How HVAC Impacts Your Business

October 14th, 2015

Dean Gamble, US EPA

Agenda

- 3 major steps of HVAC design
- 3 major steps of HVAC commissioning
- Interactive quiz – with prizes!
- How this impacts your business
- Questions & answers

Art restoration: More art, less science
HVAC design: More science, less art

Ecce Homo de Elías García Martínez.

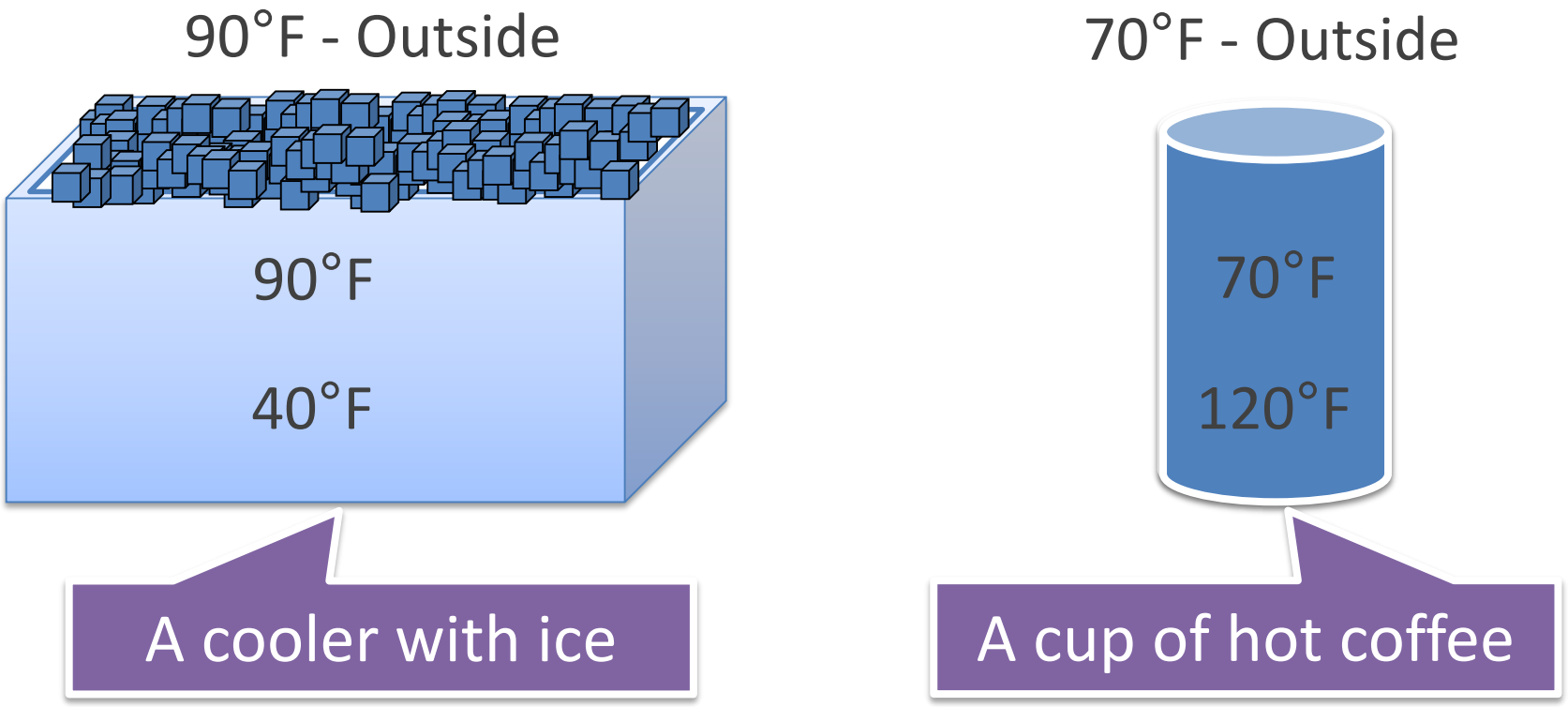
Three major steps to design an HVAC system

1. Calculate the heating and cooling loads.
2. Select equipment that meets those loads.
3. Design a duct system that gets air from the equipment to the rooms, and back.

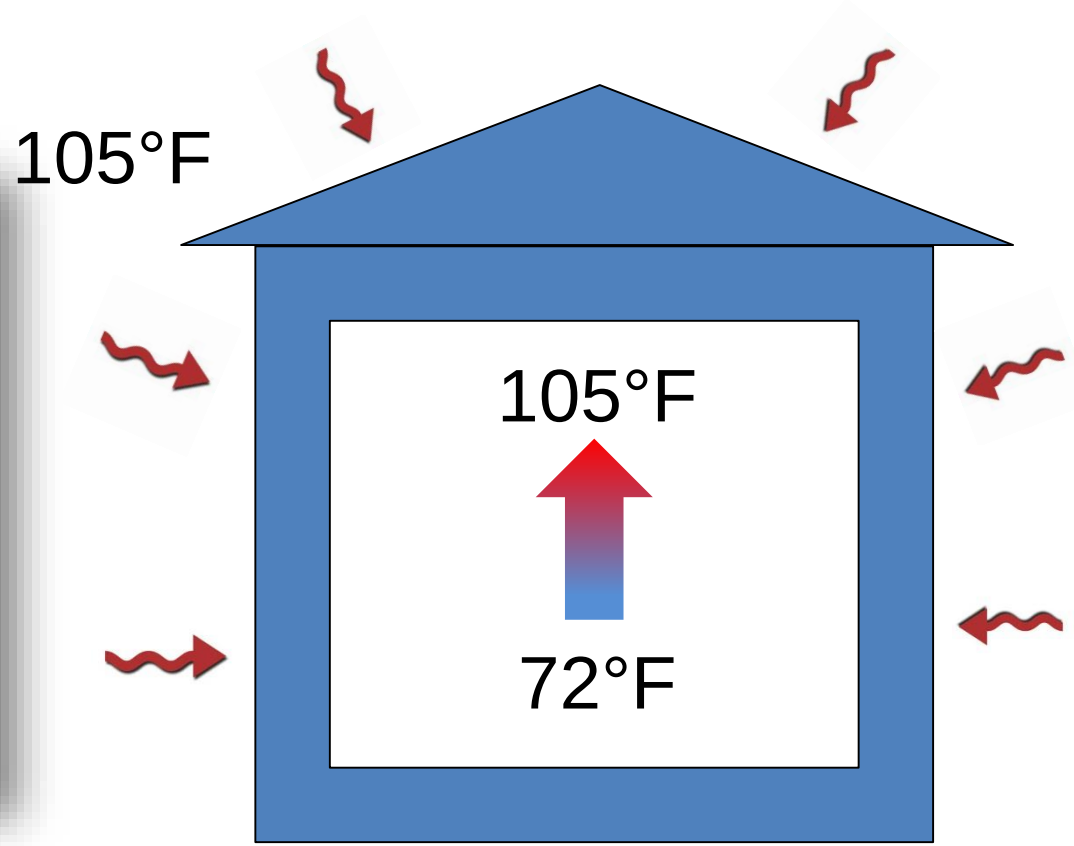
Step 1:
Calculate Heating & Cooling Loads

Step 1:
Calculate heating & cooling loads

- Energy moves from more to less.



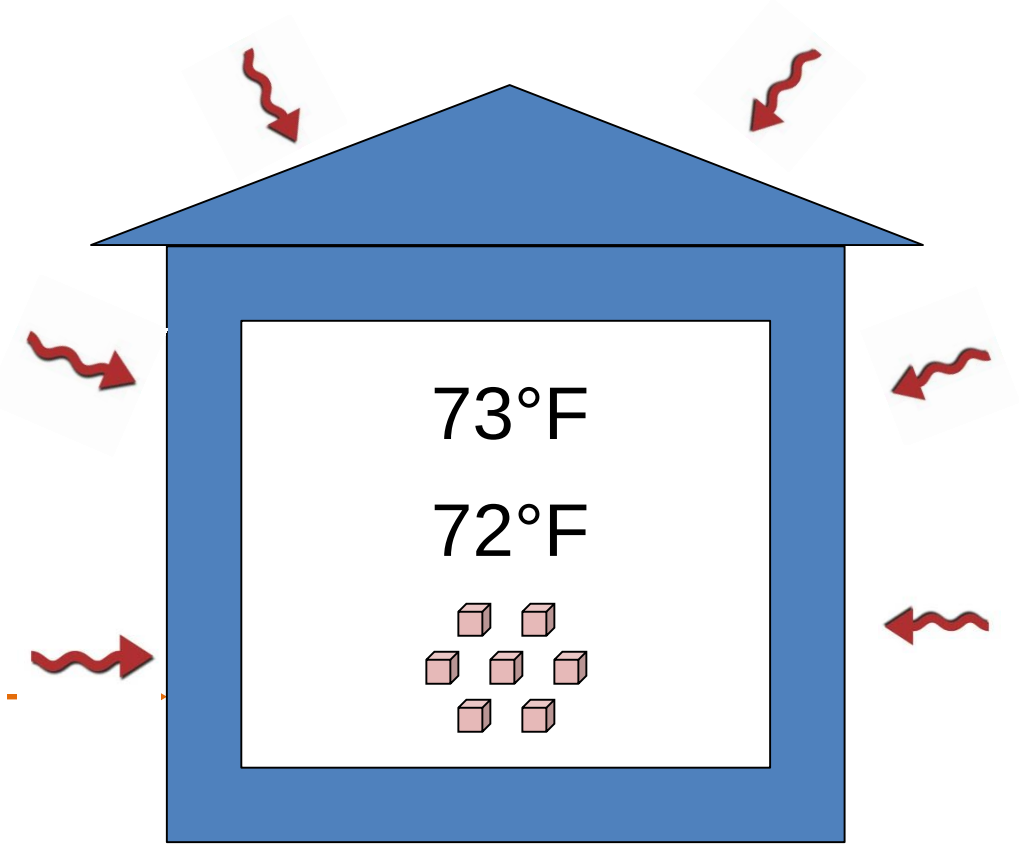
Step 1:
Calculate heating & cooling loads



Step 1:
Calculate heating & cooling loads

- Heat transfer can be quantified in British Thermal Units (Btu's).
- 1 Btu is approximately equal to the energy in a single match.

Step 1:
Calculate heating & cooling loads



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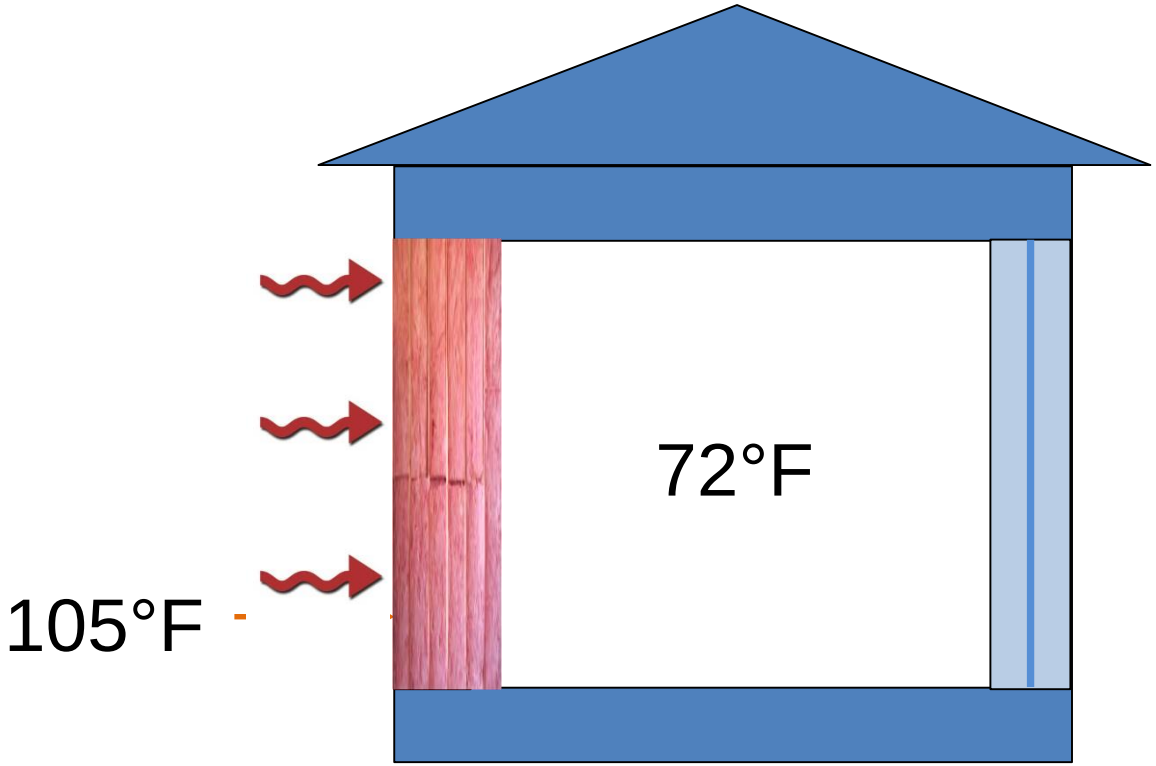

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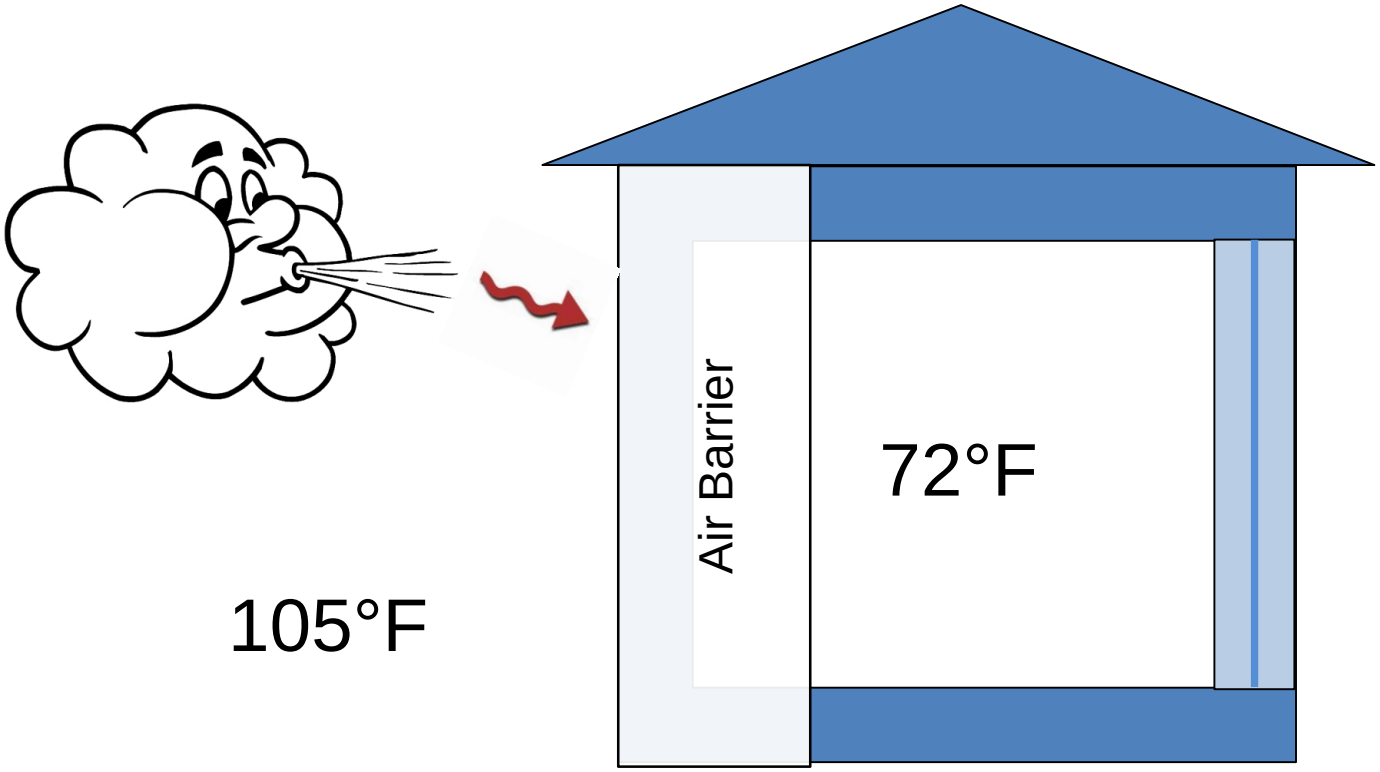

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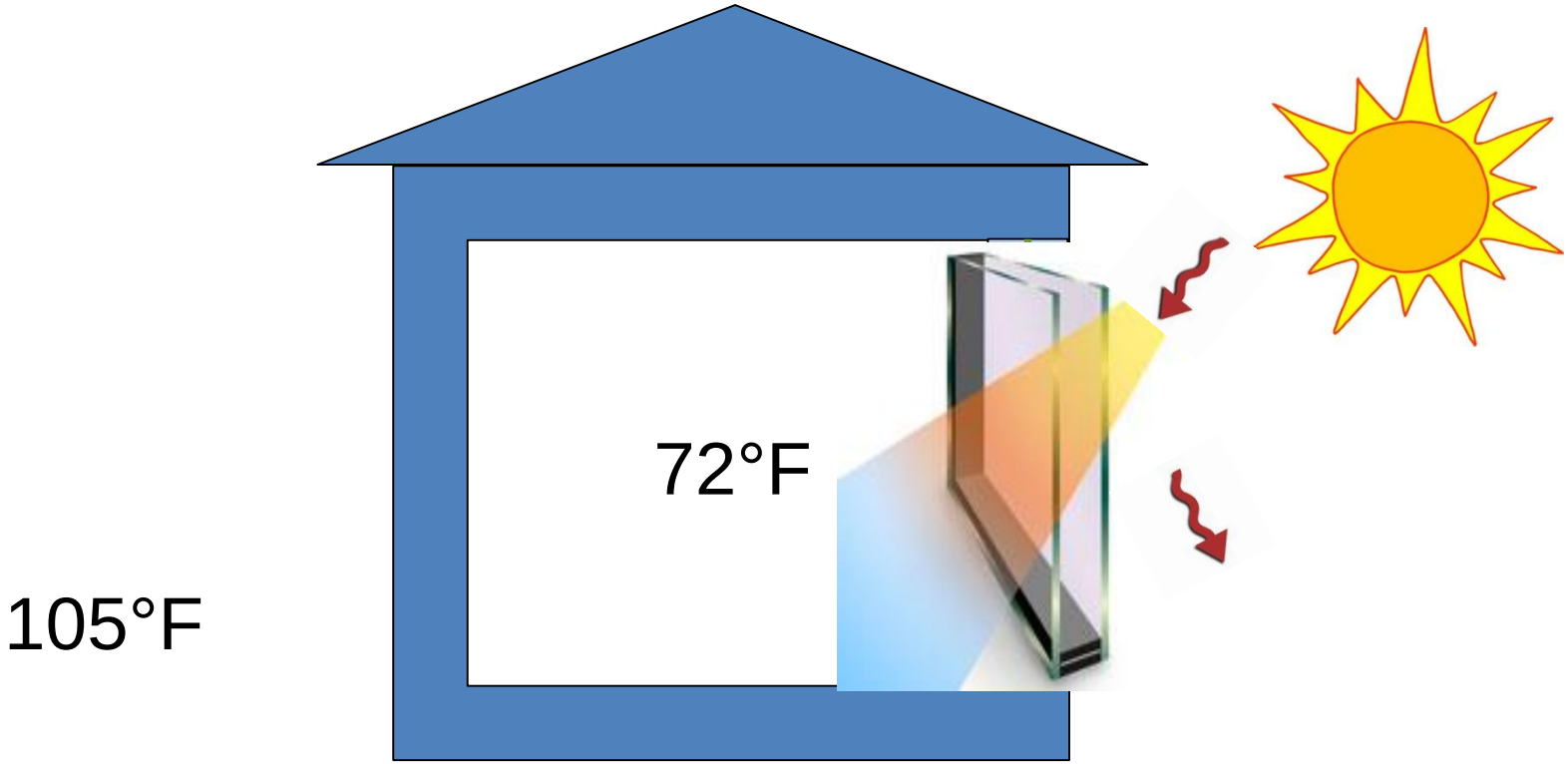

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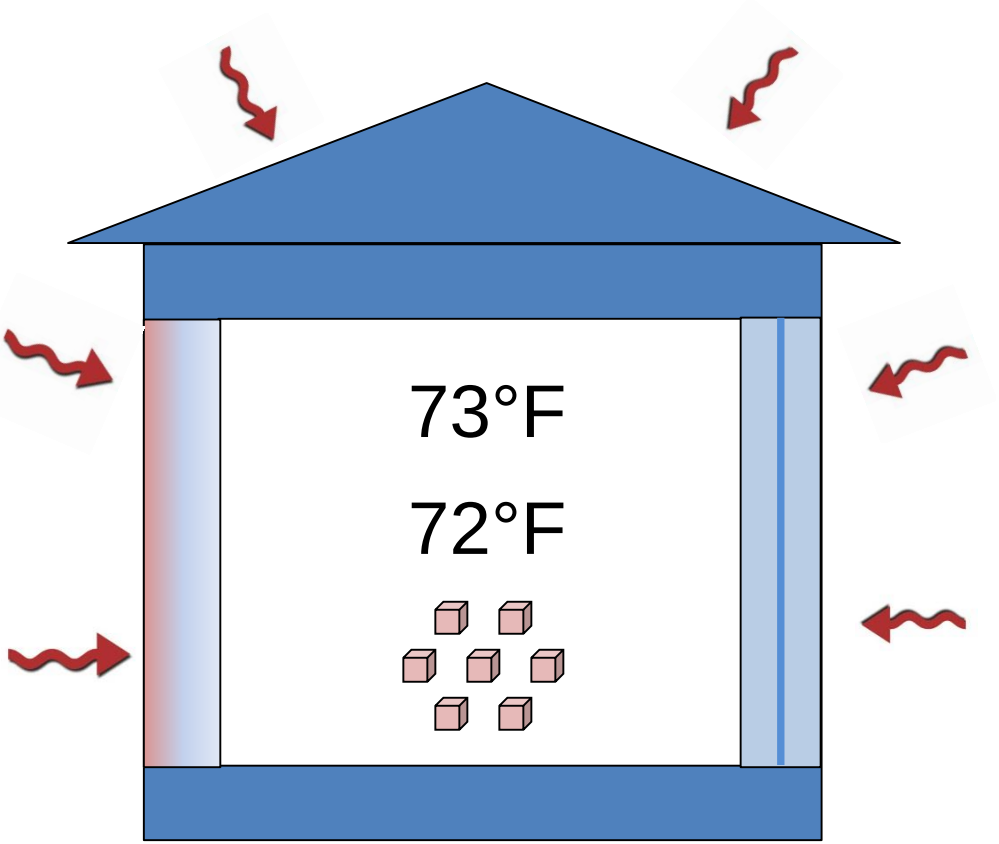
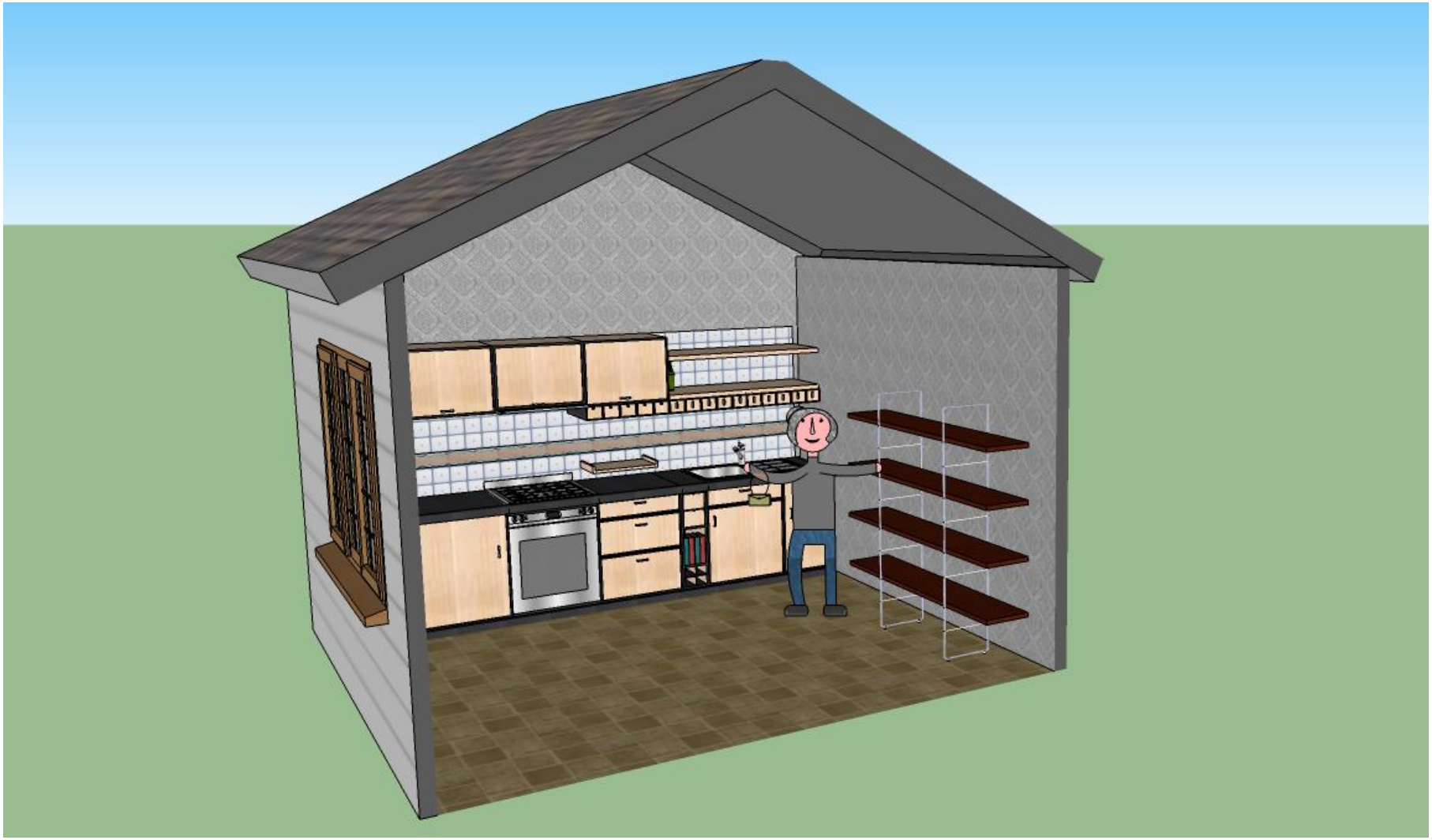


Step 1:
Calculate heating & cooling loads

- Cooling load is the maximum Btu's likely to be added to the home in a single hour during the year.

Step 1:
Calculate heating & cooling loads



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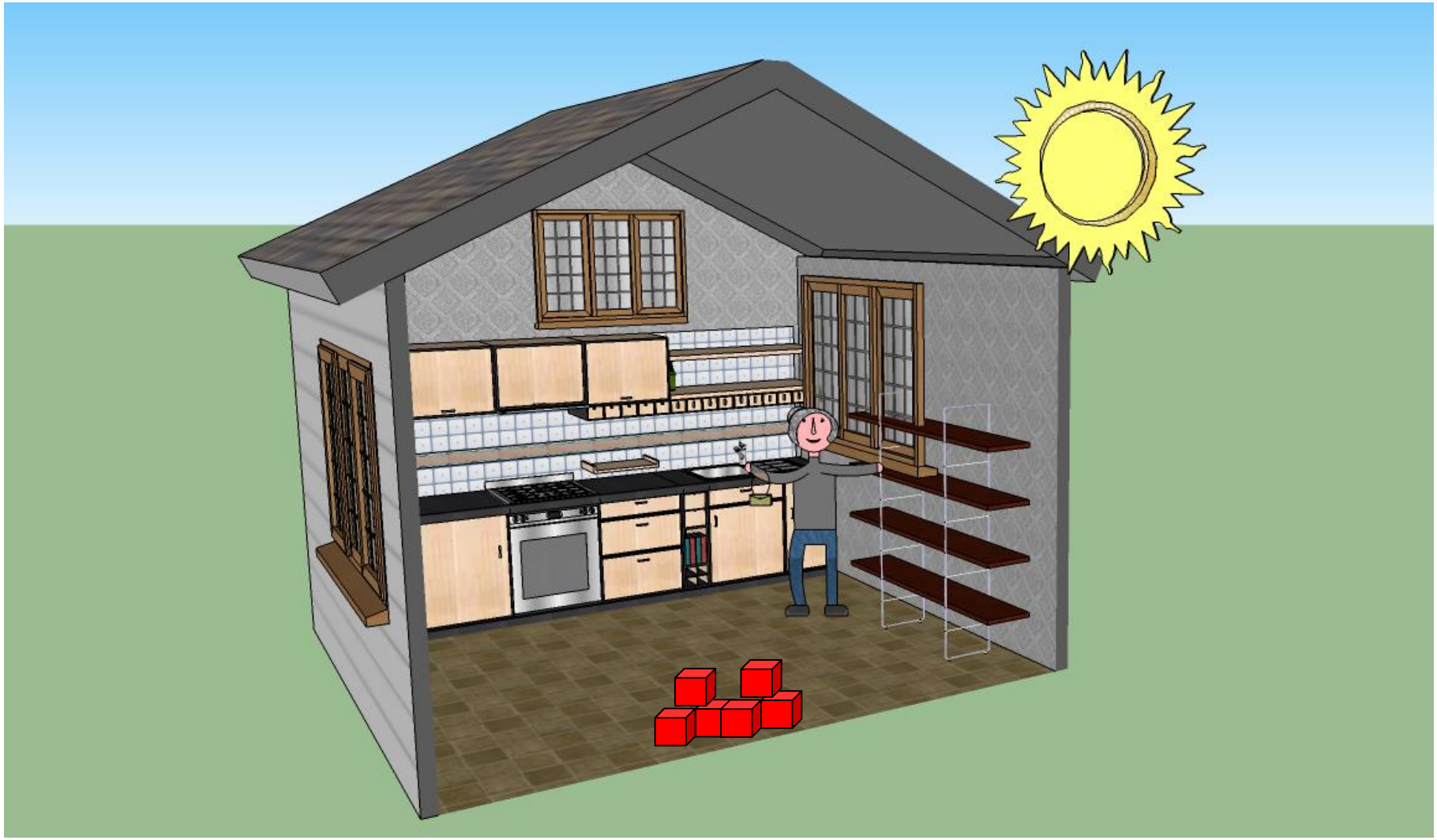

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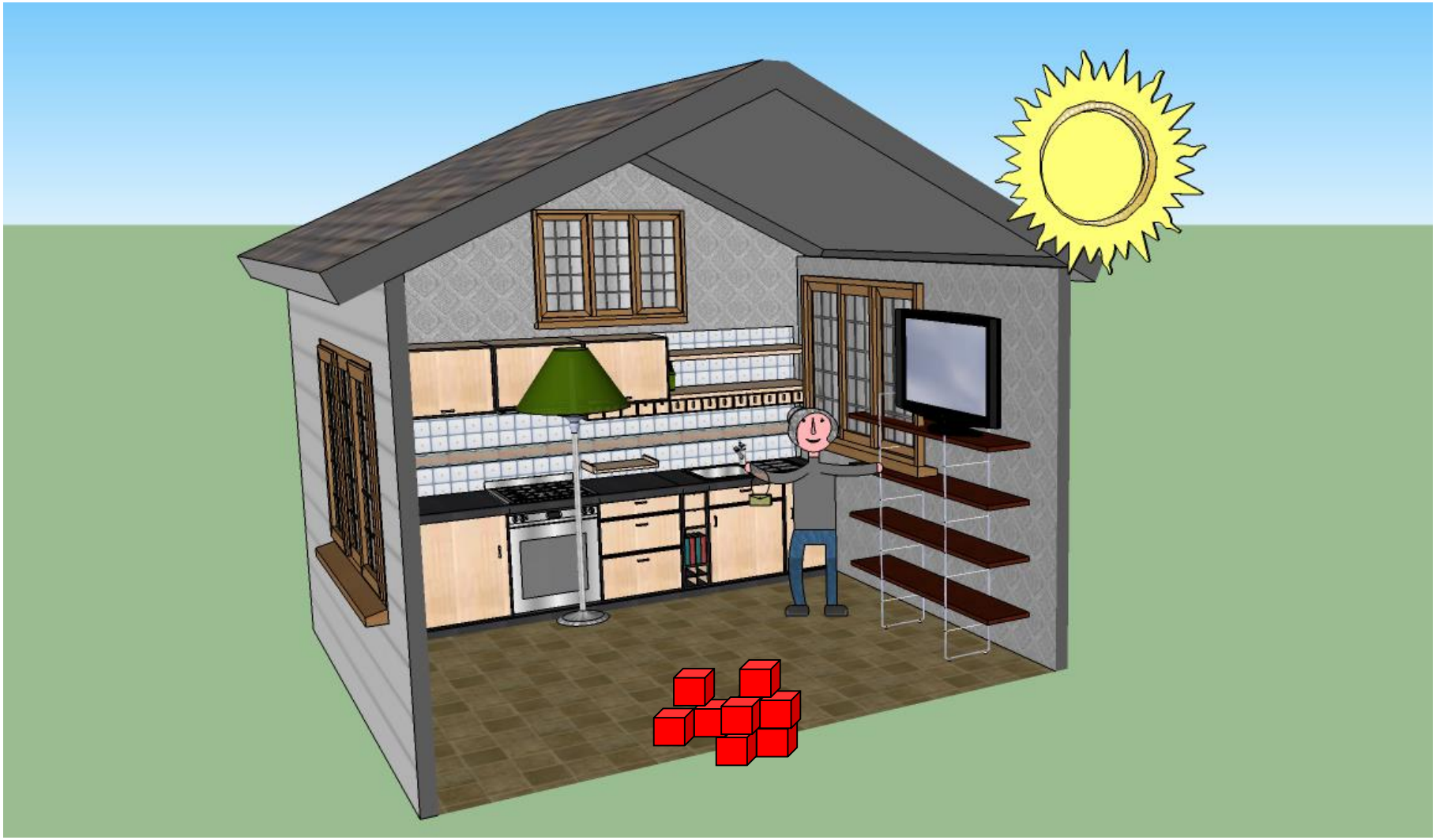

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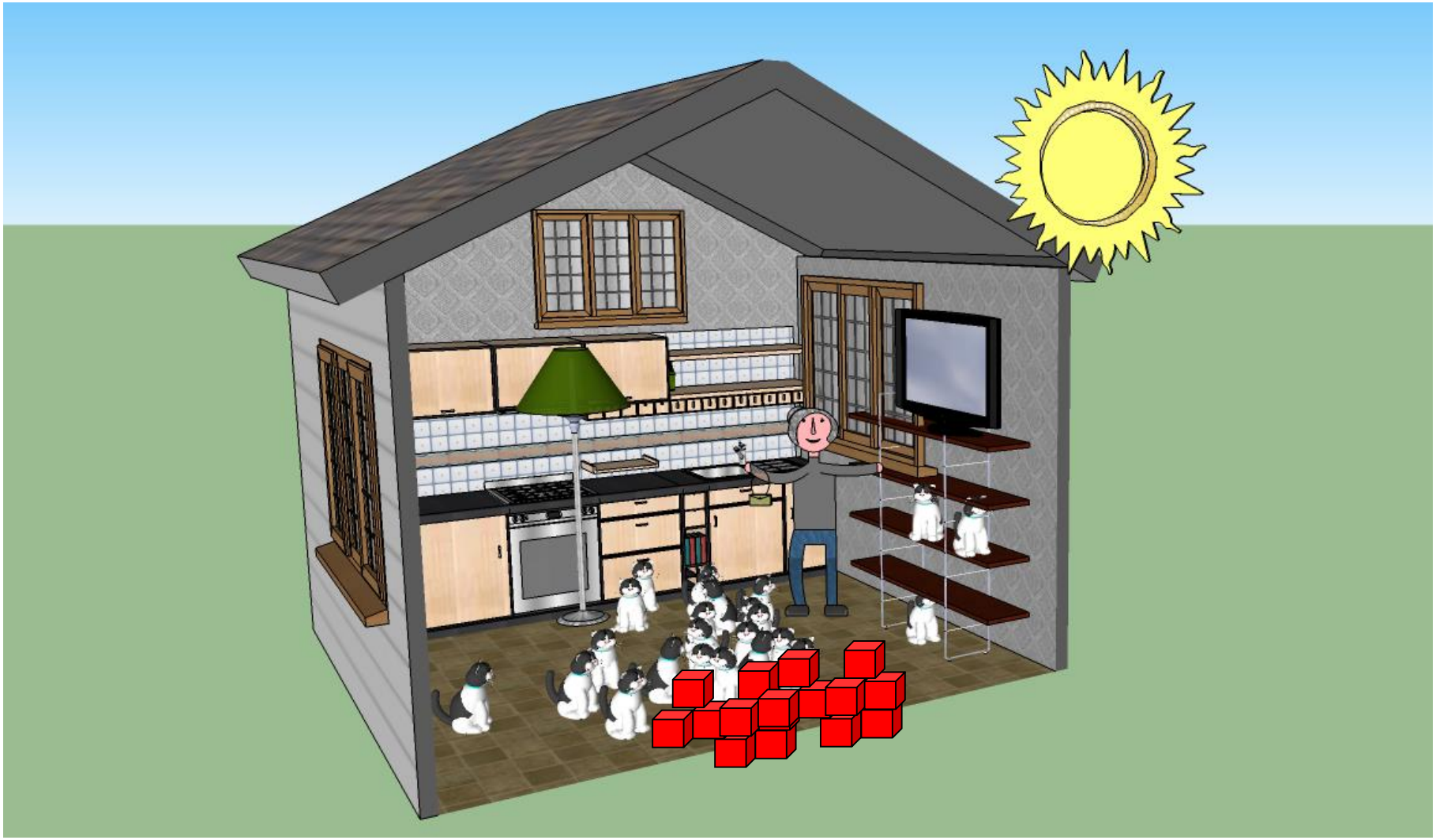
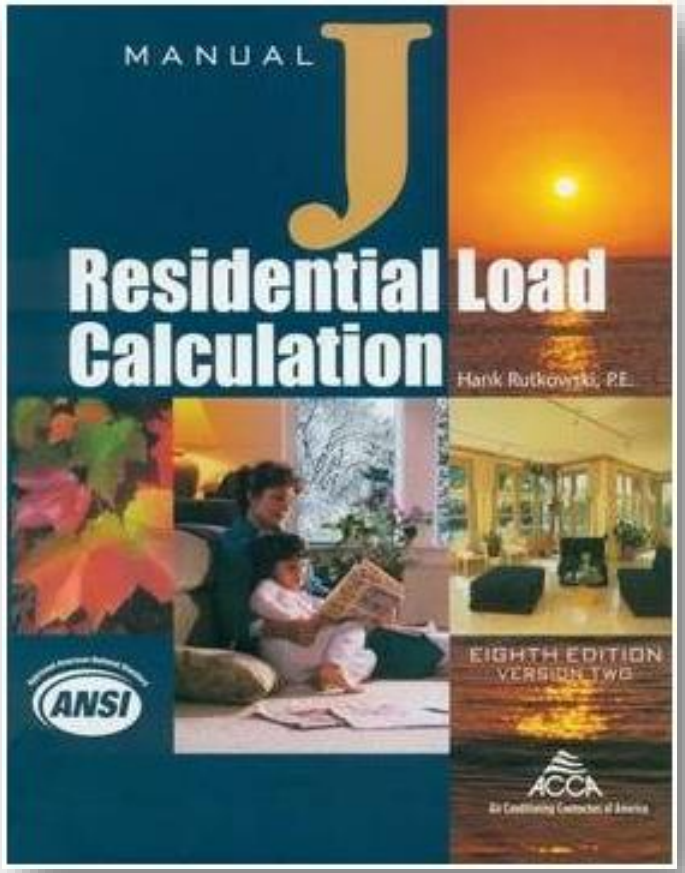


Step 1:
Calculate heating & cooling loads

- Heating load is the maximum Btu's likely to be lost from the home in a single hour during the year.

Step 1:
Calculate heating & cooling loads

- ACCA Manual J is a standard process to calculate loads.
- It defines all variables that go into load calculations.
- It provides guidance on key inputs.



Summary of Step 1: Calculate heating & cooling loads

- The first major step in the design process is to calculate the heating and cooling loads.
- ACCA Manual J provides a reliable standard process for calculating loads.

Step 2:
Select the
Heating & Cooling Equipment

Step 2:
Select equipment that meets loads

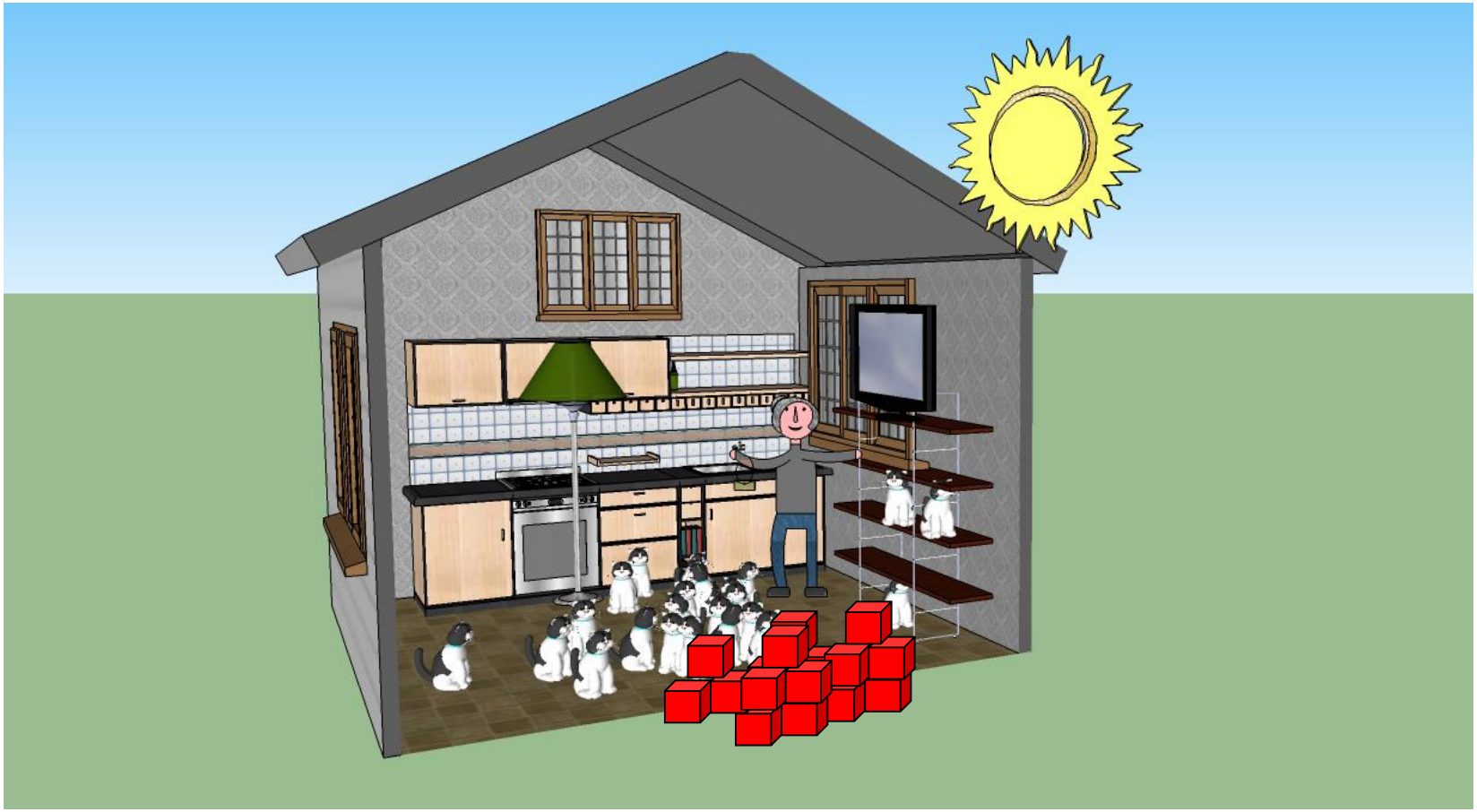
- Cooling Load – Maximum Btu's per hour added to the home.
- Cooling Capacity – Btu's per hour that equipment can remove from the home.

Step 2:
Select equipment that meets loads

Super-Simple Equipment Selection Goal

Step 2		Step 1
Capacity (in BTU's per hour)	=	**Load** (in BTU's per hour)

Step 2:
Select equipment that meets loads



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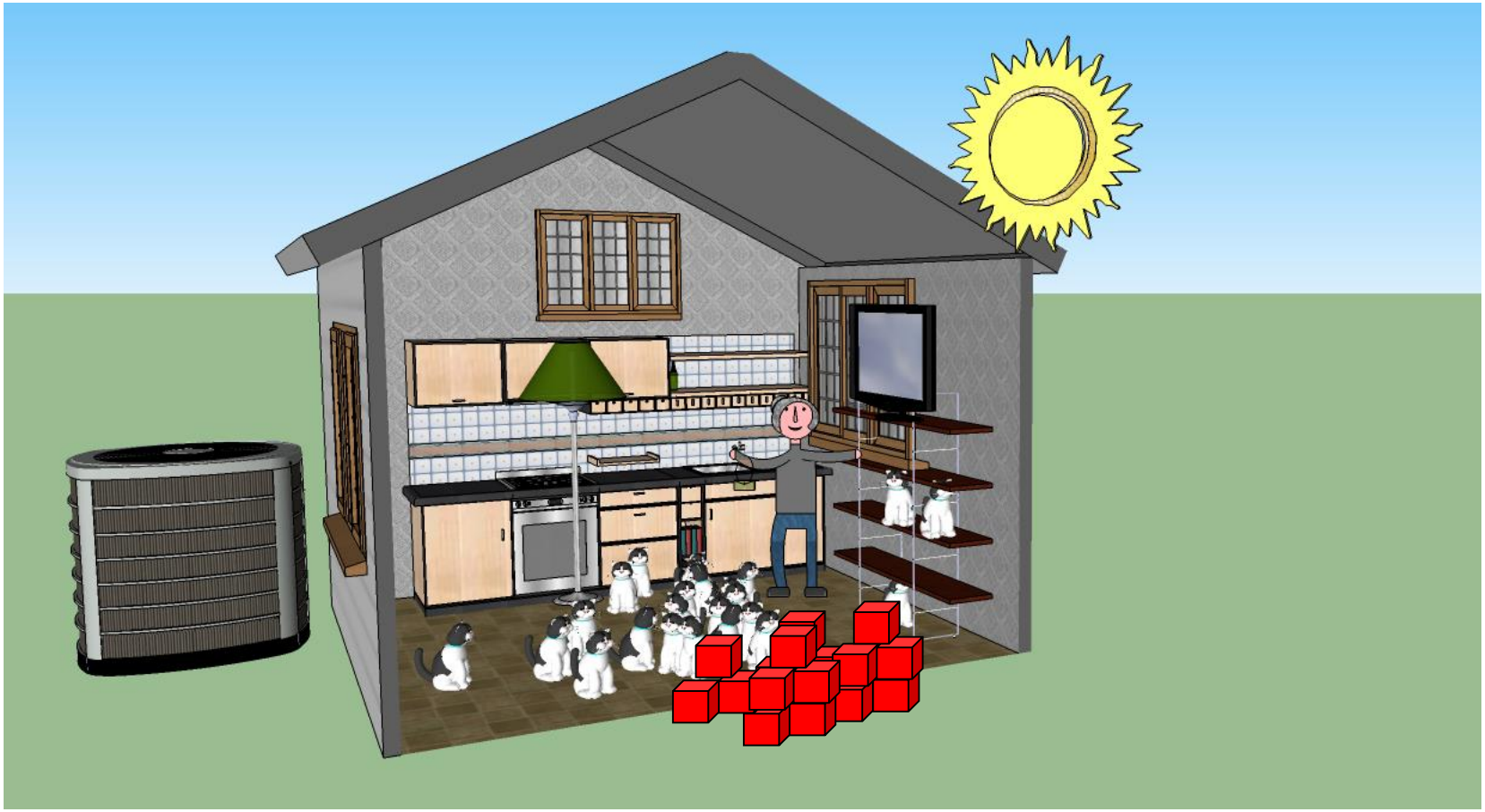
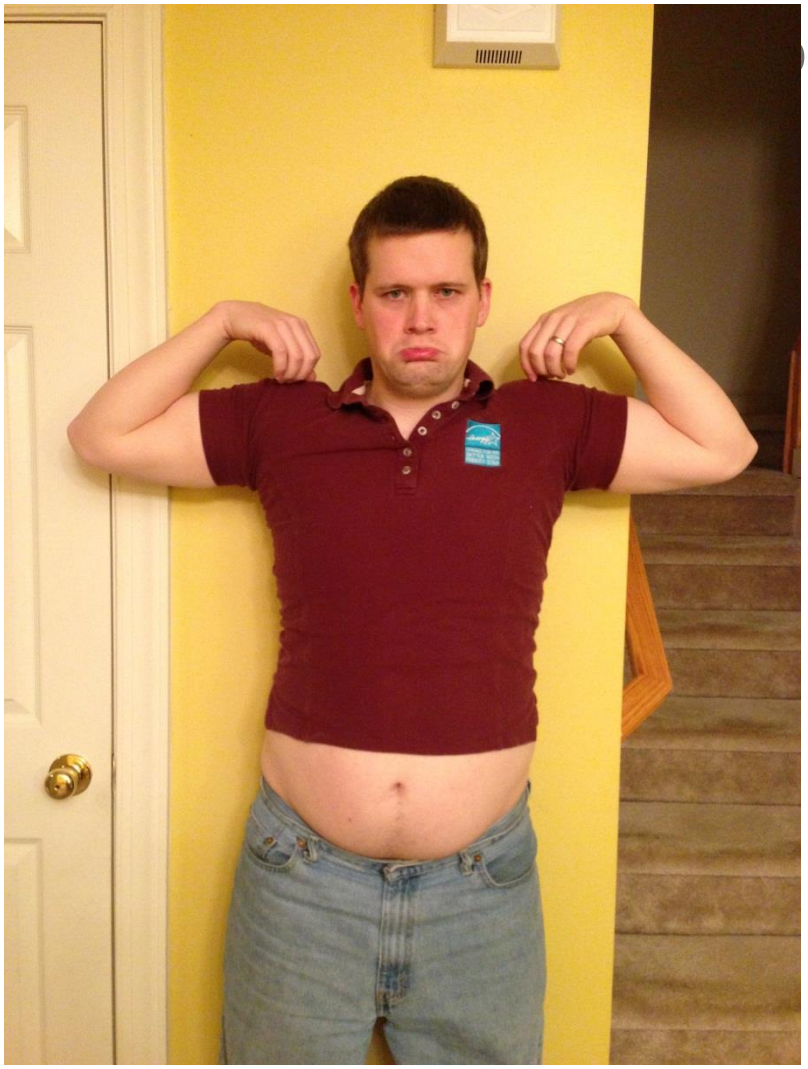


Step 2:
Select equipment that meets loads

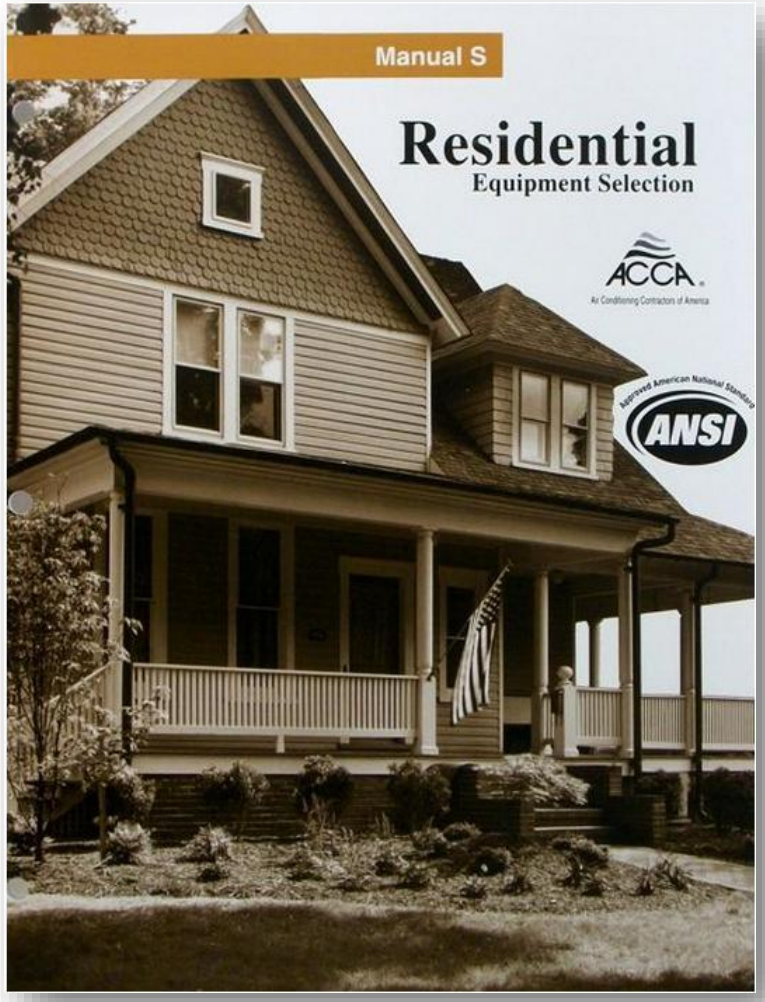
- Heating Load – Btu's per hour lost from the home.
- Heating Capacity – Btu's per hour that equipment can add to the home.

Step 2:
Select equipment that meets loads



Step 2:
Select equipment that meets loads

- ACCA Manual S is a standard process to select equipment using the calculated loads.



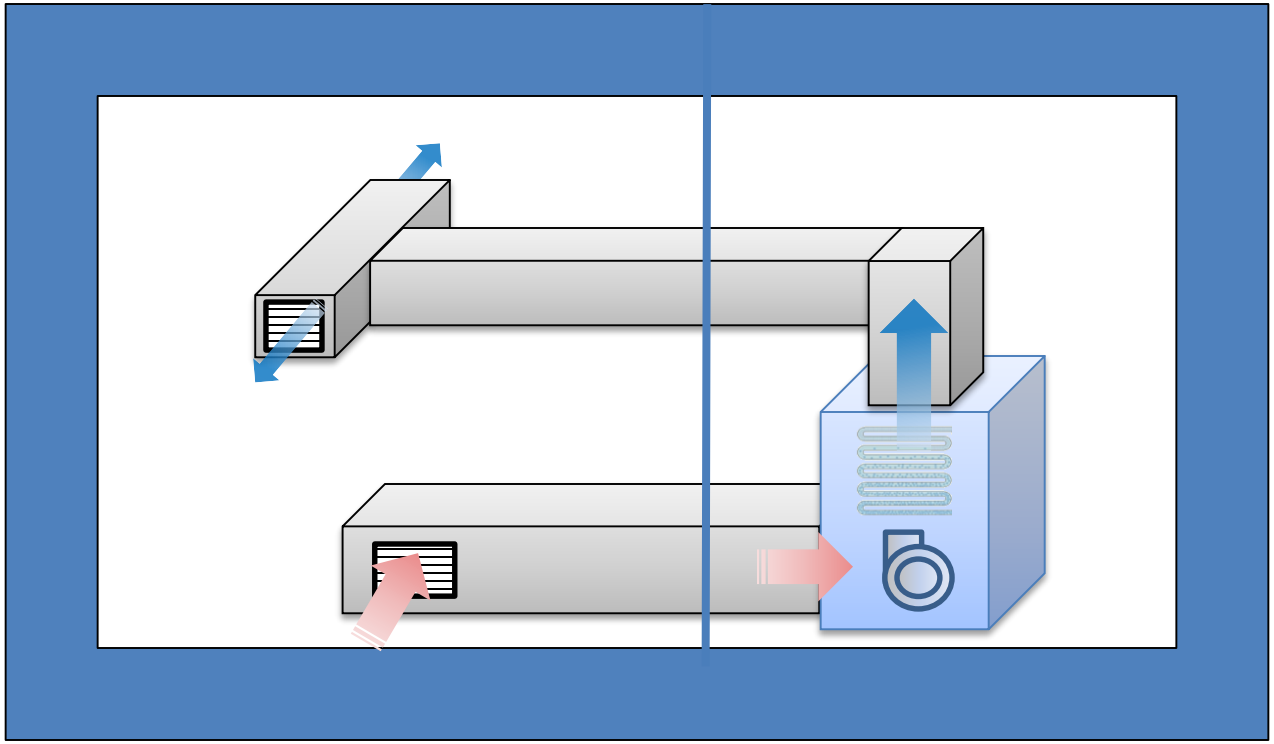
Summary of Step 2: Select equipment that meets loads

- The second major step in the design process is to select equipment that equals the heating & cooling load.
- ACCA Manual S provides a reliable standard process for doing this and includes limitations on over-sizing.

Step 3:
Design the Duct System

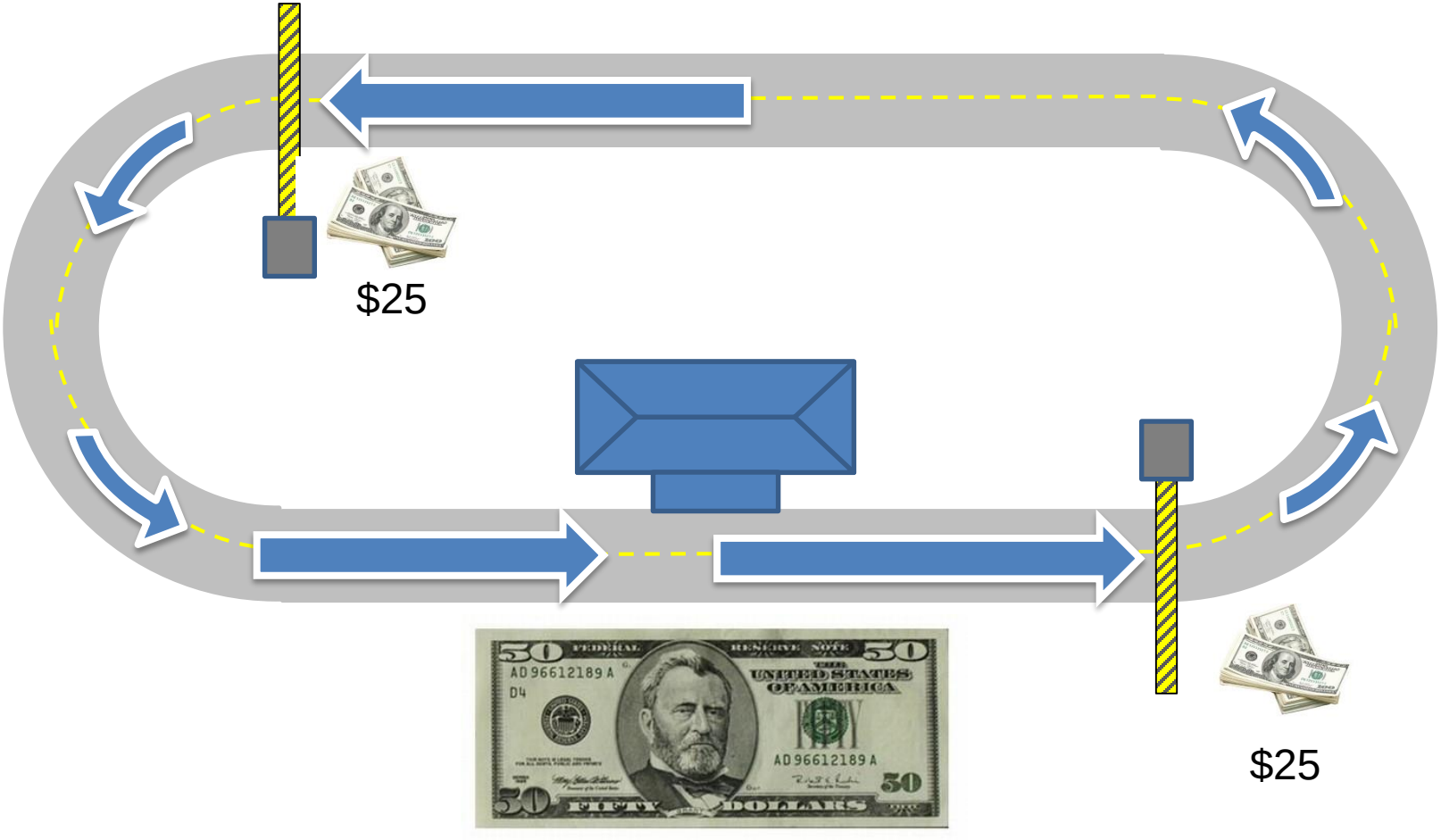
Step 3:
Design the duct system

- Design a duct system that distributes air from the heating & cooling equipment to each room, and back to the equipment.



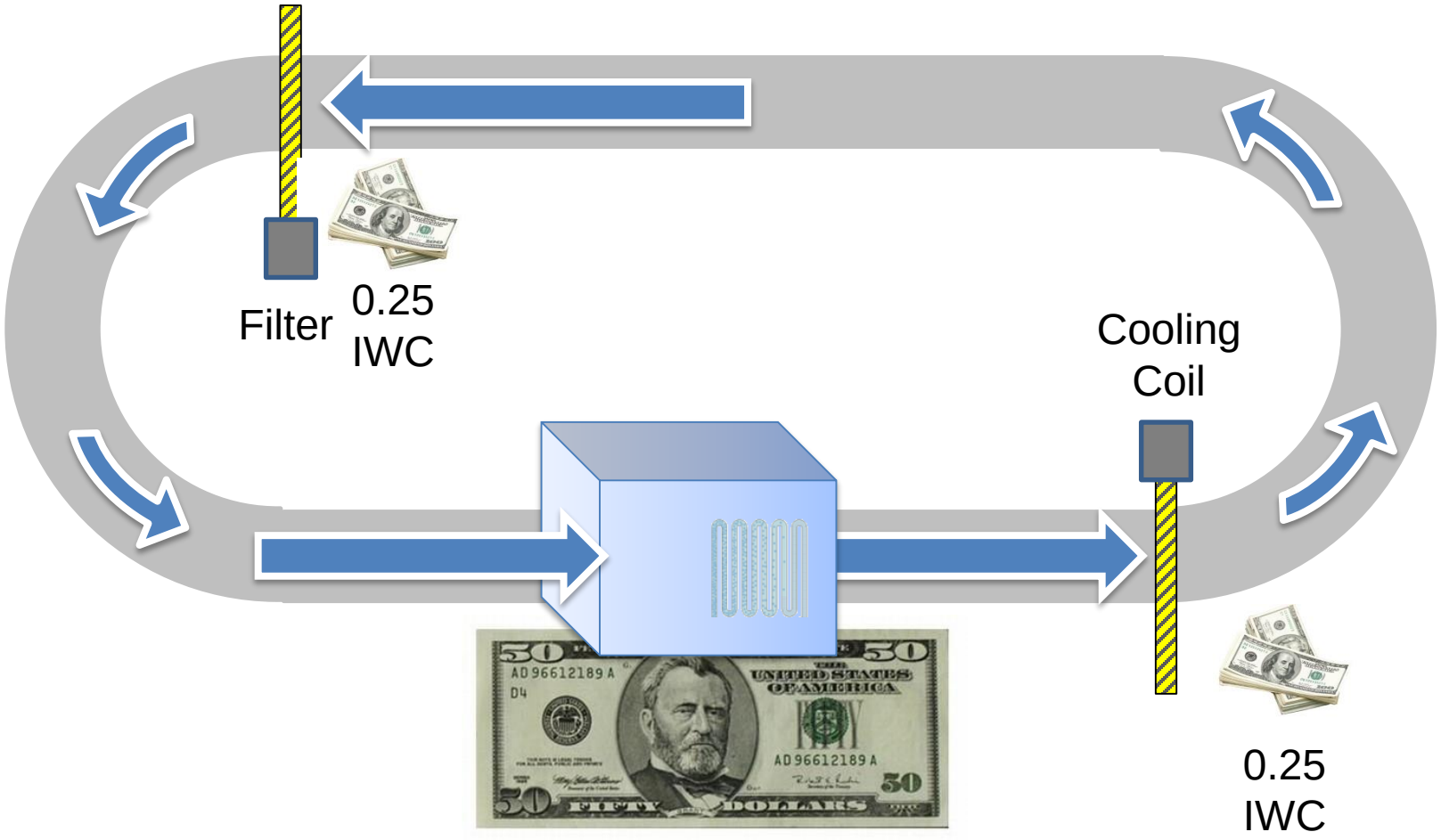
Step 3:
Design the duct system

- Driver must meet a 'budget' in dollars ($).



Step 3:
Design the duct system

- Designer must meet a ‘budget’ in static pressure (IWC).



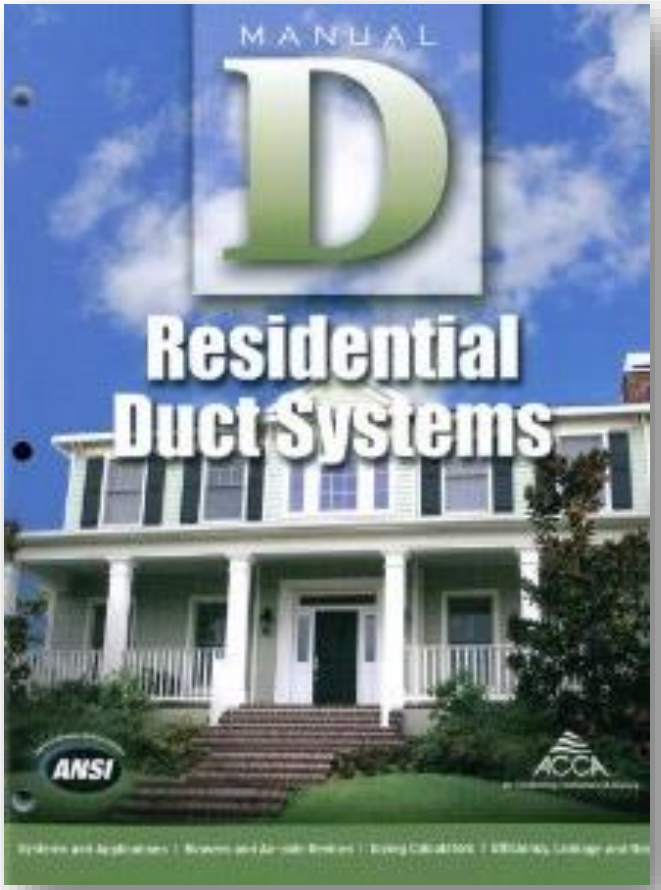
Step 3:
Design the duct system

G40UH-36A-070 PERFORMANCE													
External Static Pressure		Air Volume / Watts at Various Blower Speeds											
		High			Medium-High			Medium-Low			Low		
in. w.g.	Pa	cfm	L/s	Watts	cfm	L/s	Watts	cfm	L/s	Watts	cfm	L/s	Watts
0.00	0	1500	710	705	1290	610	565	985	465	455	830	390	375
0.05	12	1475	695	695	1275	600	555	980	465	445	820	385	365
0.10	25	1450	685	680	1255	590	545	970	460	440	810	380	360
0.15	37	1425	675	670	1240	585	535	965	455	430	805	380	355
0.20	50	1400	660	655	1225	580	525	955	450	425	795	375	350
0.25	62	1370	645	645	1205	570	510	945	445	415	790	375	345
0.30	75	1340	630	630	1180	555	500	930	440	405	780	370	335
0.40	100	1285	605	610	1140	540	475	900	425	390	745	350	325
0.50	125	1215	575	580	1080	510	450	865	410	375	705	335	310
0.60	150	1150	545	560	1015	480	430	810	380	355	655	310	290
0.70	175	1060	500	535	940	445	405	730	345	330	585	275	270
0.80	200	955	450	515	800	375	370	655	310	305	480	225	260
0.90	225	785	370	475	605	285	325	585	275	270	410	195	255

NOTE - All air data is measured external to unit with 1 in. (25 mm) cleanable filter (not furnished - field provided) in place. Also see Filter Air Resistance table.

Step 3:
Design the duct system

- ACCA Manual D is a standard process to lay out duct designs.
- It tells the designer how to determine their static pressure ‘budget’.
- It provides a procedure to use that budget to get the right airflow to each room.



Summary of Step 3: Design the duct system

- The third major step in the design process is to design a duct system that works with the selected equipment.
- ACCA Manual D provides a standard process for doing this. It ensures that the static pressure of the duct system is not too high.

Heating & cooling design summary

- The HVAC design process has three major steps:
  - Step 1: Calculate the heating and cooling loads (Manual J).
  - Step 2: Select equipment with capacity to meet those loads (Manual S).
  - Step 3: Design a duct system that can get air from the equipment to the rooms and back (Manual D).
- The ENERGY STAR Certified Homes program requires this important design process to help maintain the efficiency, comfort, and quality of every certified home.

Heating & Cooling Commissioning

Three major steps to commission an HVAC system

1. Measure HVAC fan airflow.
2. Check refrigerant charge.
3. Ensure that system is balanced.

Step 1:

Measure HVAC Fan Airflow

Step 1:
Measure HVAC fan airflow

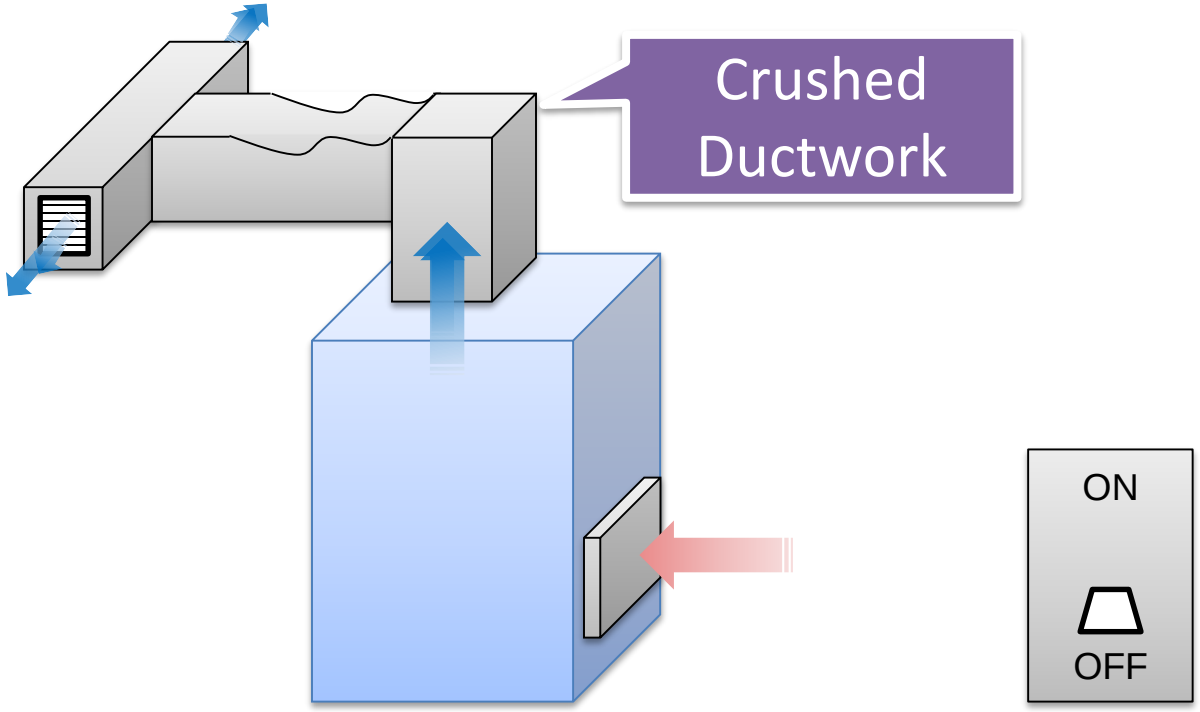
- Loads have been calculated
- Equipment has been selected
- Duct system has been designed
- Equipment and ducts have been installed
- So why do we need to check the HVAC fan airflow?

Step 1:
Measure HVAC fan airflow

- Things don't always go according to plan…

Step 1:
Measure HVAC fan airflow

- Crushed ducts, sharp bends, and other defects produce additional static pressure in the system.



Step 1:
Measure HVAC fan airflow

- Visit www.energystar.gov/newhomeshvac
- Click on “Requirements & Resources for Contractors”
- Then click on “How to Measure HVAC Fan Airflow”

https://www.youtube.com/watch?v=Dbt-gZEACXg&list=PLMvJzVnMdhhvhOKDyE_mURr0_JPC277G4&index=3

Summary of Step 1: Measure HVAC fan airflow

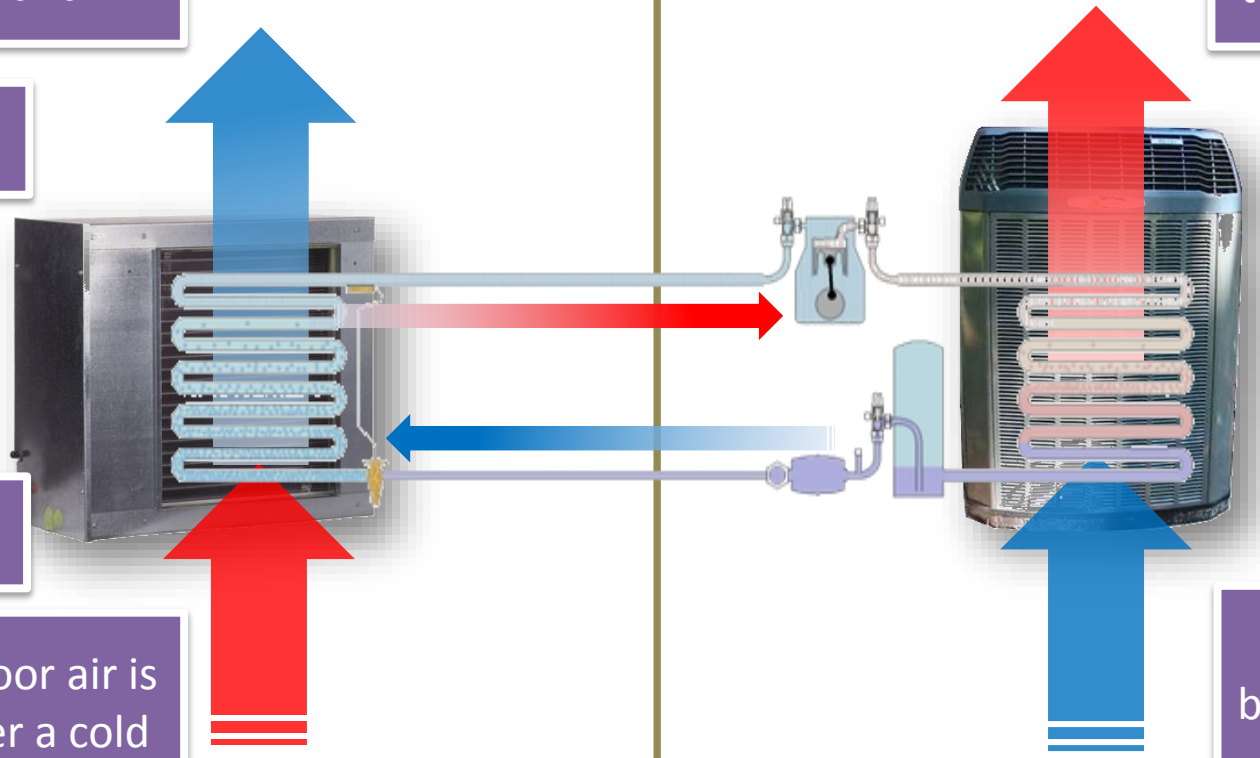
- In <20 minutes, fan airflow can be determined by measuring the static pressure & checking the fan speed setting.
- This ensures the system is operating as designed, so that the equipment can heat and cool the home as designed.

Step 2:
Check Refrigerant Charge

Step 2:
Check refrigerant charge

The air's heat is transferred to the refrigerant.

The refrigerant's heat is transferred to the outdoor air.



2

Inside the House

1

Warm indoor air is blown over a cold refrigerant coil.

4

Outside the House

3

Outdoor air is blown over the hot refrigerant coil.

Step 2:
Check refrigerant charge

- Refrigerant charge is checked in the field by the contractor by measuring the superheat or sub-cooling value.
- If the refrigerant charge is too high or too low, refrigerant can be added or removed to fix the charge.

Step 2:
Check refrigerant charge

Why is the amount of refrigerant so important to the operation of the A/C unit?

- Keep temperatures within target ranges.

Consequences of improper charging:

- Inefficient operation.
- Premature compressor failures.

Summary of Step 2: Check refrigerant charge

- Refrigerant is a vehicle to transfer heat.
- Too much or too little refrigerant can impact capacity, efficiency, and durability.
- Refrigerant charge can be tested by the contractor in <20 minutes to ensure that the right amount is in the system.

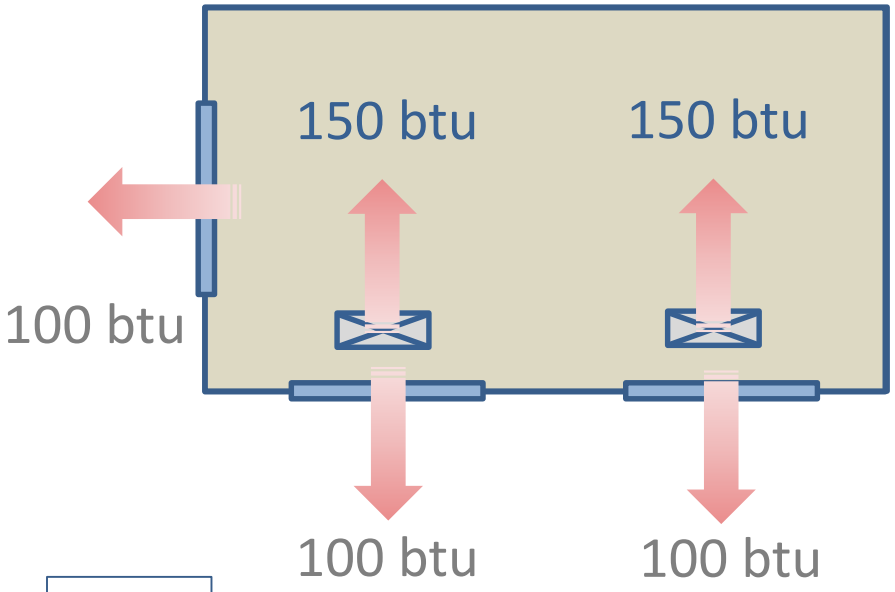
Step 3:

Ensure System is Balanced

Step 3:
Ensure system is balanced

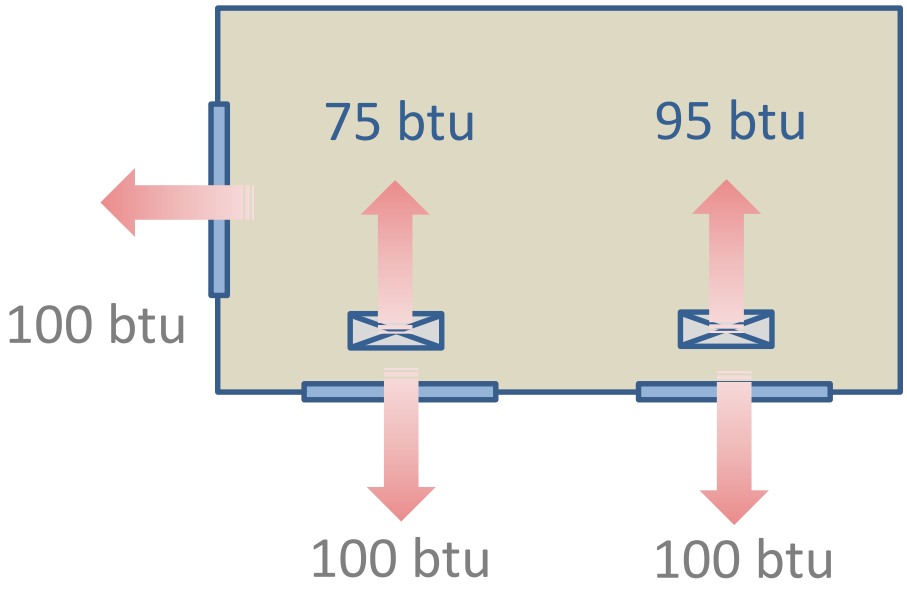
- Proper airflow is needed to deliver or remove the proper amount of heat from each room.

Room A – Correct Airflow



300 btu's out & 300 btu's in

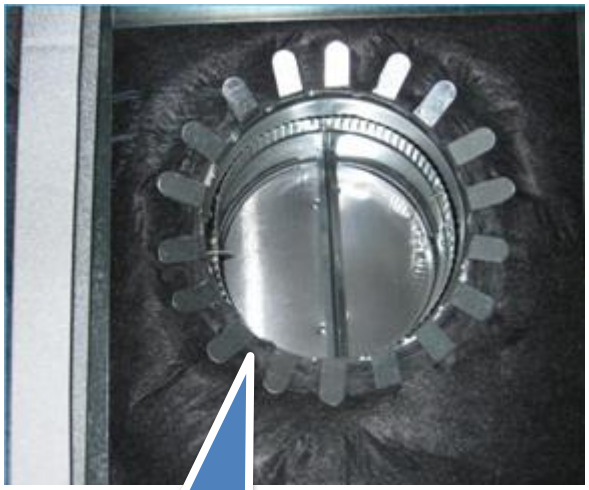
Room A – Incorrect Airflow



300 btu's out & 170 btu's in

Step 3:
Ensure system is balanced

- Unforeseen events that impact airflow relative to the design



Closed damper

Electrical wire

Summary of Step 3: Ensure system is balanced

- Air balancing ensures that the right btu's are added to and removed from each room.
- Can find problems caused by work that occurs after the equipment installation and start-up process.

Summary – Heating & Cooling Commissioning

- Step 1 - Measure HVAC fan airflow to ensure the proper amount of heated and cooled air is produced.
- Step 2 - Check refrigerant charge to ensure that the proper amount of heat is transferred from inside the house to the outside.
- Step 3 - Balance airflows at the registers to ensure proper amount of heat is delivered or removed from each room.

Interactive Quiz!

How HVAC Impacts Your Business

Installation defects in HVAC systems are commonplace

- Improper airflow:
  - Average airflow 14% below design. Proctor (1997)
  - Measured airflow ranging from 130 - 510 CFM / ton. Parker (1997)
  - Improper airflow in 44% of systems. Mowris et al. (2004)
- Incorrect refrigerant charge:
  - 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)
- 95% of units did not pass all diagnostic tests. Proctor (2004)

For Builders

- Lower first cost due to right-sized equipment.
- Reduced risk of comfort and warranty problems.
- Reputation is not left to chance.

For Raters

- Increased opportunity for services.
- Lowered risk of dissatisfied clients.
- Eventually, HERS points.

For Utilities

- Potential for increased energy savings.
- Potential for increased demand savings.
- Better outcomes during evaluations.

ENERGY STAR Certified Homes

Web:

Main: www.energystar.gov/newhomespartners
Technical: www.energystar.gov/newhomesguidelines
Training: www.energystar.gov/newhomestraining
HVAC: www.energystar.gov/newhomesHVAC

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