NREL
NATIONAL RENEWABLE ENERGY LABORATORY

A Proposed Methodology for LEED Baseline Refrigeration Modeling

Michael Deru

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Learning Objectives for this Session

1. Describe options for improving energy efficiency in commercial refrigeration.
2. Design commercial refrigeration systems for reduced greenhouse gas emissions.
3. Describe problems associated with establishing LEED energy credits for buildings with refrigeration loads.
4. Distinguish important parameters for developing models of refrigeration equipment.
5. Clarify cost effective opportunities for reducing refrigeration energy consumption.
6. Design a commercial supermarket with a 50% reduction in energy usage.

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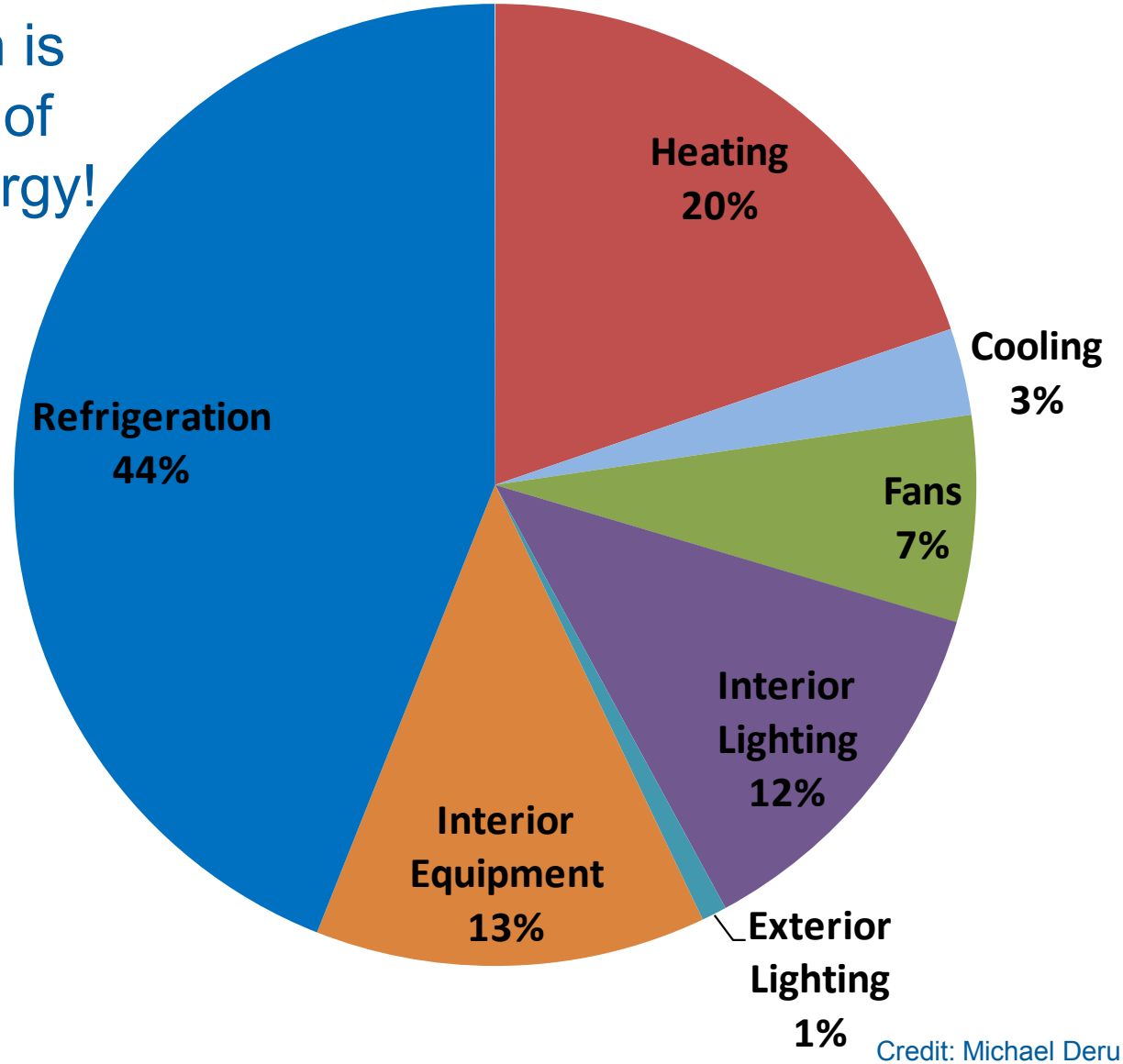
Refrigeration Modeling: What's the Big Deal?

- Large energy user
- Not all software have refrigeration models
- State of modeling algorithms is not mature
- Complex interactions with the space and HVAC
- Lots of inputs
- No established baseline

Credit: NREL Michael Deru

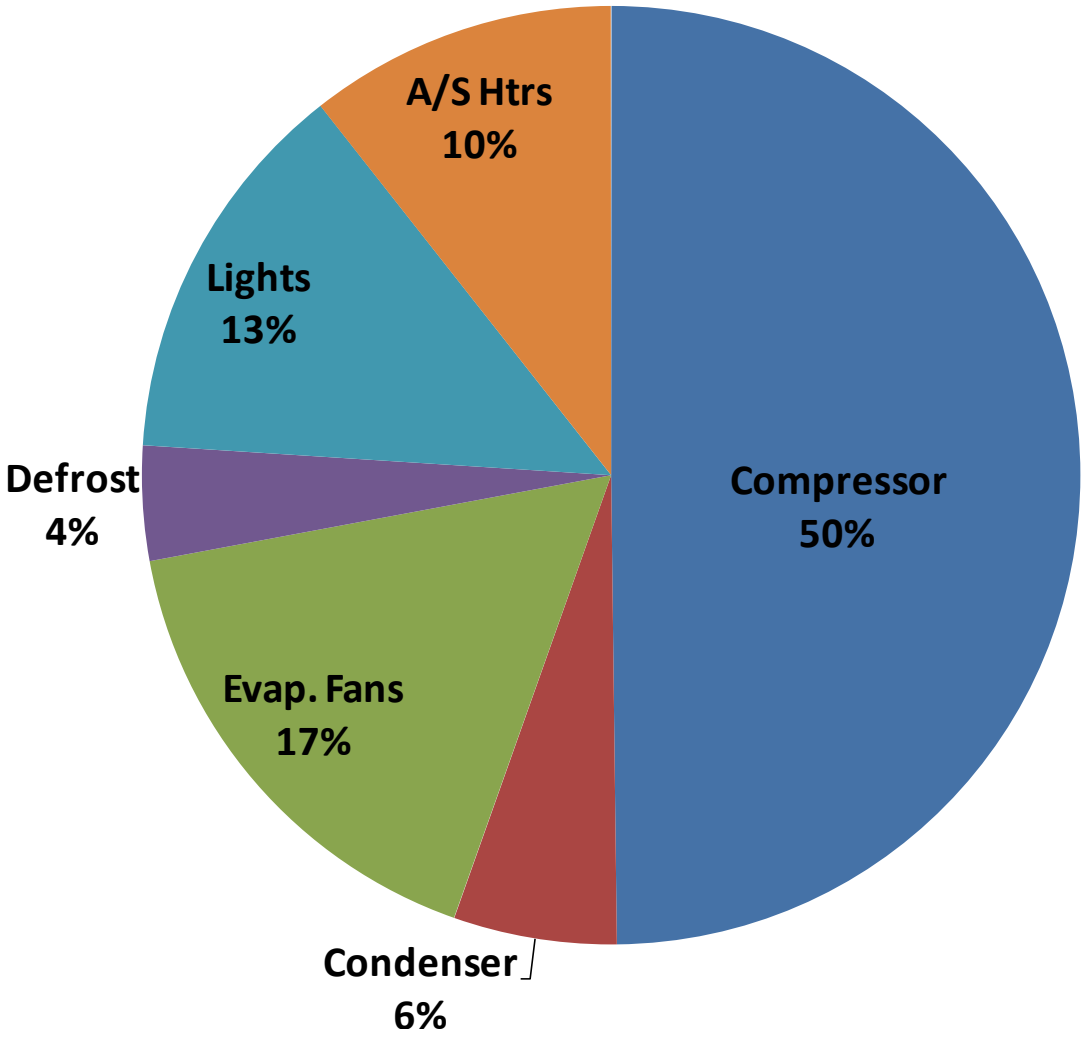
Typical Supermarket Energy Use

Refrigeration is 20% to 50% of the total Energy!



Credit: Michael Deru

Measured Refrigeration Energy End Uses



Credit: Michael Deru

Getting Started – Take Inventory

- Compressors
- Condensers
- Working Fluid
- Cases
- Operating Schedules

Credit: NREL Jennifer Scheib

Description	Size	Length	Load	SST	Fans				Defrost			
	ft	ft	1000Btu/h	°F	Amps	Volt	Phase	kW	Amps	Volt	Phase	kW
Frozen cake	3 doors	7.5	4.0	-14	1.5	115	1	0.17	8.6	208	3	3.10
Seafood Freezer	8x10x10	10	8.9	-10	3.3	208	1	0.69	10.5	208	1	2.18
Frozen seafood	4 doors	10	5.3	-14	2.0	115	1	0.23	11.3	208	3	4.07
Service seafood	12	12	14.4	13	3.6	115	1	0.41				0.00
M/D reach-in freezer	15 doors	37.5	16.5	-14	7.5	115	1	0.86	44.0	208	3	15.85
M/D reach-in freezer	18 doors	45	19.2	-14	9.0	115	1	1.04	38.8	208	3	13.98
M/D reach-in freezer	18 doors	45	19.2	-14	9.0	115	1	1.04	38.8	208	3	13.98

Energy Models – What are the Inputs?

Example input fields from a whole building program

- Reach-in cases – 35 inputs (3 performance curves)
- Walk-ins – 33 inputs
- Compressors – 8 inputs (2 performance curves)
- Condensers – 11 inputs (1 performance curve)
- System – 13 inputs

Where do they come from?

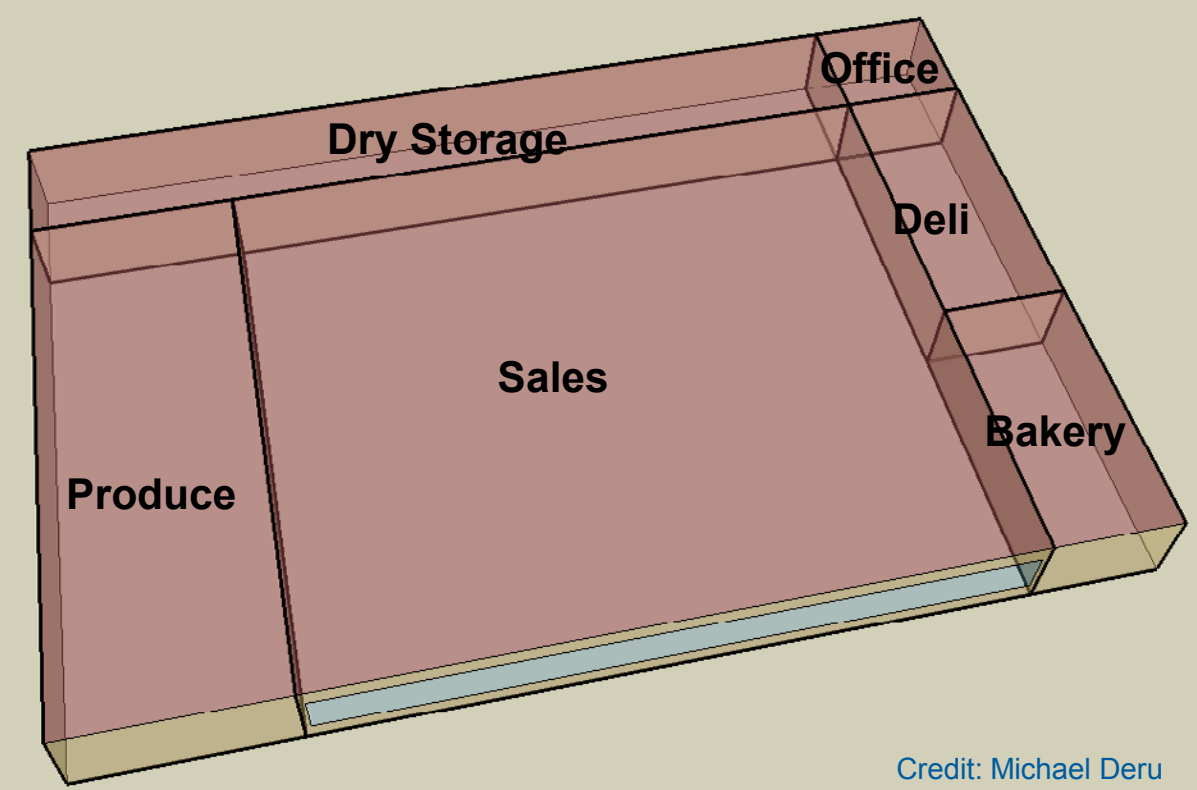
Credits: NREL Jennifer Scheib

Resources

- Energy software example files and libraries
  - Compressor curves
  - Case libraries
  - Working fluids
- Manufacturer data
- ASHRAE handbook, Journal articles, technical reports, research reports

Resources (2)

- DOE supermarket reference building model
  - 45,000 ft^2 fully defined supermarket energy model
  - Models and results for 16 climate zones



Reference Building Model Cases

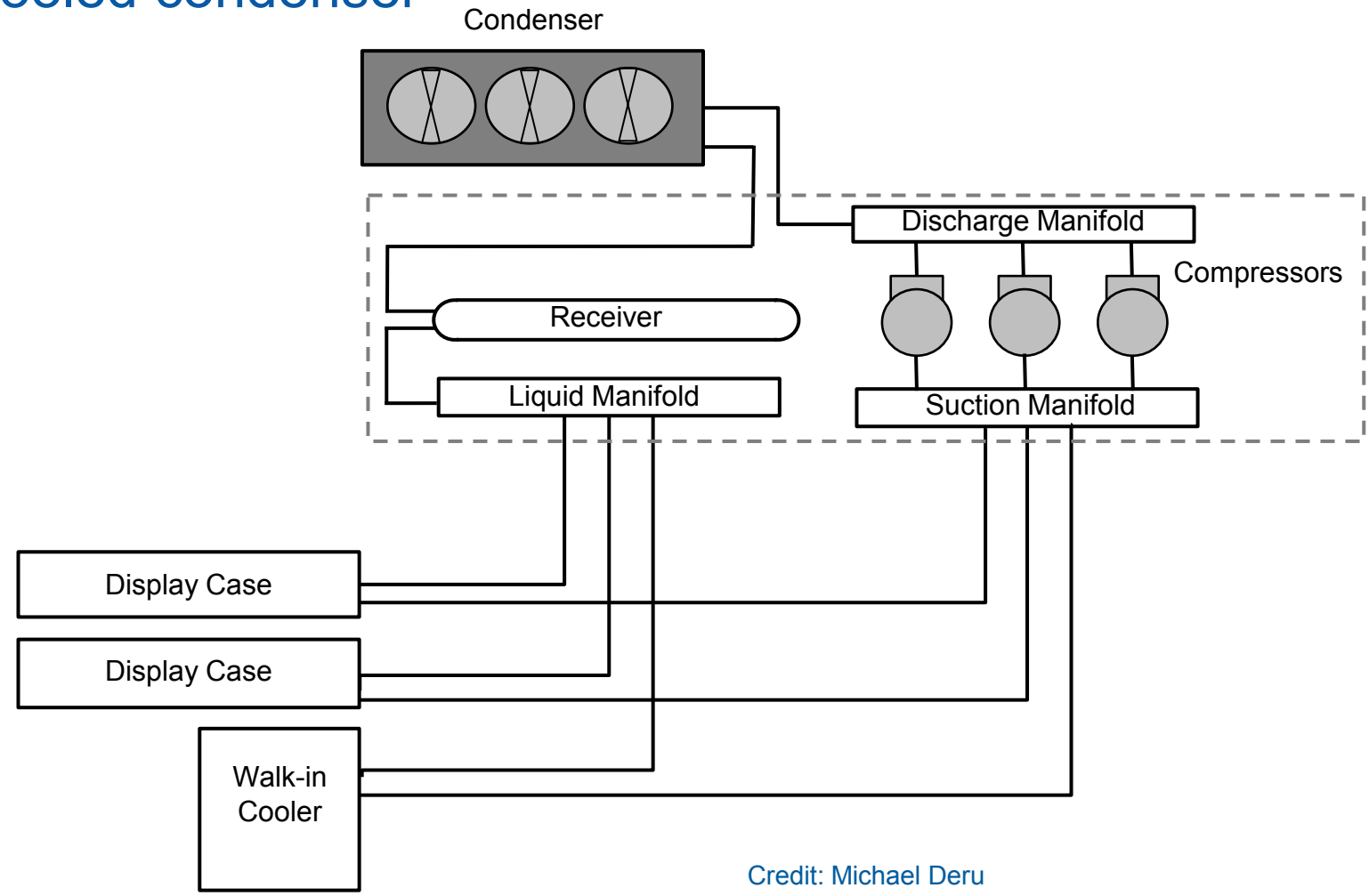
Case	Area (ft^2)	Length (ft)	Cooling Capacity (Btu/h/ft)	Evaporator Fan (W/ft)	Lighting (W/ft)	Defrost (W/ft)	Anti-Sweat (W/ft)	SST (°F)	Case Temp. (°F)	Compressor Rack
Medium Temperature										
Multideck meat cases		120	1500	26.7	11.8	135	20	15	36	A
Other multideck cases		260	1500	12.5	18.3	0	0	15	36	A
Meat walk-in	400	50	400	50	400	50	0	15	36	C
Other walk-in	2600	325	2600	325	2600	325	0	15	36	C
Low Temperature										
Reach-in cases		268	560	20	33	400	71	–25	5	B
Single-level open cases		128	550	10	0	420	24	–25	10	B
Walk-in freezer	1000	125	640	32	8	232	0	–25	–10	D

Baseline Model for Energy Savings Calculations – What are your options?

- Make-up your own
- COMNET
- Appendix G style method under development

Baseline Configuration

- Parallel compressor racks
- Air-cooled condenser



Credit: Michael Deru

Baseline Model Highlights

Compressor racks	Parallel DX reciprocating compressors, 3 – 4 racks
Suction Groups	5
Suction Temperature	3°F below lowest saturated evaporator temp
Refrigerant	404A
Case Fans	PSC motors with defined W/ft
Case Lighting	T8 lamps with defined W/ft
Anti-Sweat Heaters	Modulated control based on dew point
Defrost type	Electric with temperature termination on low temp Electric with time-off control on medium temp
Condensers	Air-cooled, constant speed fans, cycle to meet minimum SCT
Heat Reclaim	Domestic HW preheat. De-superheating of low temperature rack discharge gas

Example Savings Calculations

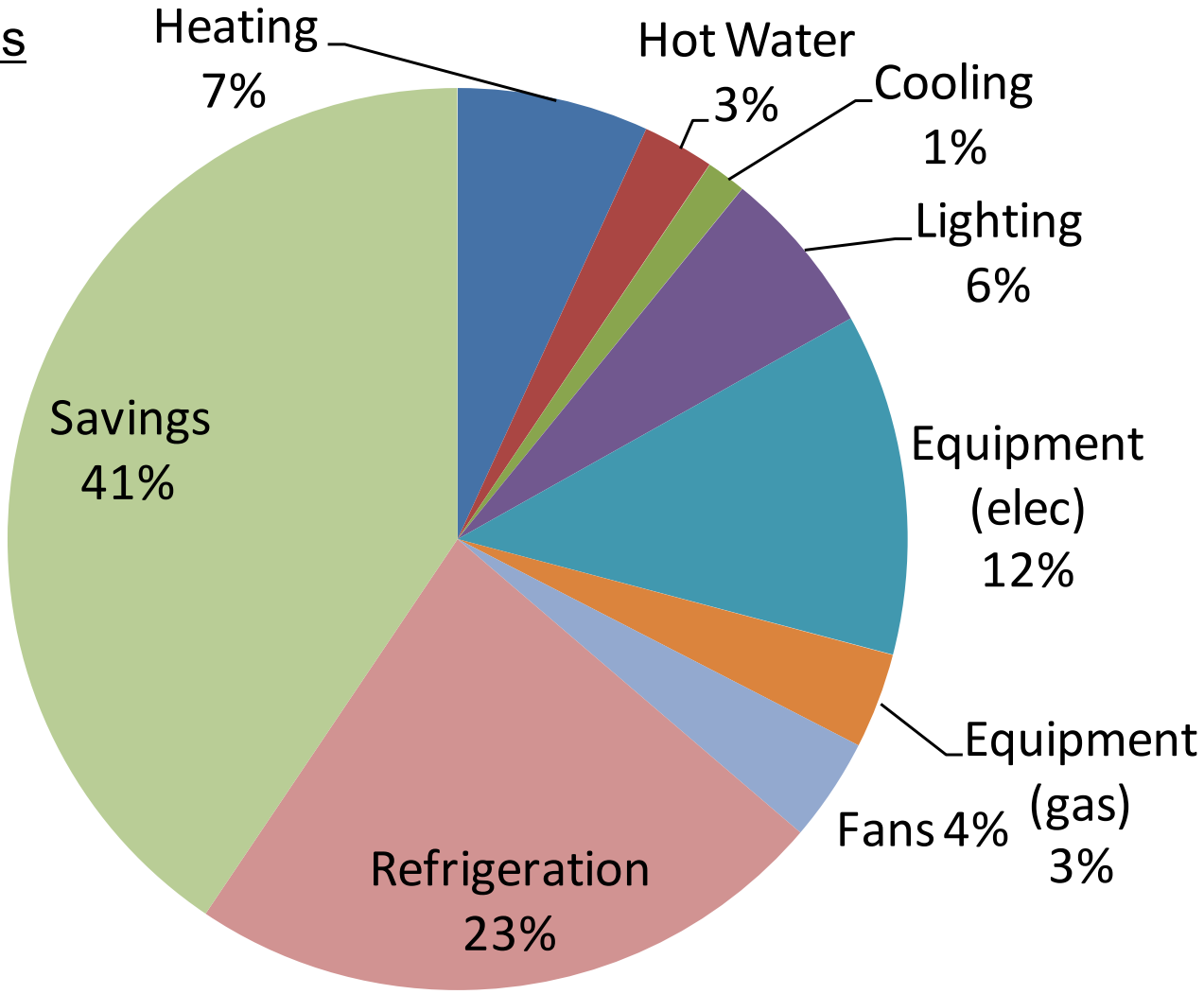
- Create and run baseline model
- Create and run proposed model
  - Added doors to medium temperature cases
  - LED case lights
  - ECM evaporator fan motors
  - Variable speed condenser fan

- Always question the results!

Credit: NREL Michael Deru

Results

Component	Savings
Heating	54%
Hot Water	47%
Cooling	44%
Lighting	57%
Equipment (electric)	20%
Equipment (gas)	20%
Fans	52%
Refrigeration	36%
Total	41%



Thank You
Questions?

michael.deru@nrel.gov