor agnostic analytics

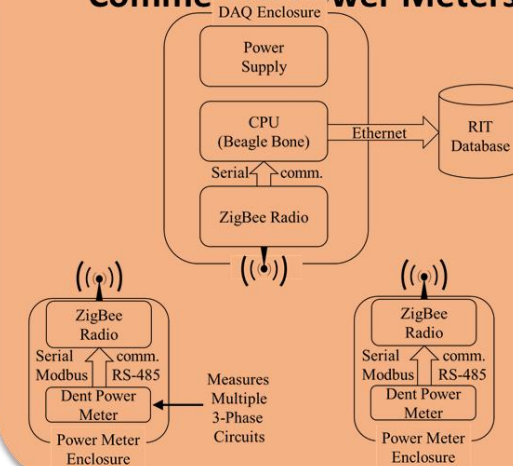
data → info. → decisions

Partners

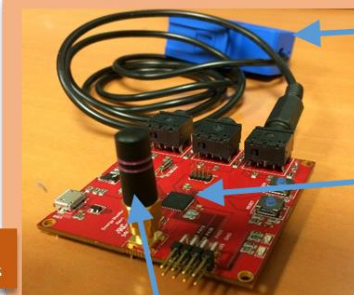


Cloud & Local storage

Data Collection System with Commercial Power Meters



Current Device Prototype



Current transducer

A/D conversion

Microprocessor

ZigBee radio

Antenna

BACnet
Modbus



Sustainability Hall: a learning, living laboratory with
~1500 sensors monitoring building performance

400 kW fuel cell CHP

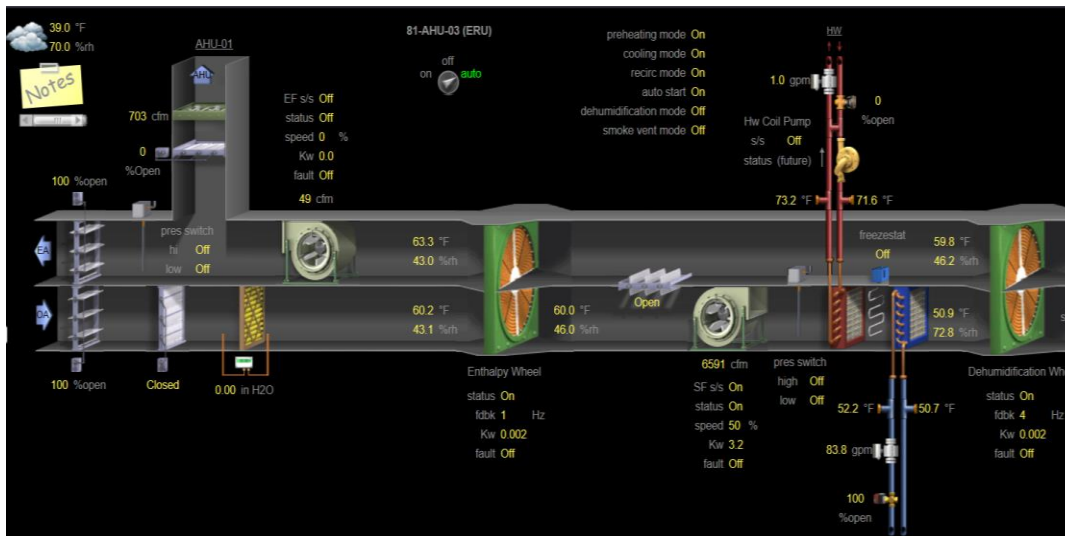


- Geo-thermal wells
- 100 kWh battery storage

40 kW solar PV



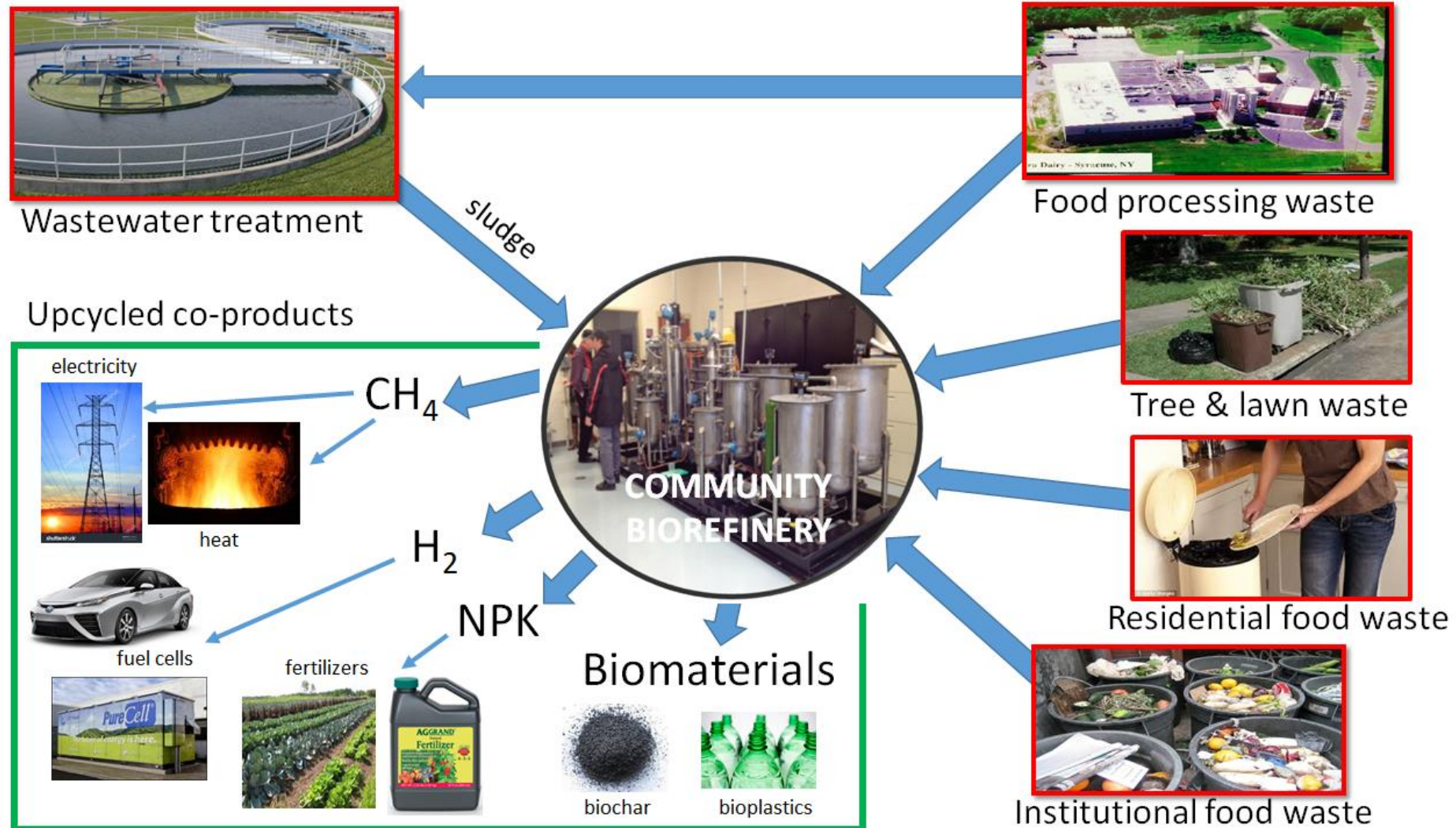
- Green roof
- Energy recovery unit



WebCTRL interface provides
access to data for analysis of
building performance and
model development

Biomass-based Distributed Generation

- Value proposition through multiple “products”: electricity, thermal energy, fertilizer, waste cost avoidance, community resilience, etc.
- Focus on technologies that can be deployed at small-to-medium scale



Thank you

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