HVAC Design for Installation

ENERGY STAR Products Partner Meeting

October 29th, 2020

Today's Panel

Abigail Daken
U.S. Environmental Protection Agency

Jon Winkler
National Renewable Energy Laboratory

Dean Gamble
U.S. Environmental Protection Agency

Christopher Dymond
Northwest Energy Efficiency Alliance

Dave Winningham
Lennox

Background on Installation in ENERGY STAR

- Stakeholder discussions indicated that at some point, investment in quality installation is a more cost-effective path to energy savings than raising criteria
- The Central Air Conditioner and Heat Pump (CAC/HP) Version 6.0 Specification introduced Installation Criteria
- Proper installation affects CACs and heat pumps, but furnaces and other product categories as well





Goals of Installation Criteria

By recognizing equipment capabilities that give contractors feedback:

- Programs can incentivize excellent installation
- Consumers remain confident in high efficiency units; good for manufacturers as well
- Proper installation ensures predicted energy savings are realized

Installation Capabilities

To certify as ENERGY STAR, CAC/HPs (with their controllers) must provide at least three of the following capabilities to aid in quality installation:

a. Refrigerant charge
b. Airflow measurement or ESP
c. Blower fan power draw
d. Test mode – lock in highest fan speed and compressor capacity

ACCA/RESNET 310

e. Automatic system discovery
f. Preprogrammed system tests

Different Efforts Target Different Circumstances

	New Homes	Existing Homes
Existing equipment		NREL research
New equipment, standard	ACCA/RESNET 310	Products
New high-efficiency equipment	ENERGY STAR V6	

Ultimately, we want it all

- In the end, we want to get as much of these savings as possible
- Jon Winkler will help quantify how much that is
- Dean Gamble will discuss ACCA/ANSI 310 and how it will fit in with programs to change practices
- Christopher Dymond will discuss program models that can work with equipment capability to start changing practices, and results
- Dave Winningham from Lennox will discuss what installation capabilities are on the market now

Contact Information

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For more information on the CAC-HP Version 6.0 specification, visit the ENERGY STAR CAC-HP Product Development Page.

Residential Installation Quality and Fault Detection

How much energy are we wasting? And how much can be saved?

Jon Winkler
Saptarshi Das
Lieko Earle
Lena Burkett
Joe Robertson
David Roberts
Chuck Booten
Jeff Munk (ORNL)

October 29, 2020

Project Overview

Problem Statement

- Over 65% of residential HVAC systems have suboptimal performance resulting in 20-30% increased energy consumption.[1,2,3]
- National energy impact of installation faults is challenging to estimate due to variations in fault intensity, building construction and location, equipment efficiency, etc.

Research Questions

- How much energy is wasted due to installation faults in central air conditioner and air-source heat pump systems?
- How much energy can be realistically saved by implementing fault detection and diagnostics?

[1] DOE, Residential HVAC Installation Practices: A Review of Research Findings. 2018.
[2] Domanski, P.A., H.I. Henderson, and W.V. Payne, Sensitivity analysis of installation faults on heat pump performance. 2014.
[3] Lstiburek, J. and B. Petit, Final Report on the Expert Meeting for Diagnostic and Performance Feedback for Residential Space Conditioning System Equipment. 2010

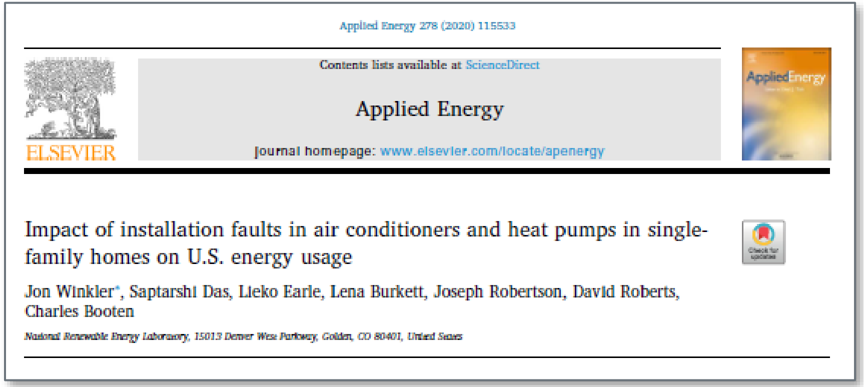
Some Caveats…

- We only looked at single-stage central air conditioners and air-source heat pumps.
- We only looked at indoor airflow rate and refrigerant charge installation faults.
- We only looked at single-family homes.

Outline

- Our Approach
- How much energy is wasted from installation faults?
- How much energy can be practically saved using fault detection?

For more details, see the following.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ELSEVIER

Impact of installation faults in air conditioners and heat pumps in single-family homes on U.S. energy usage

Jon Winkler*, Saptarshi Das, Lieko Earle, Lena Burkett, Joseph Robertson, David Roberts, Charles Booten

National Renewable Energy Laboratory, 15013 Denver West Parkway, Golden, CO 80401, United States

Winkler, J., et al. "Impact of installation faults in air conditioners and heat pumps in single-family homes on US energy usage." *Applied Energy* 278 (2020).

Our Approach

ResStock

Housing stock characteristics database

+

Physics-based computer modeling

+

High-performance computing

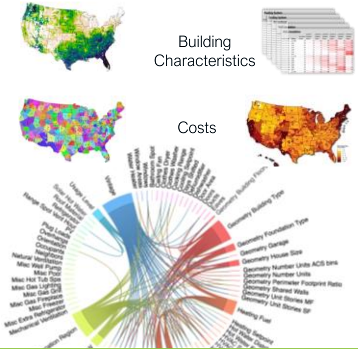
Large public and private datasets

Census Data

Building Characteristics

Climate Locations

Costs



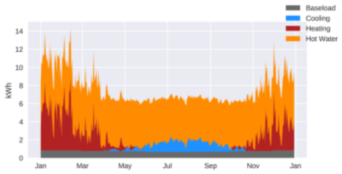
6000 probability distributions for 100 parameters structured in a dependency tree

Best-in-class models

OpenStudio

EnergyPlus

Detailed sub-hourly energy simulations



10,000s to 100,000s of simulations

NREL's supercomputer

Cloud computing

amazon web services

Big data technology stack

docker DASK Parquet presto Apache Spark

Approach Overview

Fault prevalence data + Correlation between fault level and efficiency + Annual building models = Estimated annual energy savings potential

Fault prevalence data:
- How common?
- How severe?

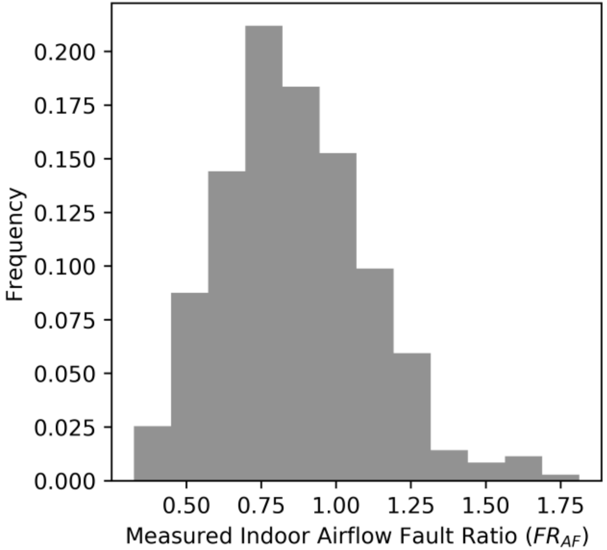
Past field studies

Generalized correlations based on laboratory data

NREL ResStock

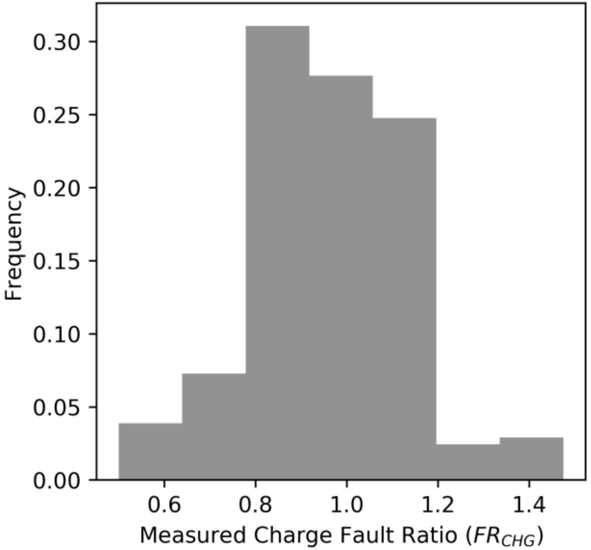
Fault Intensity Data

Indoor Airflow Fault Prevalence



- 8 studies (1995-2008)
- 354 data points
- Data lacked design airflow rate
- Raw data wasn't always available

Refrigerant Charge Fault Prevalence



- 2 studies (1996, 2002)
- 416 data points
- Most studies present qualitative results

How much are we wasting?

Total Energy Impact

Solving indoor airflow and refrigerant charge faults could save as much or more than common existing programs.

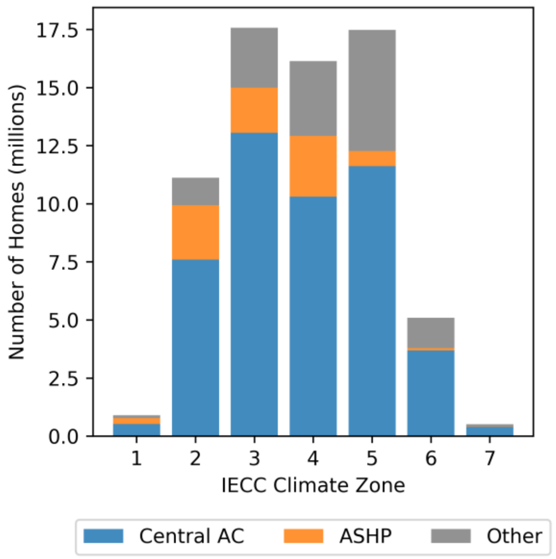
Energy Efficiency Measure	Electricity Savings (TWh/y)
Smart thermostat (not home during day)	13.7
R-38 attic insulation	17.3
Duct sealing and insulation	18.4
Indoor airflow rate and refrigerant charge	**20.7**
R-49 attic insulation	21.4
Upgrade air-source heat pump to variable-speed heat pump	21.7
SEER 16 central air conditioner	22.6

Adapted from Wilson, E., Christensen, C., Horowitz, S., Robertson, J., and Maguire, J. 2017. *Energy Efficiency Potential in the US Single-Family Housing Stock*. National Renewable Energy Laboratory, Golden, CO, 2017.

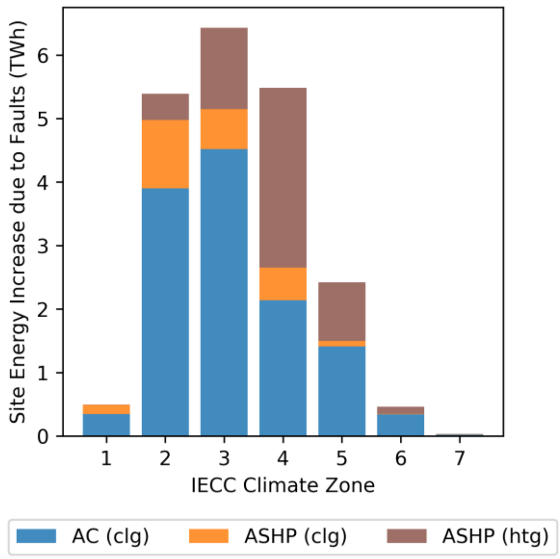
Air Source Heat Pumps

Air-source heat pumps are responsible for a disproportionate fraction of the energy waste.

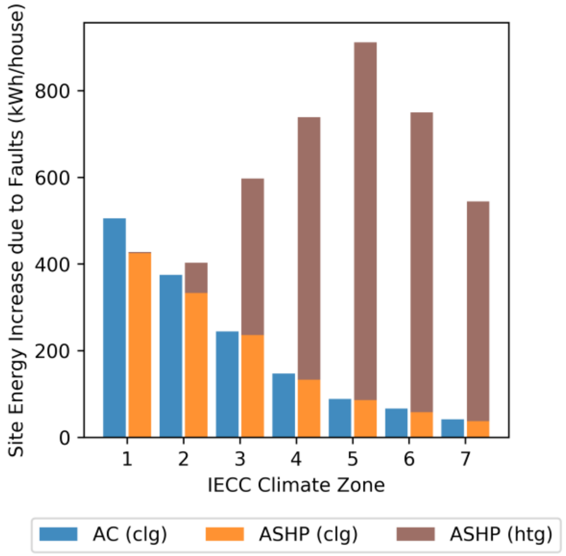
Number of ACs vs. ASHPs



Total Energy Wasted

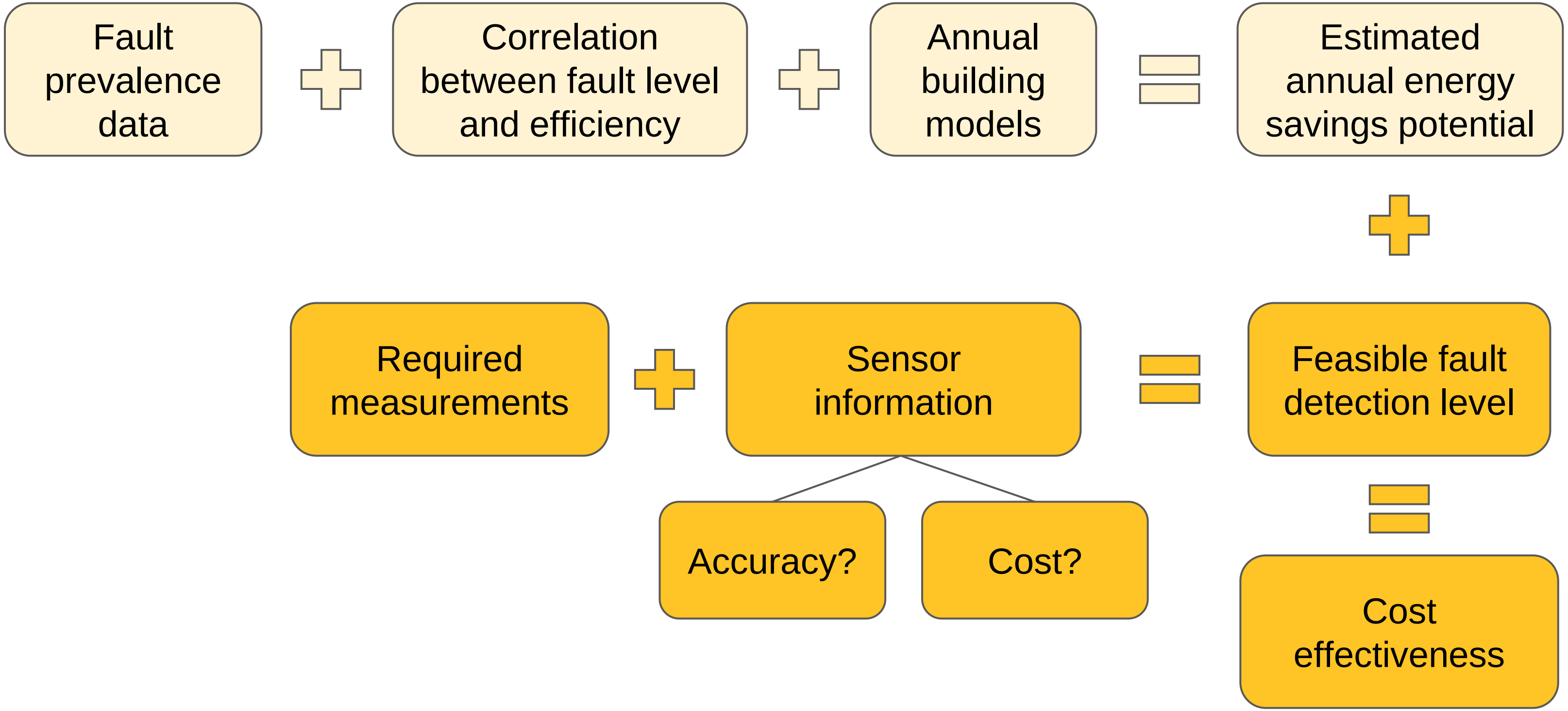


Median Energy Wasted per House



How much can we save?

Approach Overview



Performance vs. Prescriptive FDD

Performance-based – Detects and alerts users regarding performance degradation due to any combination of faults

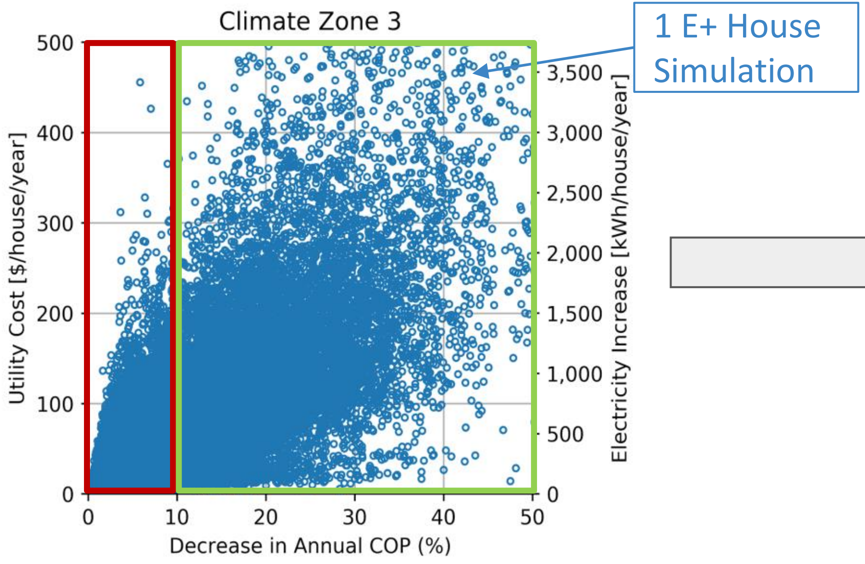
- Magnitude of COP degradation ≠ magnitude of utility cost increase
- Requires comparing measured performance to the no-fault performance
  - ~10% capacity/COP reduction would be detectable using refrigerant-side sensors

Prescriptive-based – Detect and alerts users regarding specific fault types and level

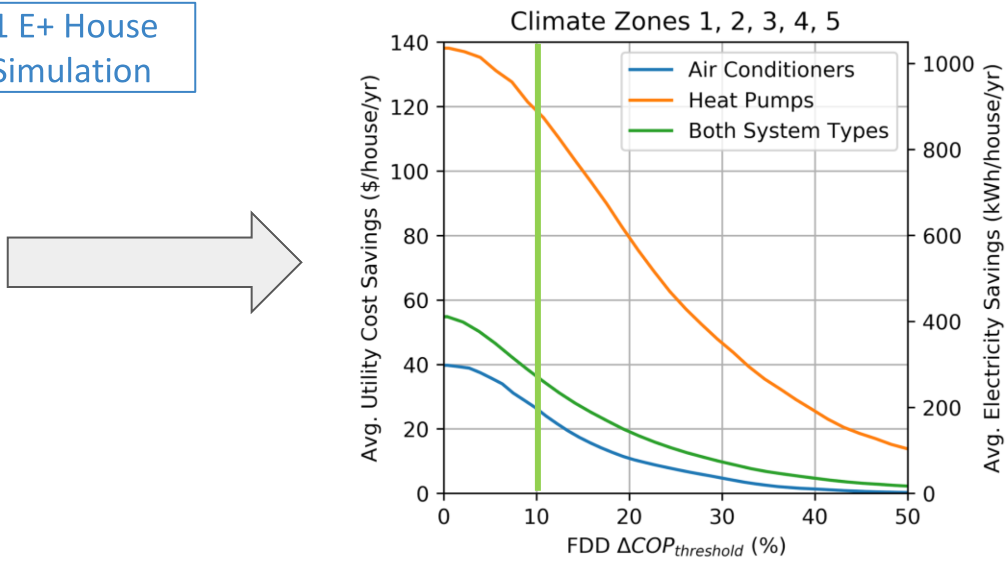
- Fault impacts vary for different equipment and system types
- Airflow fault detection feasibility ~±5%
- Charge fault detection feasibility ~±6°F subcooling

Performance-Based FDD Savings

Addressing indoor airflow and refrigerant charge faults with a COP impact ≥ 10% would save ~67% of the energy wasted.



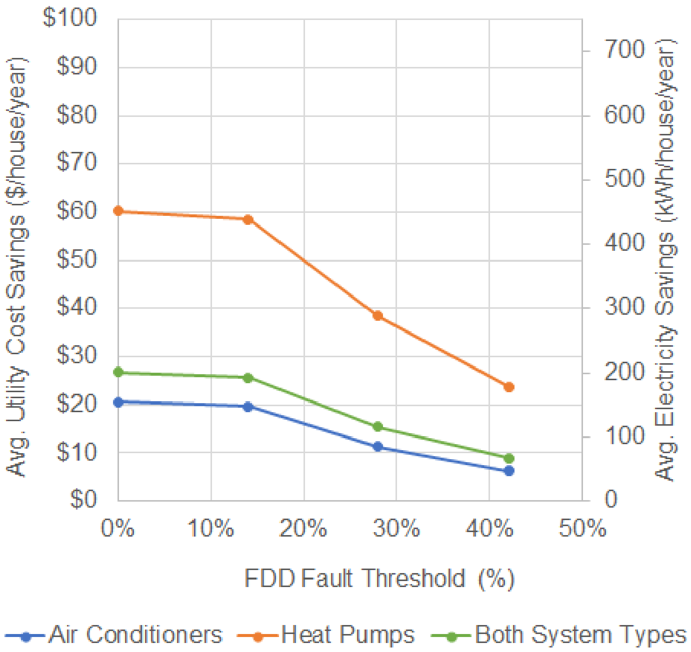
Utility cost increase is dependent on the fault intensity, house construction, climate, etc.



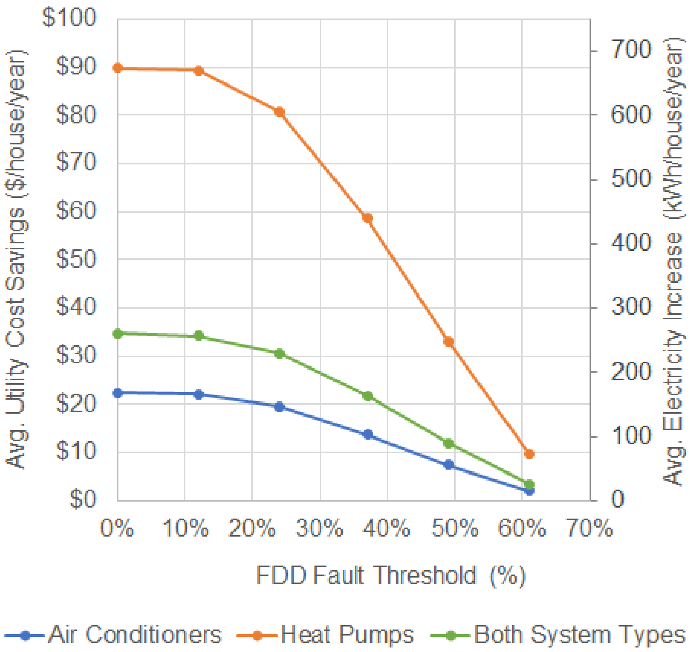
Calculate the average utility savings potential at a range of FDD COP thresholds.

Prescriptive-Based FDD Savings

Refrigerant Charge Faults



Low Indoor Airflow Faults



Cost Impacts

Fault Type	Feasible Fault Level	Annual Utility Savings ($/house/y)	OEM Hardware Cost				Payback (100% Markup) (years)
			Sensors	Controls	Indoor Blower	Total	
Refrigerant Charge/ Subcooling	±3°F	AC ≈ 15 HP ≈ 45	~$16	~$10 - $100		$26-$116	**AC: ~3-15** **HP: ~1-5**
Indoor Airflow	±5%	AC ≈ 22 HP ≈ 90		~$10 - $100	$50	$60-$150	**AC: ~5-14** **HP: ~1-3**
Capacity (Refrigerant-Side)	-10%	AC ≳ 30 HP ≳ 120	~$36	~$10 - $100		$46-$136	**AC: ~3-10** **HP: ~1-2**
Efficiency (Refrigerant-Side)	-10%						

Conclusions

- 20.7 TWh/y (0.07 Quads) of site energy waste
  - ~9% increase over baseline (no-fault) usage
  - $2.5 billion in utility cost
- Air-source heat pumps are responsible for a disproportionate fraction of the energy waste
  - 14% of homes → 39% of the energy waste
- Performance-based FDD could reduce overall energy waste by 67%
  - A 10% degradation in COP due to installation-related faults is likely a feasible and cost-effective target for performance-based FDD

Thanks!

Jon Winkler
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National Renewable Energy Laboratory
Email: jon.winkler@nrel.gov

Dean Gamble

HVAC installation defects are common

- Improper airflow in nearly 50% of systems:
  - Average airflow ~20% below target. Blasnik et al. (1995)
  - Average airflow 14% below design. Proctor (1997)
  - Measured airflow ranging from 130 - 510 CFM / ton. Parker (1997)
  - 70% of units had airflow < 350 CFM / ton. Neme et al. (1999)
  - Improper airflow in 44% of systems. Mowris et al. (2004)
- Incorrect refrigerant charge in 60-80% of systems:
  - In 57% of systems. Downey/Proctor (2002)
  - In 62% of systems. Proctor (2004)
  - In 72% of systems. Mowris et al. (2004)
  - In 82% of systems. Proctor (1997)

HVAC installation defects are common

Study Author	State	Existing or New Home?	Sample Size	Average Airflow	Airflow <350 cfm	Airflow w/in 10% of 400/ton	Energy Savings Potential	Notes
Blasnik et al. 1995a	NV	New	30	345	50%		8%	Est @ 33% combined charge/air flow correction benefits
Blasnik et al. 1995b	CA	New	10	319	90%			
Blasnik et al. 1996	AZ	New	22	344	64%	29%	10%	Est @ 33% combined charge/air flow correction benefits
Hammarlund et al. 1992	CA	New	12			30%	10%	Single family results
Hammarlund et al. 1992	CA	New	66		76%	14%	12%	Multi-family results
Neme et al. 1997	MD	New	25	340				Average for non-participant homes
Palani et al. 1992	n.a.	n.a.	n.a.				4%	Lab test of EER degradation at 25% reduction in air flow
Parker et al. 1997	FL	Both	27	270	89%	7%	10%	Field measuremts of flow; lab test of effic loss
Proctor & Pernick 1992	CA	Existing	175		44%			Random sample from PG&E Model Energy Communities Prog
Proctor 1991	CA	Existing	15			33%		Two-thirds
Proctor et al. 1995a	CA	Existing	30	300	80%	11%		SCE Coach
Rodriguez et al. 1995	n.a.	n.a.	n.a.				2%	Lab test of
Rodriguez et al. 1995	n.a.	n.a.	n.a.				10%	Lab test of
VEIC/PEG 1997	NJ	New	52	372		30%	7%	Est @ 33%
Average				327	70%	22%	8%	

Study Author	State	Existing or New Homes?	Sample Size	Charge correct to mfg spec	% over charge	% under charge	Energy Savings Potential	Notes
Blasnik et al. 1995a	NV	New	30	35%	5%	59%	17%	Est @ 67% combined charge/air flow correction benefits
Blasnik et al. 1995b	CA	New	10				8%	Est @ 67% combined charge/air flow correction benefits
Blasnik et al. 1996	AZ	New	22	18%	4%	78%	21%	Est @ 67% combined charge/air flow correction benefits
Farzad & O'Neal 1993	n.a.	n.a.	n.a.				5%	Lab test of TXV; 8% loss @20% overchg; 2% loss @20% underchg
Farzad & O'Neal 1993	n.a.	n.a.	n.a.				17%	Lab test of Orifice; 13% loss @20% overchg; 21% loss @ 20% underchg
Hammarlund et al. 1992	CA	New	12				12%	Single family results
Hammarlund et al. 1992	CA	New	66	31%	61%	8%	12%	Multi-family results
Katz 1997	NC/SC	New	22	14%	64%	23%		Charge measured in 22 systems in 13 homes
Proctor & Pernick 1992	CA	Existing	175	44%	33%	23%		Results from PG&E Model Energy Communities Program
Proctor 1991	CA	Existing	15	44%				Fresno homes
Proctor et al. 1995a	CA	Existing	30	11%	33%	56%		
Proctor et al. 1997a	NJ	New	52				13%	Est @ 67% combined charge/air flow correction benefits
Rodriguez et al. 1995	n.a.	n.a.	n.a.				5%	Lab test of TXV EER; 5% loss at both 20% overchg & 20% underchg
Rodriguez et al. 1995	n.a.	n.a.	n.a.				15%	Lab test of Orifice EER; 7% loss @20% overchg, 22% loss @ 20% underchg
Average				28%	33%	41%	12%	

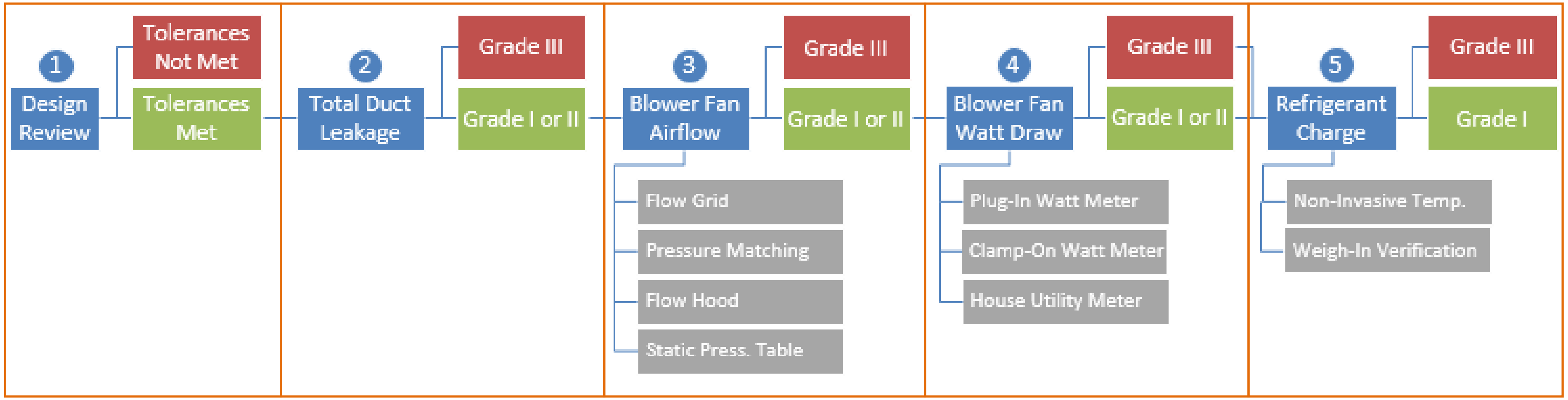
Why are these defects so common?

- Airflow is dependent on the components attached to the equipment (e.g., filter, ductwork).
- Refrigerant charge is dependent on, primarily, the length of the piping between the inside and outside equipment.
- Reasons that many installers don't account for these factors:
  - Poor or missing HVAC design
  - Generally high turnover / inadequate training among installers
  - Oftentimes, financial rewards for speed of installation, not quality installation
  - Not easy for installers or consumers to 'see' installation defects

What is ANSI / ACCA / RESNET Std 310?

- A new standard to assess the design and installation quality of HVAC systems.
- Inspired by code requirements already in place in California.
- Primarily for raters, who are not HVAC contractors, to use during home energy ratings.
- ~250,000 home energy ratings are done each year in the U.S., almost all for new construction. A subset of ~100,000 of these homes are also ENERGY STAR certified.

Std. 310: Standard for Grading the Installation of HVAC Systems



How will Std 310 help in residential new construction?

- Builders – Energy ratings, tax credit, comfort, durability.
- Raters – Valuable new service for any energy rated home.
- Utility Programs – Energy and demand benefits.
- HVAC Manufacturers – Rewarded for features that ease installation.

Could Std 310 help in the existing homes sector?

- While the Std 310 procedures are applicable to new systems installed in existing homes, one key roadblock is that Raters are not involved.
- However, Std 310 contains two alternative compliance frameworks that might be leveraged:
  - Independent Verification Reports
  - On-board diagnostics

ENERGY STAR Residential New Construction Programs

Web & Email:

Single Family: www.energystar.gov/newhomesrequirements

Multifamily: www.energystar.gov/mfnc

Email: energystarhomes@energystar.gov

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Closing the Performance Feedback Loop

Christopher Dymond

Sr. Product Manager, Northwest Energy Efficiency Alliance

ENERGYSTAR Partners Meeting - October 29th, 2020

CLASSIFICATION LEVEL: PUBLIC

The Alliance

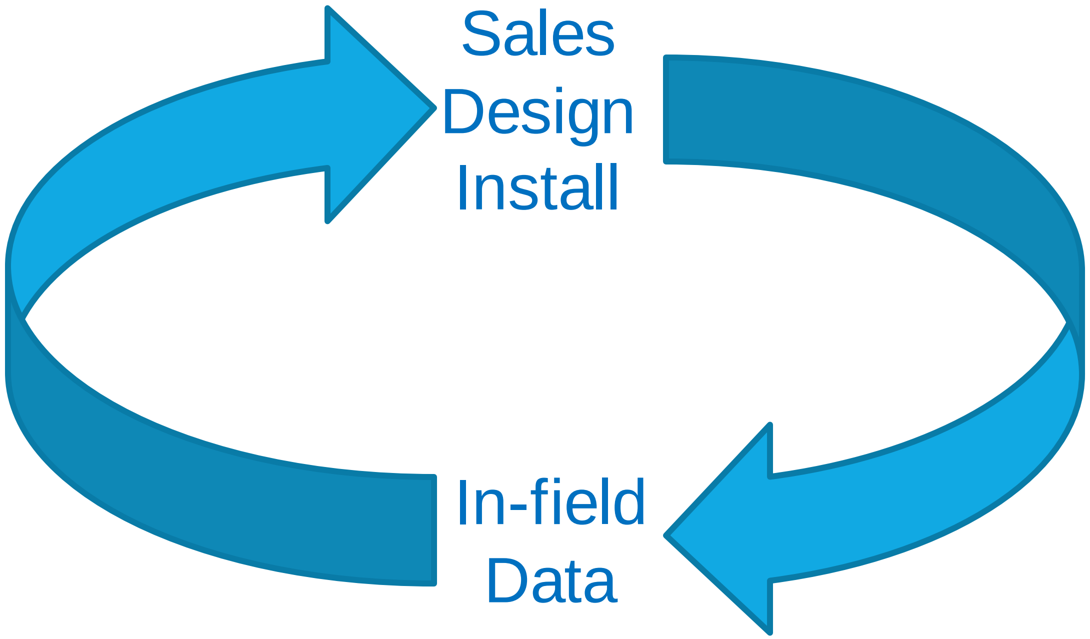
~14 million residents
20 market transformation programs

15 Primary Funders
Funded on a 5-year business cycle

Variable Capacity Heat Pumps

- VCHP are the future
- Current metrics are inadequate
- Energy performance is low contractor priority
- New in-field data collection technologies

Possible Future – Feedback on Performance



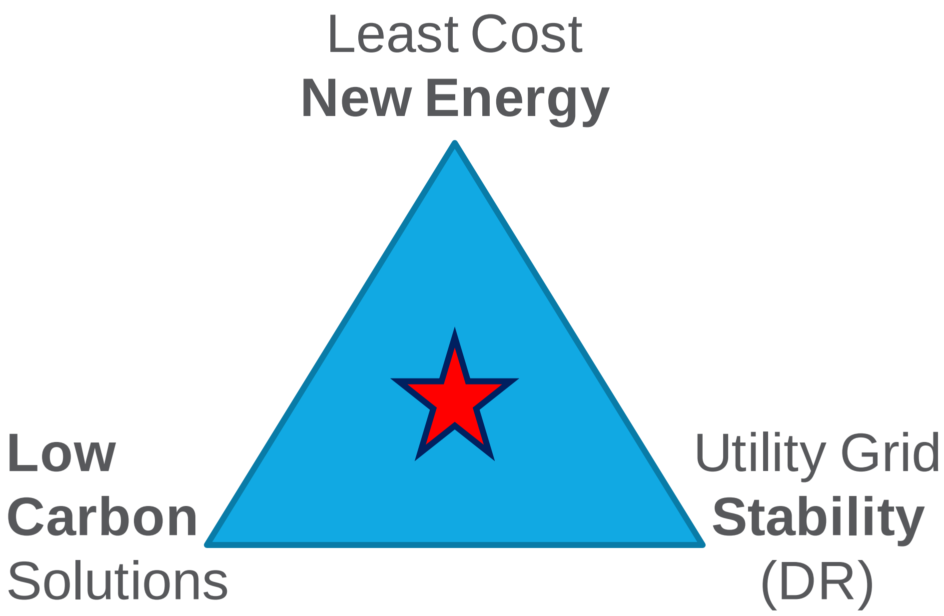
Hypothesis: In-field performance data can benefit:

1. design & install practices
2. contractor call backs
3. service and performance

Market Barriers

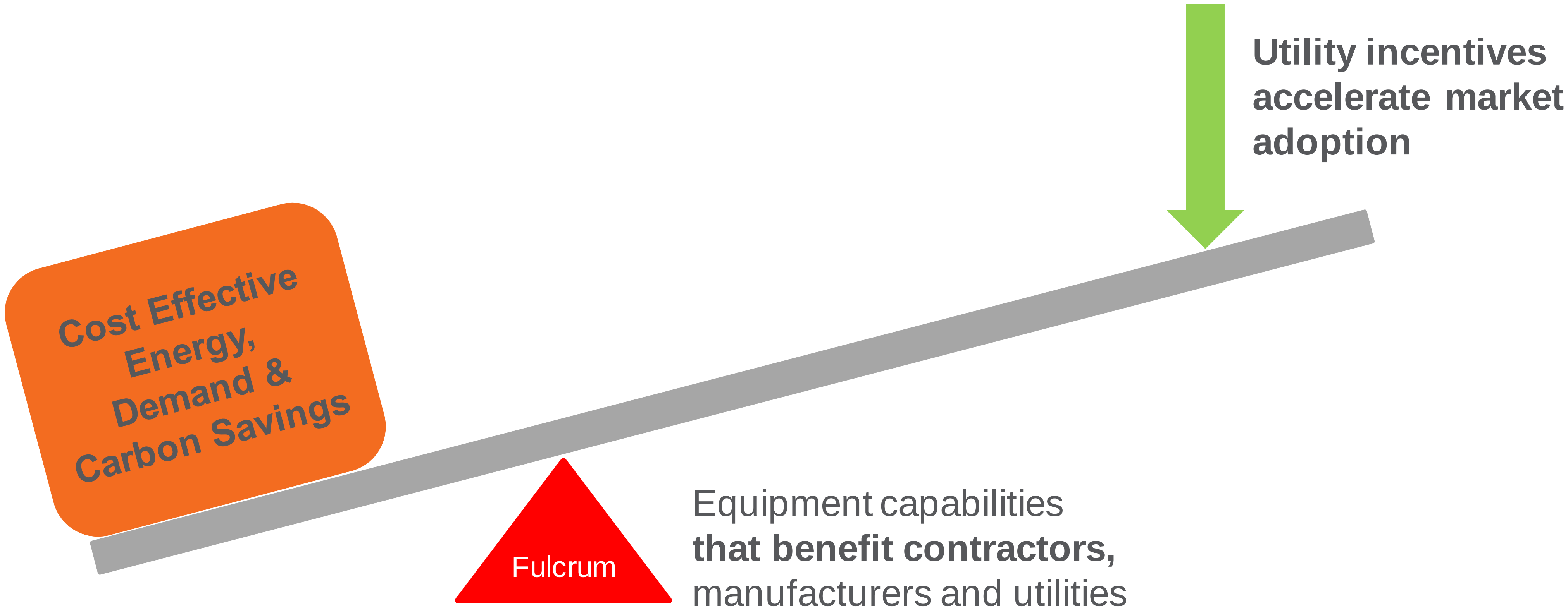
- Unproven Technology
- Inaccurate Product Differentiation
- Poor Contractor Value

Why Now



New connected controls make all 3 possible

Creating a Market Transformation Fulcrum



Roadmap Specification

Not a program requirement, but a directional guide forms a market ***fulcrum***

6 Criteria

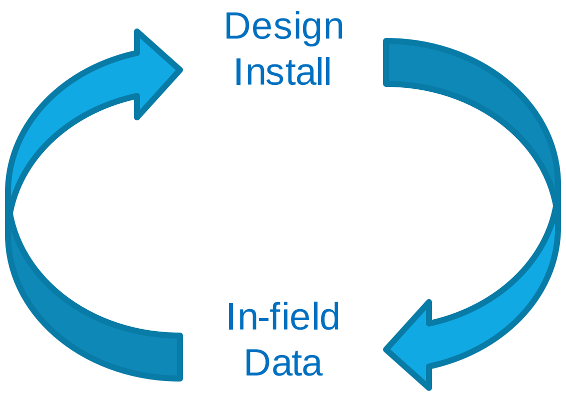
1. Performance Rating & Cap
2. Grid Response & Value
3. Automated Integration
4. Refrigerants
5. Design, Install, Monitoring
6. User Amenities

Objectives

1. Alignment of all stake holders
2. Identify what research is needed (gaps)

CRITERIA	TODAY	SOON	FUTURE
PERFORMANCE RATING & CAPACITY	• ENERGY STAR Certification (based on HSPF and SEER) • Variable speed compressors and fans	• Climate specific minimum SCOP ratings, ~ 10% more efficient than ENERGY STAR v6 • Published Max and Min Capacity Values across full operating temperature range • The matched control is ENERGY STAR certified	• Climate specific minimum SCOP ratings ~ 20% more efficient than ENERGY STAR v6 • Min capacity values are less than 1/4th max capacity values [at appropriate temperatures?]
GRID RESPONSE & VALUE	• AHRI 1380 capability • Minimizes energy use during recovery (peak man value)	• Ability to access 24hr ahead weather data to optimize comfort, performance and DR response • Ability to read external RSS for utility DR condition information • CTA 2045 port or equivalent	• DR hardware automatically connects to utility DR system (user chooses level of DR responsiveness) • Confirmation of demand response actions taken • Integrated energy storage, allowing for load flexibility without consumer impact
AUTOMATED INTEGRATION	• Controls allows integration with other htg/clg system. • Internet connection capability	• Automatic Control Integration	
REFRIGERANTS		• Refrigerant with GWP not greater than 750 • Refrigerant leak detection •	• Refrigerant with GWP not greater than 150 •
SYSTEM DESIGN, INSTALLATION, MONITORING	• Design follows ACCA design manuals • Installer has manufacturer certification of current product knowledge • Confirmation of installation to utility	• System provides data to support commissioning and baseline performance • Data confirms system basic operational via Key Performance Indicators (KPIs) • Ongoing data provides installers with alerts and diagnostic recommendation • Baseline performance captured	• System calculates real time COP and Capacity based on onboard sensors & input Complete integration of design tools with post installation verification data • Ongoing data for performance monitoring
USER AMENITIES	• Capable of remote operation via connected devices • Comfort and IAQ - TBD • Geofencing?	• System provides user with energy efficiency and demand response prioritization options • Automatic ASHRAE 62.2 verification of system (for ducted systems)	• CO and VOC sensors provide optimized performance

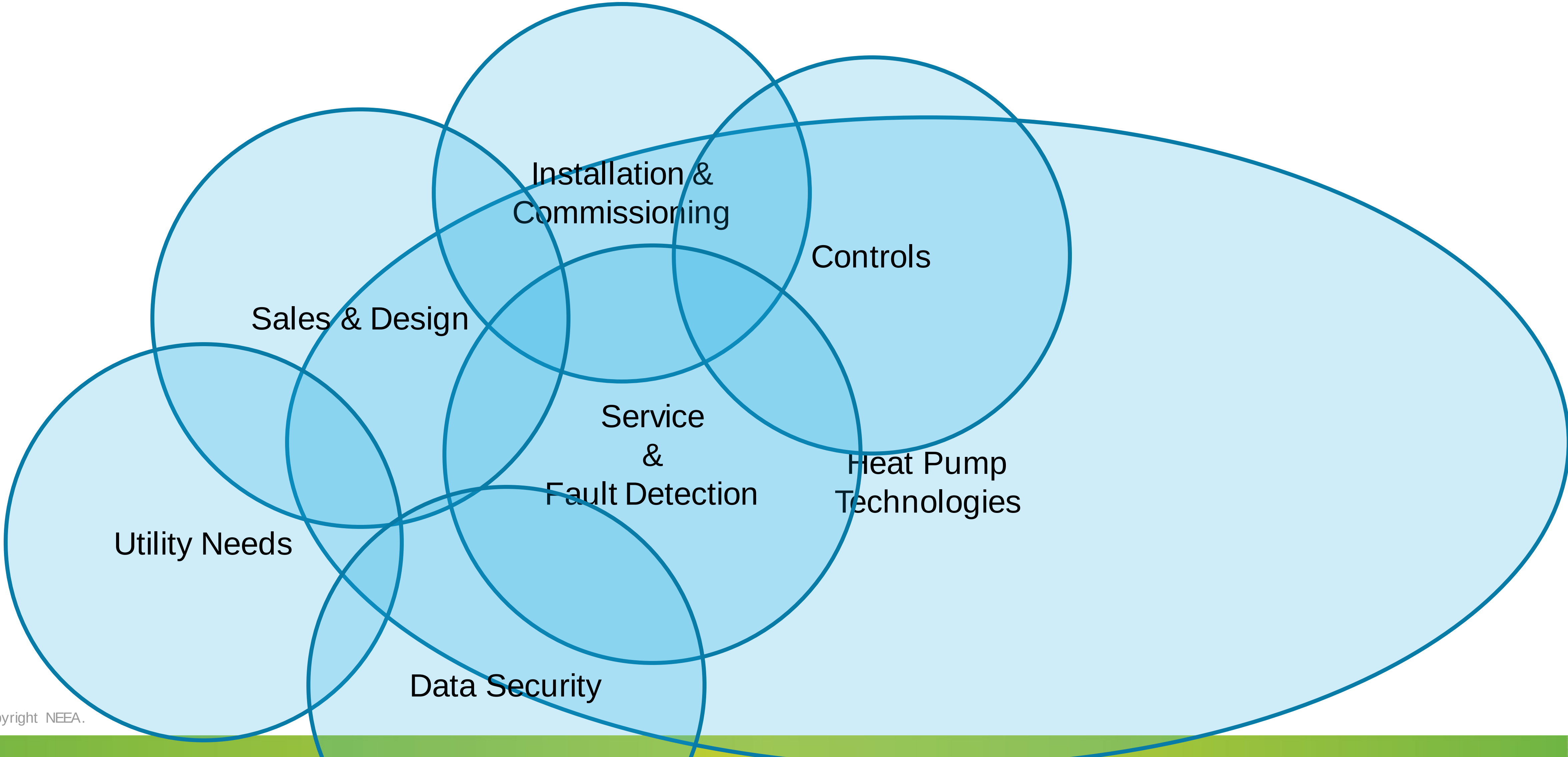
The Roadmap Focuses Our Research



- **Hypothesis:**
  - In-field performance data can improve design/install

- **Questions:**
  - Are savings real?
  - Will contractors welcome this?
  - What do utilities need in order to provide performance-based incentives?
  - What data structures/agreements need to be in place for this to work?
  - What is already available? What else is needed?
  - What is the path of least resistance?

Many Interrelated Overlapping Issues



Connected Commissioning and Control

- Validate benefits of remote diagnostics
  - Enhanced contractor value proposition
  - Utility verification and program QA
  - Increased energy and demand savings
- Evaluation of different approaches
- Both 3rd party and manufacturer products

Under Development

Collaboration Welcome

Join the Advanced HP Coalition

A Coalition of the Willing

- Goal

  To increase research collaboration among energy efficiency organizations that are working to accelerate market adoption of advanced heat pumps.

- Membership
  - ACTIVE = Fund and Guide collaborative activities
  - PASSIVE = attend webinars, provide feedback
- Committees
  - Steering Committee (NEEA, NEEP, MEEA, CEC, NRCan, EPA)
  - WG #1 – Improved Test Procedure and QPL
  - WG #2 – Roadmap Specification and Mfr Engagement
  - WG #3 – Best Practices (Design, Adaptation, Installation and Operation)

Bright Minds From These Organizations:

Questions?

- Christopher Dymond
- cdymond@neea.org

Residential HVAC Product Capabilities to Assess and Encourage Best Installation Practices

October 6, 2020

Dave Winningham

Lennox International
Sr. Engineering Manager, Regulatory Affairs

Dave Winningham, Lennox International began his career in the HVAC industry in 1978 and has led teams in the design, development and manufacture all categories of Residential and Light Commercial HVAC products. Current role includes coordination of Federal and State Regulatory issues across Lennox's Residential, Commercial and Refrigeration business segments including active participation in the ENERGY STAR program.

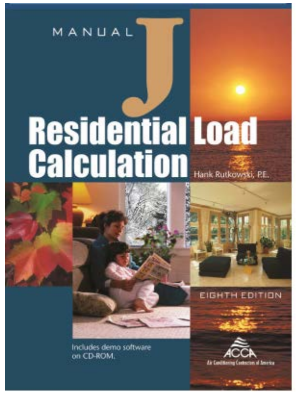
Quality Installation

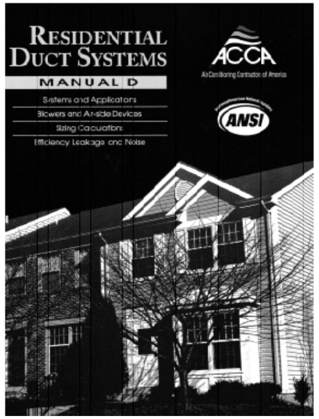
- All manufacturers spend significant time developing highly efficient products.
  - Today’s minimum efficiency products use 23% - 29% less energy than those produced prior to 2006 and will increase to 29% to 33% less energy when the 2023 DOE new standards become effective.
  - Current high efficiency product on the market can use over 60% less energy
- To ensure consumers attain these benefits proper installation is required

LENNOX INTERNATIONAL

Quality Installation

- Steps toward and Efficient HVAC Installation
  - Load Calculation
  - Appropriate Capacity and System Selection
  - Duct Design



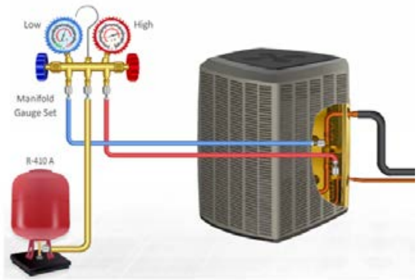


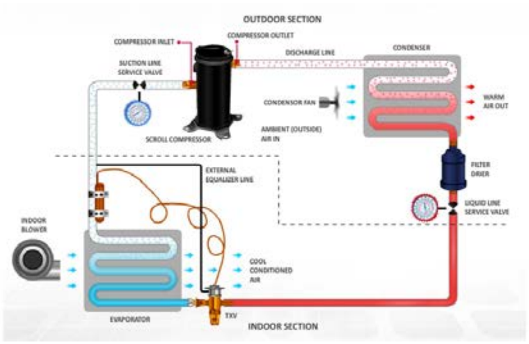
- Given these practices are followed what capabilities are available to ensure a HVAC system is installed properly?

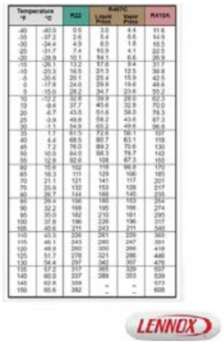
LENNOX INTERNATIONAL

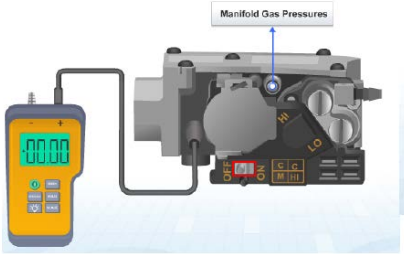
Common HVAC System Installation Issues

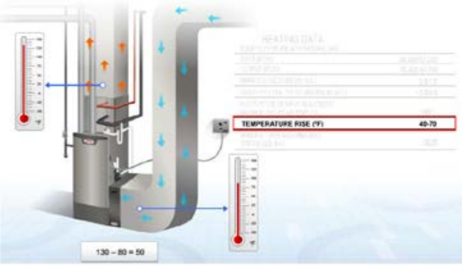
- Mis-matched Equipment
- Voltage Supply
- Refrigerant Metering Device
- Refrigerant Charge
- Airflow Setting
- Duct Static Pressure
- Furnace Gas Pressure
- Combustion Characteristics
- Temperature Rise / Fall
- Changeover Setpoints











	CO_2% For Nat		CO_2% For LPG	
	Low Fire	High Fire	Low Fire	High Fire
045	5.4 – 6.4	7.5 – 8.5	6.4 – 7.4	8.8 – 9.8
070	5.3 – 6.3	7.4 – 8.4	6.3 – 7.3	8.7 – 9.7
090	5.8 – 6.8	7.6 – 8.6	6.8 – 7.8	8.9 – 9.9
110	6.1 – 7.1	8.0 – 9.0	7.1 – 8.1	9.3 – 10.3
135	6.1 – 7.1	7.8 – 8.8	7.1 – 8.2	9.1 – 10.1

The maximum carbon monoxide reading should not exceed 50 ppm.

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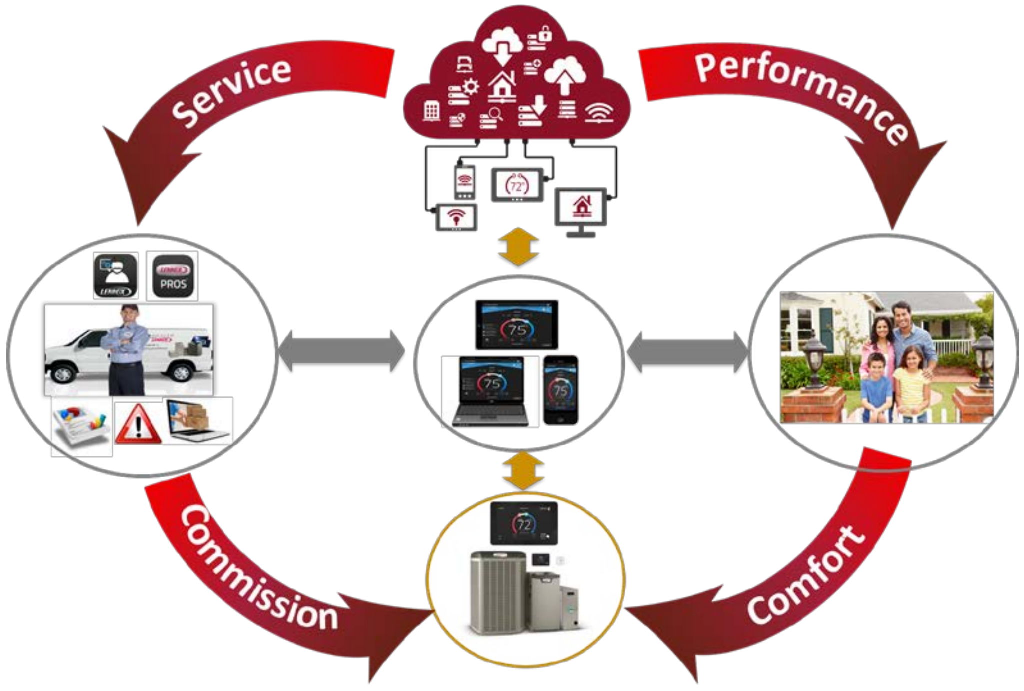
Product Features that can improve installations

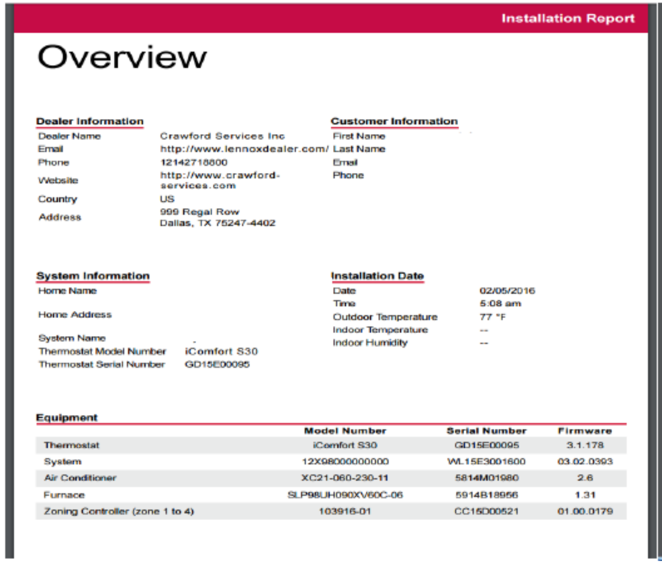
- Auto Commissioning
  - Identification of system components to ensure properly matched system
  - Automated system settings to optimize performance

<u>Lennox iComfort® HVAC Control System</u>



Product Features that can Improve Installations

- Auto Commissioning
  - Test functions with operational parameters
    - Voltage
    - Input Current/Power
    - Airflow
    - Static Pressure
    - Temperature Rise
    - Refrigerant Pressure
    - Refrigerant Temperature
    - Furnace Gas Pressure
    - Combustion Measurement



Installation Report

Overview

Dealer Information

Dealer Name	Crawford Services Inc
Email	http://www.lennoxdealer.com/
Phone	12142718600
Website	http://www.crawford-services.com
Country	US
Address	999 Regal Row Dallas, TX 75247-4402

Customer Information

First Name	
Last Name	
Email	
Phone	

System Information

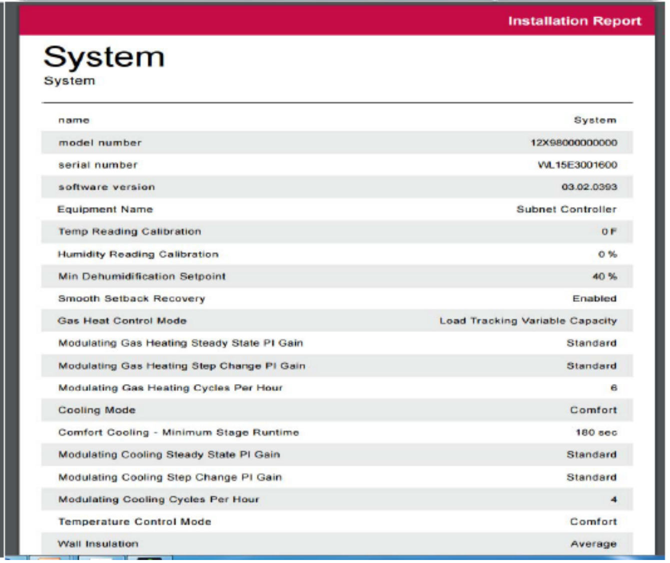
Home Name	
Home Address	
System Name	-
Thermostat Model Number	iComfort S30
Thermostat Serial Number	GD15E00095

Installation Date

Date	02/05/2016
Time	5:08 am
Outdoor Temperature	77 °F
Indoor Temperature	--
Indoor Humidity	--

Equipment

	Model Number	Serial Number	Firmware
Thermostat	iComfort S30	GD15E00095	3.1.178
System	12X98000000000	WL15E3001600	03.02.0393
Air Conditioner	XC21-060-230-11	5814M01980	2.6
Furnace	SLP98UH090XV60C-06	5914B18956	1.31
Zoning Controller (zone 1 to 4)	103916-01	CC15D00521	01.00.0179



Installation Report

System

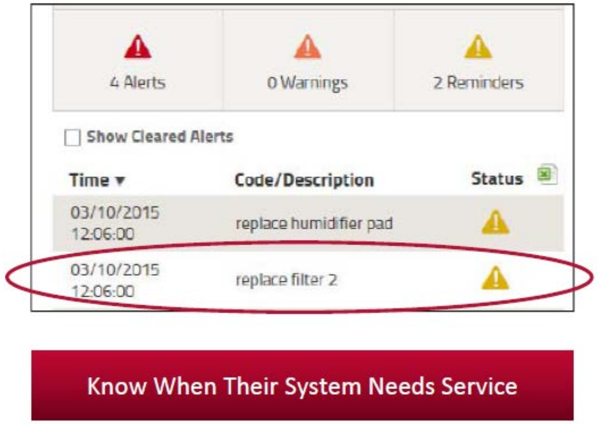
System

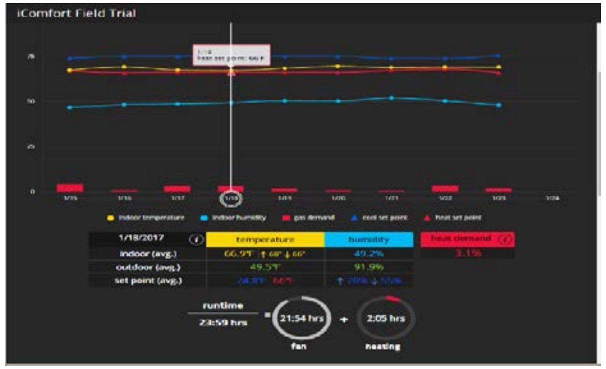
name	System
model number	12X98000000000
serial number	WL15E3001600
software version	03.02.0393
Equipment Name	Subnet Controller
Temp Reading Calibration	0 F
Humidity Reading Calibration	0 %
Min Dehumidification Setpoint	40 %
Smooth Setback Recovery	Enabled
Gas Heat Control Mode	Load Tracking Variable Capacity
Modulating Gas Heating Steady State PI Gain	Standard
Modulating Gas Heating Step Change PI Gain	Standard
Modulating Gas Heating Cycles Per Hour	6
Cooling Mode	Comfort
Comfort Cooling - Minimum Stage Runtime	180 sec
Modulating Cooling Steady State PI Gain	Standard
Modulating Cooling Step Change PI Gain	Standard
Modulating Cooling Cycles Per Hour	4
Temperature Control Mode	Comfort
Wall Insulation	Average

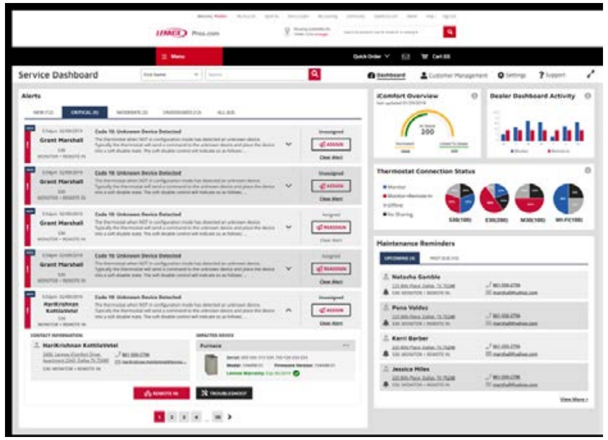
  - Installation Reporting with operational parameter flags

Product Features that can Improve Installations

- Post installation ongoing benefits
  - Performance Reporting
  - Maintenance Notification
  - Diagnostic Tools
  - Service Notification
  - Prognostic Tools







- While technology can be applied to individual system components most successful when System is Communication enabled
  - External Communication
  - Internal System Communication

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Product Features that can improve Installation

- HVAC Product Characteristics
  - The majority of HVAC products sold today are binary devices with limited system communication capability
  - High Efficiency products on the market are enabled with communication capabilities
    - Variable capacity products that require intelligent control systems to operate lend themselves to incorporate these features cost effectively
    - Technology can be applied to the spectrum of HVAC product from single stage to fully variable systems

iComfort® Communicating Control

- Advanced control communicates information about various operating parameters in the air conditioner to the iComfort® Communicating Thermostats to constantly maintain the highest level of comfort, performance and efficiency available
- **Auto Configuration** - On start-up the control automatically sends a description of the unit to the iComfort® Communicating Thermostat to automatically configure the features available

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Product Features that can improve Installation

- Inhibitors
  - Increased Cost
  - Consumer Value Proposition
  - Low Volume

Sensor Cost $$

Multiple Sensors

- Measures to improve
  - Industry migration toward smart system capabilities that enable
  - Collaboration to quantify benefits
  - Recognition for systems that provide these functions
  - Programs that encourage adoption

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Technology Enablers

Intelligent Home

Temperature
Relative Humidity
IAQ, CFM
Weather
Occupancy
Lights
Appliances
Phone
Pool
Car

Temp
RH
CFM

Wireless Connectivity & Cloud

Capacity
Power
Status

Smart Equipment

Heat
Cool
Ventilate

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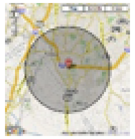
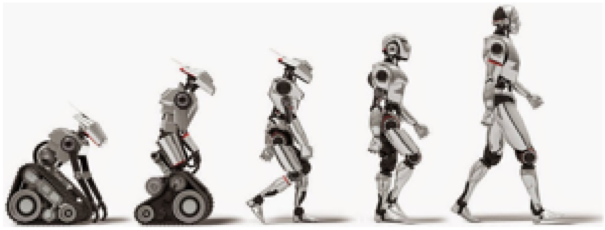
Component/Sensing Technology + Communication = Smarter Systems
Improved Installed Performance

Smart

Learning

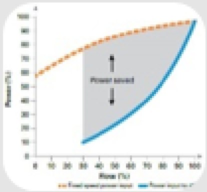


Geo-Fence



Ultra Smart

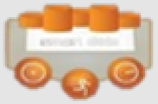
Auto Commissioning



Variable Speed Control

Performance Evaluation

Predictive Maintenance



Simplified Troubleshooting

Intuitive

LENNOX INTERNATIONAL

Lennox iComfort S30 Thermostat

- Works with Lennox communicating equipment to provide precision comfort *
- 7” HD touch display with HD video screensavers
- CEC Title 24 Demand Response compliant
- Simple 4 –wire installation
- Ultra Smart thermostat with Schedule IQ that does the programming for you
- Dealer Commissioning app for quick easy installation
- Installation reports
- Performance reports and emails
- Dealer Dashboard allows for remote monitoring, remote debug and diagnostic with homeowner consent
- Smart alerts to your dealer when system is in need of maintenance or issue arises
- “Smart Away” uses geo-fencing technology to adjust temperature while you are away
- “Feels Like” temperature adjusts temperature and humidity levels for precise comfort
- “Allergen Defender” filters the air in your home depending upon air quality levels in your area
- Weather on demand
- 7-day weather and allergen forecast display to always keep you informed
- Wireless Access for complete control anywhere you go
- Wi-Fi remote monitoring and control via any smart device
- One-Touch Away Mode
- iHarmony zoning compatible
- Humidity control for enhanced comfort
- Voice control and Home Automation integration with popular systems

•*The Ultimate Controller for precise comfort.*

Contact Information

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