U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

2021 Building Technologies Office - CBI HIT Stakeholder Engagement

Commercial Building Integration (CBI) HIT Process Overview and Prioritization Results for Review

March-June 2021

Project Charter – Purpose and Objectives

Goal: The High Impact Technology (HIT) Catalyst is designed to help identify and prioritize ***cost-effective, underutilized, deployment-ready, energy-efficient technologies*** that reduce GHG emissions so that DOE can focus its resource development and deployment activities.

Target Market and Audience: We deploy technology through partnerships including the Better Buildings Alliance (BBA), federal leaders, regional non-profits, and efficiency organizations.

Strategic Emphasis:

- *Accelerate the adoption of underutilized but available technologies* through pre-identified and pre-defined pathways (e.g., Tech demonstration; Technical resource development; Adoption campaign)
- Focus on *collaboration across applicable stakeholder groups*.

HIT Matrix: DOE's tool to assess technologies.

- Contains a list of potential building energy efficiency/GHG reduction measures
- More than 400 measures in total for 2021

HIT 2021: Identifying, Evaluating and Prioritizing

Initial Screen Metrics

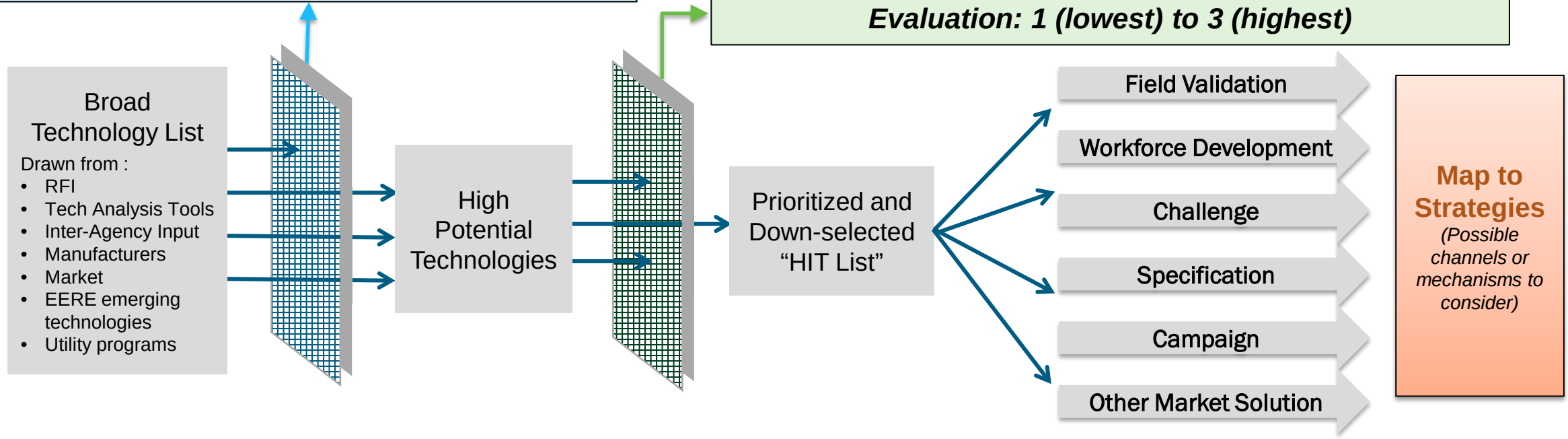
- *Nationwide GHG emissions savings impact (100% adoption)*
- *Unit site energy savings impact*
- *Technology readiness level*

Evaluation: Pass/Fail

Second Screen Metrics (Weight)

- *Energy savings (100% adoption) (40%)*
- *Grid/Utility flexibility value (20%)*
- *Stakeholder interest (10%)*
- *Cost and reduction potential (10%)*
- *Non-energy benefits (10%)*
- *Criticality of CBI involvement (10%)*

Evaluation: 1 (lowest) to 3 (highest)



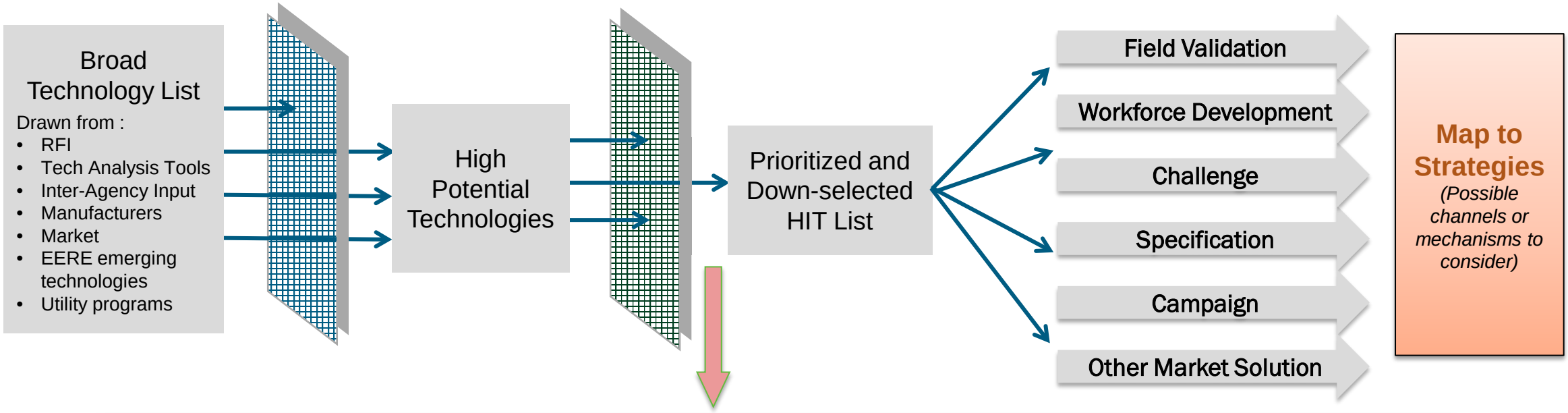
Note: See full descriptions of metrics in Appendix A for the Initial Screen and Appendix B for the Second Screen

Stakeholder engagement has resulted in FAQs on the process:

- **Q: Would a technology that reduces peak loads have high "Grid/Utility Flexibility Value" score?**
  - A: Not necessarily. Reducing peak load provides critical grid value, but it is different from flexibility value, which is the focus here (See appendix).
- **Q: Do you account for regional differences in scoring in the second screening stage?**
  - A: No, but if, for example, there is substantial stakeholder interest for a technology in one region, it will still receive a high score. Regional differences will be accounted for further when we plan specific deployment activities.
- **Q: The first slide says technologies must be "deployment-ready" – can you elaborate on what that means?**
  - A: CBI is interested in supporting deployment of technologies that can have an impact in the marketplace in the next 1-3 years. Technologies only pass the first screen if they are commercially available TODAY and ready for large scale deployment to achieve the desired impact.
- **Q: I do not see GHG emissions impact in the second screen – how come?**
  - GHG emissions rates vary widely across the country. At this step, the analysis generally relies on nationwide averages, so we have preliminarily opted to use primary energy savings as a surrogate for GHG emissions savings. In later stages the analysis may get more detailed to account for differences (e.g., regional and temporal) in GHG emissions factors.
- **Q: Do you account for [insert personal favorite non-energy benefit (NEB) here] in the NEB metric?**
  - We intend to cover all important NEBs that may provide value for each technology (and they of course vary by technology). If you think we may be missing something, please let us know. Please refer to the appendix for a non-exhaustive list of examples.
- **Q: Does energy savings potential account for embodied energy from manufacturing?**
  - A: No. Please see the appendix for the metric definition
- **Q: Why don't you account for [insert variable here] in the metrics?**
  - A: This approach was developed collaboratively, building on many years of process refinements, to optimize the requirements in line with the Building Technologies Office's and specifically the Commercial Building Integration Team's mission. We are open to input that can help improve alignment with the mission.

HIT 2021: Current Status

- We have completed a tech sweep and preliminary scoring for the two screens.
- **Stakeholder Engagement Goal:** Gather input to refine the second screen and inform the HIT list.



Stakeholder Engagement Steps:

1. Stakeholder Discussions (March-May): Gather input and feedback via six stakeholder meetings
2. Request for Information (May-June): Gather input and feedback on a refined set of preliminary results (updated 5/13/21) from broader stakeholder community

Discussion

As we review the technologies, consider:

- **Priorities** – Which should we view more (or less) favorably?
- **Omissions** – Which are missing that we should also consider?
- **Readiness** – Which have a clear and documented pathway to locking in energy savings via large-scale programs?
- **Criticality** – Which are most critical for BTO to support?
- **Next steps** – What are the specific and targeted deployment support needs?

2nd Screen Output – Top Tech Overview in Ranked Order

Refined 5/13/21 (post Stakeholder Discussions)

1. Multi-Building (e.g., District) HP
2. Low-Carbon Thermal Electrification (HP + Solar PV)
3. Secondary Glazing (e.g., Storm Windows)
4. Dual-Source (Air/Water) HP
5. Cold Climate Rooftop Unit HP
6. Whole Building AFDD and Controls
7. Ground Source HP - 3rd Party Owned Loop
8. AI-enabled Energy Management Tools
9. Perimeter Zone Daylighting
10. DC Power in Buildings
11. Air Treatment to Reduce HVAC Load
12. Advanced, Grid-Connected Refrigeration Controls
13. Small/Medium Sized Building Energy Management System
14. Thin Triple Pane Windows
15. Smart Thermostat
16. Flexible IoT for Unconnected Products
17. Variable Capacity HVAC Products
18. Grid-Connected HPWH
19. Variable Refrigerant Flow HP (VRF)
20. Wastewater-Source HP (Sewer Thermal)
21. Cold Climate Package Terminal HP (PTHP)
22. LED Grow Lights
23. Dynamic Windows (e.g., Electrochromic)
24. CO_2 Split-System HPWH
25. High-Efficiency, Integrated Equipment with Advanced Controls for Indoor Agriculture
26. Task Light & Plug Load Circuit Controls

Note: See full descriptions in Appendix C

2nd Screen Output – Top Tech Overview by Market Segment

Multiple (3+) Market Segments

- Multi-Building (e.g., District) HP
- Low-Carbon Thermal Electrification (HP+PV)
- Ground Source HP - 3rd Party Owned Loop
- Air Treatment for HVAC Load Reduction
- Variable Capacity HVAC Products
- Secondary Glazing
- DC Power in Buildings
- AI-Enabled Energy Management Tools
- Whole Building AFDD and Controls

Food Service, Grocery, and Retail

- Cold Climate RTU HP
- Advanced, Grid-Connected Refrig. Controls
- CO_2 Split-System HPWH
- Grid Connected HPWH
- Smart Thermostat
- Small/Medium BMS

Hospitality

- Cold Climate Packaged Terminal HP (PTHP)

Central Plant

- Dual-Source (Air/Water) HP
- Variable Refrigerant Flow HP (VRF)
- Wastewater-Source HP (Sewer Thermal)

Commercial Real Estate

- Cold Climate RTU Heat Pump
- Grid-Connected HPWH
- CO_2 Split-System HPWH
- Thin Triple Pane Windows
- Dynamic Windows
- Smart Thermostat
- Flexible IoT for Unconnected Products
- Perimeter Zone Daylighting
- Small/Medium BMS
- Task Lighting & Plug Load Circuit Controls

Indoor Agriculture

- LED Grow Lights
- High-Efficiency, Advanced-Control HVAC/Lighting

Heat Pumps | Non-HP HVACR | Water Heating | Indoor Agriculture | Envelope | Whole Building

Stakeholder engagement has resulted in FAQs on the tech list:

- **Q: The technologies seem inconsistent in terms of their scope/breadth – Can that be improved?**
  - A: Yes, there is room for improvement! We did our best to make apples-to-apples comparisons through consistently scoped technologies, but it is not perfect, and overlap exists in some areas as well. Give us your recommendations for improvements.
- **Q: Why don't I see energy storage technologies listed given their importance to the energy transition?**
  - A: While it is true that they provide substantial value, they do not score highly for energy savings (most, if not all, have net energy penalties) and therefore were not included in this presentation. Other areas of DOE are focusing heavily on this topic.
- **Q: Does your analysis account for impacts on transmission of COVID-19?**
  - A: Our metrics do not specifically account for this, but through DOEs collaborative efforts on the topic, the team is staying abreast of related concerns and will determine in the next phase if specific considerations must be made.
- **Q: How is it possible that the energy savings scores in the top list of technologies span such a wide range?**
  - A: Energy savings potential is weighted at 40% (see appendix) and the results are a complex interplay of all metrics that are intended to collectively elevate those technologies that best align with the Building Technologies Office's mission.
- **Q: Why don't you have [insert technology here] in the list?**
  - A: Our HIT matrix is a database of 400+ technologies, of which ~120 passed the first screen; 26 top candidate technologies are presented in the following slides and the appendix contains a list of all the technologies with a score of 1.8 or greater (an additional 18 technologies). If there is a technology that you feel is important but does not appear in this presentation, please let us know what it is and why you feel we may have missed it (or scored it such that it did not appear in these slides)
- **Q: Did you consider the benefits of two or more technologies in combination?'**
  - A: To a certain degree, yes. Certain combinations of innovative technologies provide unique value that DOE may be well positioned to support, and some of those combinations are included in the HIT Matrix. This approach is not intended to cover all combinations because of the huge number of potential combinations and the fact that a contractor determines the right solution in coordination with their customer. For example, while the quick payback period of lighting upgrades may be used to subsidize other measures, that is not a considered to be part of this analysis.

2nd Screen Top Tech – Heat Pumps (HP)

Refined 5/13/21 (post Stakeholder Discussions)

Heat Pump Technology	Primary Savings Potential (TBtu/yr)[B]	New or Existing Buildings	Key Market Segment[A]	Energy Savings	Grid Flexibility Value	Stakeholder Interest	Criticality of CBI Involvement	Cost & Reduction Potential	Non-Energy Benefits
Multi-Building (e.g., District) HP	2,000+	New Primarily	Multiple	●	◐	◐	●	◐	◐
Wastewater-Source HP (Sewer Thermal) [C]	500	New Primarily	CP	◐	○	◐	●	●	◐
Ground Source HP - 3rd Party Owned Loop [C]	2,000+	All	Multiple	●	○	◐	◐	◐	◐
Dual-Source (Air/Water) HP [C]	800	All	CP	●	○	●	◐	◐	◐
Cold Climate Rooftop Unit HP	1,000	All	CRE, FSGR	●	○	●	◐	◐	◐
Variable Refrigerant Flow HP (VRF)	1,000	All	CP	●	○	◐	○	○	◐
Cold Climate Package Terminal HP (PTHP)	500	All	Hospitality	◐	○	●	●	◐	◐
Example Package Solution – top heat pump technologies paired with on-site solar:									
Low-Carbon Thermal Electrification (HP+PV)	2,000+	All	Multiple	●	○	◐	●	●	◐

[A] CRE = Comm. Real Estate, Multiple = 3+ Market Segments, CP = Central Plant, FSGR = Food Service/Grocery/Retail

[B] Includes Non-Fuel switching applications only as a conservative estimate

[C] For consideration in single- or multi-building configuration

Legend: Low=○ Med=◐ High=●

2nd Screen Top Tech – Non-HP HVACR & Water Heating

Refined 5/13/21 (post Stakeholder Discussions)

Non-HP HVACR Technology	Primary Savings Potential (TBtu/yr)	New or Existing Buildings	Key Market Segment[A]	Energy Savings	Grid Flexibility Value	Stakeholder Interest	Criticality of CBI Involvement	Cost & Reduction Potential	Non-Energy Benefits
Air Treatment to Reduce HVAC Load	1,000	All	Multiple	●	○	○	◐	◐	◐
Variable Capacity HVAC Products	200	All	Multiple	◐	◐	●	○	◐	◐
Advanced, Grid-Connected Refrigeration Controls	200	All	FSGR	◐	●	○	◐	◐	◐

Water Heating Technology	Primary Savings Potential (TBtu/yr)	New or Existing Buildings	Key Market Segment[A]	Energy Savings	Grid Flexibility Value	Stakeholder Interest	Criticality of CBI Involvement	Cost & Reduction Potential	Non-Energy Benefits
CO_2 Split-System HPWH	600 [B]	All	CRE, FSGR	◐	○	●	◐	◐	◐
Grid-Connected HPWH	400 [B]	All	CRE, FSGR	◐	◐	●	●	○	○

[A] CRE = Comm. Real Estate, Multiple = 3+ Market Segments, CP = Central Plant, FSGR = Food Service/Grocery/Retail

[B] Includes Non-Fuel switching applications only as a conservative estimate

Legend: Low=○ Med=◐ High=●

2nd Screen Top Tech – Indoor Agriculture and Envelope

Refined 5/13/21 (post Stakeholder Discussions)

Indoor Agriculture Technology	Primary Savings Potential (TBtu/yr)	New or Existing Buildings	Key Market Segment[A]	Energy Savings	Grid Flexibility Value	Stakeholder Interest	Criticality of CBI Involvement	Cost & Reduction Potential	Non-Energy Benefits
LED Grow Lights	200	All	Indoor Ag	◐	○	●	●	◐	○
High-Efficiency, Integrated Equipment with Advanced Controls for Indoor Ag	50	All	Indoor Ag	○	●	●	◐	◐	◐

Envelope Technology	Primary Savings Potential (TBtu/yr)	New or Existing Buildings	Key Market Segment[A]	Energy Savings	Grid Flexibility Value	Stakeholder Interest	Criticality of CBI Involvement	Cost & Reduction Potential	Non-Energy Benefits
Secondary Glazing (e.g., Storm Windows)	2,000+	Existing only	Multiple	●	○	●	◐	◐	●
Thin Triple Pane Windows	900	All	CRE	◐	○	●	◐	●	●
Dynamic Windows (e.g., Electrochromic)	600	All	CRE	◐	○	◐	●	○	●

[A] CRE = Comm. Real Estate, Multiple = 3+ Market Segments, CP = Central Plant, FSGR = Food Service/Grocery/Retail

Legend: Low=○ Med=◐ High=●

2nd Screen Top Tech – Whole Building

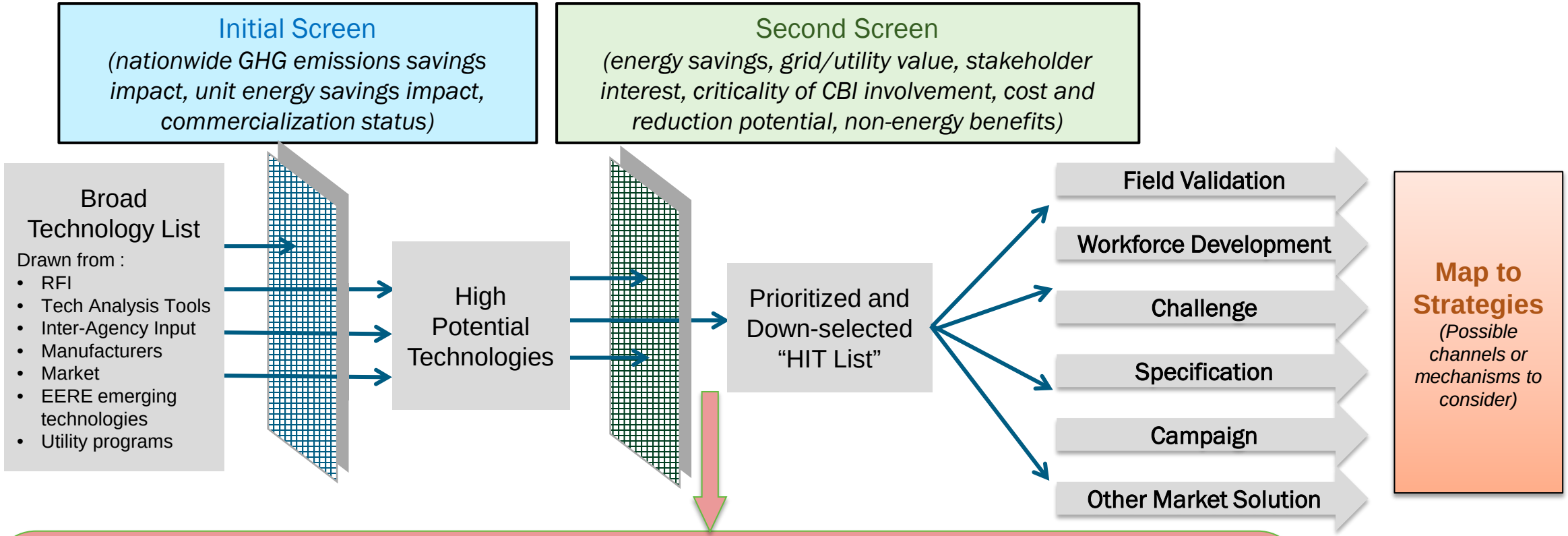
Refined 5/13/21 (post Stakeholder Discussions)

Whole Building Technology	Primary Savings Potential (TBtu/yr)	New or Existing Buildings	Key Market Segment[A]	Energy Savings	Grid Flexibility Value	Stakeholder Interest	Criticality of CBI Involvement	Cost & Reduction Potential	Non-Energy Benefits
Whole Building AFDD and Controls	1,000	All	CRE	●	○	◐	◐	◐	●
AI-Enabled Energy Management Tools	500	All	Multiple	◐	◐	◐	●	◐	●
Perimeter Zone Daylighting	800	All	CRE	●	○	◐	◐	◐	◐
DC Power in Buildings	1,200	All, but uses vary	Multiple	●	○	◐	◐	◐	◐
Small/Medium Sized Building Energy Management System	700	All	CRE, FSGR	◐	●	◐	◐	○	◐
Smart Thermostat	600	All	CRE, FSGR	◐	●	◐	○	○	◐
Flexible IoT for Unconnected Products	600	All	CRE	◐	◐	○	●	●	○
Task Light & Plug Load Circuit Controls	200	All	CRE	◐	●	○	○	○	○

[A] CRE = Comm. Real Estate, Multiple = 3+ Market Segments, CP = Central Plant, FSGR = Food Service/Grocery/Retail

Legend: Low=○ Med=◐ High=●

Next Steps



Next Steps:

1. Conduct stakeholder workshops in March, April, and May
2. Update second screen with initial feedback
3. Publish RFI to gather additional feedback
4. Complete second screen updates and identify 2021 HIT list
5. Develop draft 2021 Deployment Strategy
6. Circulate Deployment Strategy for feedback from labs and external stakeholders

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Appendix A – First Screen Scoring Metrics

FIRST SCREEN			
CRITERION			SCREENING SCORE DESCRIPTION
Nationwide GHG Emissions Savings Impact	YES	Pass	GHG Emissions reductions are achieved via: **Efficiency:** national technical energy savings potential (100% adoption) of >50 TBtu/yr (primary energy) OR **Substantial indirect savings:** a) Enablement of cost-effective beneficial electrification based on projected grid mix in the next 5 years; OR b) Flexibility: optimal use of low-emissions-factor power (especially shed)
	NO	Fail	Does not meet the requirements above
Unit Energy Savings Impact	YES	Pass	Unit site energy savings of 10% or more energy reduction or equivalent, relative to standard baseline
	NO	Fail	Does not meet the requirements above
Commercialization Status	1	Fail	Measure prototypes of the full system or subsystems are not ready for testing outside the lab
	2	Pass	Measure prototypes already in the field or will be in the next 3 years through normal market channels
	3	Fail	Technology adoption is beyond the level appropriate for DOE involvement (excluding codes/standards)

Appendix B – Second Screen Scoring Metrics

Score	Description – Energy Savings (Weight = 40%)
High = ●	>700 TBtu/yr primary energy savings potential (on-site electric + fossil fuel)
Med = ◐	200-700 TBtu/yr primary energy savings potential (on-site electric + fossil fuel use)
Low = ○	<200 TBtu/yr primary energy savings (on-site electric + fossil fuel use)

Score	Description - Grid Flexibility Value (Weight = 20%)
High = ●	Extensive flexibility benefits via load shedding/shifting/modulation that enable grid operators to better dynamically manage supply/demand including reduced emissions and incorporation of more renewable energy resources
Med = ◐	Moderate flexibility benefits to the grid as listed above
Low = ○	Little or no flexibility benefits to the grid as listed above

Appendix B – Second Screen Scoring Metrics (Cont.)

Score	Description – Stakeholder Interest (Weight = 10%)
High = ●	Clear interest from stakeholders indicates higher likelihood of market adoption; stakeholders express interest in value of DOE involvement
Med = ◐	Some support and interest, but DOE support could provide increased capacity or reach; building owner needs may be limited and/or not well articulated
Low = ○	Little interest from industry stakeholders

Score	Description – Criticality of CBI Involvement (Weight = 10%)
High = ●	Clear gap exists for critical support needed for substantive market impact
Med = ◐	Industry providing only some support OR clear gap for DOE support not critical to the commercialization pathway for the technology
Low = ○	Industry already encouraging and progressing independently

Appendix B – Second Screen Scoring Metrics (Cont.)

Score	Description – Cost & Reduction Potential (Weight = 10%)
High = ●	Currently or expected to be cost effective OR significant cost reductions may be expected in soft costs or via tech breakthroughs
Med = ◐	Perceived as expensive, but may offer more cost benefits OR additional analysis needed to understand real cost and market/technical barriers
Low = ○	Not cost-effective (payback > 10 years)

Score	Description – Non-Energy Benefits (Weight = 10%)
High = ●	Substantive non-energy benefit(s) of value to customers and stakeholders exist
Med = ◐	Non-energy benefits present, but not a significant market consideration
Low = ○	No obvious non-energy benefits

Example Non-Energy Benefits: improved IAQ, improved comfort, reduced downtime, elimination of high-GWP refrigerants, enabler of low-carbon electrification, smaller footprint, water savings, easier commissioning, less complex installation, improved installation quality/consistency.

Appendix C – Definitions of Second Screen Tech (Score > 1.8)

Rank	Technology	Description
1	Multi-Building (e.g., District) HP	District scale heat pump to serve multiple off-takers in a community-based architecture; may include innovative business models to promote low-cost solutions; could include air-source, ground-source, waste-water source
2	Low-Carbon Thermal Electrification (HP+ Solar PV)	Rooftop solar (PV) paired with space heating units deployed in tandem to provide 100% of building heating (assuming net metering is present) with renewables, electrifying 100% of gas/oil heating load, potential to include central plants, cold climates, hot water
3	Secondary Glazing (e.g., storm windows)	Interior and exterior retrofit window solution with low emissivity coatings to reduce heating and cooling loads and increase comfort
4	Dual-Source (Air/Water) HP	Demonstrate and deploy dual source heat pumps in commercial buildings in non-coldest climates; for providing water source (for simultaneous heat recovery) and air source capabilities
5	Cold Climate Rooftop Unit HP	Development of techniques to raise heat pump performance at low-ambient; elimination of defrost (or frost buildup) and backup heat sources to improve the application of cold-climate heat pumps.
6	Whole Building AFDD and Controls	Whole building software tool that communicates with an EMIS and uses AI to determine faults that significantly increase whole building energy consumption- optimal whole building controls for fault detection and diagnostics in large comm. buildings (>100,000 sq ft.)
7	Ground Source HP - 3rd Party Owned Loop	Implement new financial and business models in conjunction with GSHP to improve effectiveness and strength of applicability. Research strategies to improve GSHP ground-loop cost and performance; also consider siting, installation, and modeling to reduce costs.
8	AI-Enabled Energy Management Tools	Artificial intelligence (AI), encompassing machine learning (ML) and other problem-solving approaches to leverage large amounts of data for sensing, predictive control, and analytics to optimize performance of building systems (HVAC, lighting, etc.)
9	Perimeter Zone Daylighting	Research, develop, and demonstrate daylight-responsive dimming (Photosensor-Based Lighting Controls) in commercial buildings
10	DC Power in Buildings	The use of DC power distribution within buildings instead of traditional AC distribution, which enables savings from reduced AC/DC conversions for solar PV, battery storage, and DC-based equipment
11	Air Treatment to Reduce HVAC Load	Reduces the volume of outside air required to maintain indoor air quality (IAQ) by using absorbent materials to selectively remove contaminants from HVAC airflow while minimizing pressure drop

Second Screen Outputs – 1 of 4

Appendix C – Definitions of Second Screen Tech (Score > 1.8)

Rank	Technology	Description
12	Advanced, Grid-Connected Refrigeration Controls	Advanced controllers in new system installations with GEB capability to participate in demand response: 1) reduced compressor cycles 2) shift peak load time with scheduling mechanisms/inherent thermal storage, 3) robust control for efficiency and fault reduction
13	Small/Medium Sized Building Energy Management System	Low cost, open architecture energy management platform allows building operators to coordinate commercial off-the-shelf hardware, solar photovoltaic and demand response systems within a single management/control user interface
14	Thin Triple Pane Windows	Highly insulating triple glazed glass (thin non-structural center glass and argon or krypton fills) that do not require changes in current frame designs
15	Smart Thermostat	Fully programmable and equipped with wireless connectivity, featuring standard temperature sensors with humidity, CO2, and motion options - pneumatic controls (Wireless BACnet Thermostat, Verdant)
16	Flexible IoT for Unconnected Products	All in one hardware and software solution built to be able to grow and adopt new technologies. with visuals of the system and installed devices, such as real-time 3D views, charts, dashboard, web and iOS controls, allowing for easy control and monitoring (GridRabbit)
17	Variable Capacity HVAC Products	Use of variable capacity compressors in HVAC products to more precisely respond to cooling needs and increase efficiency
18	Grid-Connected HPWH	HPWH can be deployed with an existing water heating system and utilize an existing water tank in small commercial buildings (health care, food service, and lodging)
19	Variable Refrigerant Flow HP (VRF)	Similar to ductless split systems but with larger capacity (condensing units up to 30 tons) with the ability to control the amount of refrigerant flowing indoor units, allowing simultaneous heating and cooling in separate zones without using the compressor
20	Wastewater-source HP (Sewer Thermal)	Uses a self-contained refrigerant-based heat pump to recover energy from wastewater, greywater, and blackwater streams exiting commercial buildings or existing sewer systems
21	Cold Climate Rooftop Unit HP	Development of techniques to raise heat pump performance at low-ambient; elimination of defrost (or frost buildup) and backup heat sources to improve the application of cold-climate heat pumps.
22	LED Grow Lights	Use of LED lights in indoor agriculture operations

Second Screen Outputs – 2 of 4

Appendix C – Definitions of Second Screen Tech (Score > 1.8)

Rank	Technology	Description
23	Dynamic Windows (e.g., Electrochromic)	Automated shades for exterior or interior integrated with other controls and building management systems to lower energy costs and reduce glare and over-heating. Dynamic windows includes electrochromic, photochromic, and thermochromic tints
24	CO_2 Split-System HPWH	HPWH where the heat pump and water storage are separated into distinct units, and CO2 is used as the refrigerant in the heat pump, which sits outside (and doesn't reduce heat inside)
25	High-Efficiency, Integrated Equipment with Advanced Controls for Indoor Ag.	Packaged equipment and controls for high-efficiency lighting, ventilation, space conditioning, and water supply systems for indoor agriculture facilities; widely applicable across crop and building types (e.g., supplemental greenhouses, vertical farms)
26	Task Light & Plug Load Circuit Controls	Use of controllable power outlets that are turned off during unoccupied hours using timer control, and that respond to trends in building use to optimize comfort and efficiency
27	Variable Speed Motors (All Applications)	Deploy variable speed motors in place of single-speed motors in multiple residential & commercial applications
28	Micro CHP	Combined heat and power (CHP) cogeneration unit that is suited to small building applications (<50 kW) to produce electricity or mechanical power and useful thermal energy (heating and/or cooling) from a single source of energy
29	RTU Control Retrofit (DCV+Econ+VSD+Other)	Controller pack to RTU with gas furnace for demand-controlled ventilation, with digital economizer (differential high limit control), low excess baseline ventilation, fan control, robust start, warmup ventilation lockout, occupancy sensor standby, and temperature limits
30	Energy Management for Data Centers (IT)	Server virtualization, decommissioning of unused servers, consolidation of lightly utilized servers, better management of data storage, and purchasing more energy-efficient servers, UPSs, and PDUs
31	LED Retrofit Kits with Advanced Lighting controls (ALC)	Retrofit kits with advanced lighting controls, designed to upgrade existing recessed fluorescent troffer lighting to LED lighting without requiring a full fixture replacement or work in the ceiling plenum
32	Human Centric/Adaptive Lighting	Optimizes lighting output and spectrum for occupant health/productivity while reducing unnecessary output
33	Facility Integrated Cloud-Based Building OS with Machine Learning	Cloud-based building OS with platform and analytics also available in an internal server environment that integrates into any facility while using ML to build a memory of building rhythm to predict, prescribe, and influence building performance (Nantum Building OS)

Second Screen Outputs – 3 of 4

Appendix C – Definitions of Second Screen Tech (Score > 1.8)

Rank	Technology	Description
34	Aerogel in Walls, Ext R-20	Rolled aerogel sheet in walls in all commercial buildings (exterior insulation (R-20)), such as Thermablok. Especially good at preventing heat loss through framing.
35	Modified Atmosphere Insulation Panels R-40	Modified atmosphere insulation (MAI) is a next-generation insulation technology achieving about R40/inch. It contains an evacuated nano-porous core encapsulated by a barrier film.
36	Airflow Balancing (e.g., 75°F)	A method of maintaining constant rates of airflow in all zones to improve indoor air quality and lower excess energy use
37	Monitoring Based Commissioning (MBCx)	Turnkey hardware-software solution to enable cost-effective, monitoring-based RCx of small comm. buildings. Contains a suitcase of sensors for short-term data collection and a software application that analyzes sensor data, identifies problems, and generates recommendations
38	Liquid Desiccant AC (LDAC)	Multi-stage liquid desiccant dehumidifier and cooler controlled by measuring the total enthalpy in the building and adjusting either humidity or temperature for comfort, to optimize building loads, increase efficiency, and reduce peak loads
39	Cold Climate DOAS Rooftop Heat Pump	Dedicated outdoor air rooftop packages only - develop techniques to raise heat pump performance at low-ambient temperature; consider elimination of defrost (or frost buildup) and backup heat sources to improve the application of cold-climate heat pumps
40	Cold Climate VRF Heat Pump	VRF systems only, Commercial Ductless Split Heat Pump Systems and Inverter-Driven/Variable-Speed Compressors - Develop techniques to raise heat pump performance at low-ambient temperature
41	In-Building Wastewater Recycling	Wastewater recycling systems designed for hotels and laundry facilities to reduce water and detergent use, preventing reheating
42	Solar WH Ind Act, Gas BU	Decrease cost & deploy indirect, active solar water heating with gas back-up to commercial buildings
43	Integrated Heat Pump (IHP)	Develop, demonstrate, and deploy integrated heat pumps which can provide space cooling, heating, ventilation, and dehumidification while maintaining comfort and meeting domestic water heating needs
44	Building-Focused Distributed Energy Resource Management Systems (DERMS)	Application that allows access into smart inverters, storage, combined heat and power units (CHPs) and other distributed generation resources to improve grid reliability, ensure power quality, and enable ancillary services. Currently solar/storage/generator focused.