FORCED AIR SYSTEMS IN HIGH PERFORMANCE HOMES

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What are the issues?

1. Sizing
   - When is too small too small?
2. Distribution
   - Can we get good mixing at low flow?
3. Performance
   - Humidity Control
   - Part load efficiency
   - Blowers & thermal losses

Sizing

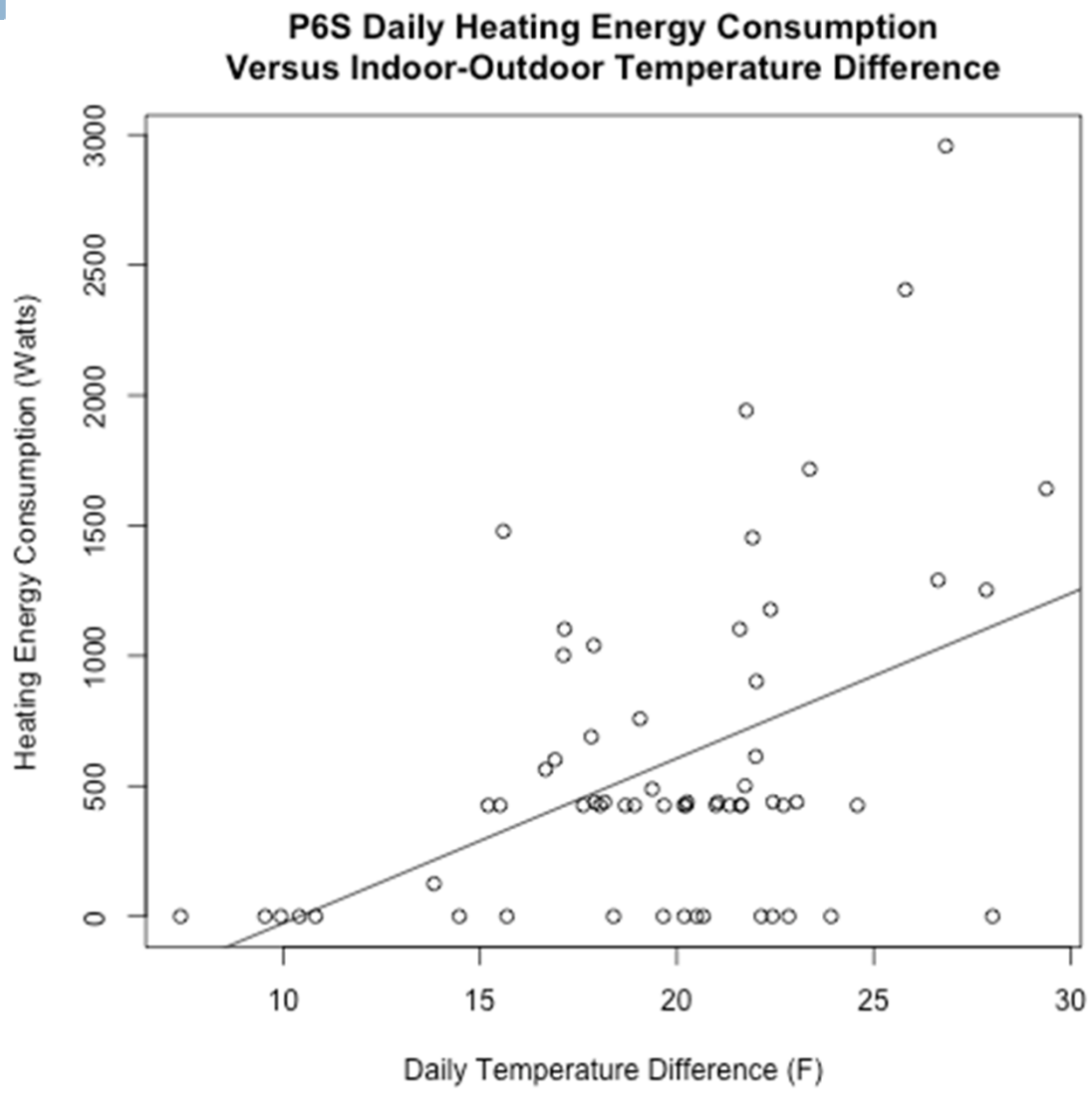
- Part-load – not an issue with modern equipment
- Careful about predicted loads – a small error becomes a big problem for tightly sized systems
- Too Low Capacity = not robust
  - Extreme vs. design days
  - Change in occupancy
  - Party mode
  - Recovery from setback

Sizing

- Conventional wisdom – a good envelope = easy to predict and not sensitive to indoor conditions
- But….. Heating and cooling become discretionary – large variability depending on occupants
  - Absolute energy changes small – relative changes large

Challenges to Precise Sizing in High Performance Homes

- Inconsistent relationships between heating system energy and temperature difference
- Homes are not simply thermostat controlled
- Heating has become more discretionary
- Internal and solar gains could also cause this, or "heat when home" strategies



Distribution: Comfort Guidelines

- ASHRAE 55 sets ranges for Temperature and humidity
  - Building America field data shows that houses spend a lot of time outside Std. 55 limits
  - Are occupants more adaptable (home vs. office)?
- ACCA 4-6F recommended maximum differences between rooms

Can we be more flexible in High Performance Homes?

- What is acceptable indoor humidity in High Performance Homes?
  - High and more uniform surface temperatures = less condensation = higher indoor RH OK
  - Probably limited by condensation on registers?
- Field measurements indicate same humidity throughout house BUT lower RH (<5% diff.) on second floor due to average higher temperatures

Distribution

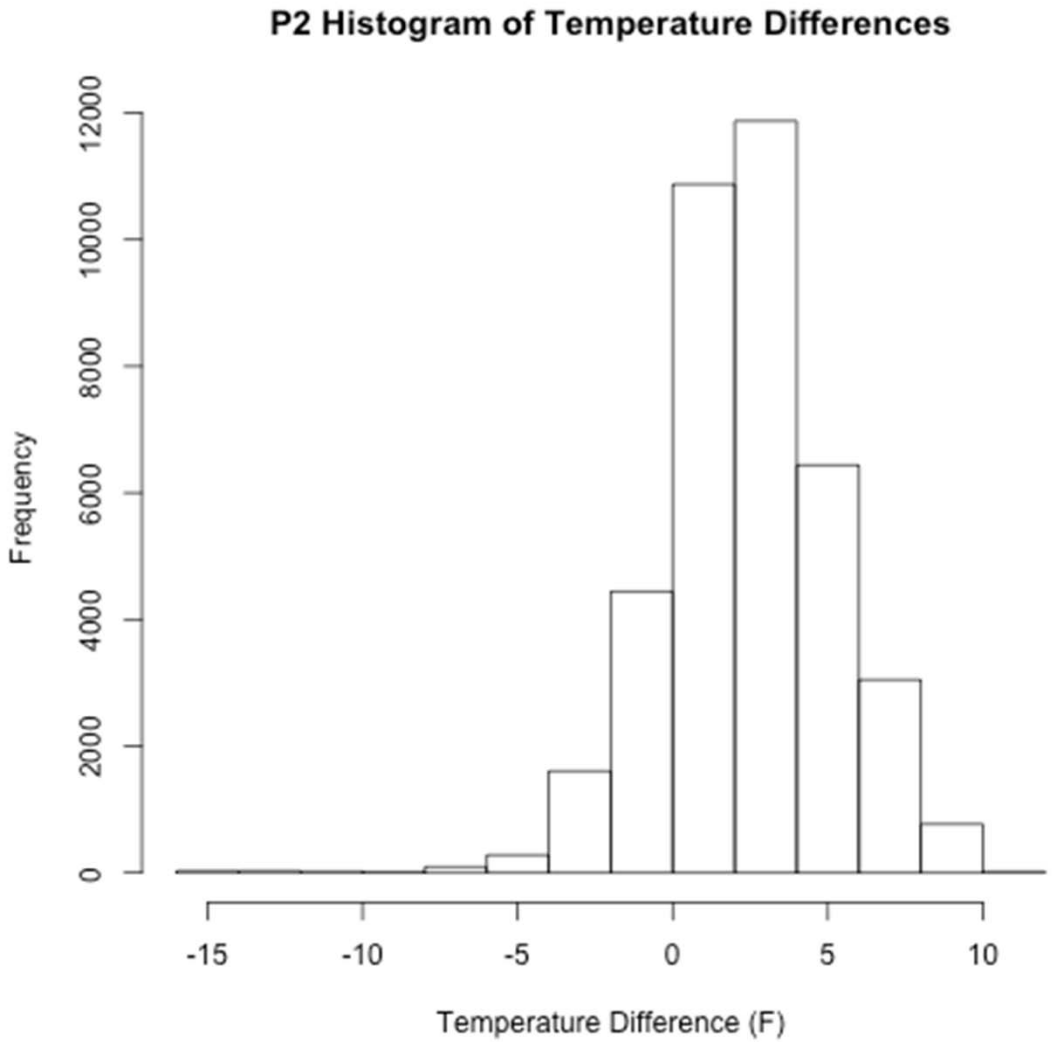
- Solar loads – heating one half of house relative to other – needs zoning or smart air movement or good solar control
- Longer transit times = bigger conduction losses
  - Ducts MUST be inside & insulated
  - Keep duct runs short – centrally locate HVAC

Distribution – Integration with Ventilation

- Continuous HRV/ERV either stand alone or using same ducts
- Similar magnitude air flows as heat/cool BUT maintenance issues
- Need a good envelope

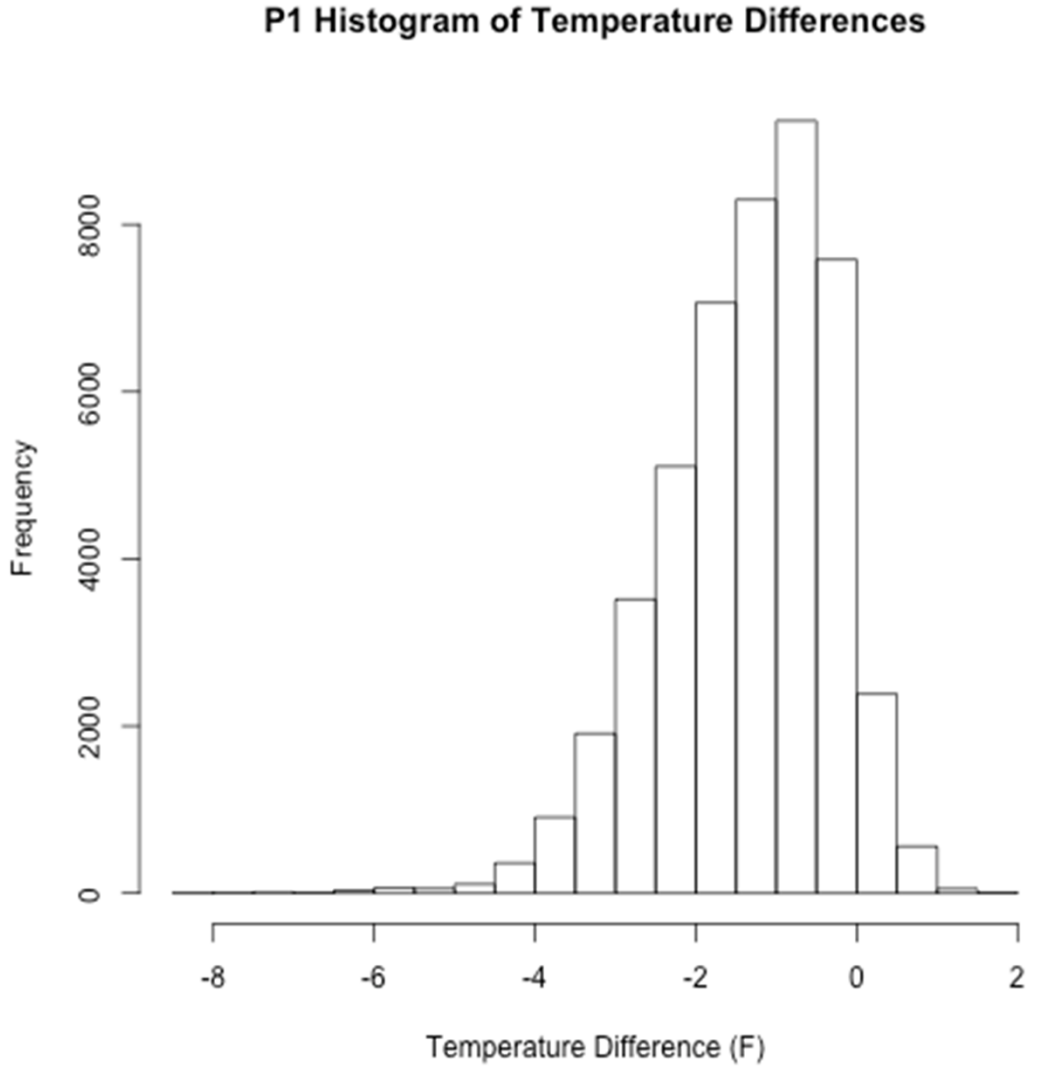
Temperatures Between Floors in OK home

- Temperatures in a wide band
- Would not meet ACCA requirements 25% of the time
- Typical Forced air heat/cool system
- 1200 cfm in 2400 sq.ft. home + continuous ERV
- 5.7 ACH50 envelope



Temperatures Between Floors in High Performance Home with ERV

- Temperatures in a narrow band
- Electric Baseboard heat
- Would meet ACCA requirements
- 150 cfm continuous in 1600 sq.ft. home
- 270 cfm50 envelope

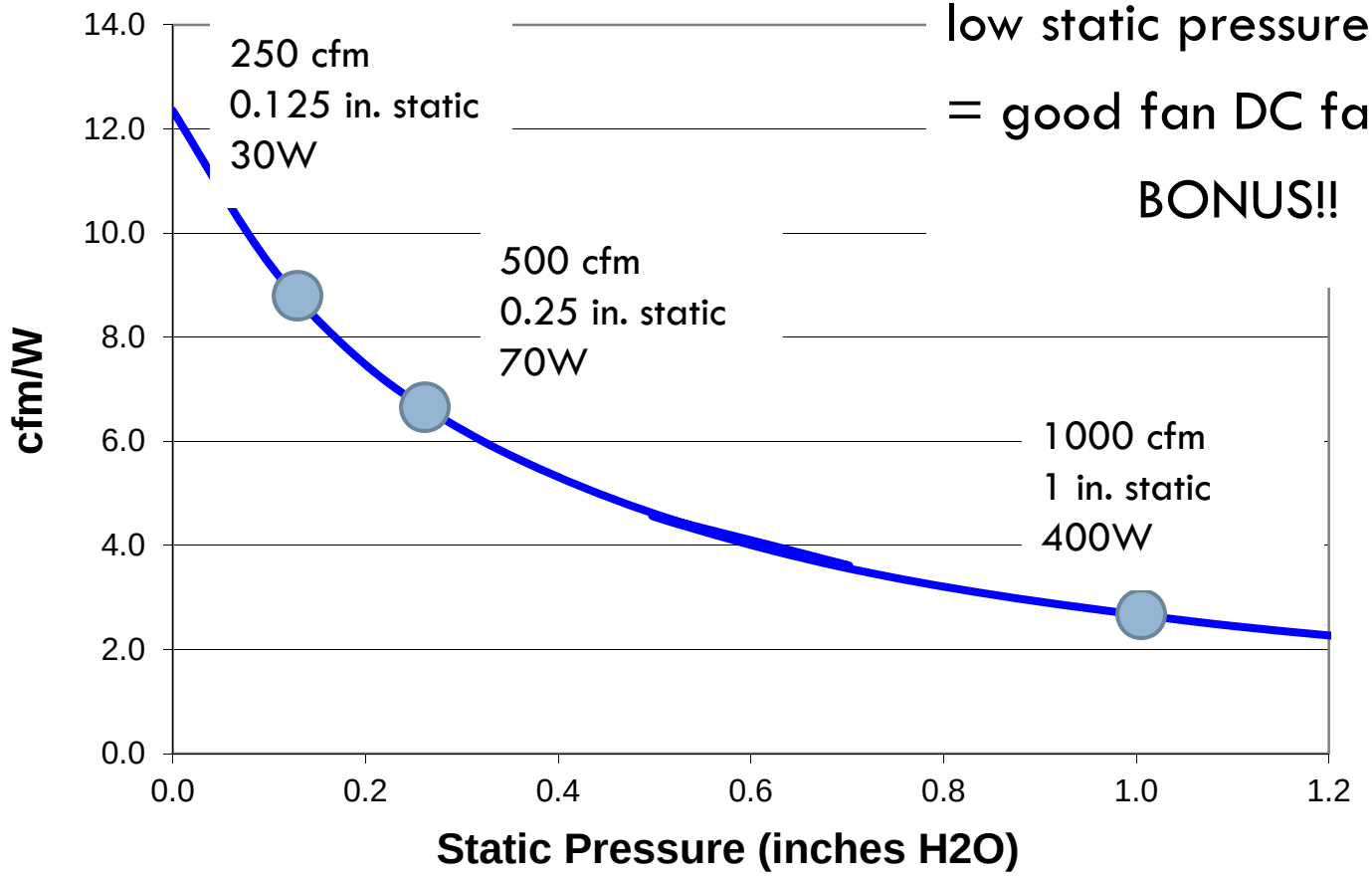


Performance – a good blower

Small flow + same ducts and filter = low static pressures

= good fan DC fan performance

BONUS!!

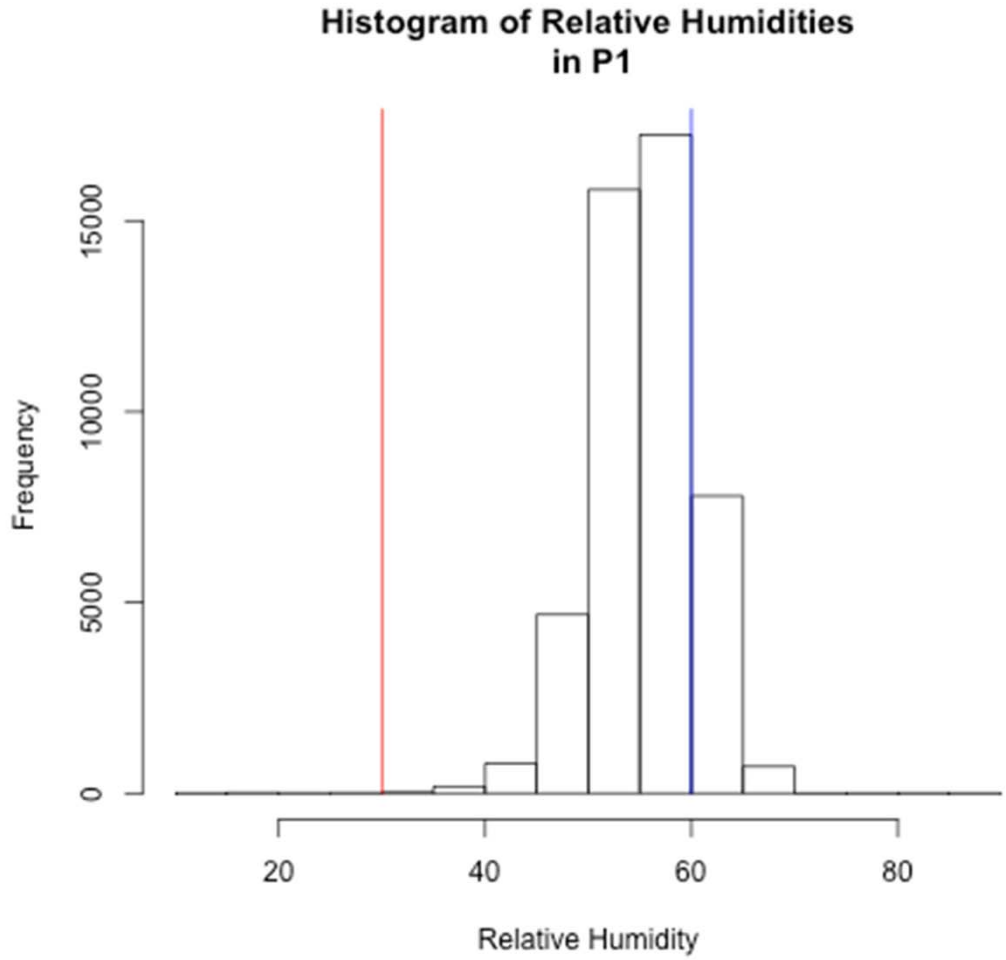


Performance - Humidity

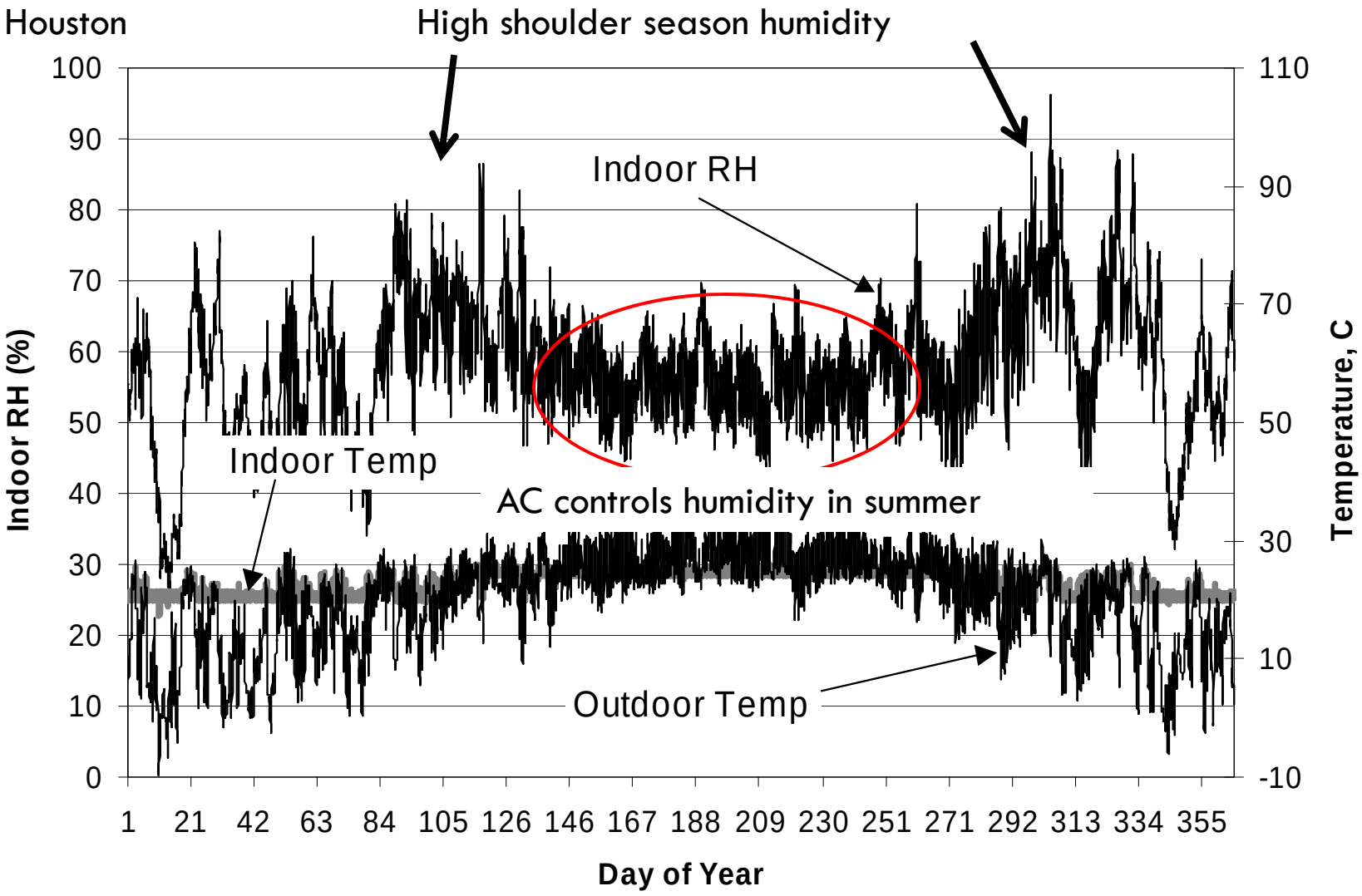
- Same Latent Load + Low Capacity = Potential Humidity Issues
  - Need stand-alone humidity control
  - Dehumidifier or ventilation – depends on climate
- High Performance Homes have higher average humidity but less extreme humidity – a more controlled environment
- ASHRAE 62.2 compliant kitchen and bath venting = less latent load
- High humidity when AC off – not a part-load or capacity issue

Relative Humidity in High Performance Home

- Narrow Band near 60%
- Almost nothing over 65%
- Similar results in simulation studies for ARTI & ASHRAE
- Humidistat activated ERV (lo to hi flow)



Humidity a shoulder season issue



Recommendations

- Some extra capacity is OK
- Ducts must be inside and insulated
- Use BPM/DC blowers for low fan power
- Use independent humidity control: dehumidifiers and ventilation + kitchen and bath exhausts
- Integrate with continuous ventilation as distribution option
- Think about solar load control/zoning for asymmetric solar loads

Setpoint? – What Setpoint?

- Occupant thermal preference?
- Occupant desire to reduce energy usage?
- Enhanced radiant environments?
- Discretionary heating?