

U.S. DEPARTMENT OF
ENERGY

Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

Integration Technology R&D

Commercial Buildings Integration - Building Technologies Office

February/March 2019



Integration R&D Analysis: Purpose and Objectives

Today we will review and discuss the specific areas of research that provide a significant opportunity to integrate across commercial buildings to **understand and prioritize** within the landscape of integration R&D technologies.

We welcome targeted and detailed follow-on engagement. Let us know if you have additional thoughts:

Amy Jiron: amy.jiron@ee.doe.gov

Matt Guernsey: matt.guernsey@navigant.com

Today we will:

1. Present our methodology for identifying and narrowing the list of technologies.
2. Review metric definitions used for scoring technologies.
3. Discuss the 26 highest scoring integration R&D technologies by system type:
 - Energy management and information systems
 - Sensing and control
 - HVAC&R
 - Envelope and Lighting
 - Other

Integration R&D Analysis: Background

Commercial buildings that are...

- constructed and operated so that they can consistently adapt and improve
- to reduce energy costs for businesses,
- serve as a resource to the electric grid,
- while supplying comfortable conditions and services that enable occupant productivity and health.

Target Market and Audience

We support integration R&D through public and private sector engagement: commercial buildings industry via the Better Buildings Alliance (BBA), technology developers, utilities, trade associations and federal leaders. This engagement is designed to provide information on market-based barriers, opportunities and solutions to support more effective research, development and validation.

Strategic Emphasis:

- *Earlier stage technology for integration* of component, system and whole building energy savings.
- An ongoing focus is on *engagement and collaboration across multiple stakeholder groups*.

Integration Technology Analysis: Methodology

- **Two-stage Screening :**
 - Develop a list of potential integration measures for prioritized R&D.
 - Measures and savings potential drawn from a wide array of sources to ensure comprehensive coverage.
 - More than 450 measures in total.

Initial Screen Output:
Pass/Fail

Initial Screen

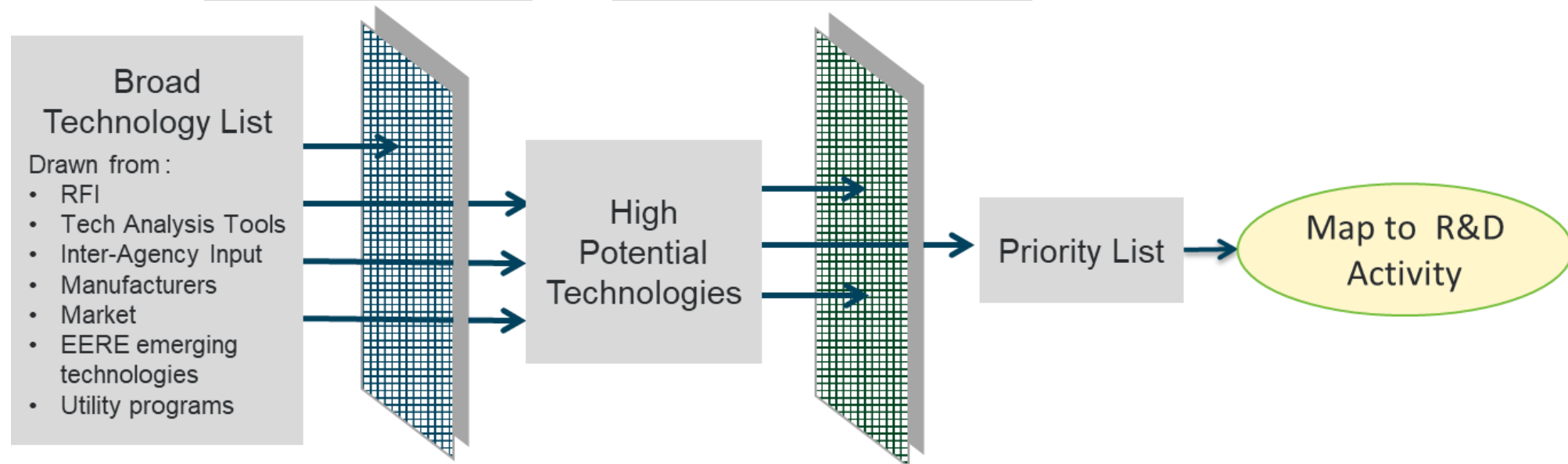
(energy savings,
integration focus, suitable
technology readiness)

Secondary Screen

(development opportunity,
manufacturing R&D needs,
understanding of cost/benefit,
grid/utility value)

Second Screen Output:

Score of 1 (lowest) to 3 (highest)

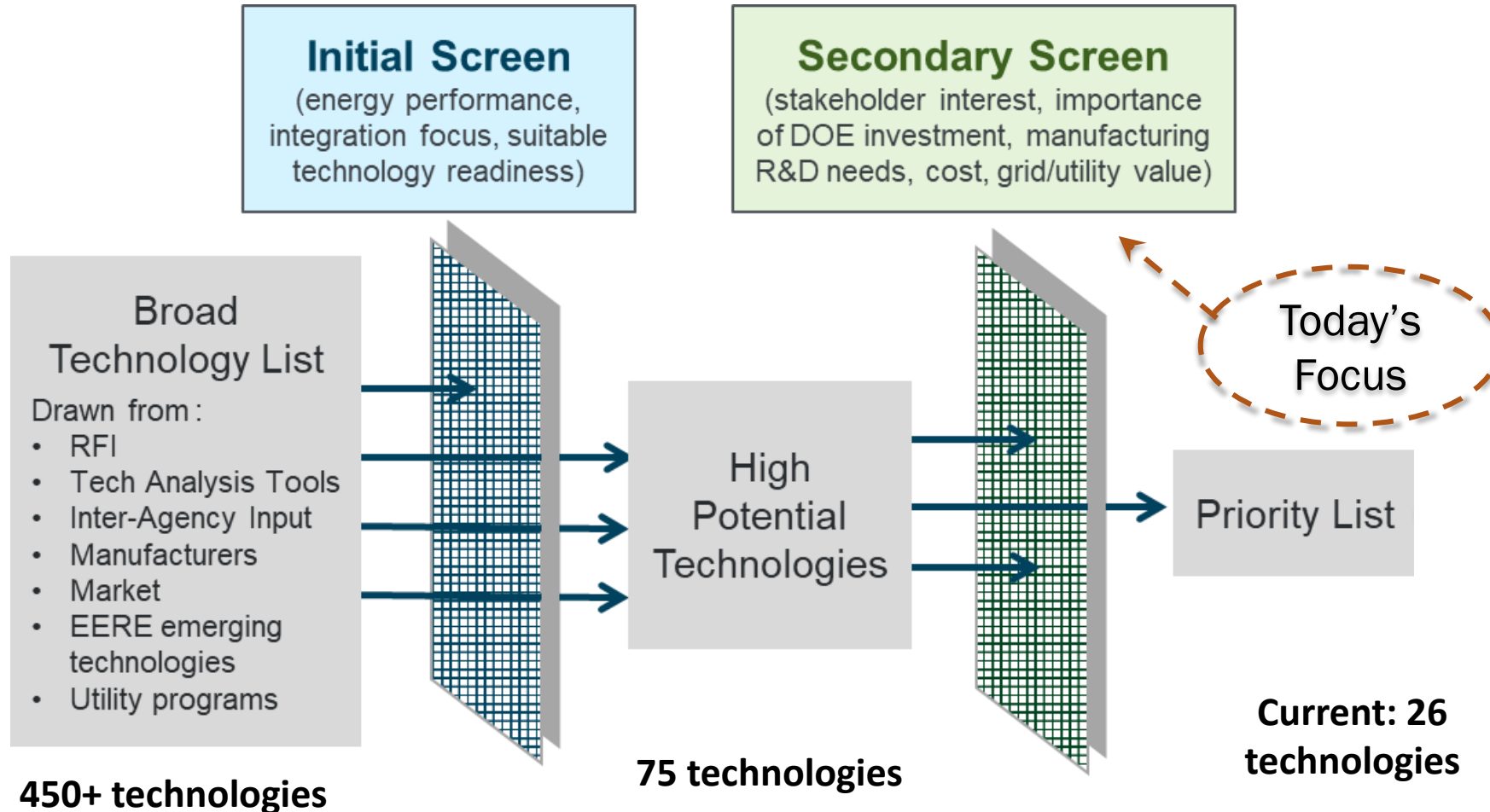


Integration Technology Analysis: Methodology

- The second screen produces a rankable score for each measure
- We considered the following factors to determine the score:
 - Current development activity
 - Manufacturing R&D needs
 - Understanding of cost and reduction potential
 - Grid/utility value
- Final score is an average of the scores for each of the factors (equal weight)

Integration Technology Analysis: Today

- We have completed a tech sweep and preliminary scoring for the two screens.
- **Today's goal: Gather input to refine the second screen and inform the priority list.**



Scoring Metrics

Score	Current Development Activity
3 = ●	Clear opportunity for DOE support to drive substantial impact
2 = ●	Other programs are investing, but DOE support would provide increased capacity or reach
1 = ●	Existing investment is substantial & the path for the tech is clear

Score	Manufacturing R&D Needs
3 = ●	Significant opportunity manufacturing-related R&D or technical support or to provide access to rapid manufacturing
2 = ●	Some opportunity exists for DOE to support manufacturing R&D
1 = ●	Little opportunity for improvement via DOE support

Scoring Metrics Cont.

























Score	Understanding of Cost and Reduction Potential
3 = ●	Costs are not well understood; potential exists for DOE-driven, significant cost reductions
2 = ●	More techno-economic analysis is required to understand costs and the potential for cost reduction
1 = ●	Costs are well understood and there is no opportunity for DOE

Score	Grid/Utility Value
3 = ●	Extensive benefits to the grid in the form of increased reliability, resiliency, or flexibility (timing of loads, power [or reactive power], or energy source)
2 = ●	Moderate benefits to the grid (excluding efficiency)
1 = ●	Little or no benefits to the grid (excluding efficiency)

Technology Prioritization: Discussion

















- **Which scores should we refine?**
 - Do you agree or disagree with the scores?
 - On what basis?
 - Do you have any sources to share to substantiate a different score?
- **Do any measures in the top ranked lists surprise you?**
- **Are there any key omitted technologies?**

Prioritization Results: Energy Management & Info. Systems

EMIS Measure Name	Savings Potential (Tbtu/Yr)	Current Development Opportunity	Mfg. R&D Needs	Cost/Benefit and Reduction Potential	Grid/Utility Value
AI-Enabled Energy Management Platform (BMS/EMS)* -Machine learning improves predictive capabilities and dynamic controls	500				
Smart City IoT Platform* -Enabling system for multi-building efficiency and smart, connected city infrastructure & services	1000				
Small Building EMS -Specifically for buildings with a wide range of end-uses and businesses	250				
Automated Whole Building Diagnostics -Integrated, whole-building fault detection and diagnostics systems	250				
Energy Management for Data Centers -Sector-specific systems serving unique needs	100				
Energy Management for Food Service Buildings -Sector-specific systems serving unique needs	100				





























*New addition to HIT Matrix

Prioritization Results: Sensors & Controls

Sensors & Controls Measure Name	Savings Potential (Tbtu/Yr)	Current Development Opportunity	Mfg. R&D Needs	Cost/Benefit and Reduction Potential	Grid/Utility Value
Integrated System Controllers for Solar PV + Storage* -Smart management packages optimizing performance, economics, grid value	500				
Model Predictive Control (MPC) for HVAC* -Control strategy based on energy-model-based predictions of load and performance	500				
Smart Wireless Sub-Meter* -Enabling management for individual circuits/loads using self-commissioning, plug-and-play meters	100				
Model Predictive Control (MPC) for Water Heating -Control strategy based on energy-model-based predictions of usage and performance	100				

*New addition to HIT Matrix













Prioritization Results: HVAC&R

HVAC&R Measure Name	Savings Potential (Tbtu/Yr)	Current Development Opportunity	Mfg. R&D Needs	Cost/Benefit and Reduction Potential	Grid/Utility Value
Thermal Energy Storage for Heating -Heat load storage using water, bricks, etc. to load shift and reduce capacity needs	500				
Micro-Combined Heat & Power (CHP) -10-100 kW CHP systems, including control/dispatch strategies for maximum efficiency/economic value	1000				
Thermal Energy Storage for Cooling -Cooling load storage using water, ice, etc. to load shift and reduce capacity needs	500				
Liquid Desiccant A/C -Use of desiccants for latent load control, including for load shifting via high-volume storage of regenerated desiccants	250				
Separate Sensible and Latent Heating -Reduce capacity & increase efficiency of HVAC by separately managing temperature and humidity (commonly leveraging liquid desiccant A/C)	100				
HVAC with Advanced Controls for Indoor Agriculture* -Sector-specific HVAC systems + controls	50				
Monitoring Based Commissioning (MBCx) for HVAC&R -Maintaining optimal performance via real-time monitoring of systems	500				

*New addition to HIT Matrix













Prioritization Results: Building Envelope, Lighting

Building Envelope Measure Name	Savings Potential (Tbtu/Yr)	Current Development Opportunity	Mfg. R&D Needs	Cost/Benefit and Reduction Potential	Grid/Utility Value
Phase Change Materials in Building Envelope -Embedded energy storage smooths HVAC loads and improves comfort	500				
Transparent Photovoltaic Windows -Building-integrated PV in place of windows	250				

Lighting					
Wireless Lighting Sensors for Enhanced Analytics and Interop. -Low cost data collection and integration with other systems	250				
LED Lighting and Controls for Indoor Agriculture* -Sector-specific lighting systems + controls	50				
Solar Collectors for Building-Interior Daylight via Fiber Optics -Uses daylight to serve interior spaces	1000				

*New addition to HIT Matrix

Prioritization Results: Water Heat, Whole Bldg. & Multi-System

Water Heating Measure Name	Savings Potential (Tbtu/Yr)	Current Development Opportunity	Mfg. R&D Needs	Cost/Benefit and Reduction Potential	Grid/Utility Value
PV Powered Water Heating* -Savings from reduced PV inverter losses through direct connection of PV to a DC-powered water heater	50				
Whole Building and Multi-System					
Direct Current (DC) Power in Buildings* -Savings from reduced AC/DC conversion losses from PV and other DC-based equipment, plus efficiency gain of DC motors in HVAC&R	500				
Combination Solar PV/Thermal (PVT) Collectors -Dual-use collectors reduce installed cost and improve electrical output via reduced panel temps	500				

*New addition to HIT Matrix

Next Steps

1. Complete stakeholder input workshops.
2. Refine second screening and identify 2019 priority list.
3. Draft integration R&D roadmap.
4. Circulate report for feedback.

Questions?