Simplified Space Conditioning

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IBACOS, Inc.
Building America Technical Update
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Rethinking HVAC Design

- Traditional Method
  - Assume envelope losses dictate the load
  - Room by room load analysis
  - Pick Equipment and distribute to meet the load in each room
- New Method
  - Consider how the occupants live in the building
  - Seriously consider internal gains in both heating and cooling
  - Consider ventilation strategy
  - Design system

If you are:

- A production builder
- Participating in “above code” programs
- Following ACCA Manual RS or ASHRAE 55
- Need to prove “delivering heat to each habitable room”
- Concerned about litigation

- Play it safe, Use Manual J, S & D and condition every space
  - But you still might have comfort complaints…

Research Results

- A Typical Production Home, Central CA

Roseville, CA. ~1800 s.f. single story

Assembly	Specifications
Concrete Slab	R-10 vertical slab edge insulation
Framed Walls	2x4 16-in. O.C. with R-15 cavity plus R-3 sheathing
Roof	R-49 blown attic insulation at floor, radiant barrier at roof sheathing
Windows	U = 0.28, SHGC = 0.26
Building Air Leakage	2.45 ACH at 50Pa
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Heating Load	23,891 Btuh
Cooling Load	17,193 Btuh
System	95% AFUE Gas furnace with 16 SEER AC
Distribution	Insulated Flexible Ductwork located in conditioned space
Ventilation	Bathroom exhaust fans, Fresh air duct into AHU Return

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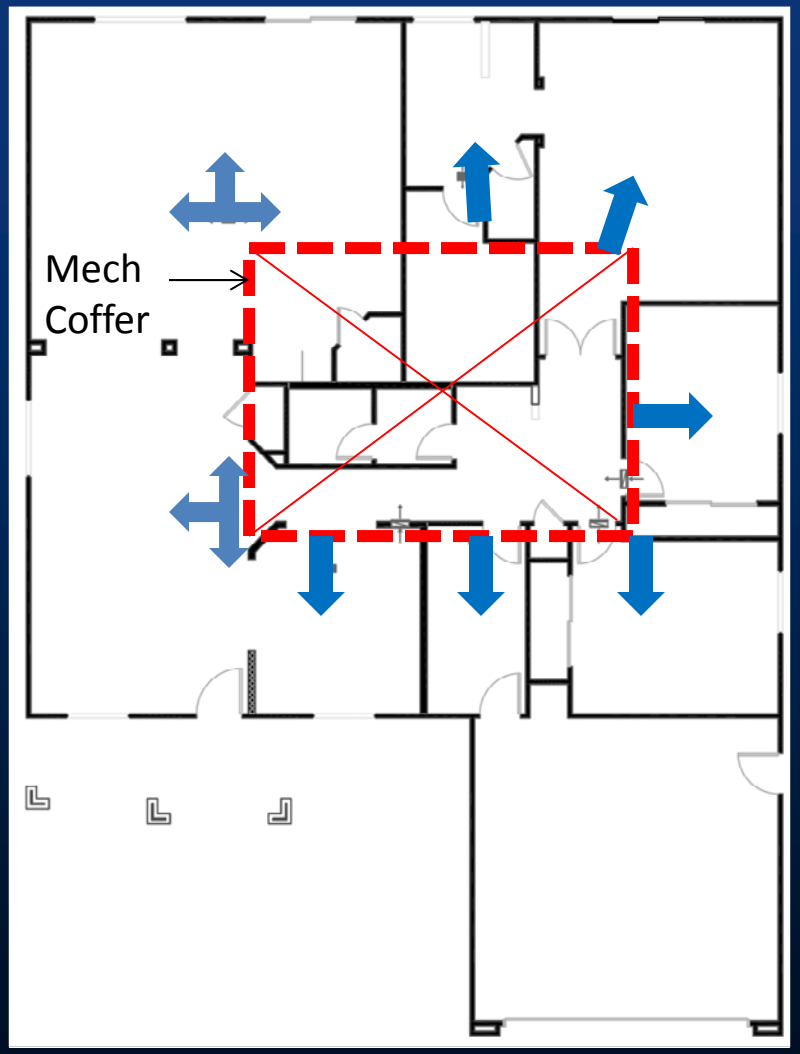
Single Story, 4 Bedroom, Central CA

- Distribution to Each Room
- Compact Duct System in Conditioned Space
- Right Sized
- Never 100% balanced by the HVAC contractor
- Probably represents a “typical” good HVAC job



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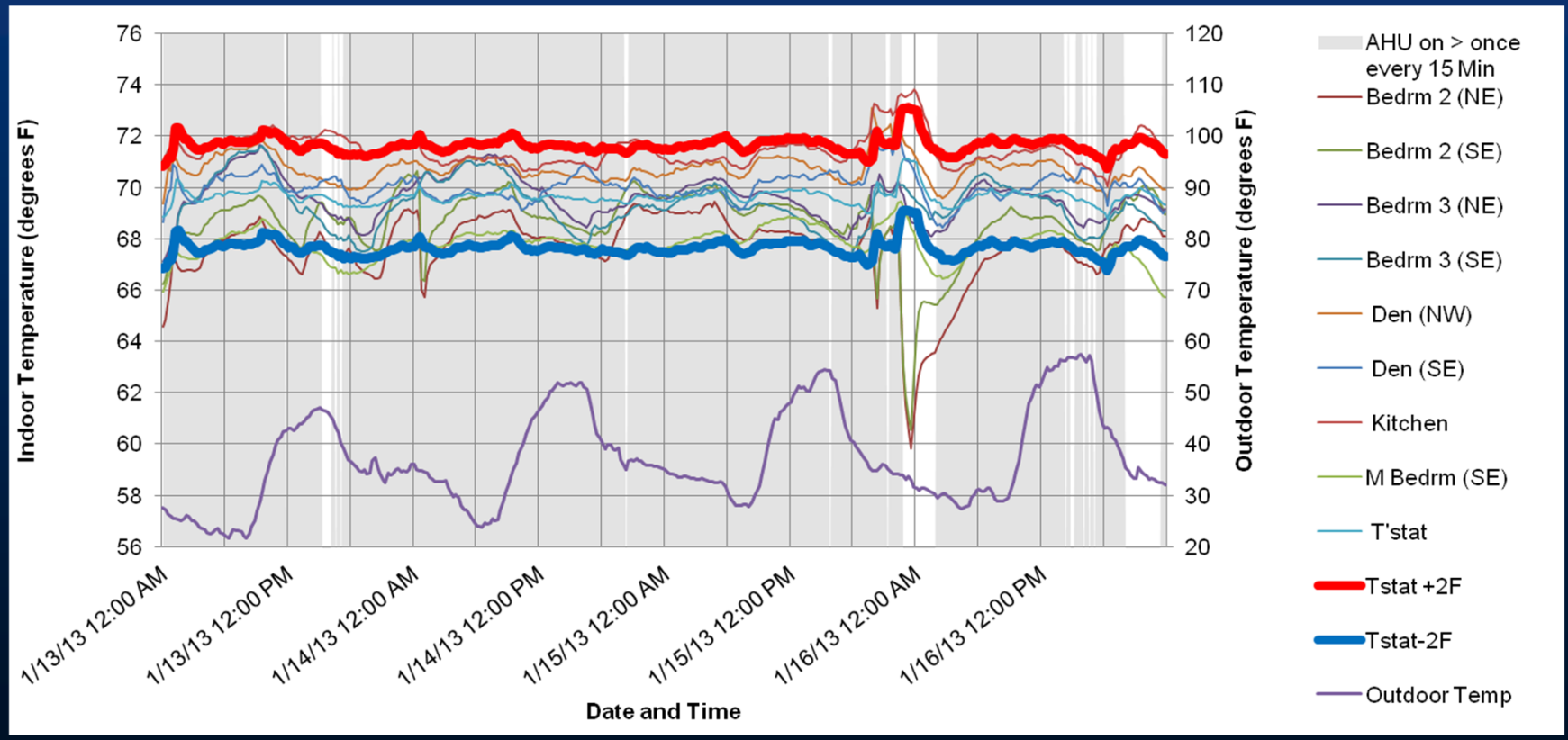
Room Temperature Performance

Room to t'stat temperatures over 2012/13 heating season mostly within +/- 2ºF, cooling within +/- 3ºF



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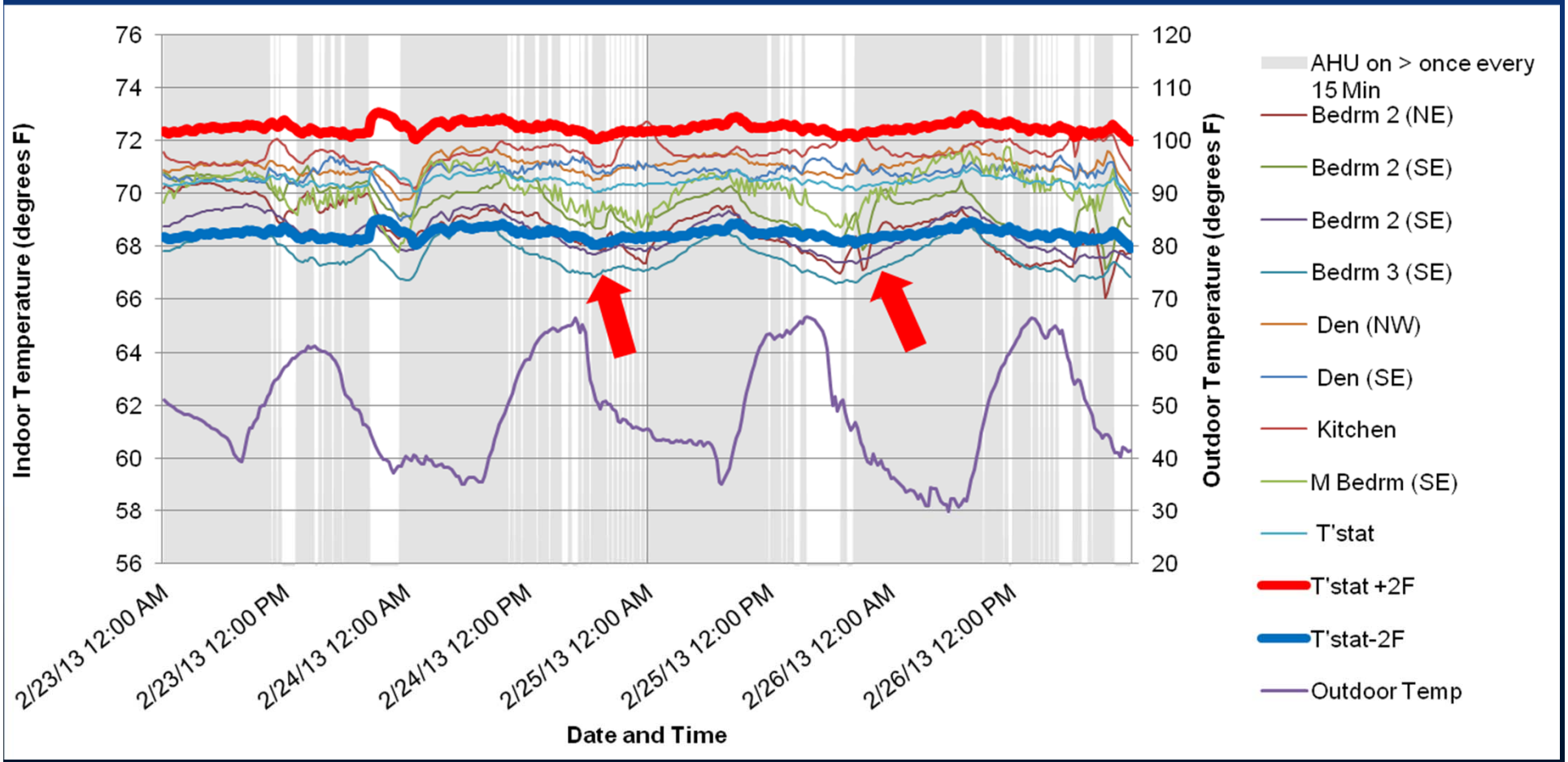
Room Temperature – late winter



A “client-tuned” HVAC system:

- Do you want temperatures in each room to be uniform with one another?
- Do you want individual control in each room?
- Do you keep your doors closed frequently?
- Do you like to adjust your thermostat a lot?
- TV’s, computers, etc. in the bedrooms?

One House Many Systems

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Pittsburgh PA

Assembly	Specifications
Concrete Slab	R-10 continuous below slab
Basement Walls	R-25 finished portion, R-19.5 unfinished portion
Framed Walls	R-30 cavity insulation - framing fraction of 15% R-10 continuous exterior sheathing
Roof	R-60 blown insulation at floor of vented attic
Windows	306 sq. ft., U = 0.24, SHGC = 0.22
Building Air Leakage	0.54 ACH at 50Pa
Heating Load	18,526 Btu/h (5,430 W)
Cooling Load	11,236 Btu/h (3,293 W)
Distribution Systems	“Right Sized” Fully Ducted Full Volume; Partially Ducted Low Volume; Dual Point
Ventilation	ERV - Exhausted from bathrooms - Supplied into AHU return or to bedrooms

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Winter 2012 – Cold Days

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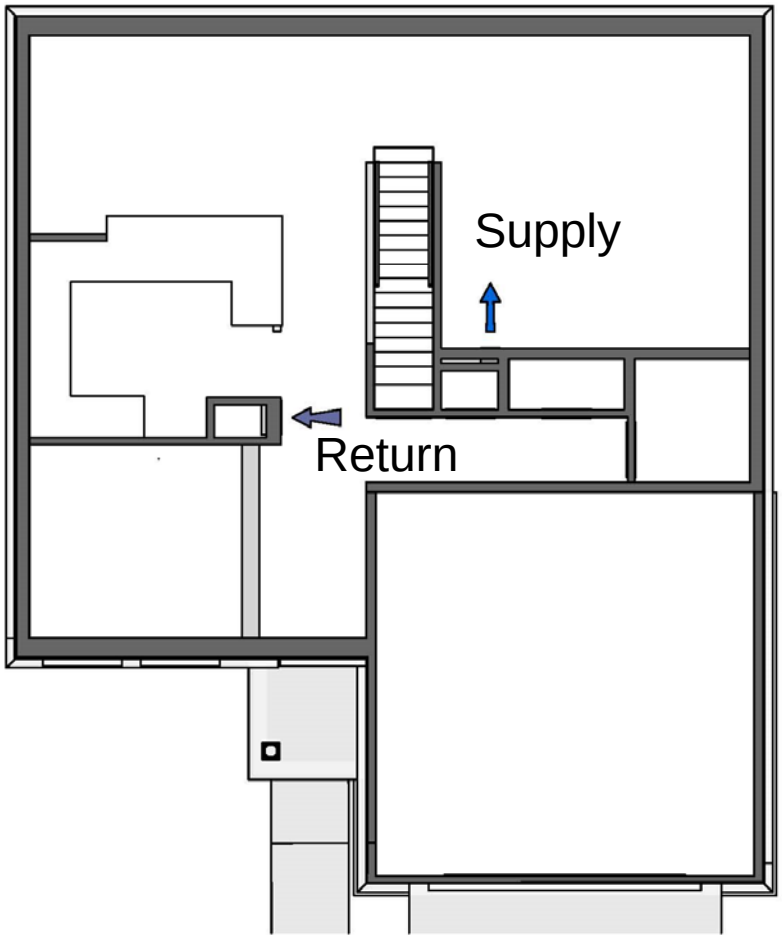
Simplified Space Conditioning

Single Point on 1st Floor



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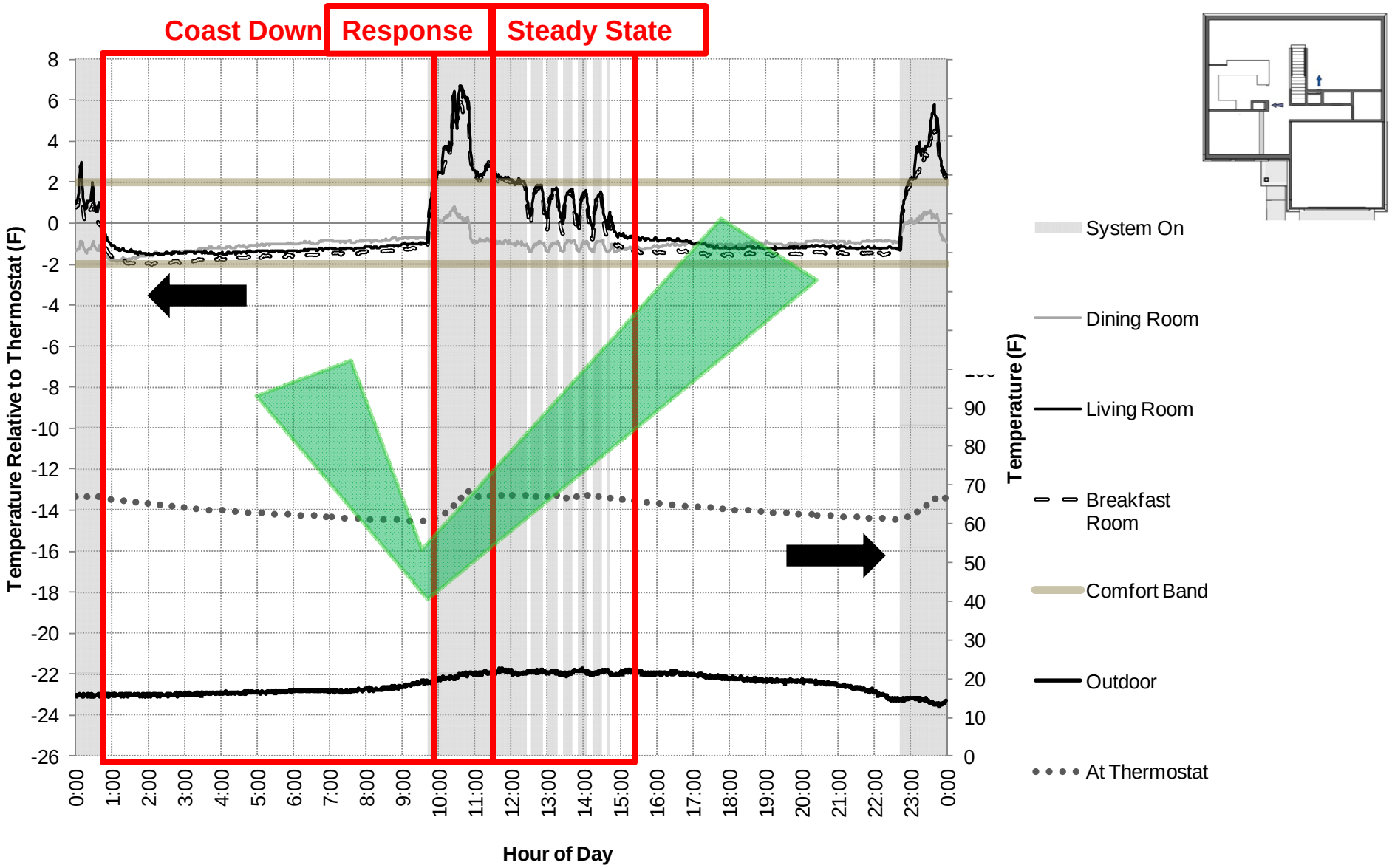
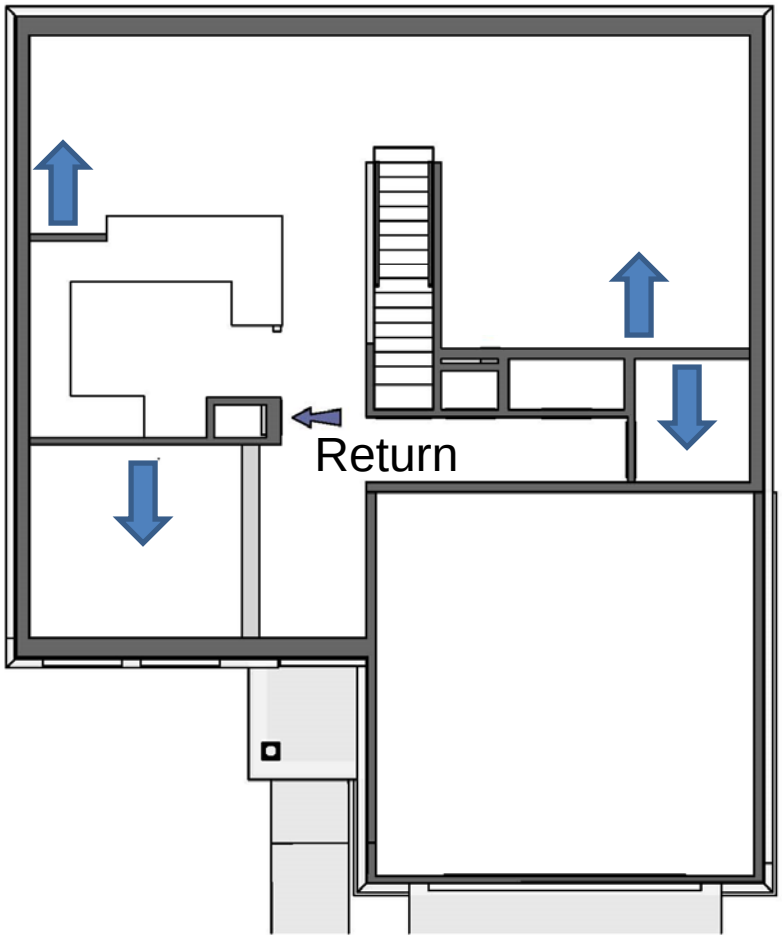
Single Point on 1st Floor – Winter Cloudy Day



“Right Sized” on 1st Floor



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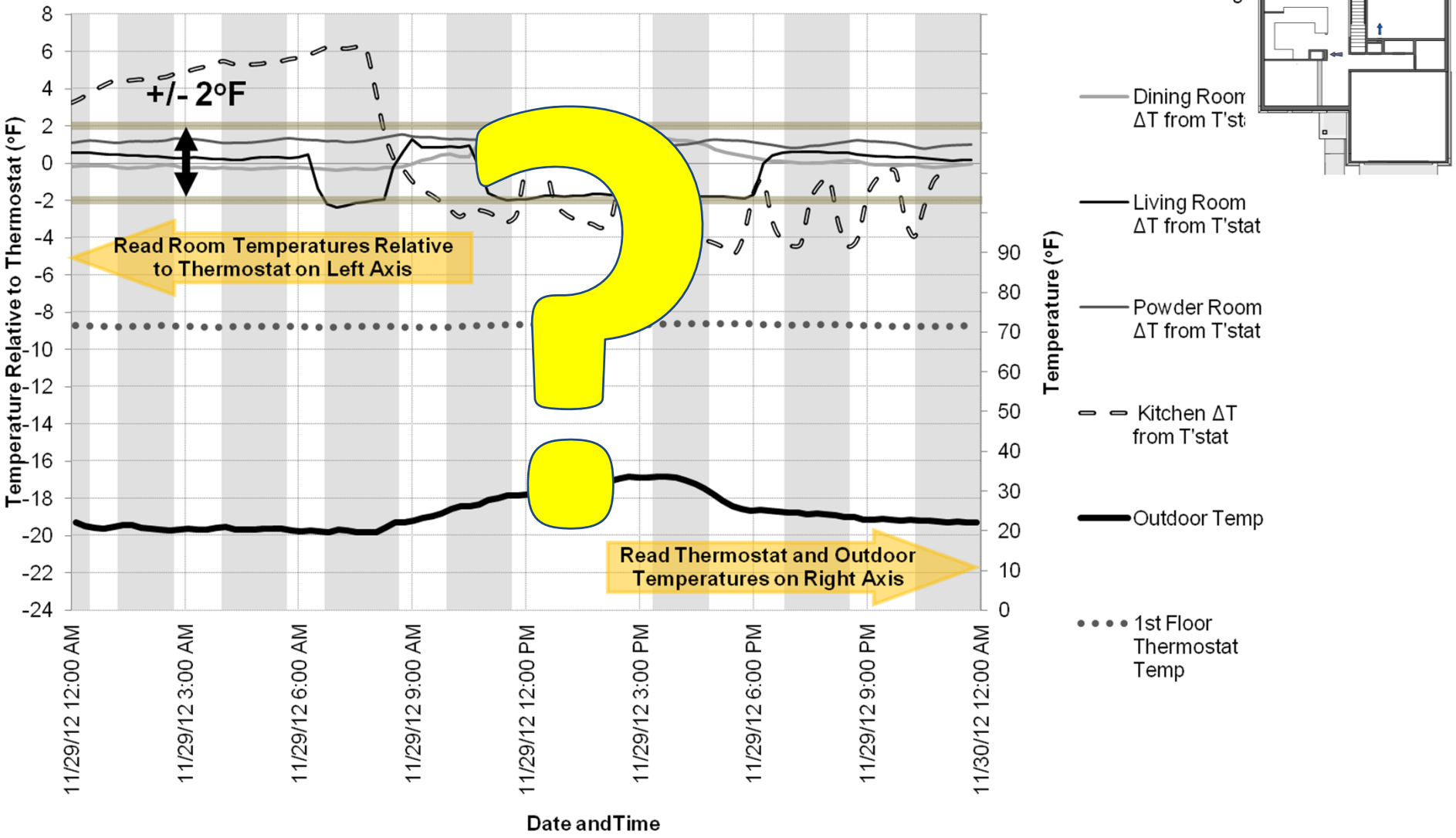
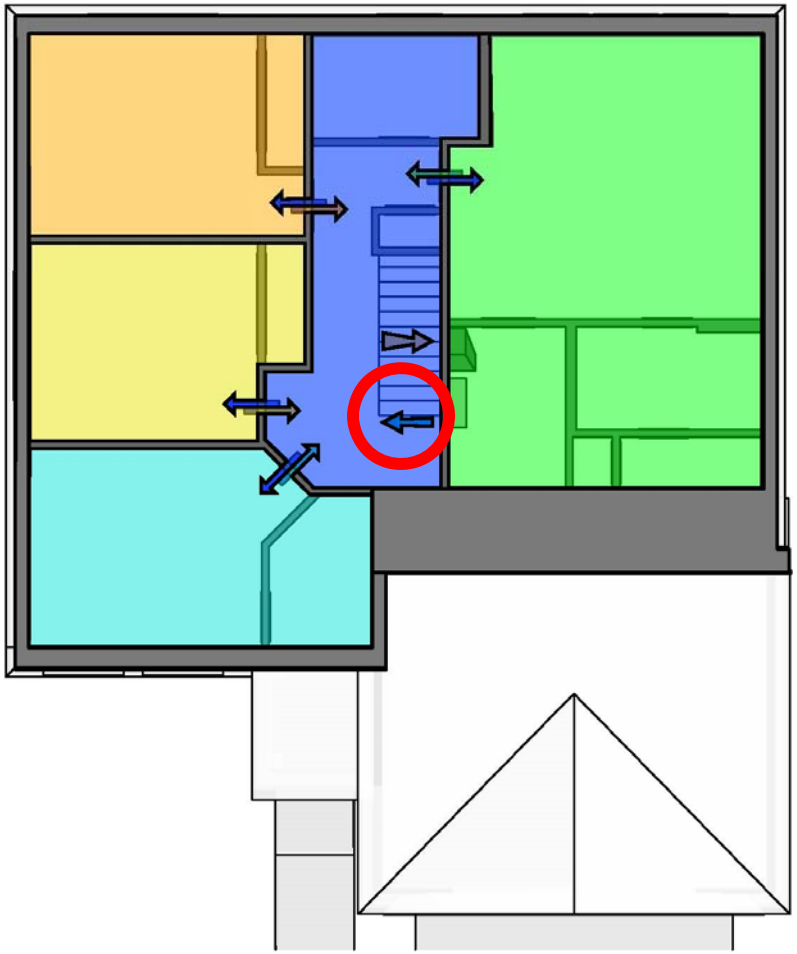
Simplified Space Conditioning

"Right Sized 1st Floor – Winter Sunny Day

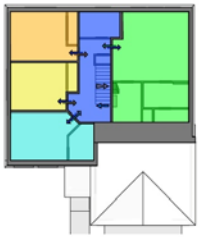


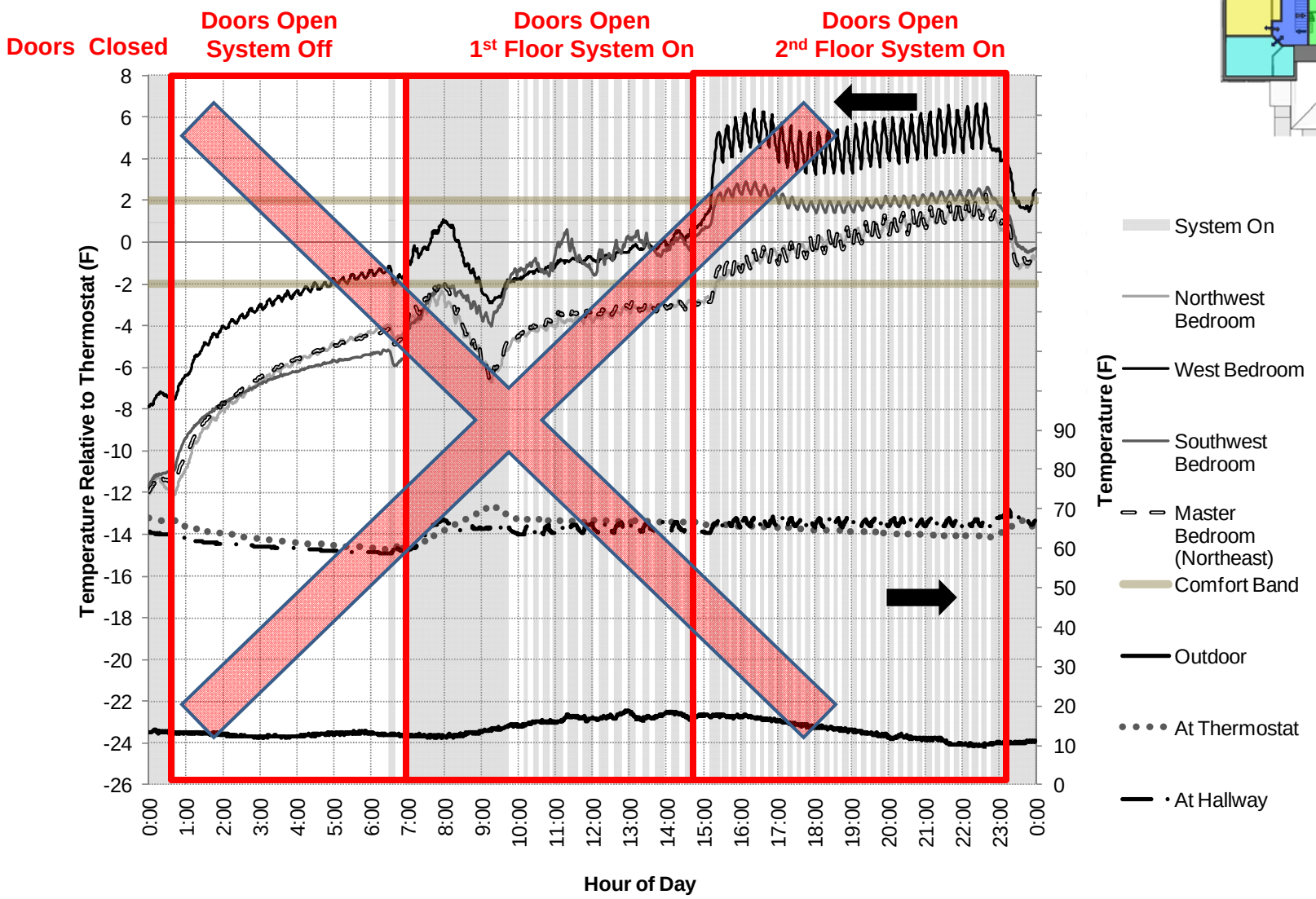
Single Point on 2nd Floor



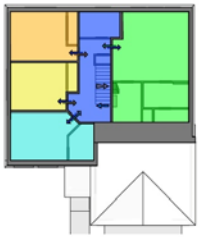
Single Point on 2nd Floor – Doors Open

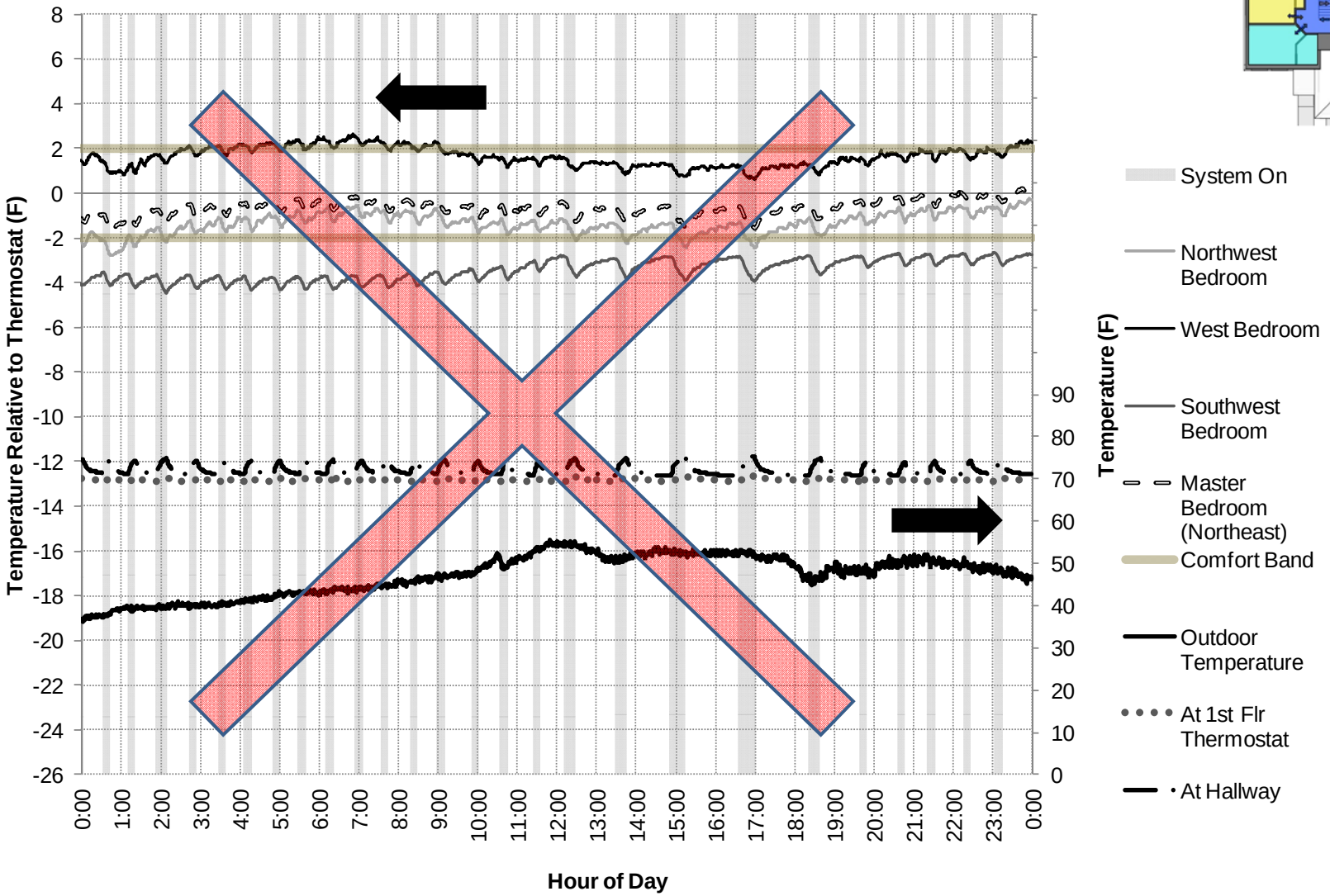
Sunny Day



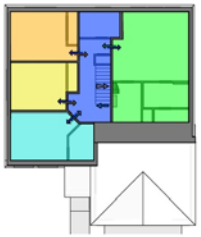


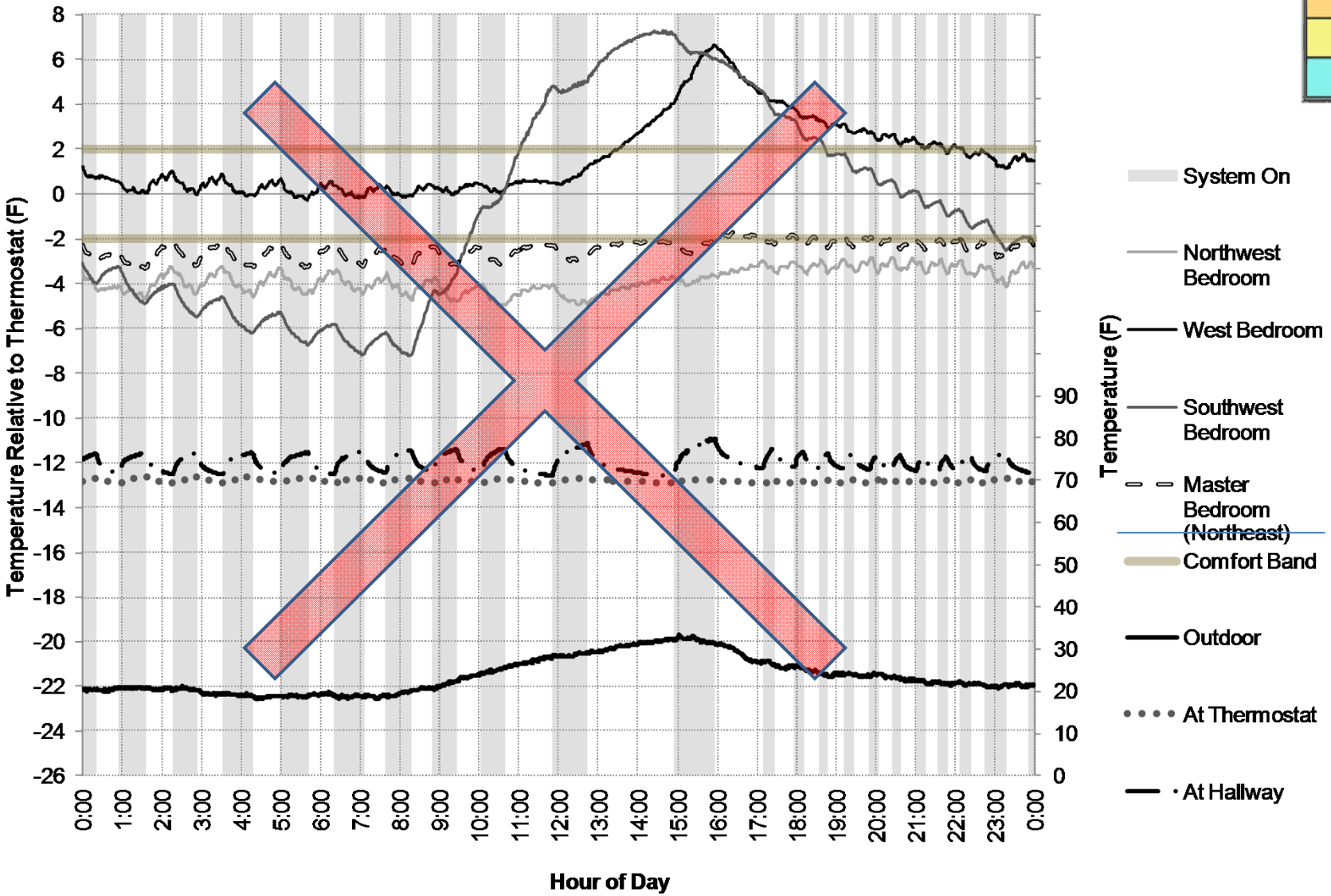
Single Point on 2nd Floor – Doors Closed, Transfer Fans, Cold Cloudy Day



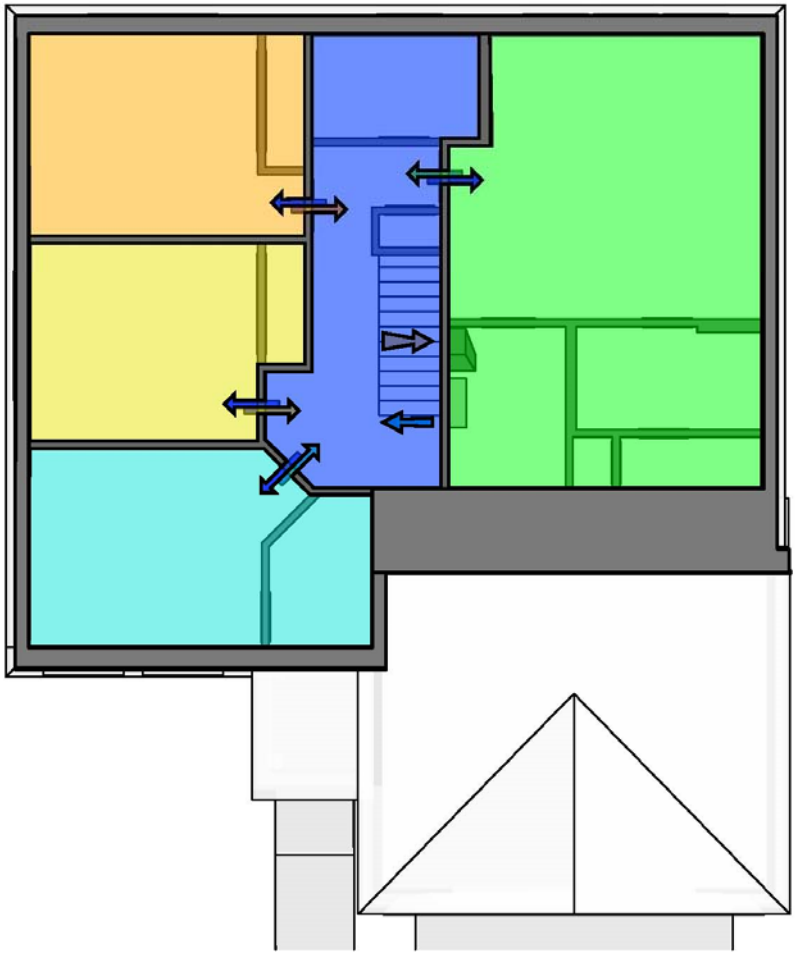


Single Point on 2nd Floor - Doors Closed
& Transfer Fans, Cold Sunny Day

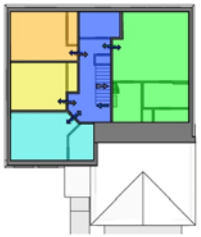


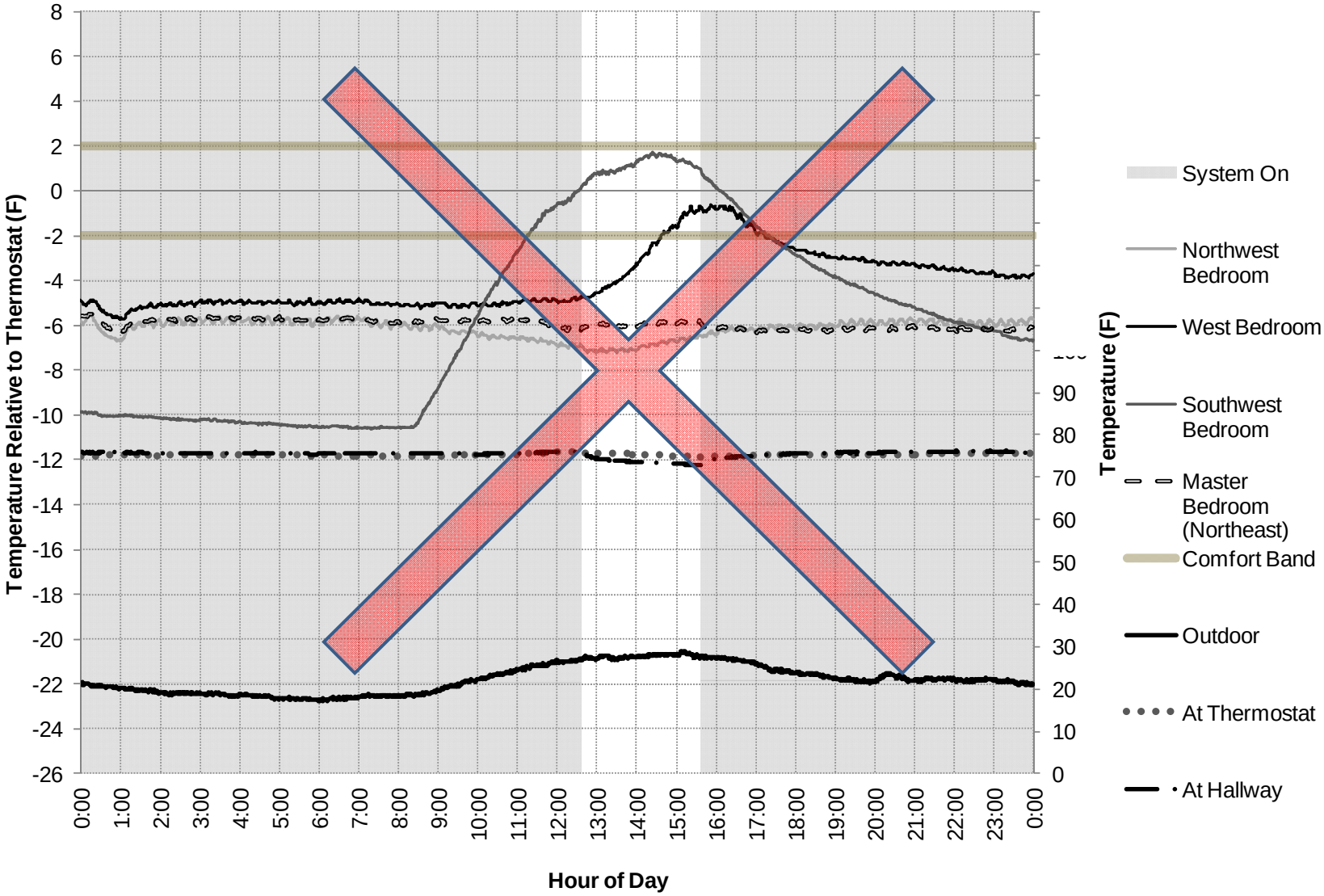


Multi point 2nd Floor
Doors Closed 15 CFM/Room

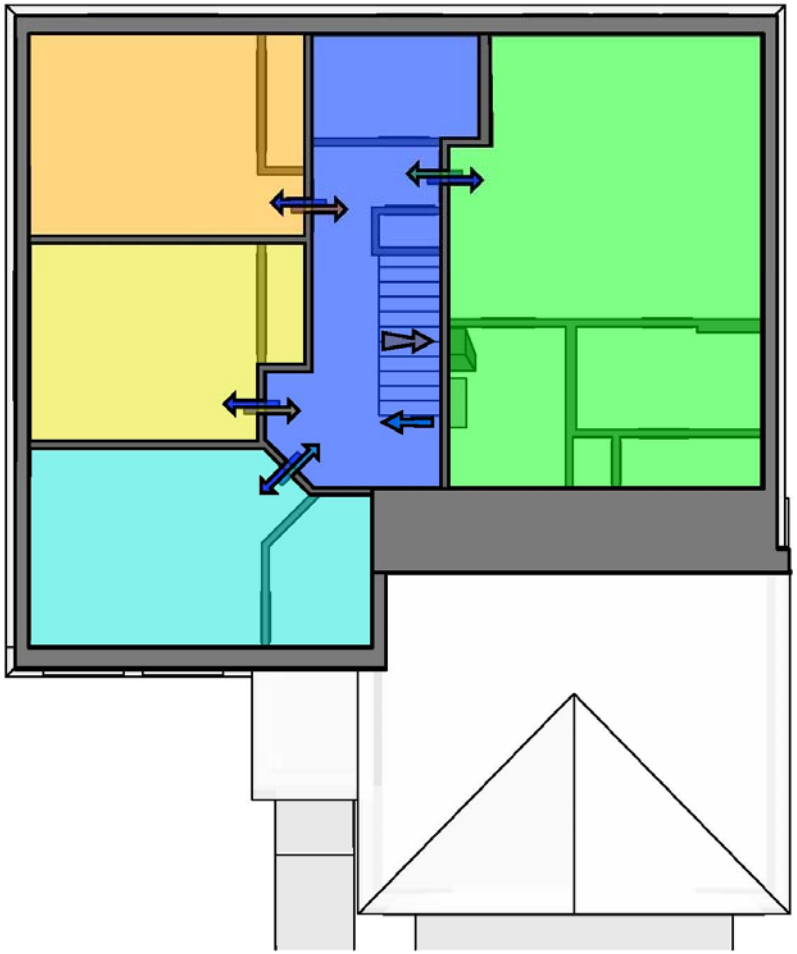


Multi point 2nd Floor - Doors Closed , Cold
Sunny Day



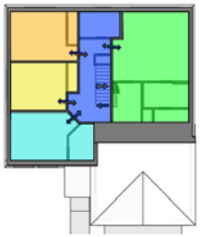


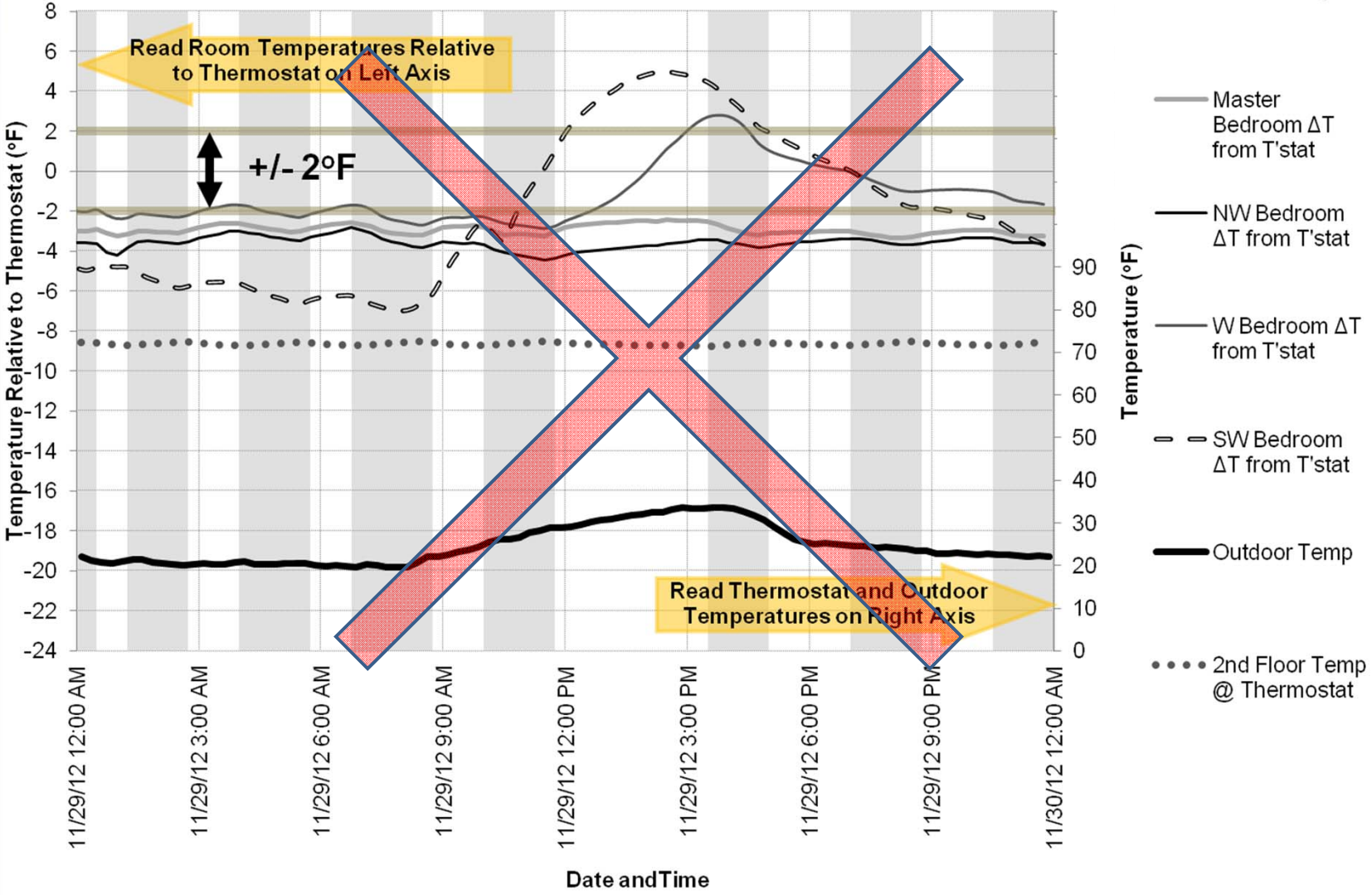
“Right Sized 2nd Floor – Supply in every room



"Right Sized 2nd Floor - Doors Closed

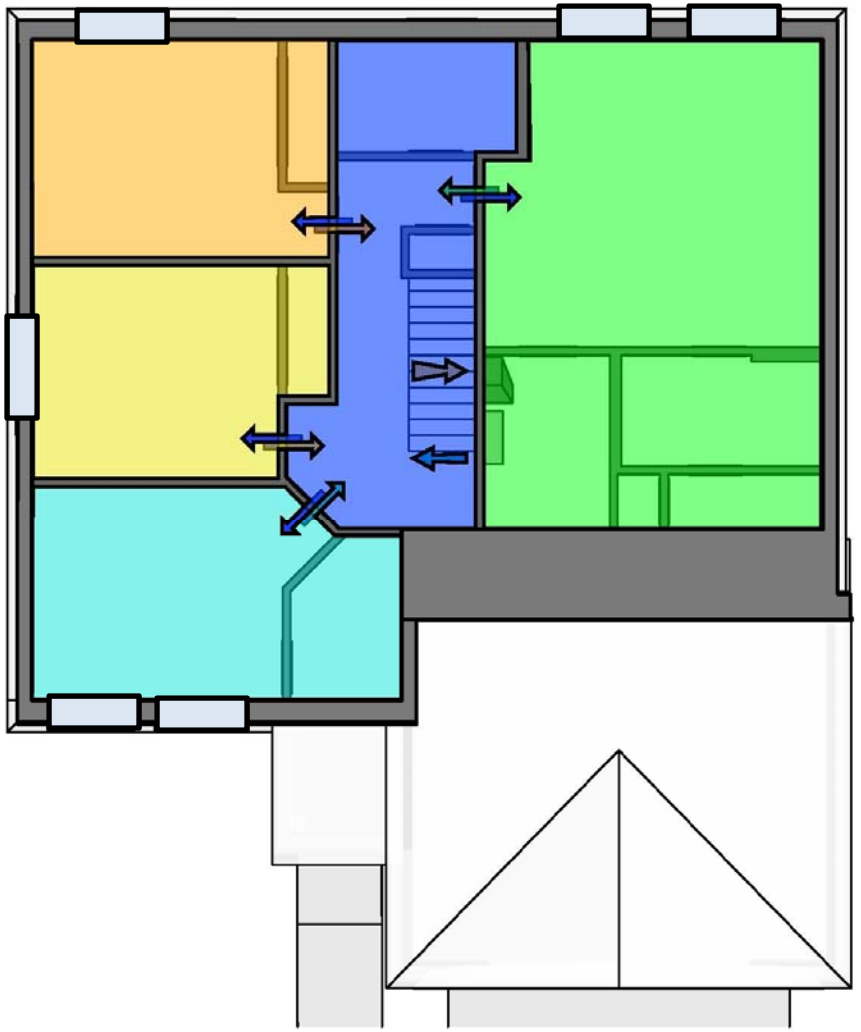
T'Stat in Hall, Cold Sunny Day





Why?

- Room to wall area ratio
  - “Panel Heating”
  - Need Highly Conductive Walls?
- Location of Single Point supply relative to transfer fan / door locations
- Solar gains not equal



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Summer 2012 – Hot, Sunny Days

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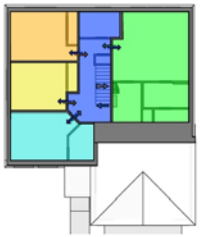
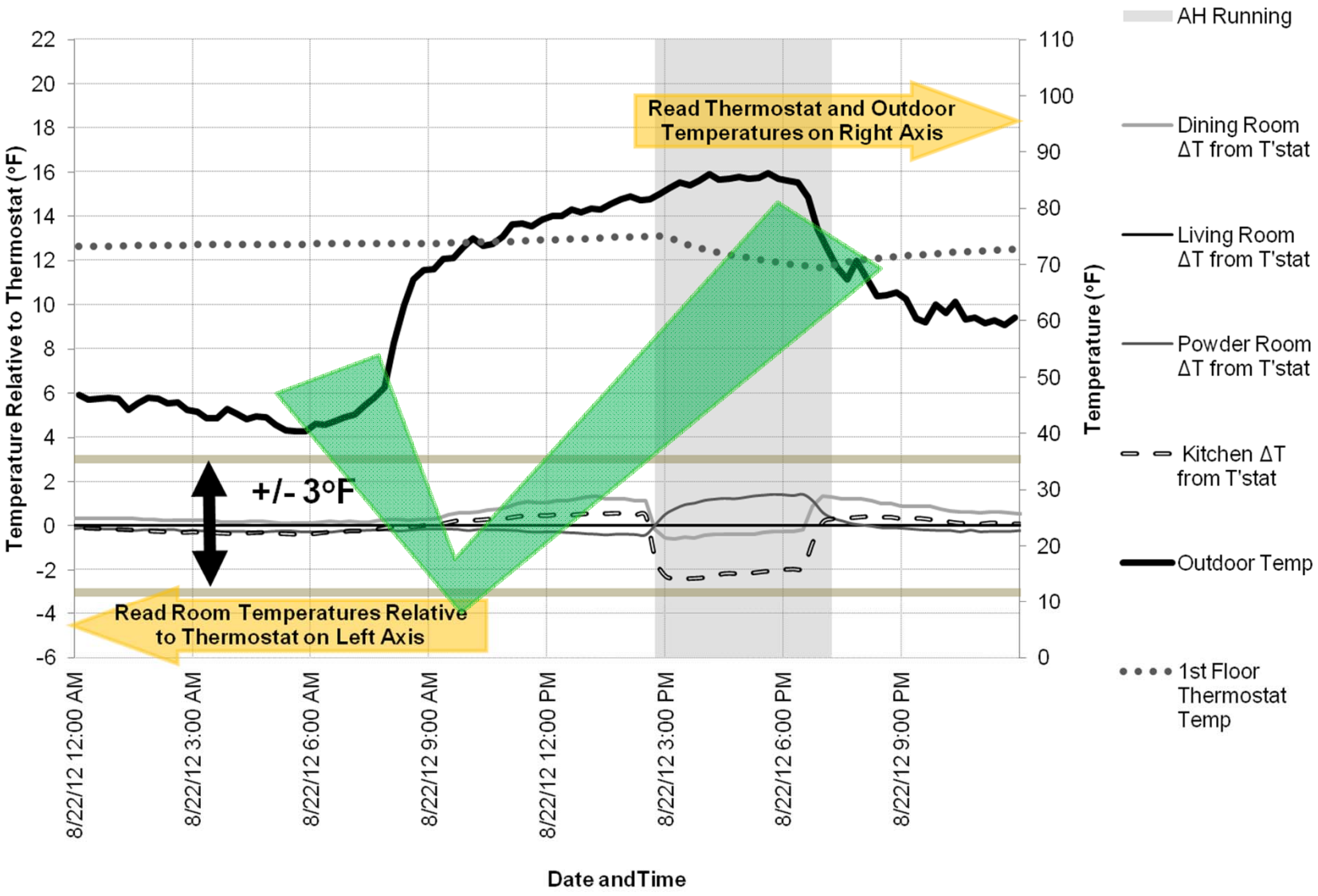
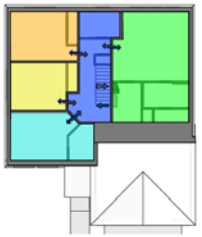
Single Point , 1st Floor – Transfer Fans Sunny Hot

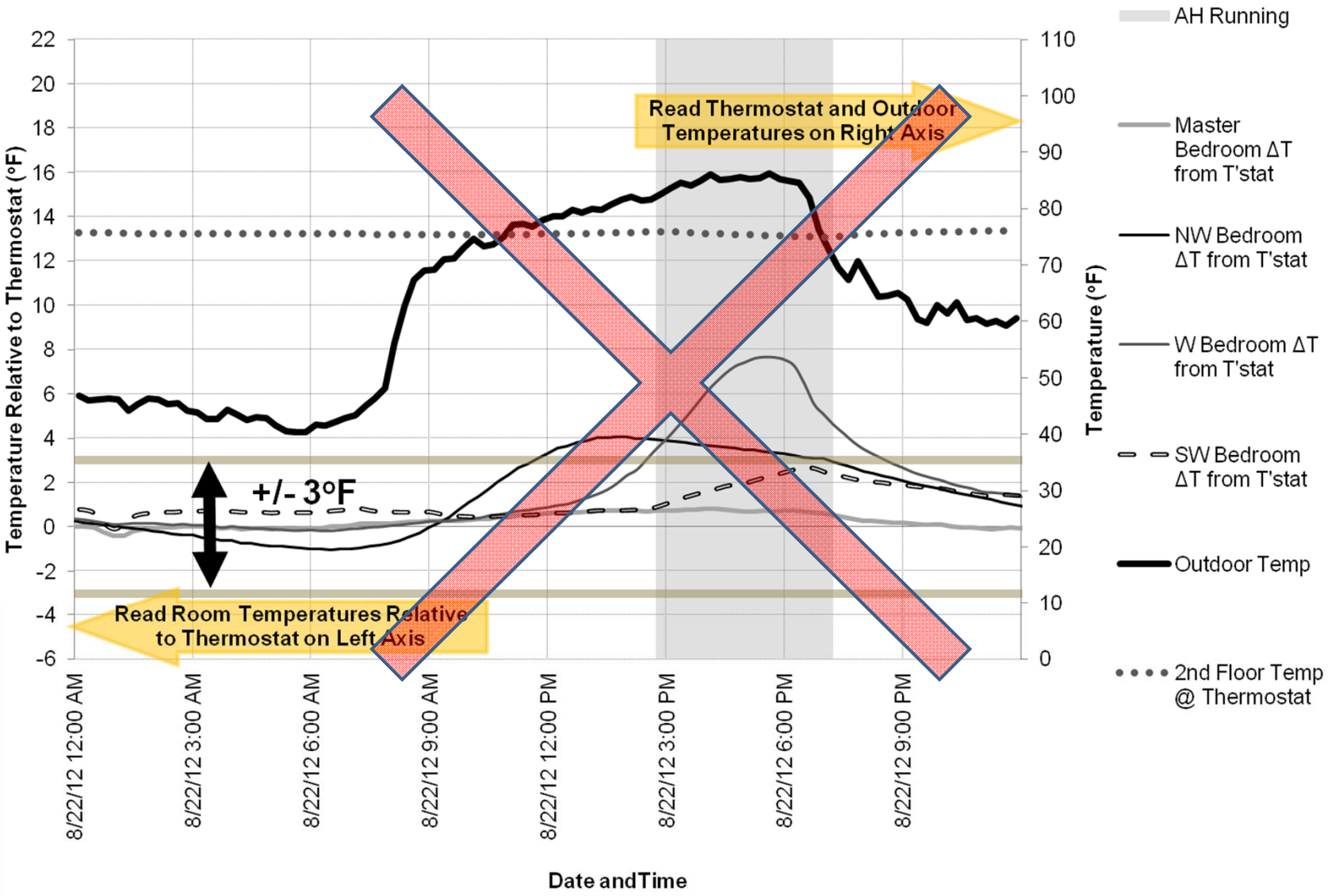
Summer Day





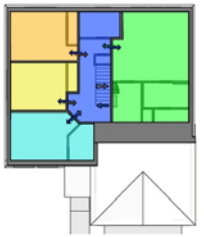
Single Point on 2nd Floor – Transfer Fans, Hot Sunny day

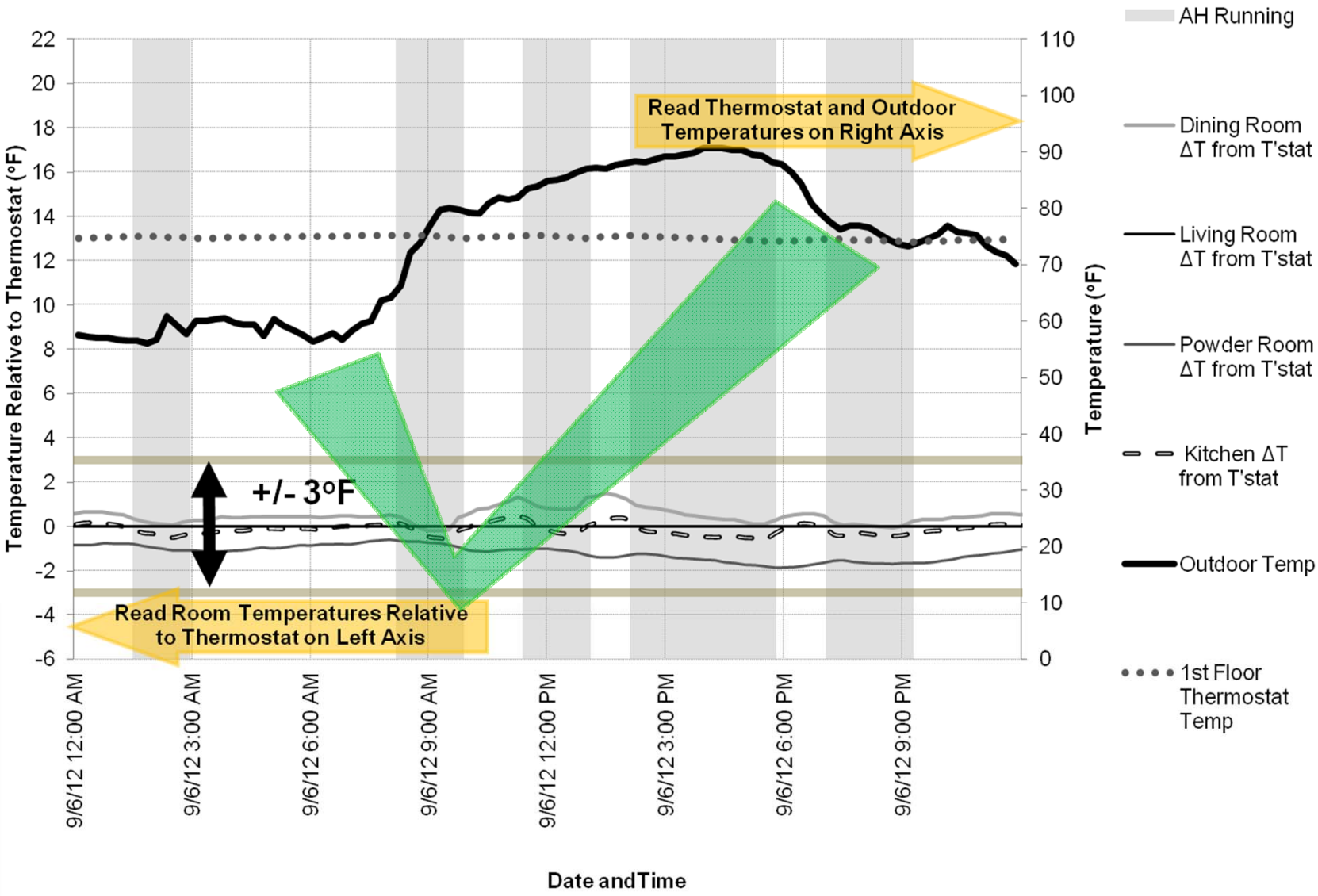




Ventilation Airflow, 1st Floor – 15

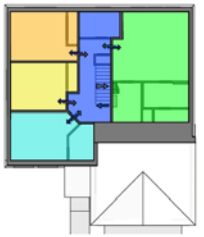
CFM/Room Sunny Hot Day

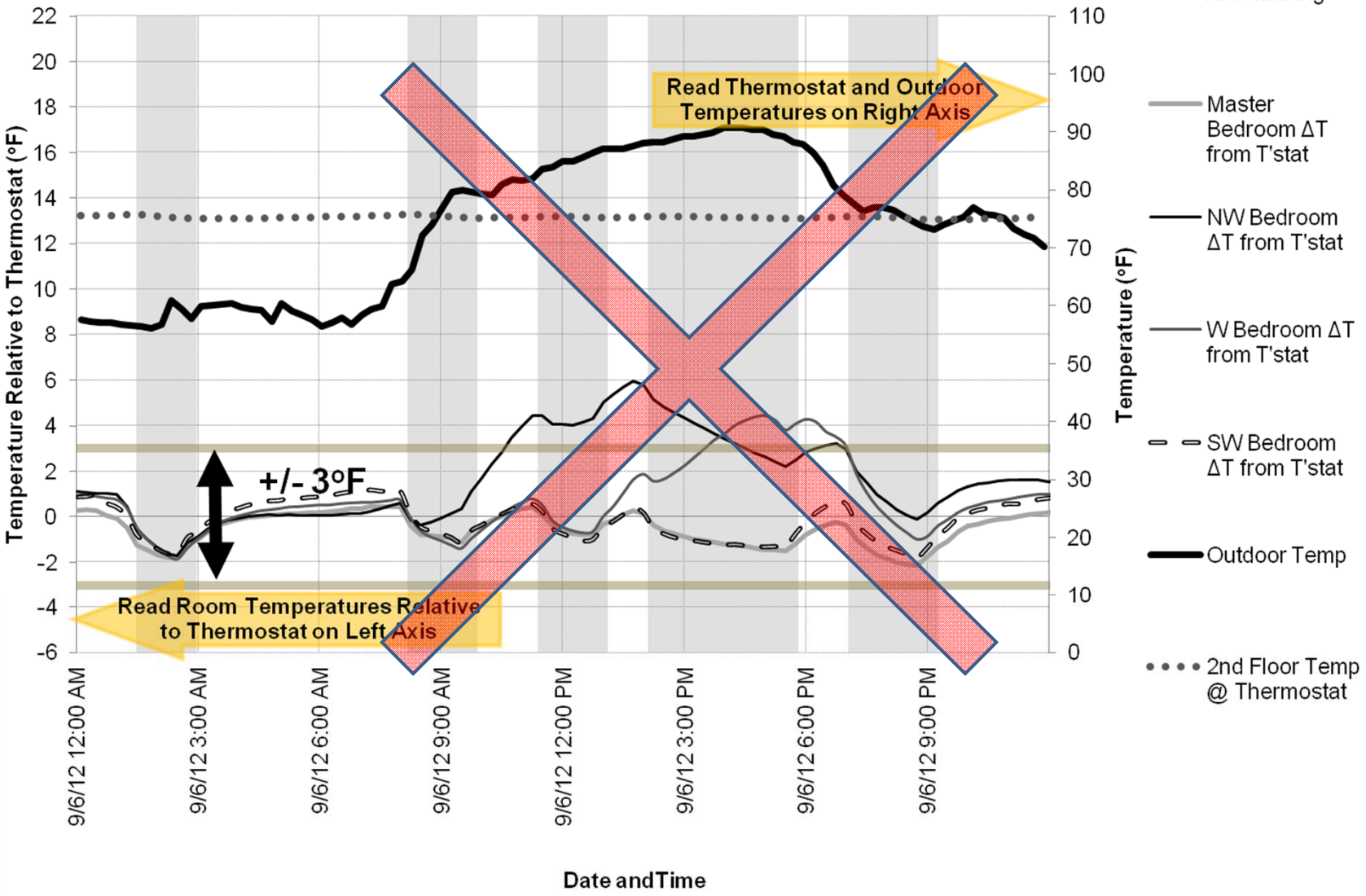




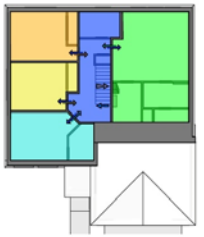
Ventilation Airflow, 2nd Floor – 15

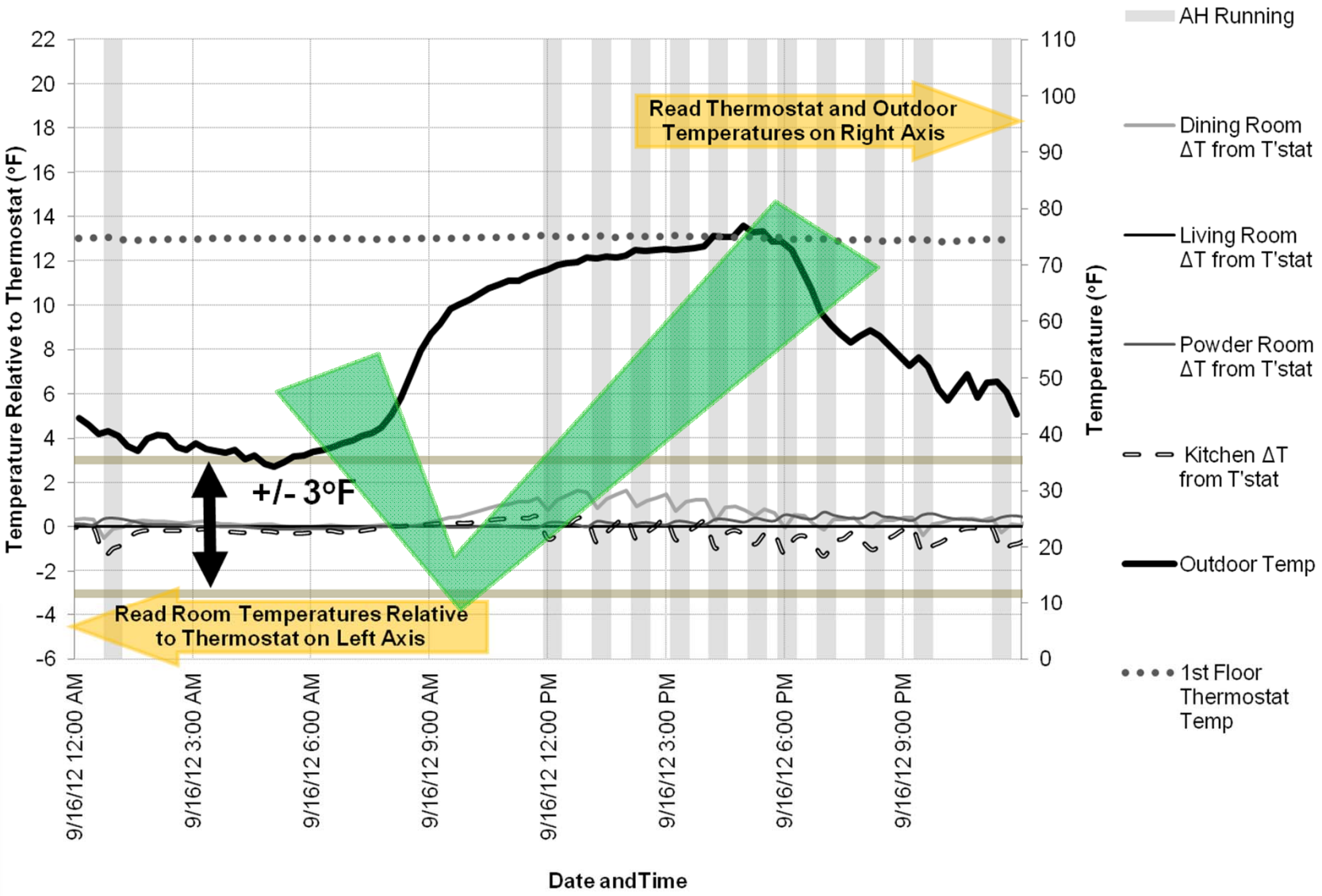
CFM/Room Sunny Hot Day



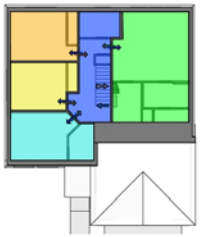


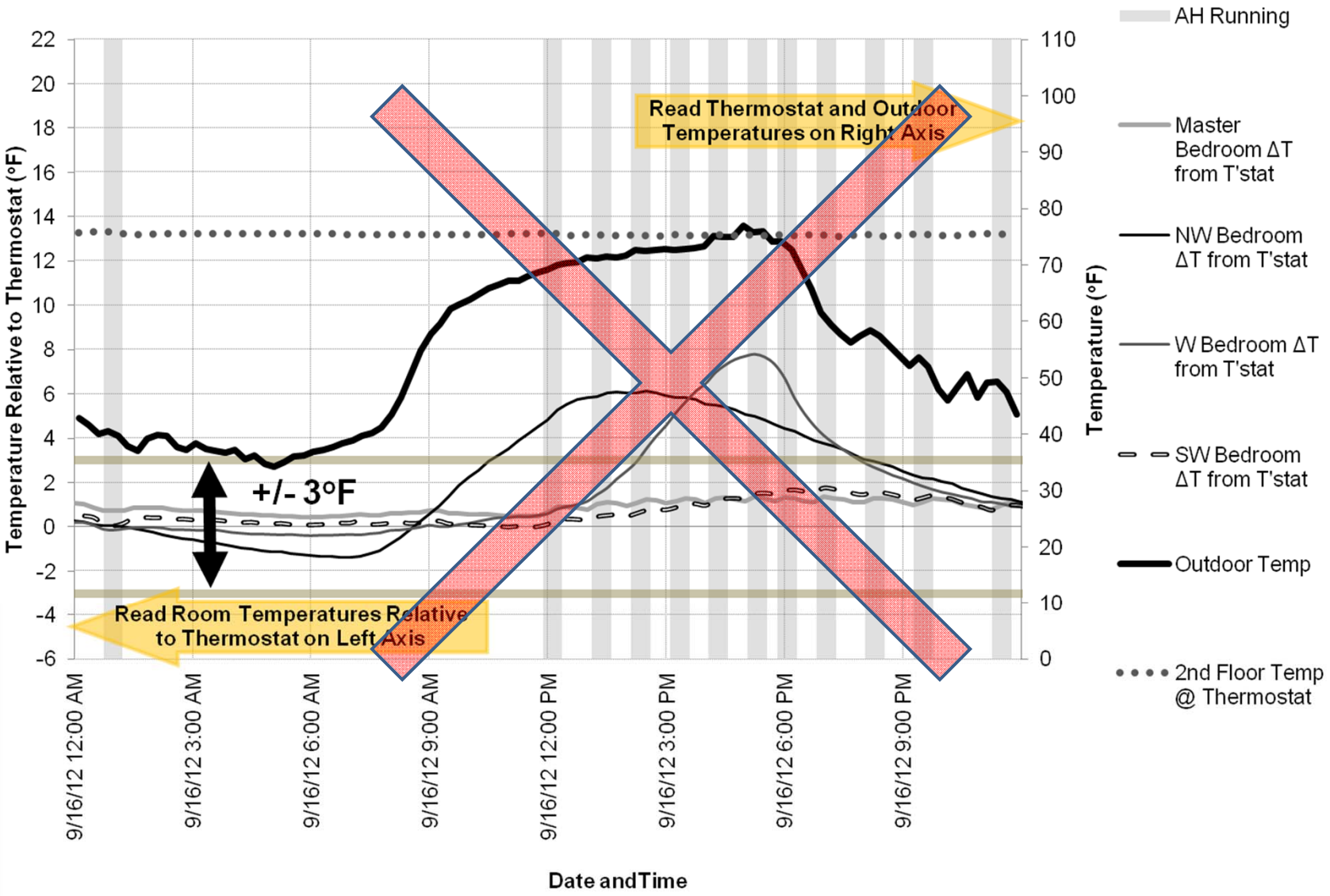
"Right Sized" 1st Floor – Distribution to Each Room, Sunny Hot Day





"Right Sized" 2nd Floor – Distribution to Each Room, Sunny Hot Day





Conclusions

- Large open spaces can be effectively conditioned form one point
  - Proper location in house, register selection / throw pattern critical
- Set up / Set back is hard to do uniformly
- Factors to consider when designing a HVAC system for a low-load house:
  - Sunlight (windows)
  - Internal gains and interior door positions (occupants lifestyle)
  - Ventilation strategy

What Should Grandma Do?

- RIP
- Slow and Steady wins the race
  - High sidewall supply outlets work well
- Comfort uniformity is enhanced by periodic fan circulation – like what you need for fresh air
  - Multiple temperature sensors to control fan only operation
  - Locate sensors in “worst case” rooms
- To truly zone you probably need a unit in each room, or match rooms with equal solar gains
  - Zoning by floor with multiple temp sensors per system or per zone

Thank You

- Questions?

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