Saving Energy Nationwide in Structures with Occupancy Sensing (SENSOR)

Advanced Energy Conference

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New York, NY

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Technology to Market Advisor
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ARPA-E Program Portfolio

ARPA-E recently launched a $20M (15 team) program aimed at saving energy in buildings through advanced occupancy sensing technologies

arpa·e
CHANGING WHAT'S POSSIBLE

The SENSOR Team

Program Director: Dr. Jenny Gerbi
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Technology to Market Advisor: Patrick Finch
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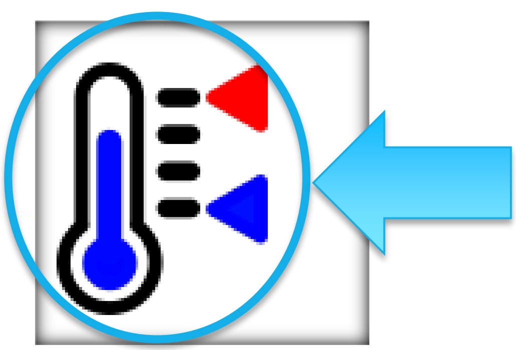
Lead Technical SETA:
- Dr. Brian Borak
- (Brian.Borak@hq.doe.gov)

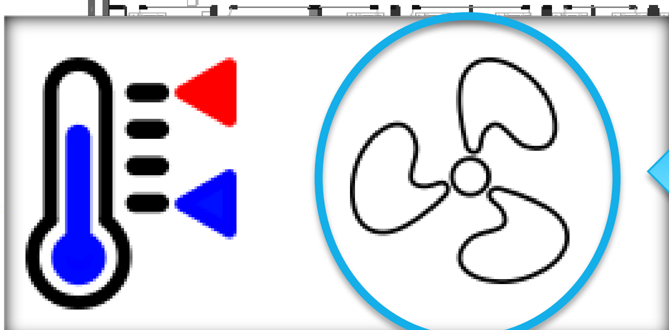
The goal of SENSOR is to save multiple quads of energy across both residential and commercial buildings… but how?

What happens when you’re not home?

http://www.builderhouseplans.com/house-plans/bhp/hwbdo69293.html



What happens when you're not at work?



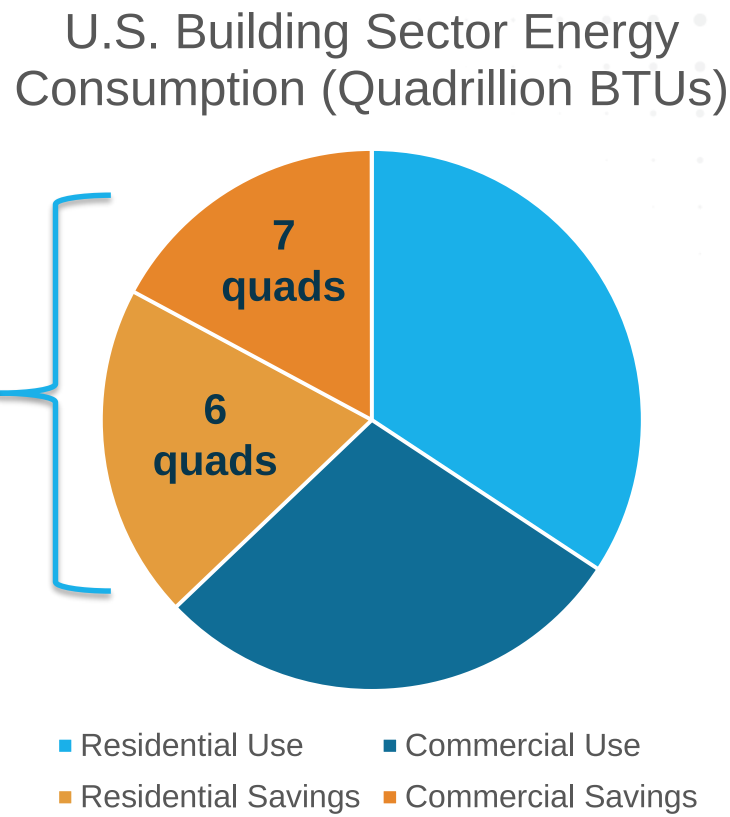
What's Missing?
DATA.

Existing Buildings = 35 QUADS of Energy

13 QUADS of energy usage is addressable through sensing technology (~37%):

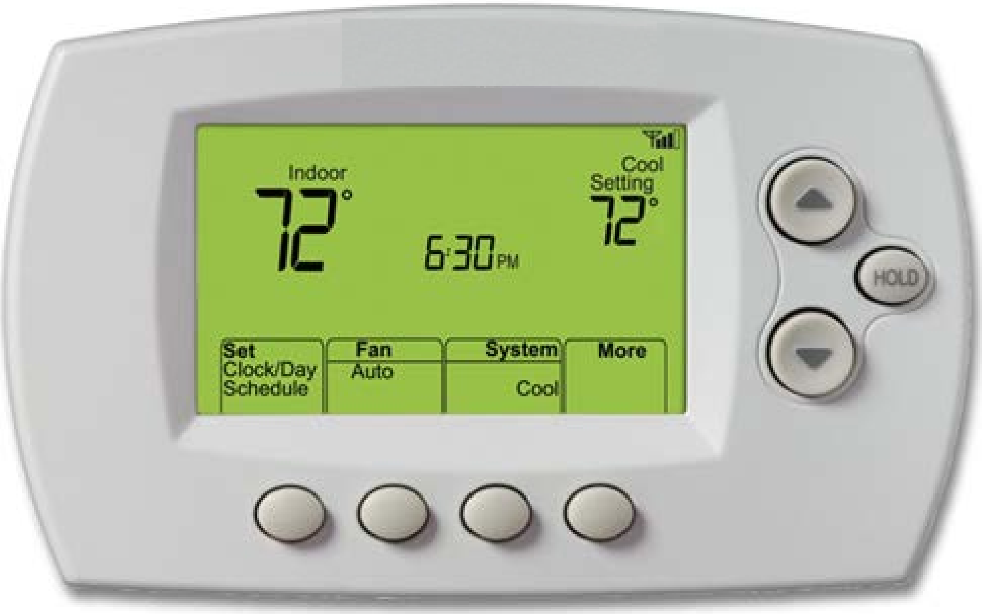
Res + Comm

EIA's RECS 2009 and CBECS 2012



A small change (even 10%) = huge savings!

Can users supply the data?

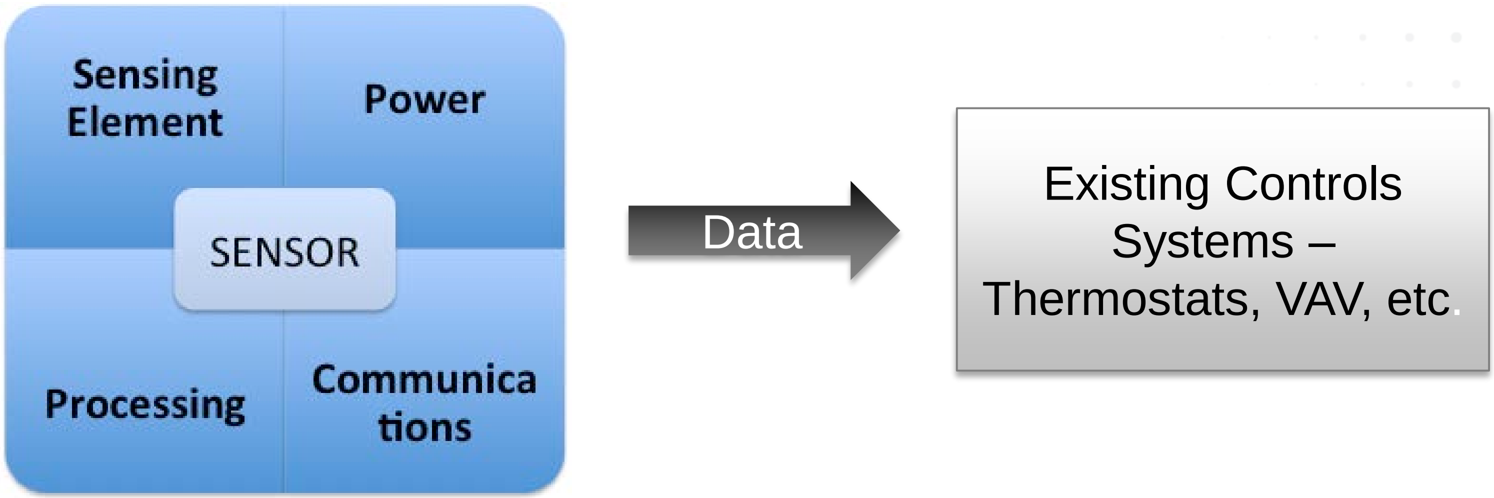


This is a SUBTLE, DIFFICULT problem

This was hard. Why didn't it work?

Human Interaction – Need to Approach Differently!

Or can sensors provide the data for us?

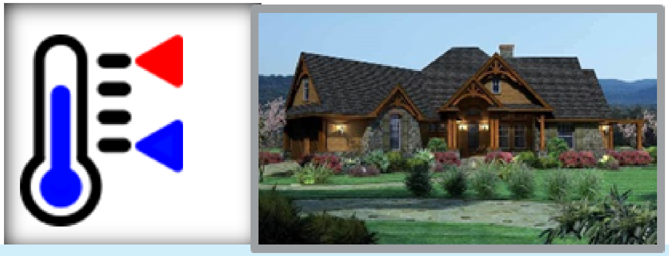


There is a lot we <u>can</u> sense…
But we currently don't have what we need.

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

Goal: Highly Accurate Occupancy Sensing

1. Residential



Need accurate, timely, low-cost BINARY human presence data to enable autonomous thermostats.

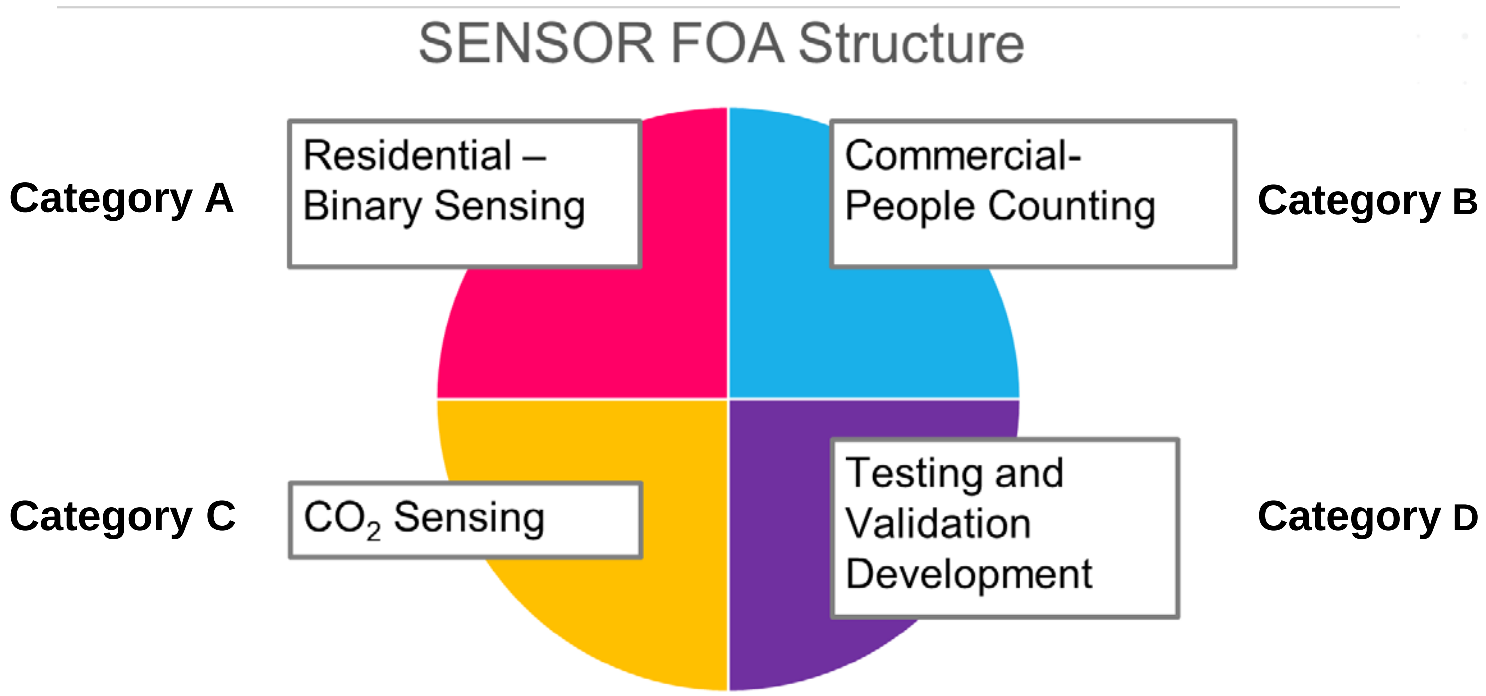
2. Commercial

Need accurate, timely, low-cost people counting *and* CO_2 data to enable the use of demand control

If we had this info now… we could remove human error from the equation

*Advanced Occupancy Sensors for Better Buildings Workshop: https://arpa-e.energy.gov/?q=workshop/advanced-occupancy-sensors-better-buildings-workshop

SENSOR Technology Categories



**SENSOR FOA Section I.C – I.D., Section I.D – I.E of the SBIR/STTR FOA (Program Objectives and Technical Categories of Interest)*

Residential (Cat A) Technical Metrics

Category A Performance Metrics: RESIDENTIAL		
Demonstrated Energy Savings	≥ 30%	
Number of Failures (false negatives)/year, 95% confidence	≤ 2	
Minimum Maintained & Recalibration Requirement	≥ 3 years	
Price Metrics:		
Residential Price:	≤ 0.06 $/sqft	Total sensor system price including installation/commissioning
General Requirements for all Hardware:		
No Beacons Required	For example, smartphones or any other wearable tech	
Communication Protocol for output to Control System	Open-source and secure	
Privacy concerns addressed	Deliver plan for addressing privacy (or perceived privacy) barriers to deployment and use (For example, demonstrating adherence to wiretapping laws in all states)	
Security and Flexibility	No cloud computation – all computation to occur locally at sensors or within local sensor system	
Ease of self-commissioning	A plan must be presented. Example: inclusion of simple screen, app, LED indicators, or the like available to a user such that the system can be easily self-tested upon startup, and the number of occupants validated; “peel, stick, and button press” technology that does not require skilled labor for placement or installation	
Testing and Validation		
Ensuring adoption diversity	Ensure a varied number of skin colors, body types, and physical ability levels (i.e. use of wheelchairs and the like) are adequately represented in both simulation and laboratory-scale testing scenarios	
Ensure adoption flexibility	Validation protocols must be developed for at least three distinct scenarios in the residential sector, including household pets, for both the simulation and laboratory-scale testing scenarios.	

Category A & B Performers

Category A

- **Duke University – Durham, NC**
  - *Detecting Human Presence Using Dynamic Metasurface Antennas (DMA)*
- **Endeveo, Inc. – Boston, MA**
  - *Hotspot Enabled Accurate Determination of Common Area Occupancy Using Network Tools (HEADCOUNT)*
- **State University of New York at Stony Brook – Stony Brook, NY**
  - *SLEEPIR – Synchronized Low-energy Electronically-chopped PIR Sensor for Occupancy Detection*
- **Syracuse University – Syracuse, NY**
  - MicroCam: A Low Power and Privacy Preserving Multi-modal Sensor Platform for Occupancy Detection
- **United Technologies Research Center – East Hartford, CT**
  - PEOPLE: Platform to Estimate Occupancy and Presence for Low Energy Buildings

Category B

- **University of Colorado Boulder – Boulder, CO**
  - *Battery-free RFID Sensor Network with Spatiotemporal Pattern Network Based Data Fusion System for Human Presence Sensing*
- **Boston University – Boston, MA**
  - *Scalable, Dual-Mode Occupancy Sensing for Commercial Venues*
- **Cornell University – Ithaca, NY**
  - *Indoor Occupant Counting Based on RF-backscattering*
- **Rensselaer Polytechnic Institute – Troy, NY**
  - *Reflected Light Field Sensing for Precision Occupancy and Location Detection*
- **Scanalytics, Inc. – Milwaukee, WI**
  - *Floor Sensors for Occupancy Counting in Commercial Buildings*

Category C & D Performers

Category C

- **Matrix Sensors, Inc. – San Diego, CA**
  - *Stable, Low Cost, Low Power, CO2 Sensor for Demand-controlled Ventilation*
- **N5 Sensors, Inc. – Rockville, MD**
  - *Digital System-on-chip CO2 Sensor*
- **Purdue University – West Lafayette, IN**
  - *Building-integrated Microscale Sensors for CO2 Level MonitoringSyracuse University – Syracuse, NY*

Category D

- **Iowa State University – Ames, IA**
  - *Simulation, Challenge Testing & Validation of Occupancy Recognition & CO2 Technologies*
- **University of Alabama – Tuscaloosa, AL**
  - *Quantification of HVAC Energy Savings for Occupancy Sensing in Buildings Through an Innovative Testing Methodology*