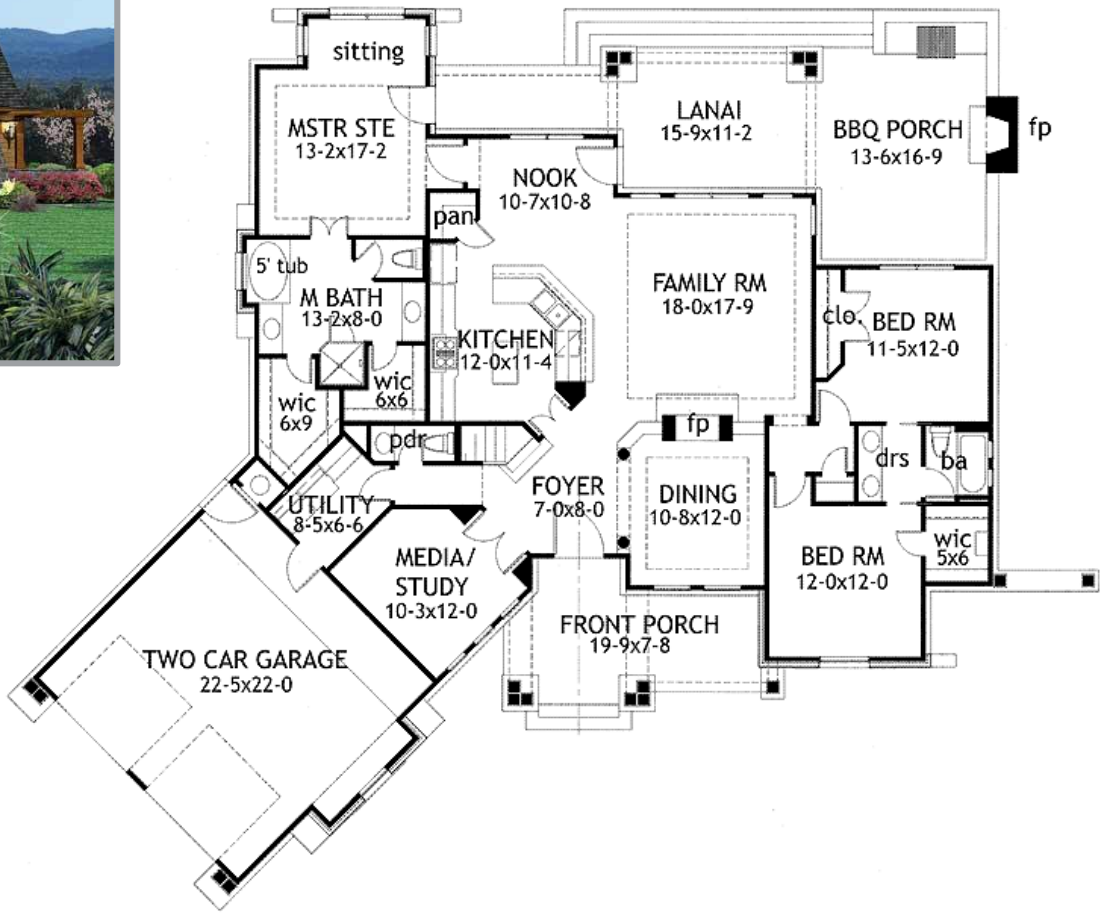
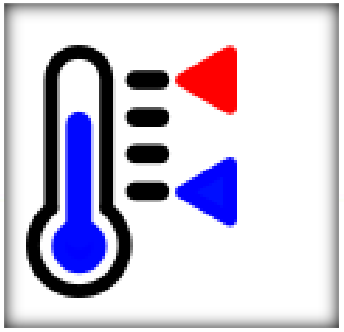
Advanced Occupancy Sensors for Better Buildings Workshop

July 12 – July 13, 2016
Portland, OR

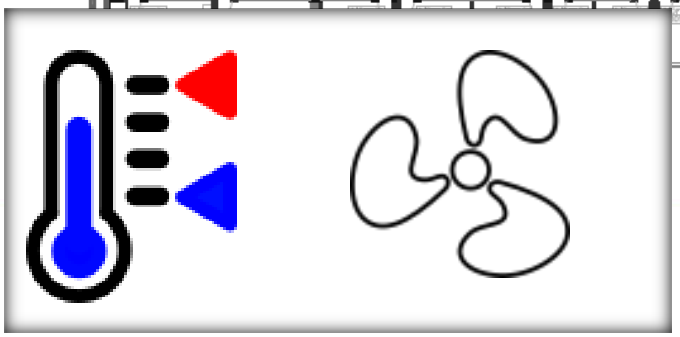
PD: Jennifer Gerbi

What happens when you're not home?





What happens when you're not at work?



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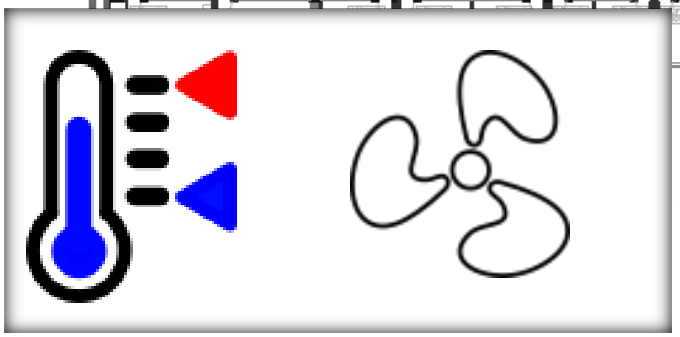


What's Missing?

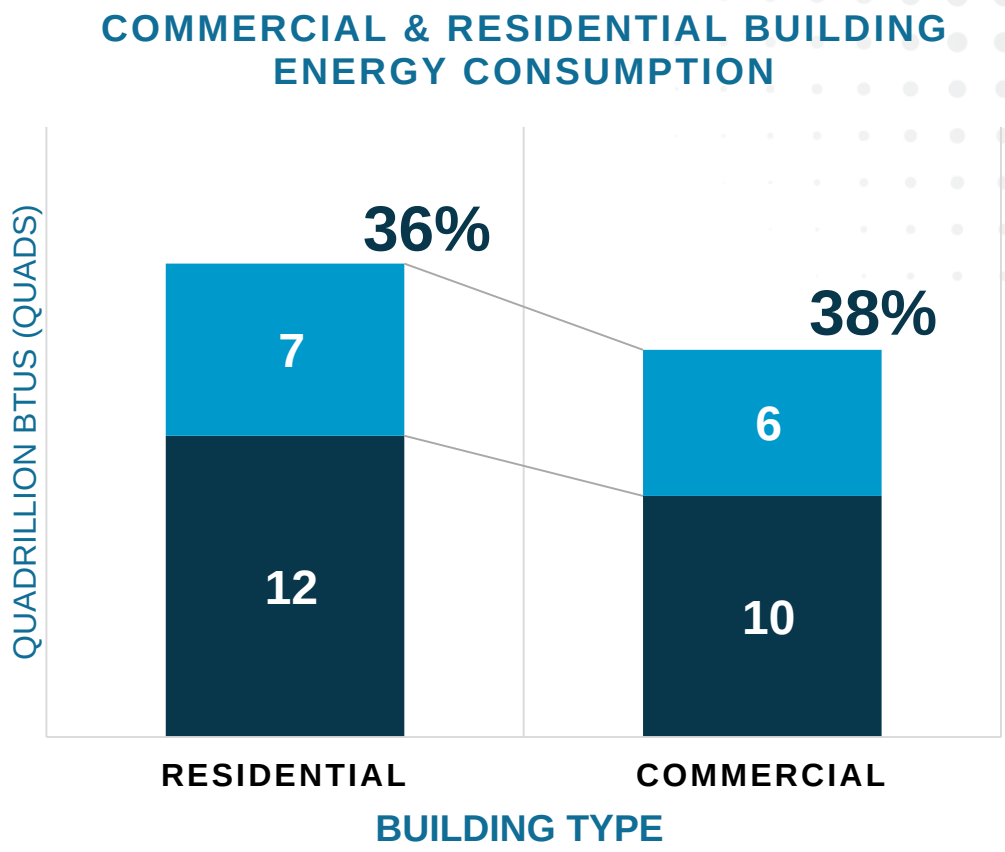
DATA.

Existing Buildings = 35 QUADS of Energy

13 QUADS:

Res + Comm

We waste SO MUCH of this!



EIA's RECS 2009 and CBECS 2012

~7.5% reduction = 1 quad

Use technology to stop wasting what we don't need.
Pragmatically. Invisibly.

Can users supply the data?

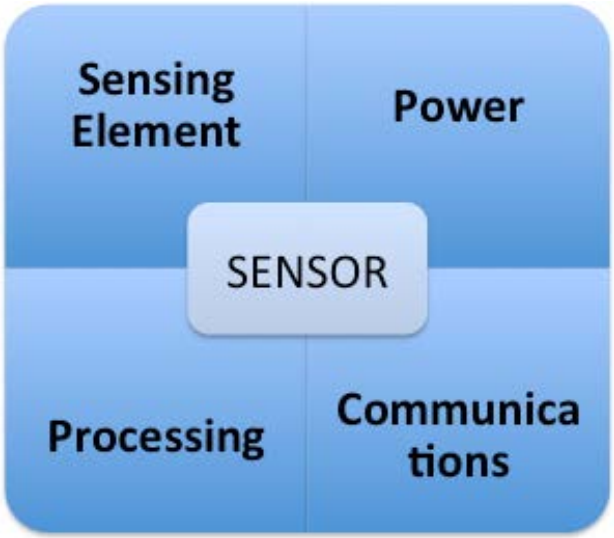
This is a SUBTLE, DIFFICULT problem

This was hard. Why didn't it work?

Human Interaction – Need to Approach Differently!

2 PM Dr. Alan Meier - LBNL

Can SENSORS do this for us?

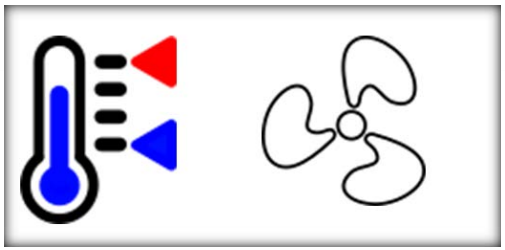


Existing GOOD Controls Systems – Thermostats, VAV, etc.

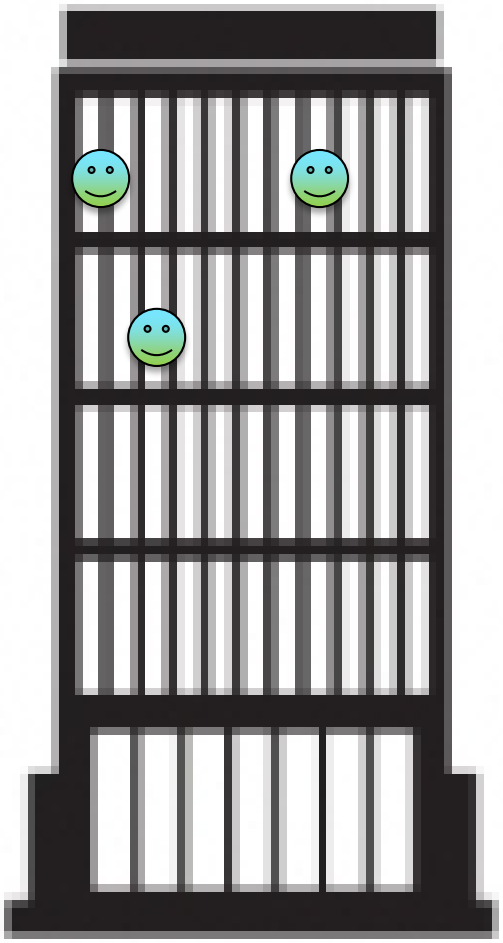
What do we require for autonomous control?

There is a lot we <u>can</u> sense…
But we don't have what we need.
Garbage in = garbage out

There is one thing we <u>can't</u> sense…



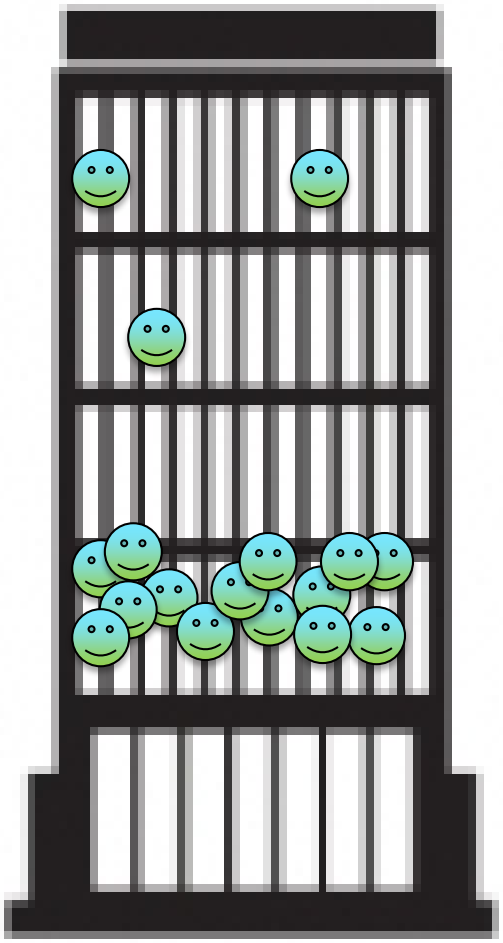
Key Gap



Occupancy Sensing.

Not motion sensing.

Key Gap

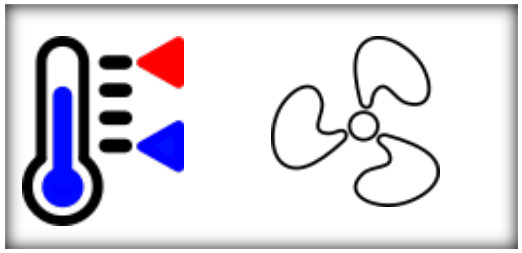


Occupancy Sensing.

Not motion sensing.
Not device sensing.
Not identity sensing.

Is a space occupied?

How many in a zone?



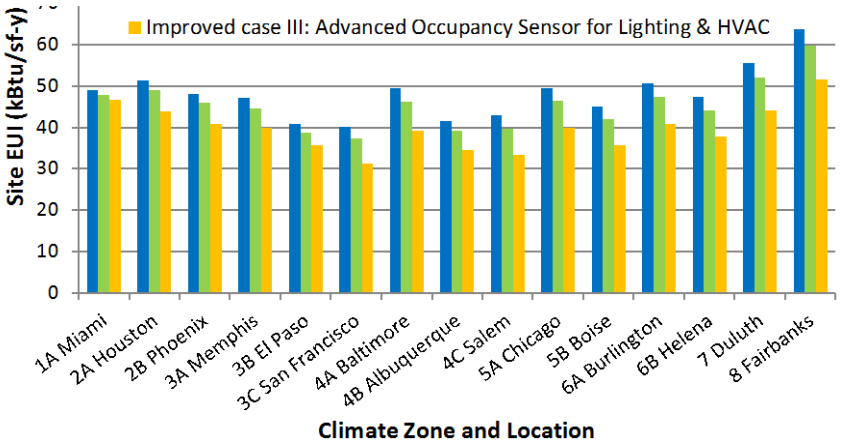
If we had this info now….

If we had this info now….

10-60***% reduction*** in HVAC energy

Even simple, non-connected systems can!
Active/DR MUCH bigger opportunity

PNNL - 22072



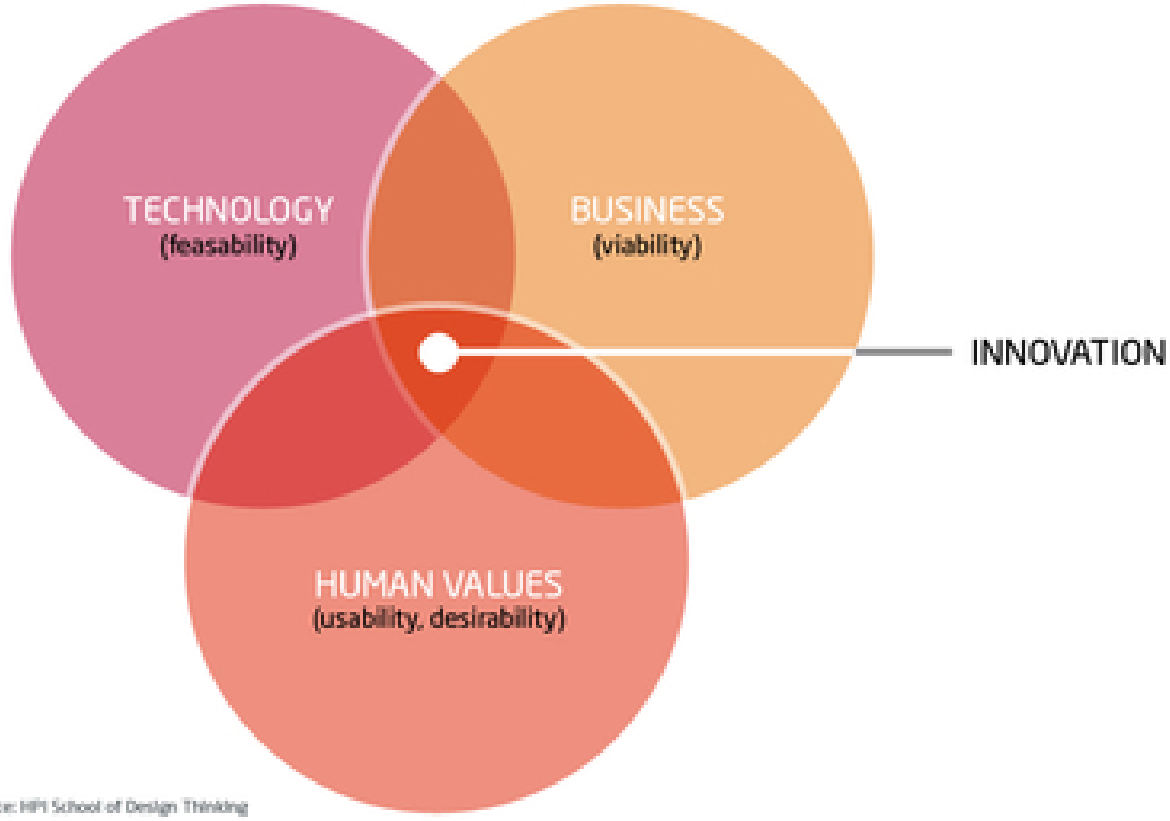
Simulations

Field Trials

2:20 PM Dr. Michael Brambley - PNNL

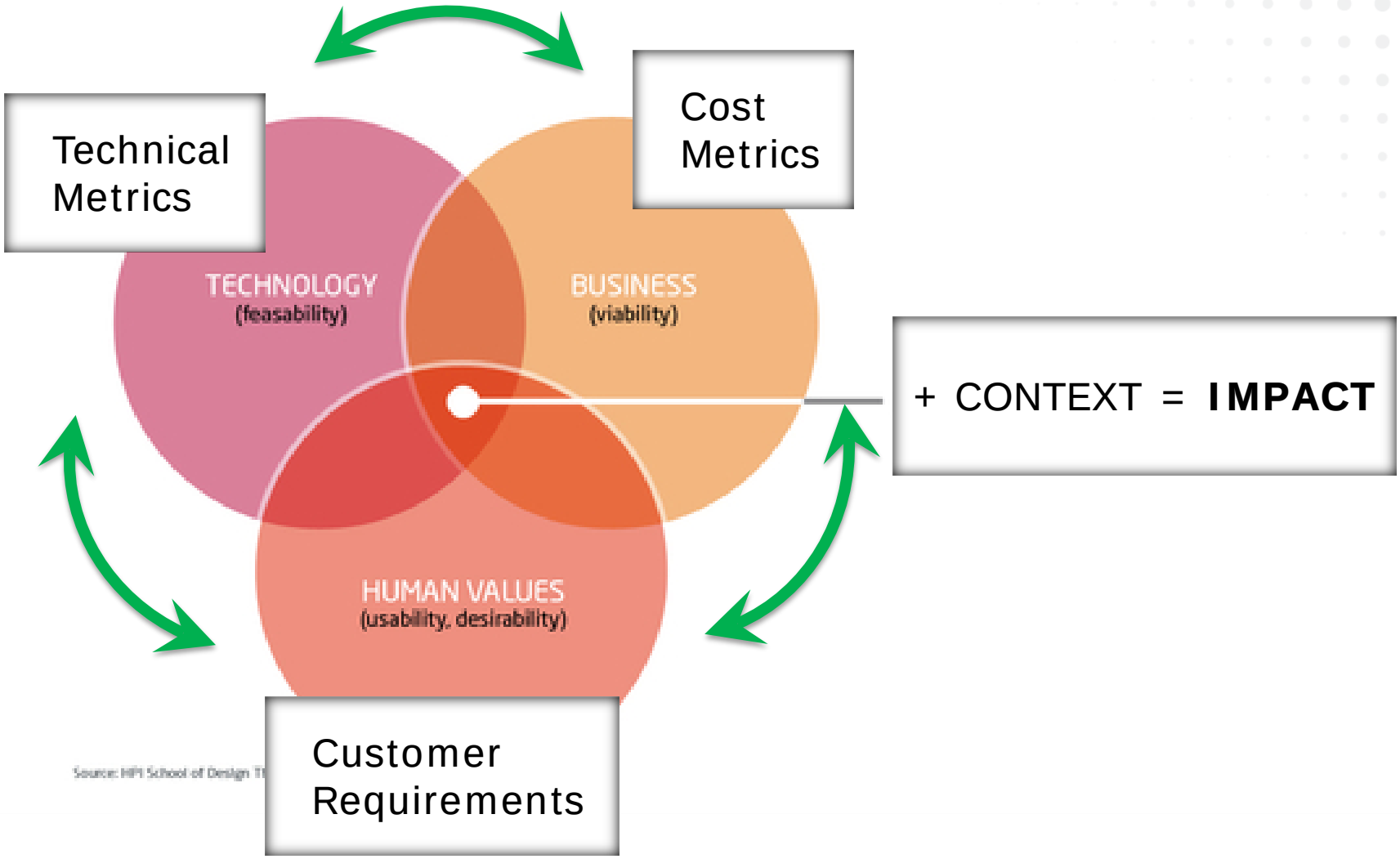
Wed – 9:30 AM Dr. Hayden Reeve - UTRC

How will we do this?

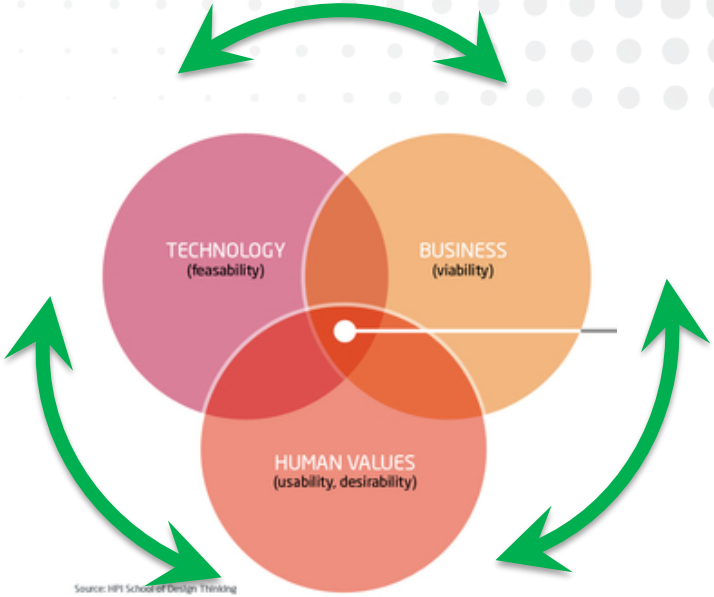


Source: HPI School of Design Thinking

How will we win?



How will we win?



- Break out of current technology paths
- Include tech to MARKET as key….***start to finish***
- Bring together traditionally disparate teams
- Focused, targeted, critical path

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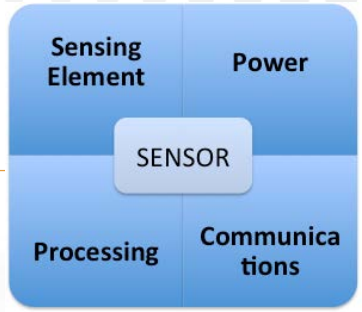
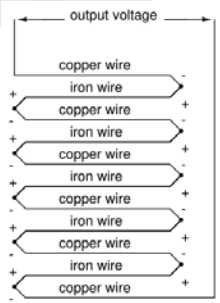
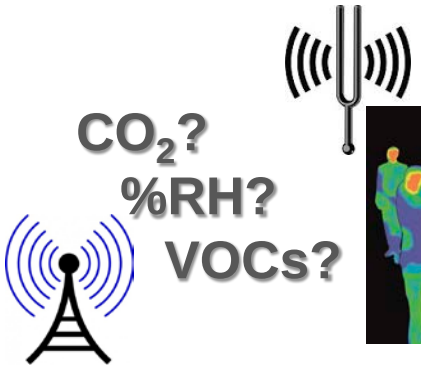
Tech Opportunities

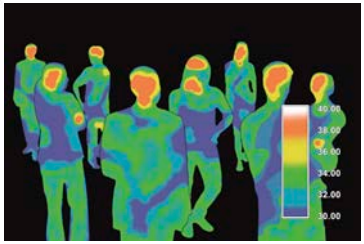


Presence vs counting are very different problems

- Sensor-on-chip
- New low power electronics packaging
- Advances in advanced algorithms + multi-modal sensing
- Novel/optimized materials and surfaces
- Interoperability/standards





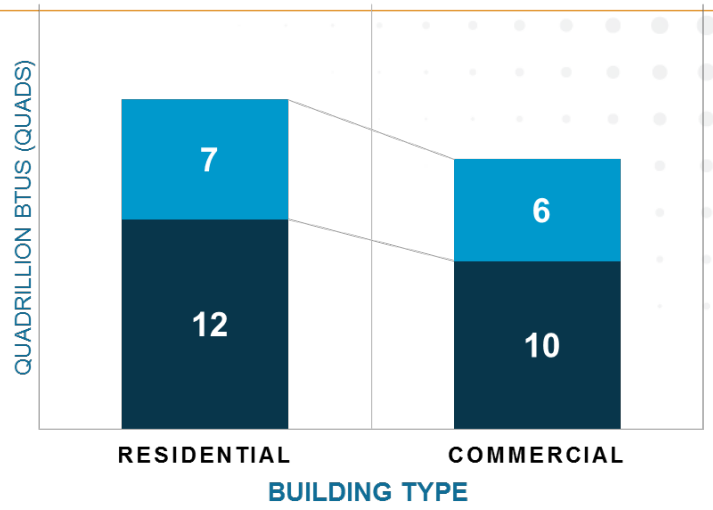


***Wed 9:50 AM* Shadi Hawawini,** PsiKick

***Wed 11:30 AM* Tech Panel Discussion**

We need the freedom to bring these efforts together… Novel LOW COST sensors. How low cost?...

Initial Cost Metrics Overview



A brief look at ROI for initial value guidance:

- **Scenario 1 - 15% savings**
- **ROI: 3 years**

Demand Response, Indoor Air Quality, all brings more value…

SOURCE:
www.enocean.com

Commercial Cost Metrics

Savings Scenario 1: 15%

Using the national average for electricity and natural gas - $0.10/kWh and $0.027 respectively.

SAVINGS	ASSUMPTION:		15%		TECHNOLOGY COST LIMIT RETRO-FIT PROJECT FEASIBILITY ($/ SQ FT)	
ADOPTION RATE	100%	25%	100%	25%		
	POST-RETROFIT SAVINGS (Quadrillion Btus)					
Principal building activity	ALL U.S. BUILDING STOCK		U.S. BUILDINGS with EXISITNG BAS		ALL U.S. BUILDING STOCK	U.S. BUILDING STOCK with EXISTING BAS
All Buildings	0.899	0.225	0.382	0.096	$0.51	$0.22
Education	0.122	0.030	0.087	0.022	$0.53	$0.38
Food sales	0.014	0.003	0.005	0.001	$0.40	$0.15
Food service	0.037	0.009	0.005	0.001	$1.08	$0.15
Health care- inpatient	0.075	0.019	0.069	0.017	$1.86	$1.73
Health care- outpatient	0.030	0.008	0.014	0.004	$0.76	$0.36
Lodging	0.053	0.013	0.021	0.005	$0.49	$0.19
Mercantile/ Retail	0.130	0.032	0.072	0.018	$0.50	$0.27
Office	0.205	0.051	0.107	0.027	$0.56	$0.29
Public assembly	0.081	0.020	0.039	0.010	$0.75	$0.36
Public order and safety	0.015	0.004	0.007	0.002	$0.56	$0.24
Religious worship	0.025	0.006	0.006	0.001	$0.32	$0.08
Service	0.033	0.008	0.004	0.001	$0.42	$0.05
Warehouse and storage	0.041	0.010	0.005	0.001	$0.14	$0.02
Other/ Vacant	0.036	0.009	0.008	0.002	$0.31	$0.07

Initial Market Overview

Who is the customer?
Who is the user?

- DEPLOYMENT
- LIFETIME
- PROOF OF EFFICACY
- Interoperability
- Ease of Use
- Aesthetics
- Flexibility
- Incorporate IAQ? IAQ *LEADS*?

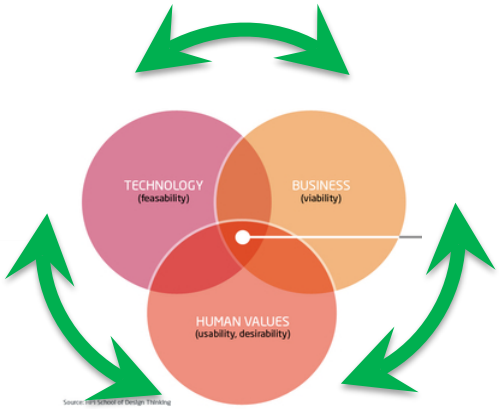
***Wed 12 PM* User Facility Presentations**

Here, you will help inform this…

ABB	*EERE-BTO*	*Psikick*
Amphenol Advanced Sensors	*EPRI*	*Spruce Capital*
Analog Devices Inc.	*FIU*	*SRI International*
ANL	*GE Global Research/AI & Learning*	*Stony Brook University*
Apsis Automation, LLC	*IBM T.J. Watson Research Center*	*Syracuse University*
Architectural Applications	*Infineon Technologies*	*Telkonet*
Bosch	*Ingersoll-Rand*	*Temple Univ.*
Boston University	*LBNL*	*The Univ. of Texas at San Antonio*
California State Univ. Dominguez Hills	*NEEA*	*United Technologies Research Center*
Cree Inc.	*NREL*	*Univ. of Florida*
Daikin US Corporation	*ORNL*	*University of Michigan*
DUKE ENERGY	*PARC*	*WeatherBug Home*
Ecobee Inc	*Phillips*	*X*
EcoVox, Inc.	*PNNL*	*ZAN Compute*

Today: MARKET

- PANEL
- BREAKOUT



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Portland Marriott Waterfront
Portland, OR

	Day 1 Agenda	*Location*
11:00 - 11:45	Registration	*Oregon Ballroom Foyer*
11:30 - 12:00	*Lunch [Please be seated by Noon]*	*Oregon Ballroom Salon F*
12:00 - 12:15	Welcome and Introduction to ARPA-E — Patrick McGrath, ARPA-E	
12:15 - 12:45	Workshop Background & Objectives — Jennifer Gerbi, ARPA-E	
1:00 - 1:45	Attendee 1 min introductions	
1:45 - 2:00	*Break/Networking*	
2:00 - 2:40	Invited Presentations — Presenters: Alan Meier, LBNL; Michael Brambley, PNNL	
2:40 - 3:30	Panel Discussion: User needs; identifying the market pull and requirements for occupancy sensing technologies. — Panelists: Ryan Hoest, EcoVox; Mark Malchiondo, Ecobee; Michael Rowand, Duke Energy; Kenneth Seeton, CSUDH; Michael Siemann, Weatherbug	
3:30 - 3:45	*Break/Networking*	
3:45 - 5:00	Breakout 1: The Market Challenge	*Oregon Ballroom Salon F, G, H & Portland Conf. Room*
5:00 - 5:15	*Break/Networking*	
5:15 - 6:00	Report Out from Breakout 1 & Adjourn for Day 1	*Oregon Ballroom Salon F*

DAY #1 BREAKOUT

The Market Challenge

Groups are asked to mock up and convey their ideal, dream occupancy sensing solution to a potential customer in either the A) Residential (temp control only – includes multi-residential) or B) Commercial (includes ventilation) market. This should include:

- *the cost ($/sq ft) of units*
- *installation cost or attributes ($/sq ft or project)*
- *compatibility with retrofit systems*
- *performance attributes*

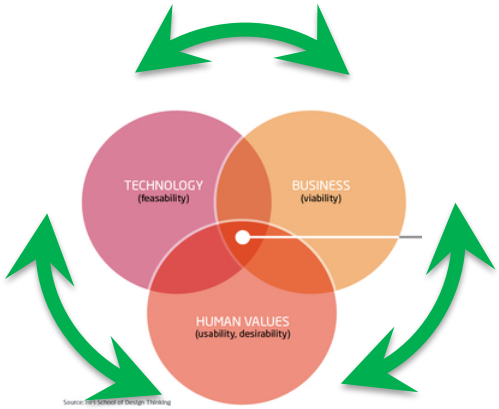
The group should be prepared to say what barriers to adoption and deployment exist, and why the above helps to mitigate them.

DAY #1 – Inform T2M Strategy

- ID Biggest impact segments vs. 1st adopters [Narrow Scope]
- Prioritize key attributes that are essential to achieving scale
- Identify *customers*
- **Identify key industry partners that are critical to enabling scaling of technology and align program with their requirements**
  - Vendors
  - Utilities
  - NGOs
  - Others?

Tomorrow: TECH

- PANEL
- BREAKOUT



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DAY #2 BREAKOUT

The Technical Challenge

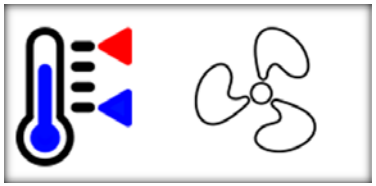
Given the input from Breakout 1, including cost, deployment, and lifetime targets, develop your ideal occupancy sensing solution for select indoor environments.

Detail the pros and cons for utilizing state-of-the art technologies vs. what would be desired in novel, yet-to-be developed technologies.

Consider: accuracy, cost, installation, calibration, operation, and maintenance of occupancy sensing technologies.

DAY #2 Inform Metrics

$/sq ft
Lifetime + calibration
Interoperability Standards
False Neg Rate = 0.0?%
False Pos Rate = ?
Accuracy @ distance x^2
<u>Pet vs Human</u>
Aesthetics
Time Sensitivity: #/hour



$/sq ft
Lifetime + calibration
Interoperability w/VAV
False Neg Rate = 0.0?%
False Pos Rate = ?
Accuracy @ distance x^2
Aesthetics
<u>Density Accuracy</u>
<u>Accuracy @ distance y^2</u>
Time Sensitivity: #/hour

Add more: what would YOUR metrics be?

TEAM:

Technical:

Dr. Russel Ross, Lead Technologist (BAH)

Dr. Christopher Konek, Associate (BAH)

Kristen Brown (Fellow)

Market:

Michelle Coates, Senior Consultant (BAH)

Patrick Finch, Lead Associate (BAH)

Thank you!

Let’s dig in!