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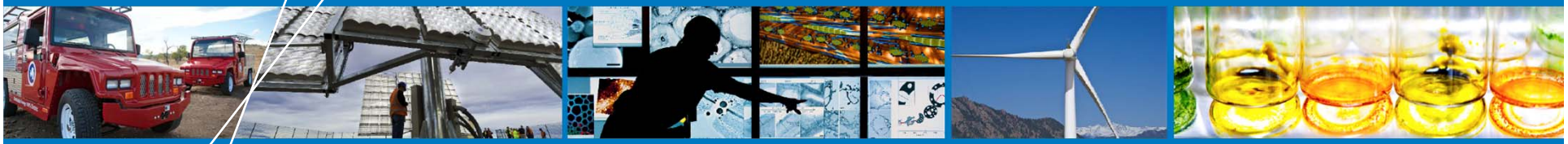
Indoor Temperature and Humidity Data Collection and Analysis

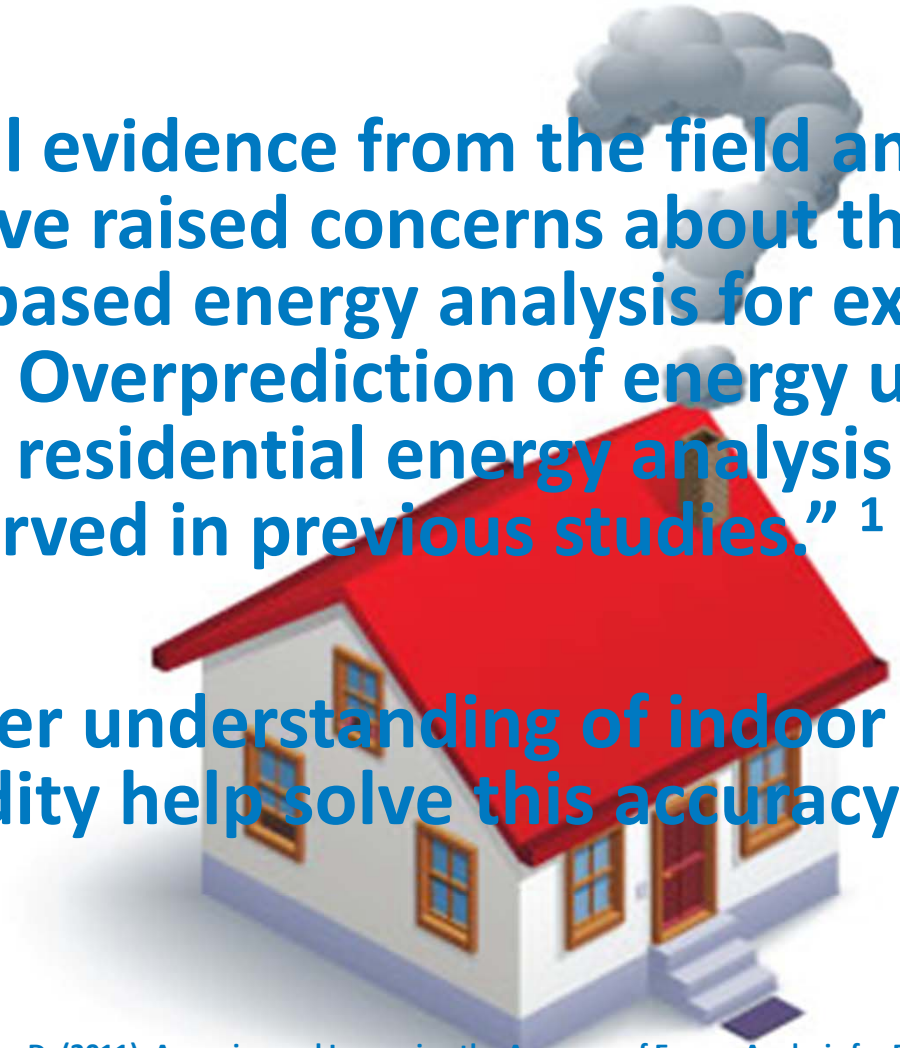


Chuck Booten, NREL

Paul Norton, NERD

Cheryn Metzger, NREL

Why do we care about indoor Temp/RH?



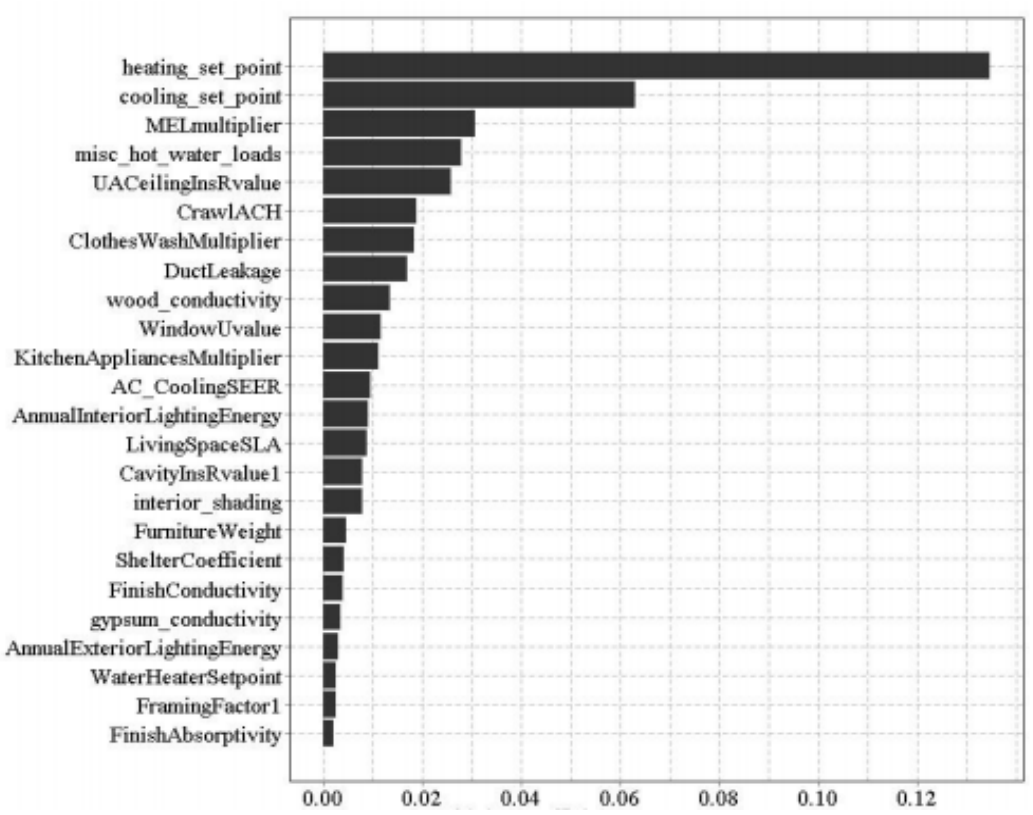
"Anecdotal evidence from the field and controlled studies have raised concerns about the accuracy of software-based energy analysis for existing homes. …. Overprediction of energy use and savings by residential energy analysis methods has been observed in previous studies." [1]

Can a better understanding of indoor temperature and humidity help solve this accuracy issue?

1. Polly, B.; Kruis, N.; Roberts, D. (2011). Assessing and Improving the Accuracy of Energy Analysis for Residential Buildings. 41 pp.; NREL Report No. TP-5500-50865; DOE/GO-102011-3243. http://www.nrel.gov/docs/fy11osti/50865.pdf

Why do we care about indoor Temp/RH?

- Space conditioning can account for about half of home energy use
- Indoor temperature has a large effect on energy use
- Temperature and humidity affect comfort, health and safety, and durability



Influence of various inputs on simulated energy use for a particular house

BA House Simulation Protocol

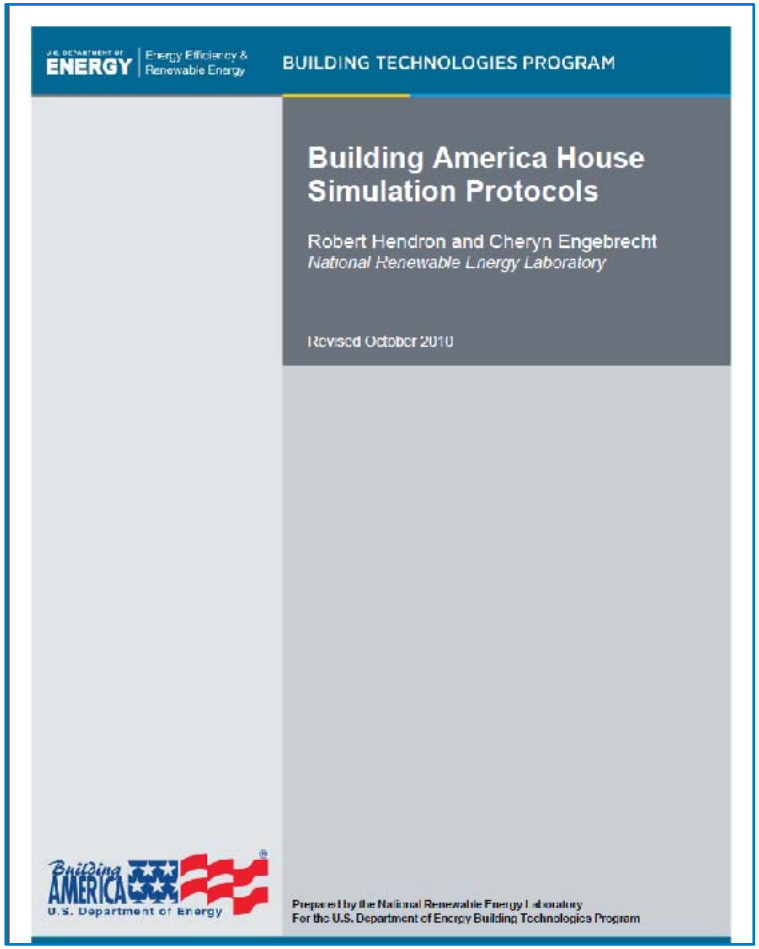
Set point for cooling:

76°F with no setup period

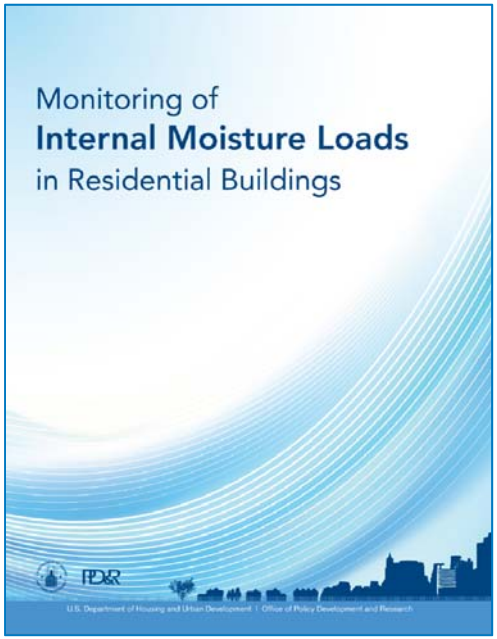
Set point for heating:

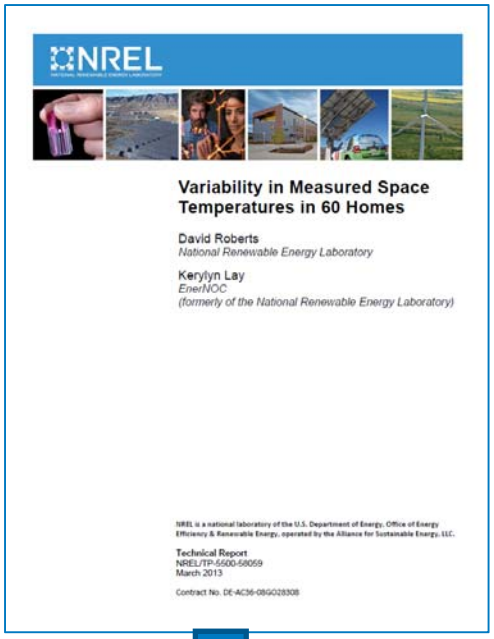
71°F with no setback period

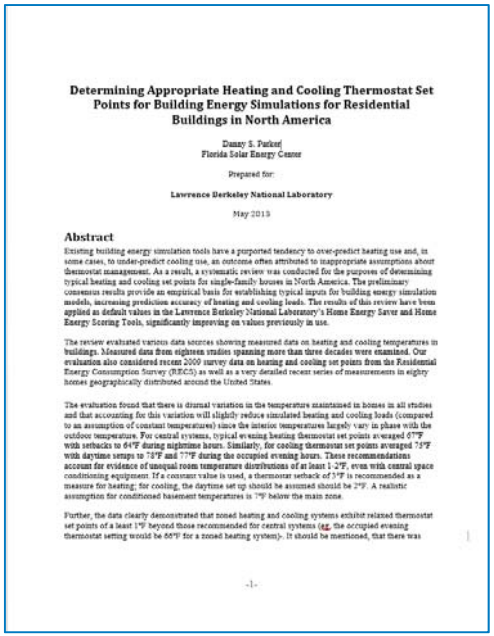
(These were based on based on ASHRAE Standard 55-2004 and the Residential Energy Consumption Survey (RECS) of 2005)



Some initial studies raised concerns







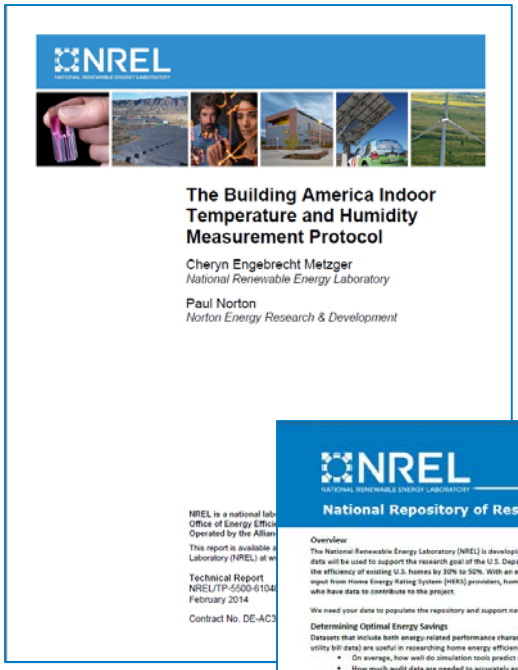
What data is needed?

- **Hourly T&RH measurements in the living room and all bedrooms**
- **Outdoor T&RH**
- **Runtime of space conditioning equipment**
- **Ideally one year of data.**
  - A *minimum* of two weeks of data near the peak of the heating or cooling season

These measurements are often done with stand-alone battery powered loggers (such as HOBOs) provided by NREL. NREL may also be able to provide installation assistance.

Temp and Humidity Measurement Protocol

- **Who is it for?**
  - Anyone collecting temp/RH data in houses (utility programs, researchers, etc.)
- **What does it do?**
  - Guides people through a best practice method for gathering useful T/RH data
- **Why is standardization needed?**
  - Statistical analysis for understanding the important drivers of T/RH distribution requires lots of similarly formatted data
- **How does data get used?**
  - Improved simulation models and inputs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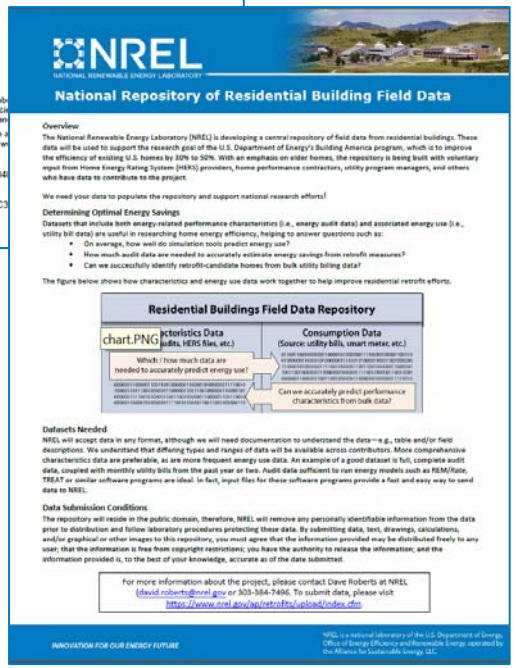
The Building America Indoor Temperature and Humidity Measurement Protocol

Cheryn Engebrecht Metzger
National Renewable Energy Laboratory

Paul Norton
Norton Energy Research & Development

Technical Report
NREL/TP-5500-6104
February 2014

Contract No. DE-AC3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National Repository of Residential Building Field Data

Overview

Determining Optimal Energy Savings

Residential Buildings Field Data Repository

Consumption Data
(Source: utility bills, smart meter, etc.)

Which / how much data are needed to accurately predict energy use?

Can we accurately predict performance characteristics from bulk data?

Datasets Needed

Data Submission Conditions

For more information about the project, please contact Dave Roberts at NREL (david.roberts@nrel.gov or 303-384-7496. To submit data, please visit https://www.nrel.gov/ap/retrofits/upload/index.cfm

INNOVATION FOR OUR ENERGY FUTURE

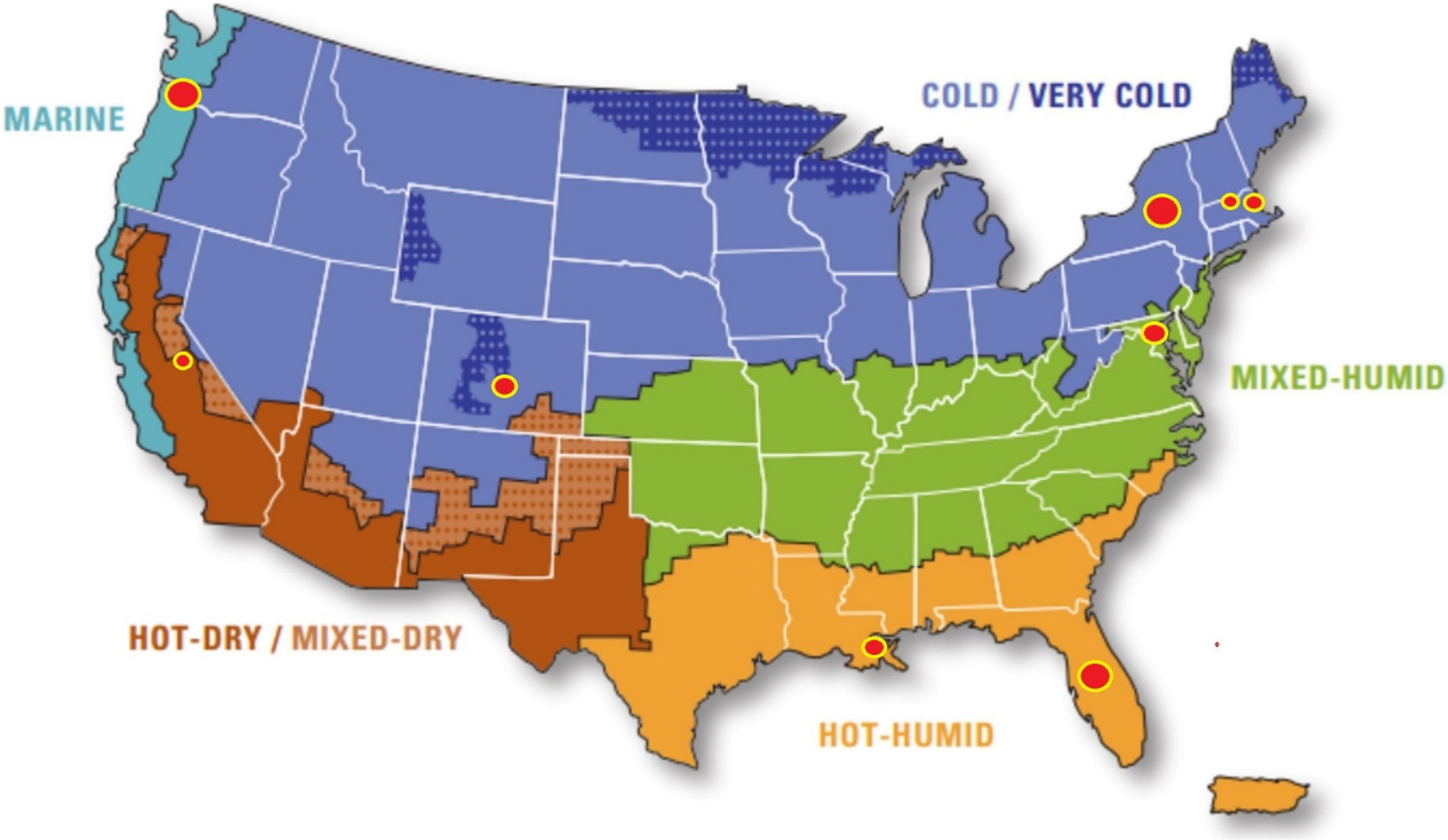
Current Project Scope

- Implement Protocol
- We expect to collect data on over 350 homes of different types in a variety of climates
- Data collection will continue through 2015.
- The BA Home Simulation Protocols will be updated as needed.

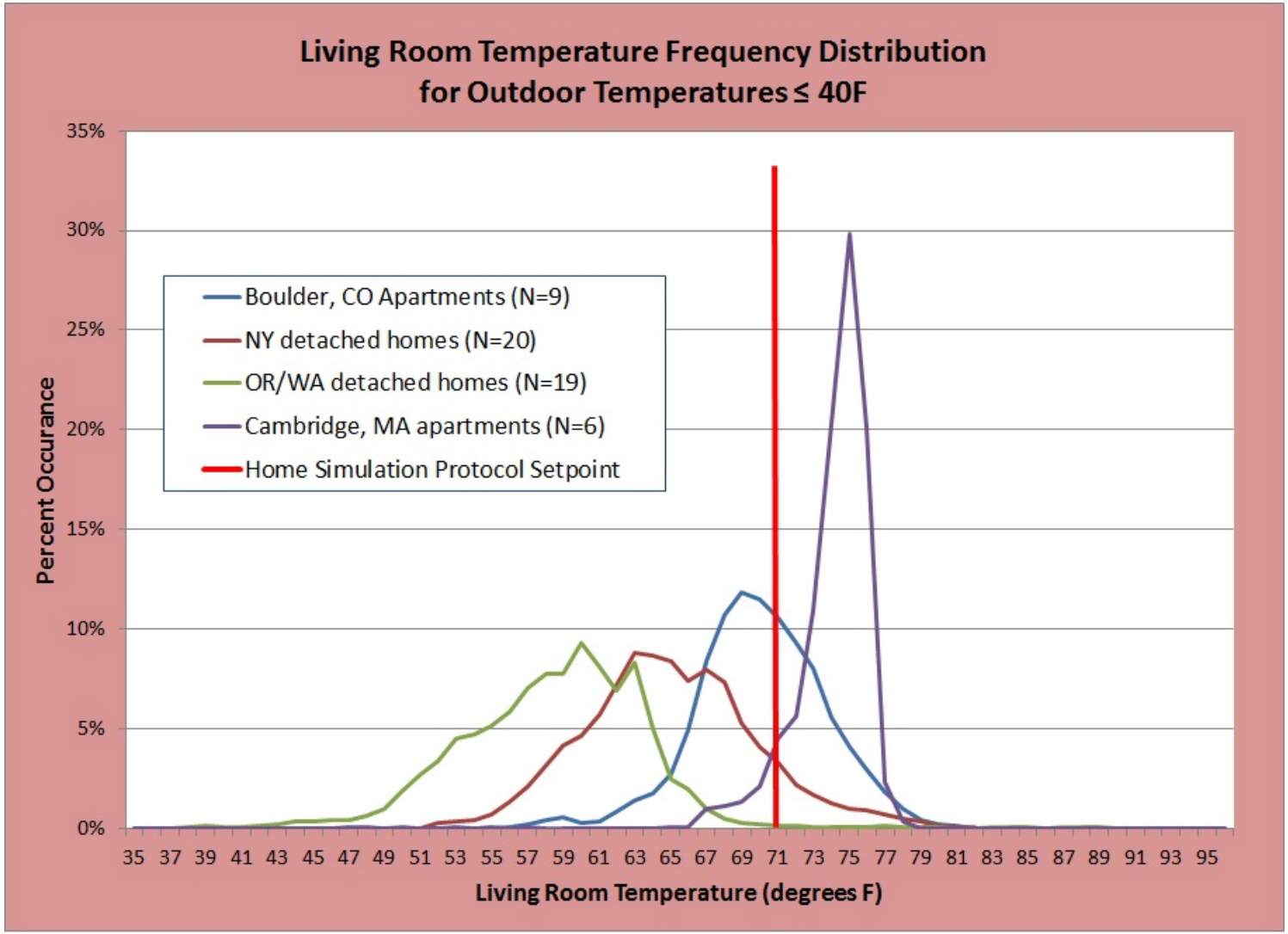
Current Data Distribution

Location	Number of homes	Type of Homes	BA Climate Zone
New York	20	single family detached	Cold
Florida	20	single family detached	Hot-Humid
Oregon	20	single family detached	Marine
Greenbelt, MD	10	Apartments	Mixed-Humid
Boulder, CO	1	single family detached	Cold
Boulder, CO	9	Apartments	Cold
New Orleans, LA	8	single family detached	Hot-Humid
New Orleans, LA	2	single family detached	Hot-Humid
Cambridge, MA	11	Apartments	Cold
Devins, MA	10	single family detached	Cold
Fresno, CA	5	single family detached	Hot-Dry
Denver, CO	5	single family detached	Cold
Anticipated additions for 2014			
TBD	50	Apartments	Hot-Dry or Hot-Humid
TBD	20	Apartments	Cold
All Homes	**191**		

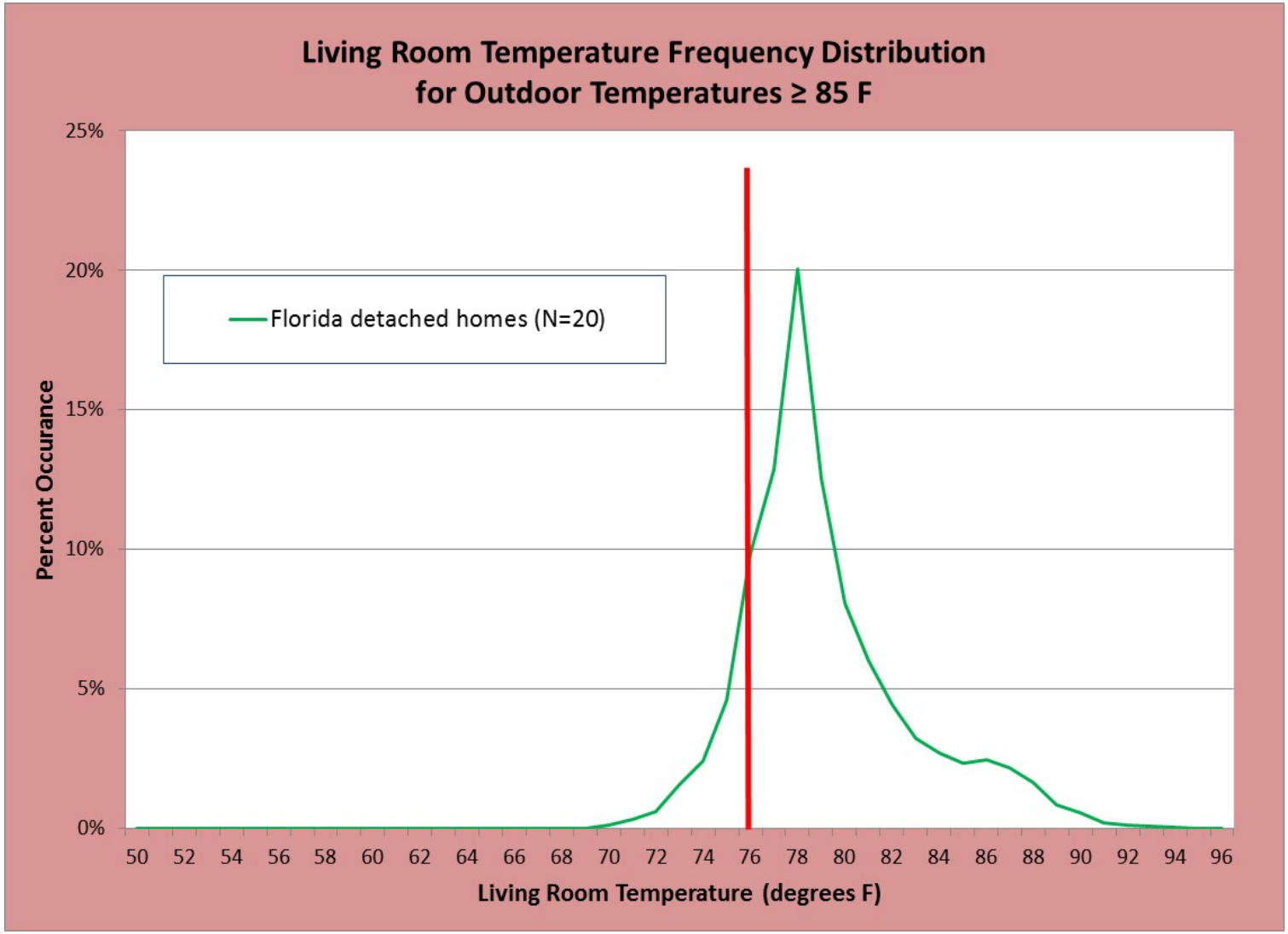
Current Data Distribution



Indoor Temperatures During Heating

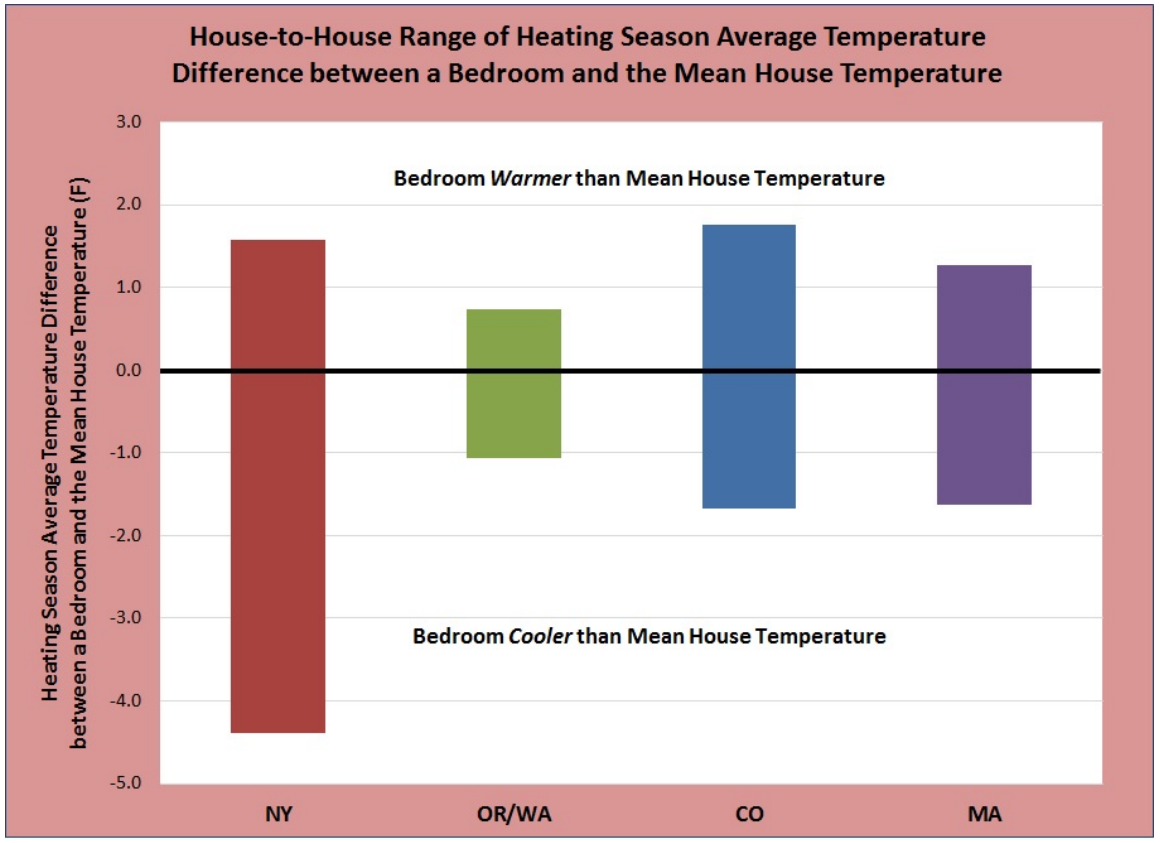


Indoor Temperatures During Cooling

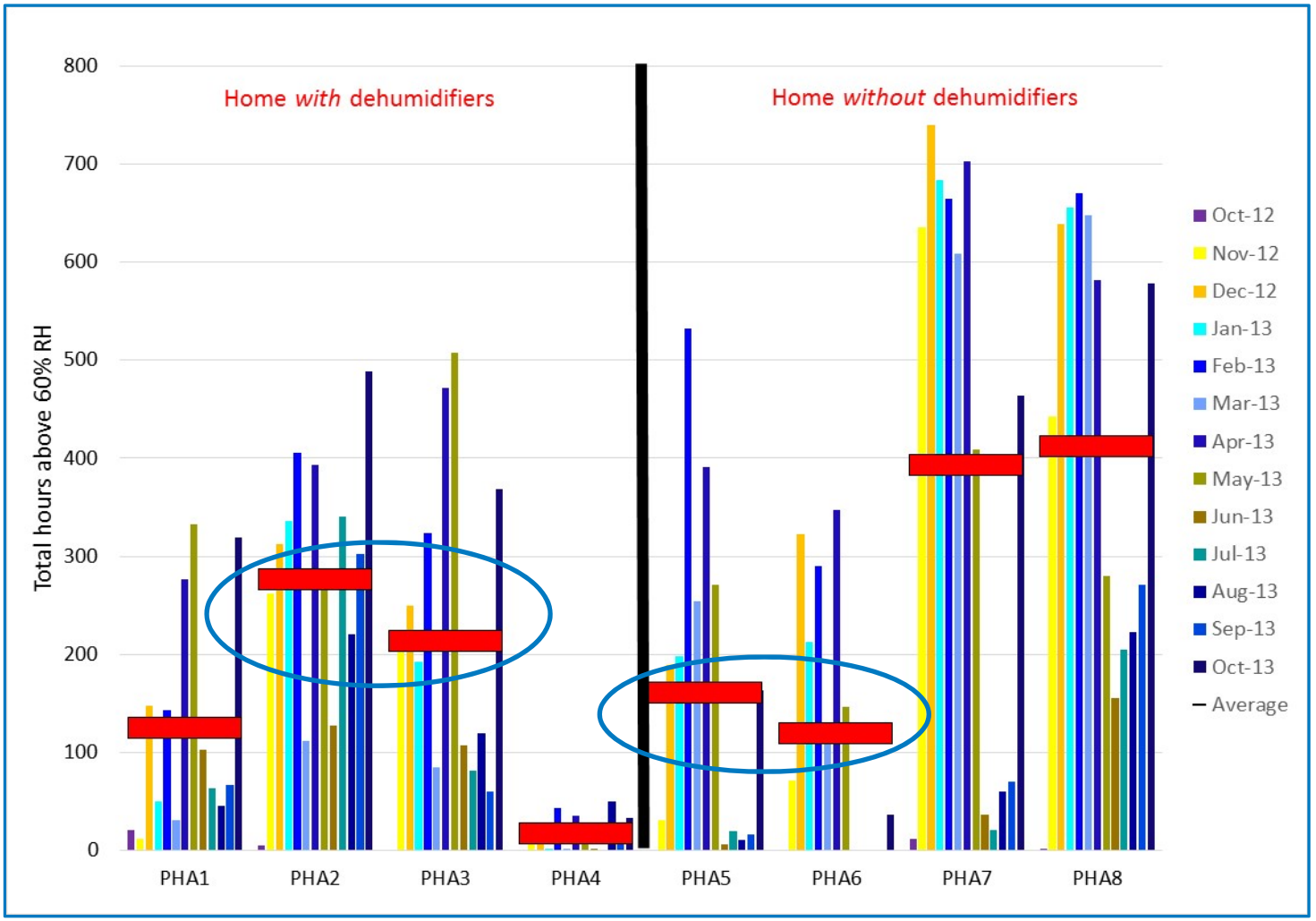


Temperature distributions within homes

- Within houses variations are +/- X deg F on average
- Some rooms warmer, some colder



RH Variability - New Orleans Example



Source: Kerrigan, P., and Norton, P., 2013.Evaluation of the Performance of Houses with and without Supplemental Dehumidification in a Hot-Humid Climate

What caused the variability?

	PHA1	PHA2	PHA3	PHA4	BDC1	BDC2
Occupancy (# of people)	1*	1 or 2**	4	4	1	1
Hours above 60% RH	Average	High	High	Low	Low	Low
Humidity Ratio	Average	Low	High	High	Average	Low
Indoor Temperature	Average	Low	Average	High	High	Low
Master Bath Fan	Average	Low	Low	High	High	Low
Hall Bath Fan	Average	Low	Low	High	Low	Low
Dehumidifier Electricity	Low	High	Low	High	Average	Low
Heat Pump Electricity	Average	High	High	High	Low	Low
DHW Electricity	Average	Low	High	High	Low	Low
Cooking Electricity	High	Average	High	Low	Low	Low
Clothes Dryer Electricity	Average	Low	High	High	Low	Low

Source: Kerrigan, P., and Norton, P., 2013.Evaluation of the Performance of Houses with and without Supplemental Dehumidification in a Hot-Humid Climate

Initial Data Trends

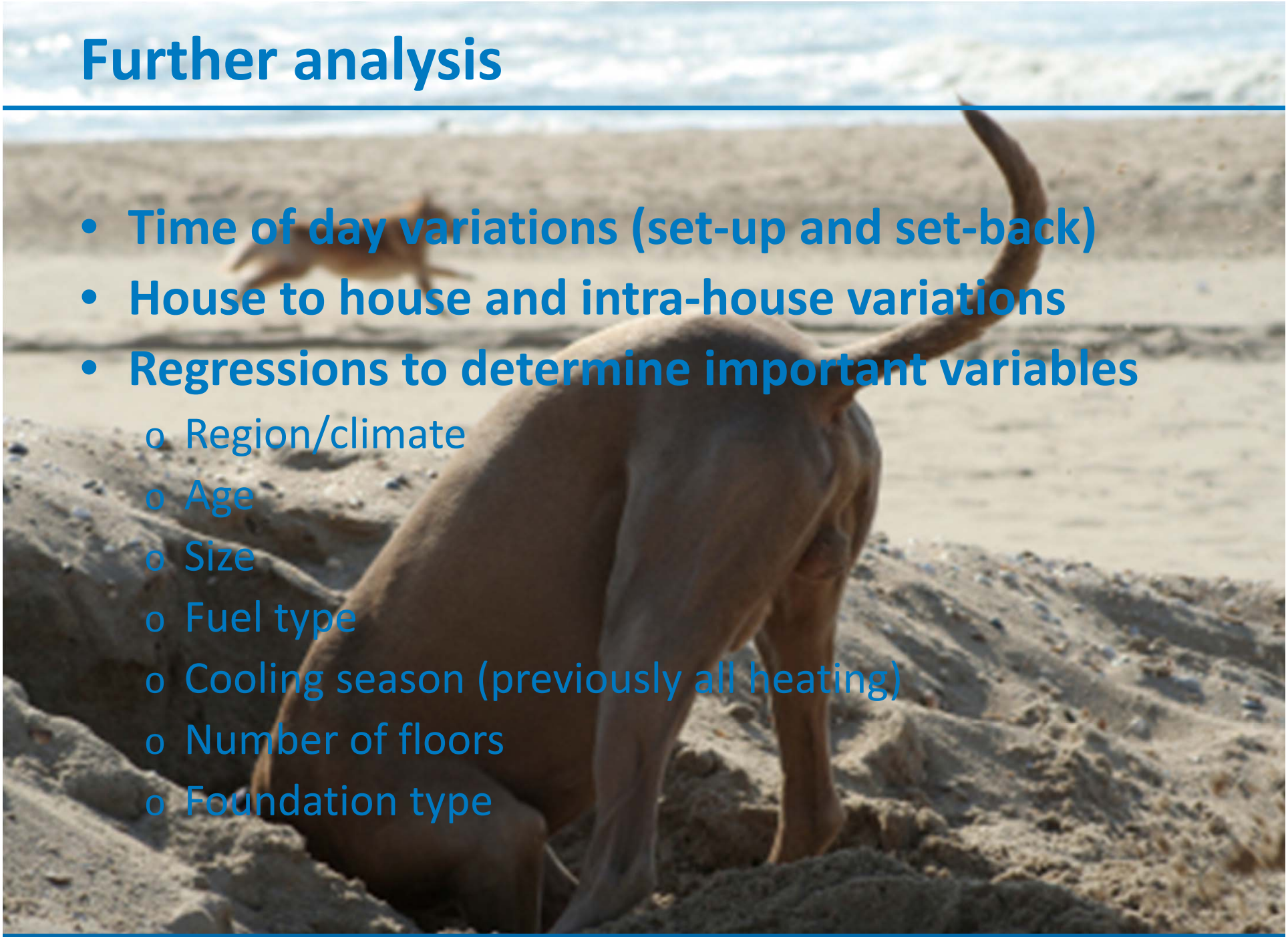
- **Significant variability in indoor temperature and humidity – we need more data**
  - Project-to-project, House-to-house, Room-to-room, and hour of day.
- **Most of the initial data lack space conditioning equipment runtime data – we need more data**
- **Early data may indicate HSP heating setpoint is too high, but we need more data.**

…….Oh, and did we mention….. we need more data!

More data!

- **NREL wants to collaborate**
- **If you have data already, we want to include it in this study**
- **Expand the scope of the existing data…**
  - Older homes
  - Warmer climates
  - More single family detached homes

Further analysis



- **Time of day variations (set-up and set-back)**
- **House to house and intra-house variations**
- **Regressions to determine important variables**
  - Region/climate
  - Age
  - Size
  - Fuel type
  - Cooling season (previously all heating)
  - Number of floors
  - Foundation type

Contact

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