

DOE-BTO Summary Wrap-Up

Technical Meeting

Physical Characterization of Connected Buildings Equipment

Chicago, Illinois
January 28-29th, 2015

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BTO Technical Meeting

- **Background:**

- BTO envisions that valuable services can be delivered to end-users, the grid, and society using connected building equipment at scale.
- In order to quantify the ability of connected equipment to deliver services, the physical and informational responses of the equipment must first be understood.
- Engaging industry in the development of physical characterization protocols through the public meeting process and ASRAC working group is desired.

- **Prior Public Engagement**

- Public meetings held on April 30th and July 11th 2014.
- “A Framework for Characterizing Connected Equipment,” Published in EERE-BT-NOA-0016, FR V.79, N.157, 47633, Aug. 14, 2014.

- **Goals of technical meeting held in January 2015:**

- Discuss outstanding issues raised in past characterization meetings.
- Hear from industry on their vision and perspective of connected equipment.
- Develop prioritized list of equipment to be characterized.
- Strengthen case for ASRAC to form a working group for developing characterization protocols.
- Continue to engage industry in an open and transparent process.

Agenda: Jan. 28th, 2015

Time	Topic	Presenter
1:00 pm	Welcome, Ground Rules, Introductions	J. Ramirez, FMCS
1:15	DOE Introduction, Vision, Context, and Core Operating Principles	J. Hagerman, DOE-BTO
1:45	Discussion Topics Identified by Stakeholders During Previous Public Meetings	
	<ol style="list-style-type: none"> 1. Scope and status of ongoing, related work 2. Reference architectures and their implications 3. Viewpoints in eligibility and approved responses 4. Impact of characterization on voluntary programs 5. Implications of interoperability on characterization 6. Identifying services that can be delivered 7. Informing stakeholders of services that can be delivered 	<p>E. Mayhorn, PNNL E. Mayhorn, PNNL S. Whalen, PNNL J. Hagerman, DOE-BTO J. Hagerman, DOE-BTO J. Hagerman, DOE-BTO J. Hagerman, DOE-BTO</p>
3:30	Invited Industry Presentations	
	<p>Speakers were asked to address each of the following questions:</p> <ul style="list-style-type: none"> • What is your vision for connected equipment? • What are the key challenges to market uptake? • How can DOE help industry address these challenges? • What timeline do you envision for uptake? • Who should be involved in the development of characterization protocols? 	<p>L. Petrillo-Groh, AHRI R. Lord, United Technologies L. Kiff, Honeywell J. Bentz, Johnson Controls R. Narayanamurthy, EPRI</p>
5:30	Adjourn	

Agenda: Jan. 29th, 2015

Time	Topic	Presenter
8:00 am	Key Outcomes from Day 1	J. Ramirez, FMCS
8:15	Inventory of Equipment from DOE-BTO Prioritization Tool	J. Hagerman, DOE-BTO
8:45	Early Thinking on Connected Equipment Maturity Model	S. Whalen, PNNL
9:00	Prioritizing Connected Equipment for Characterization	J. Ramirez, FMCS
10:15	Break	
10:30	Test Rig Facilities to Characterize Connected Equipment	C. Booten, NREL
11:30	Next Steps	J. Hagerman, DOE-BTO
11:45	Adjourn	

Industry Participants



- Traulsen
- Johnson Controls
- NAFEM
- AHRI

- Southern Company
- Emerson
- EPRI
- United Technologies

- Honeywell
- Lennox

A brief summary of each discussion topic in the agenda session titled “Discussion Topics Identified by Stakeholders During Previous Public Meetings” is given in the following slides 7-12

Discussion Topic #1: Scope/Status of Ongoing Related Work

EPA - Energy Star Program

- Developed criteria to recognize connected equipment
 - Defined target response requirements for 2 specific grid services
 - Peak load reduction
 - Spinning reserve
 - Require communications to be based on any standards listed in SGIP catalog, NIST Smart Grid Framework, or those adopted from well known standards making organization
 - Connected equipment allowed to consume 5% more energy than normally required
- Developed test methods to verify response requirements
 - Residential refrigerators and freezers, clothes washers, dishwashers, and pool pumps (in progress)

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Australia - Department of Industry

- Developed a standards-based strategy to create a market for electrical products with demand response capabilities
- Established terminology, basic architecture, and satisfactory response modes based on DLC and price driven DR arrangements
- Developed voluntary standard AS/NZS 4755
- Prioritized equipment based on current challenges with the Australian power grid
 - Covers residential air conditioners, water heaters, pool pumps, and EVs
- Verified consumer satisfaction with requirements defined through field testing

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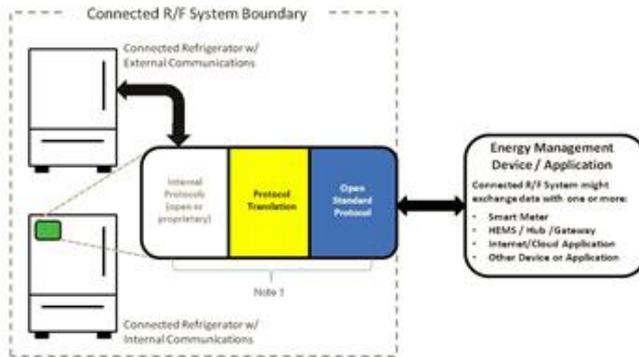
• Summary

- Other work is almost exclusively focused on characterizing demand response
- Need to consider consumer satisfaction when developing characterization protocols
- Complement, not replicate, ongoing work when possible
- Leverage lessons learned from other efforts
- Participate in related efforts as invited/permitted

Discussion Topic #2: Reference Architectures & their Implications

Bounding Example 1

Connected equipment has the capability to receive, interpret and respond to external signals.



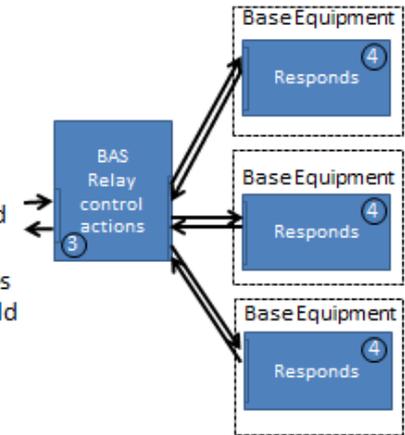
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Bounding Example 3

Questions

1. What is considered to be the connected equipment?
2. Which components should be characterized?
3. What physical and informational capabilities should be characterized in connected equipment?
4. Should there be different categories of connected equipment that should be characterized differently?
5. What should be the scope and boundaries for characterizing connected equipment?



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Summary

- Articulate the boundaries of connected equipment
- Establish common characterization approach for similar equipment types
- Help identify functionality that could be included
- Orient proxy equipment (i.e. interface between signal and equipment – like HEMS)

Discussion Topic #3: Eligibility Criteria and Approved Responses

Approved Response List

- DOE proposes an approved response list to assure stakeholders that equipment responses have value and reflect services
- Developing and maintaining the approved list of responses may reside with a committee responsible for developing characterization protocols

Should there be an approved list of responses to be characterized?



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Minimum Eligibility Criteria

- Propose that equipment have minimum features in order to qualify for characterization as connected equipment (go/no-go)
- For example, minimum features may include:
 - Two-way digital electronic communication
 - At least one automated response from an approved list of responses

Should there be a step to determine eligibility for characterization?

If so, what are the minimum features?

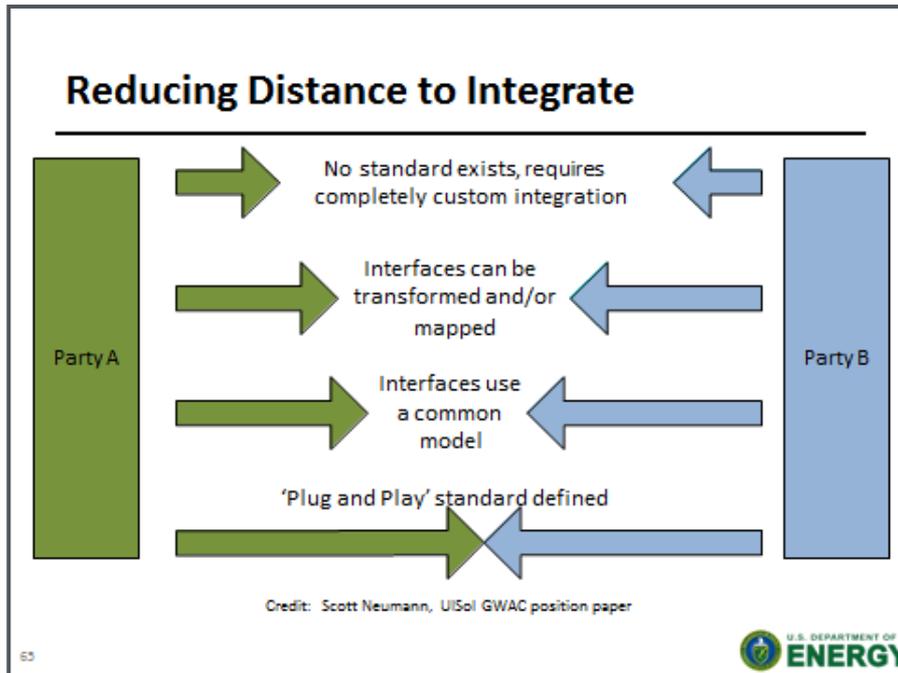


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Summary

- General agreement that there should be approved responses
- The LEED program is an example of implementing approved responses
- Allows for varying degree of sophistication
- Must be done in a way that does not stifle innovation
- Possibly look to CEE as an example of providing eligibility/approved list

Discussion Topic #4: Implications of Interoperability on Characterization



National Strategy for Interop Whitepaper*

- Task 1: Develop an interoperability vision
 - Invite stakeholders to align on an aspiration for the future
 - Result: vision document through technical meetings engagements
- Task 2: Develop a baseline and framework for stakeholder taxonomy
 - Assemble sources of interoperability information
 - Identify a stakeholder taxonomy and important organizations
 - Result: landscape document and plan for stakeholder engagement
- Task 3: Develop a multi-year roadmap
 - Prepare a process to create a roadmap
 - Result: roadmap document through technical meeting engagements

"The deployment of connected equipment is an untapped national opportunity – for operational efficiency, for new business growth, and to lessen the effects and burdens of climate response."¹⁰

* Joe Hagerman, "Towards a National Strategy for the Interoperability of Connected Equipment," 14 Aug 2014

U.S. DEPARTMENT OF ENERGY

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• Summary

- Deployment of connected equipment at scale will only occur if interoperability is addressed
- Consider interoperability looking forward, legacy equipment will eventually be replaced
- IT, Interoperability, Security and privacy are viewed as major barriers
- Proprietary solutions will evolve in the absence of a compelling interoperability case.

Discussion Topics: Impact of Characterization on Voluntary Program (#5)

Identifying of Services that can be Delivered (#6)

Impact of Characterization on...

- Utility programs for connected equipment
 - Develop business models
 - Quantify benefit
 - Craft incentive programs
 - Identify new value streams
- Owners of connected equipment
 - Weigh benefits of connected equipment vs. non-connected equipment
 - Increase awareness of new opportunities and value streams
 - Understanding capabilities

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The Reference Guide: A Vision for Services

- Grid Services
 - Traditional services the Grid needs-from DR to Ancillary Services
 - How can EERE technologies deliver these services at the lowest cost?
 - McKinsey report quantifies the value of these services but it does not match solutions to EERE technologies
- End User Services
 - Operations, Maintenance, and Energy Efficiency of behind the meter assets (example: EE, Continuous Commissioning)
 - EERE technologies have historically focused on these services. How can we best consolidate these value streams?
- Energy Market Services
 - New services where energy production and “use” can be exchanged between parties (potentially outside of regulated markets). Example: Provision of energy storage to avoid capacity charges
 - How do we explain and then help the market capture these values? We must identify potential energy market services that can be provided by these technologies.
- Societal Services
 - Services that “society” needs or values (example: Staging of recovery)



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• Summary

- Characterization can help service providers define their voluntary programs
- Characterization can help consumers evaluate benefits of connected equipment
- Classes of services were described and additional service examples were invited

Discussion Topic #7: Informing Stakeholders of Services that can be Delivered

Informing Stakeholders of Services

- As potential users of connected equipment; utilities, building owners, operators, and consumers should be aware of service that connected equipment can deliver.
- What information should be communicated?
 - Checklist of responses connected equipment is capable of
 - Metrics from characterization
- How should information be communicated?
 - Periodic reports
 - Online registry
 - Label rating or scoring program
 - Some combination

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Informing Stakeholders of Services

- As makers of connected equipment, manufacturers should be aware of the functions and responses that are needed to provide services to users.
- What information should be communicated to manufacturers?
 - Information from characterization of non-connected equipment
 - Guidelines or specifications for response capabilities
- How should information be communicated?
- In general, what should DOE's role be in informing manufacturers and users?

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• Summary

- Consumers should be made aware of services that connected equipment can deliver
- Manufacturers should be made aware of functions that might be needed to provide services
- Discussed what and how information can be communicated to consumers and manufacturers

Industry Presentations



- **Key industry stakeholders were invited to share their perspective on connected equipment and to discuss the following five questions:**
 1. What is your vision for connected equipment?
 2. What are the key challenges to market uptake?
 3. How can DOE help industry address these challenges?
 4. What timeline do you envision for uptake?
 5. Who should be involved in the development of characterization protocols?

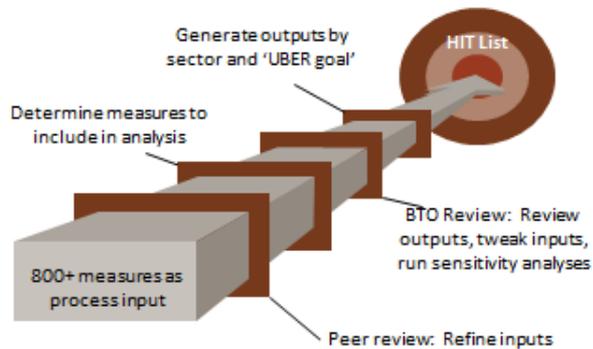
Please see the separate presentations provided by industry on the DOE Buildings to Grid meeting website

Inventory Equipment from DOE-BTO Prioritization Tool (Day 2)

Example #1: The P-Tool can be used to identify high impact technologies

A list of High Impact Technologies (HITs) are developed for the following end-use areas:

- Windows
- Envelope
- Water Heating
- HVAC
- Appliances
- Miscellaneous Electric Loads (MELs)



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Within the commercial building sector, there are many different technologies that consume energy

	Energy Use (TBTU, 2010, site)	Floorspace (billion sq.ft.)		Energy Use (TBTU, 2010, site)	Floorspace (billion sq.ft.)
Cooling			Electronics		
1. Rooftop Unit.....	219	35	1. Office Equipment - non-PCs....	227	81
2. Chiller (Recip., screw, scroll)....	107	17	2. Office Equipment - PCs.....	137	81
3. Centrifugal Chiller.....	62	10	Water Heating		
4. Residential Style A/C.....	34	9	1. Natural Gas Water Heaters....	460	38
5. Well/Window A/C.....	32	8	2. Electric Water Heaters.....	90	17
6. Air- & Ground-Source Heat Pump	7	1	3. Distillate Water Heaters.....	20	3
Heating			Appliances		
1. Natural Gas Furnace.....	1,082	41	1. Refrigeration Equipment.....	392	81
2. Natural Gas Boiler.....	334	21	2. Cooking Equipment.....	209	81
3. Distillate Boiler.....	91	3	3. Dishwashers.....	84	0.4*
4. Electric Resistance.....	77	3	Lighting		
5. Electric Boiler.....	36	3	1. Linear Fluorescent.....	2,716	1,631*
6. Distillate Furnace.....	39	3	2. High Intensity Discharge.....	540	33*
7. Air- & Ground-Source Heat Pump	47	3	3. Reflectors.....	166	76*
			4. General Service Lamp.....	141	75*

* Note: Stock is provided in equipment units (millions), rather than commercial floor space.

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• Summary

- Prioritization tool could help with identifying high impact equipment for characterization
- Criteria such as technical potential and adoption potential are applicable to connected equipment as well

Early Thinking on Connected Equipment Maturity Model

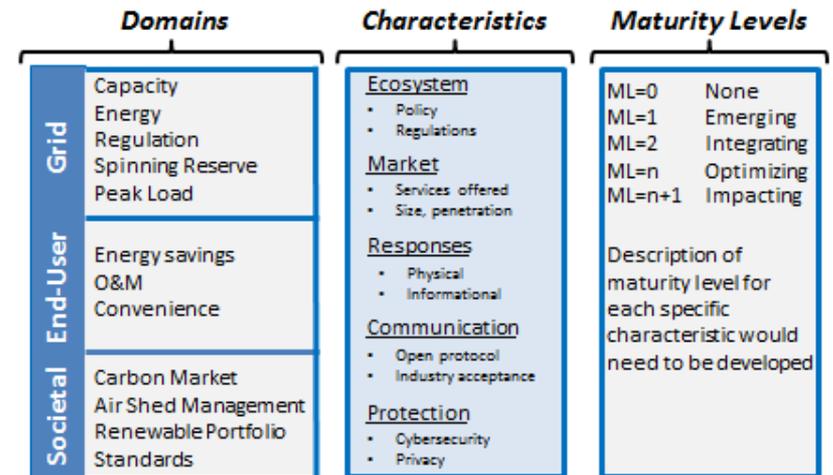
Essential Elements of Maturity Models

- **Domains**
 - Broad areas of importance (value) over which maturity is tracked
 - For example: Risk management
- **Characteristics**
 - Detailed attributes within a domain for which survey questions
 - For example: Does a database exist for capturing risks? Are the risks regularly evaluated? Are the formal procedures for risk mitigation?
- **Levels**
 - Score given to quantify maturity usually having a number and title
 - For example: 0=Default, 1=Initiating, 2=Improving, 3=Pioneering

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Maturity Model for Connected Equipment



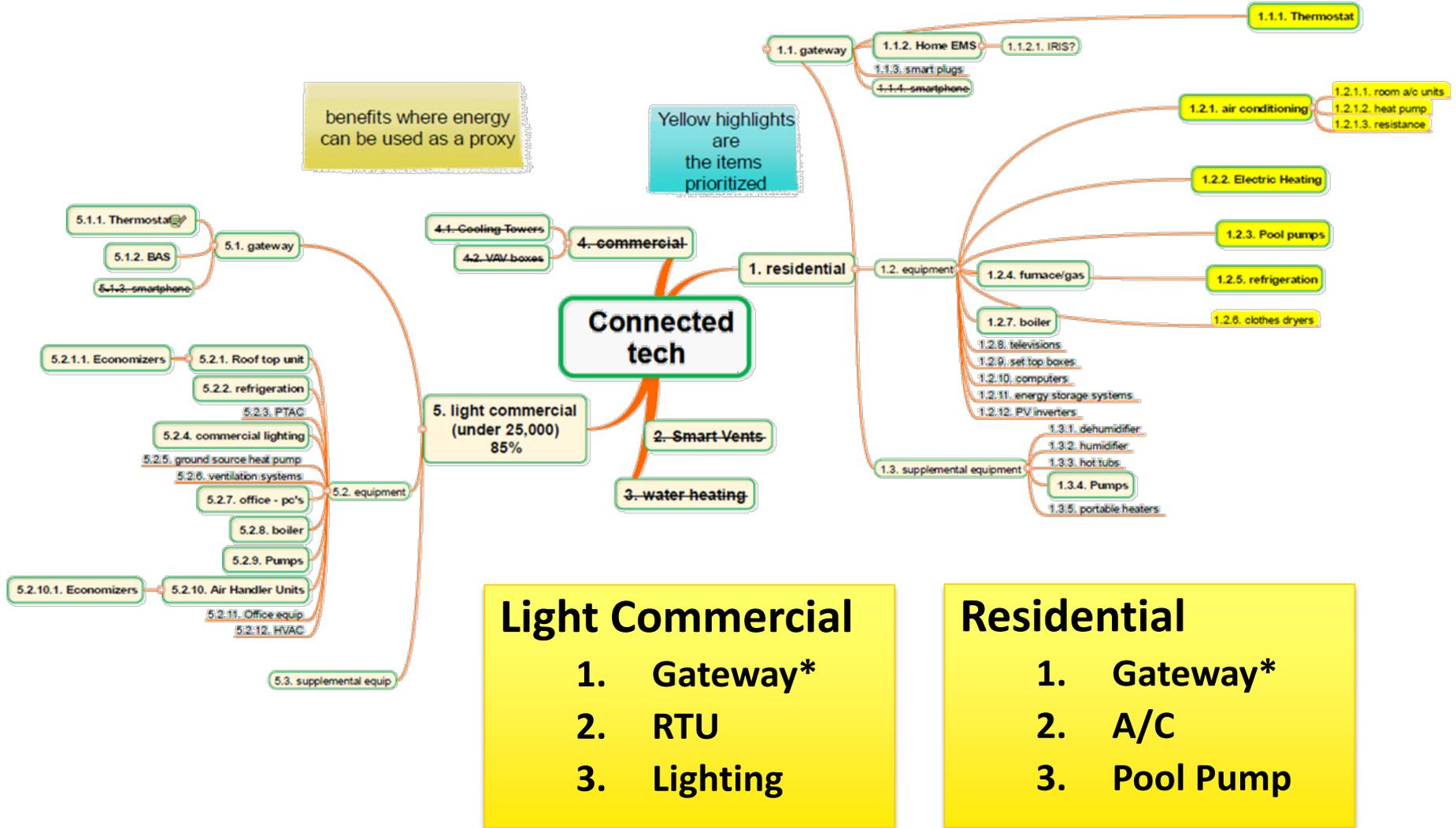
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• Summary

- Tool for evaluating the status of connected equipment at the national, sector, industry, or specific equipment type
- Models used to benchmark status, analyze gaps, prioritize improvement efforts, inform road mapping efforts, track progress over time
- Support for undertaking maturity model with industry engagement

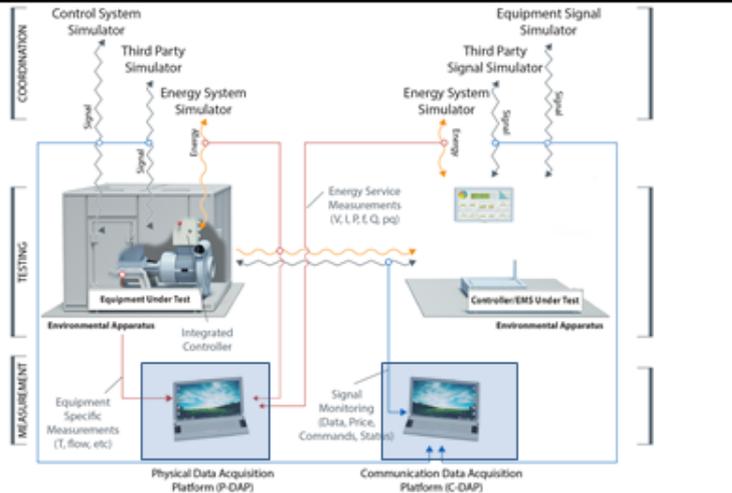
Initial Thinking on Prioritization of Connected Equipment for Characterization: Working Session with Industry



By "Gateway" we are referring to equipment such as a thermostat, BEMS, HEMS or other proxy that acts as an interface for the base equipment.

Test Rig Facilities to Characterize Connected Equipment

Measurement

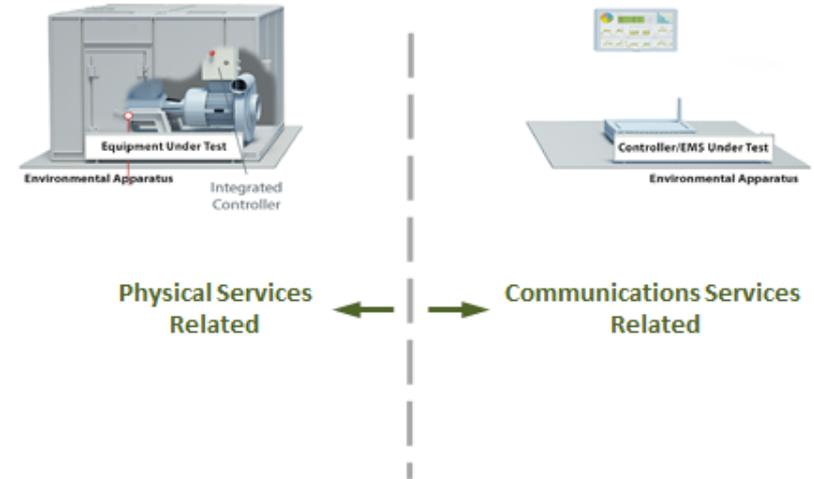


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Testing

the sequence of procedures and conditions the equipment will be subjected to for characterization



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- **Summary**

- Discussed test rigs for characterizing physical and informational responses
- Experiments will leverage existing test methods where possible to minimize burden
- Test rig facility will undergo public review process similar to characterization framework

General Meeting Takeaways

- **Going beyond demand response**

- DR has existed for more than 30 years, and most consumers have little incentive to use or purchase equipment with DR capability
- Need to identify the needs for connected equipment from the consumer perspective in addition to other stakeholders
- Market needs should be understood horizontally (needs of different stakeholder groups) and vertically (categories within a stakeholder group)
- From consumer perspective, drivers for connected equipment will likely be ease-of-use, comfort, cost savings, and building automation; not grid related services
- Utilities want more capabilities to shape load

General Meeting Takeaways (2)

- **Boundaries and scope of connected equipment characterization**
 - Should focus on equipment for residential and the 80% of commercial buildings without advanced building controls; not legacy systems
 - Gateway and base equipment should be characterized individually
 - For gateway equipment (e.g. HEMs, thermostats) two-way communication is key to verify performance
 - Consider effectiveness of the ecosystem and not just the individual components
 - May be more value in characterizing informational responses than physical responses

General Meeting Takeaways (3)

- **Minimum requirements for connected equipment**
 - Define min. requirements or baseline criteria for equipment
 - Innovation will be primarily in higher-end equipment
 - Utilities want to identify capabilities are & incentivize useful ones
 - Technical working group perfect way to establish min. requirements
- **Maturity Model**
 - Stakeholder groups agreed that a maturity model for connected equipment would be useful
 - Consider market segments in model
 - Dividing markets vertically could help identify which consumer markets may see value from providing grid services

General Meeting Takeaways (4)

- **Prioritized Equipment**

- Gateways (e.g. HEMs, thermostats) were deemed the highest priority for characterization protocol development
- Next priority is space conditioning equipment (RTUs for light commercial buildings , ACs for residential)

- **Other key comments**

- Agreement that there may be different levels of being “connected”
- Take small steps to start with because they are at least tractable
- In absence of interoperability, proprietary solutions will be developed
- Biggest barriers for a connected equipment market are business case and interoperability/security/privacy
- There is a considerable difference between consumer behavior and equipment needs in residential and small commercial buildings