The Effects of Demand Response Programs and Residential Energy Efficiency On Consumer Comfort

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PSERC Webinar

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Demand Response

- FERC 2009 National Assessment of Demand Response Potential:
  - up to 100 GW, 10%, residential peak demand reduction potential by 2019
  - residential is the largest single contributor with saturation of central a/c the key factor.
  - No improvements assumed to a/c or residential efficiency
  - Report notes efforts to integrate demand response and energy efficiency
  - Also notes lack of data and need for research on combined programs and of energy efficiency alone

Demand Response

- How will improved residential energy efficiency affect electric system energy, system peak demand and the demand reduction available from demand response programs?

Ward Jewell, The Effects of Residential Energy Efficiency on Electric Demand Response Programs. *Hawaii International Conference on Systems Sciences 47*, January 2014.

- How will demand response programs affect peak demand, total energy consumption, consumer comfort, and economics of residences with different energy efficiency profiles?

Ward Jewell, The Effects of Demand Response Programs and Residential Energy Efficiency on Consumer Comfort . *2013 Frontiers of Power Conference,* Stillwater, Oklahoma, October 2013.

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Residential Cooling Comfort

- Maintain indoor air temperature of 75°F for 97.5% of the hours from June through September
  - *ASHRAE Handbook,* A/C Contractors of America *Manual J*
- *Acceptable temperatures:* 19-28°C (67-83°F)
- allowable cyclic variation, 15 minutes or less: 1.1°C (2.0°F)
  - ASHRAE standard 55-2010

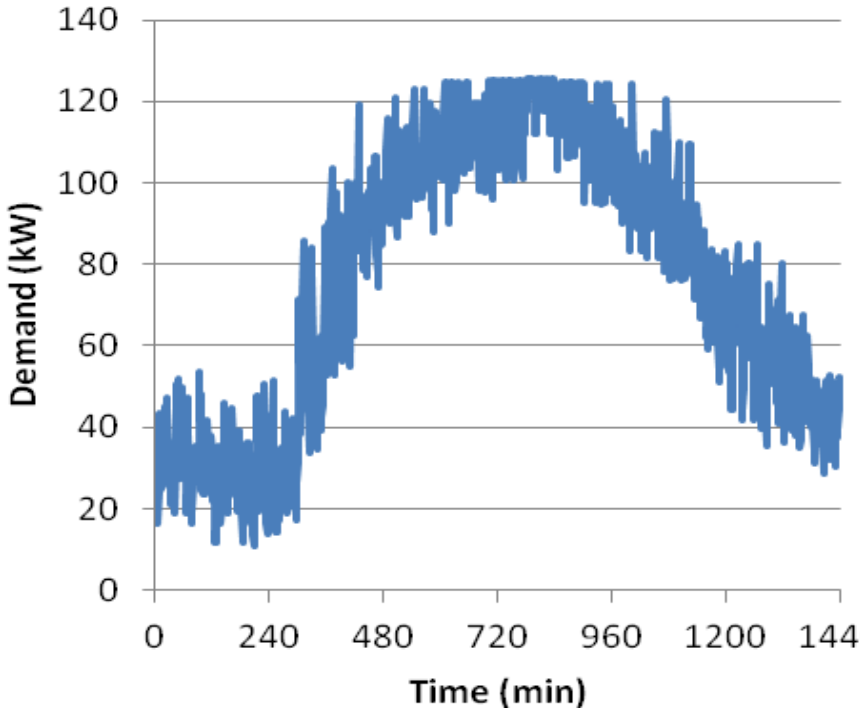
Six houses were simulated

Gridlab-D

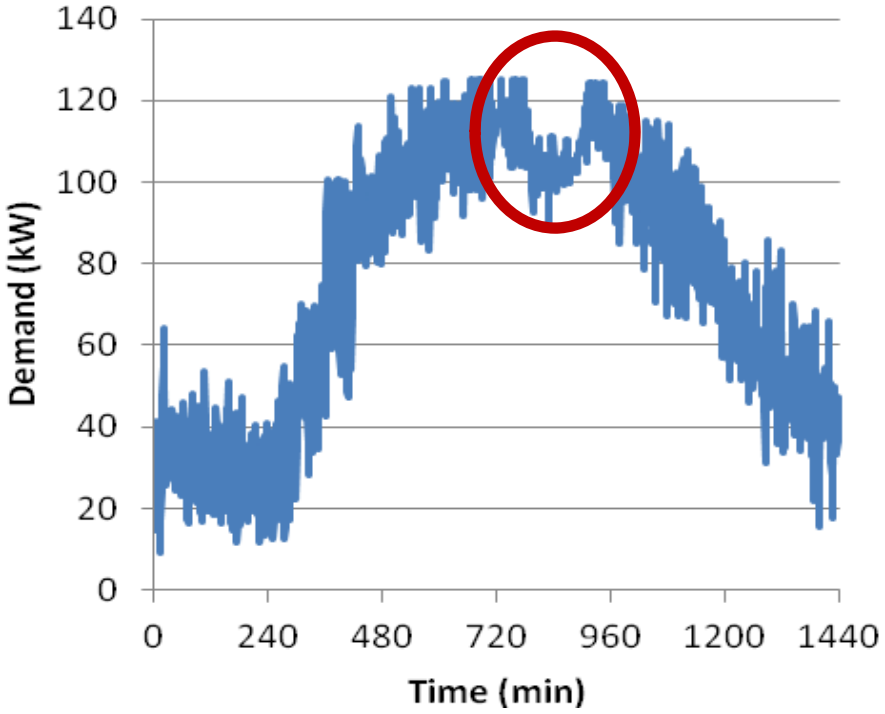
Case	Thermal Integrity	A/C size (Btu/hr)
1	Little	87,900 (oversized)
2	Little	56,800 (proper)
3	Normal	56,800 (oversized)
4	Normal	36,350 (proper)
5	Good	36,350 (oversized)
6	Good	28,550 (proper)

Demand Response Programs:

5, 10, and 20 minute a/c shutoff
once between 2-4 pm
24 houses



No demand response event



20 minute a/c cycling
Evenly distributed
throughout 2 hour period

Relative Demand Reduction from 20 minute a/c cycling

Thermal Integrity	A/C size (Btu/hr)
Little	87,900 (oversized)
Little	56,800 (proper)
Normal	56,800 (oversized)
Normal	36,350 (proper)
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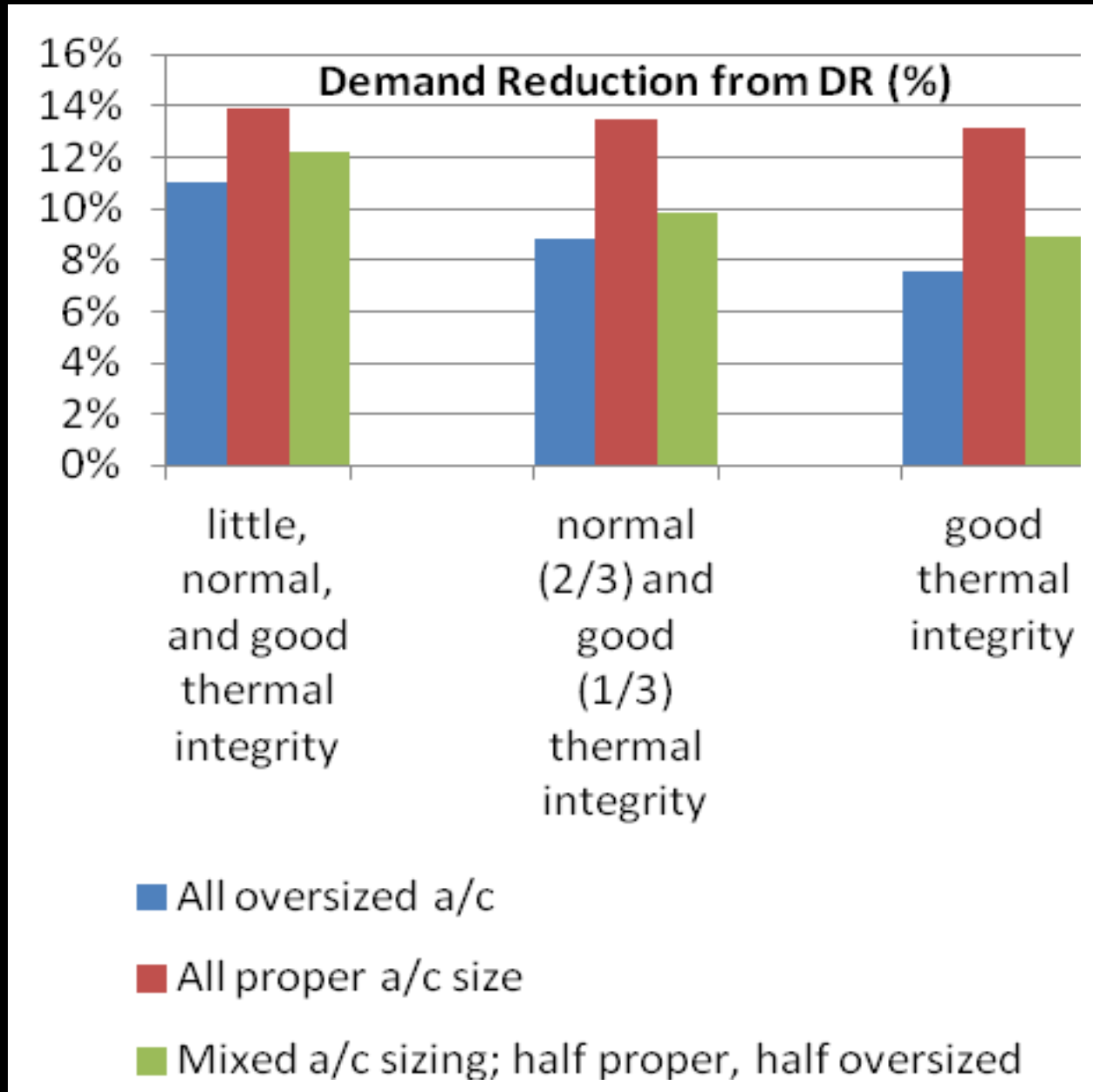

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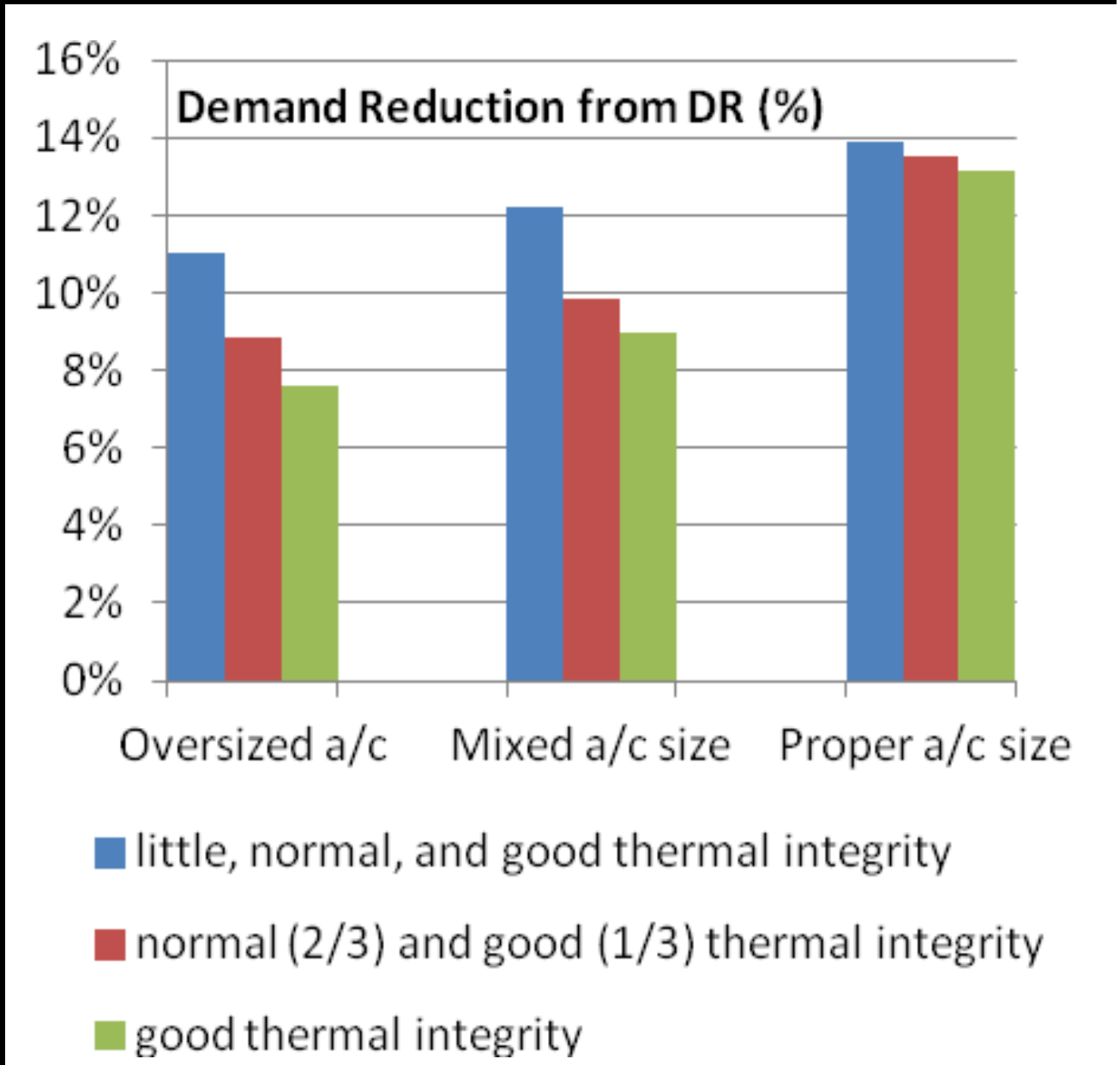
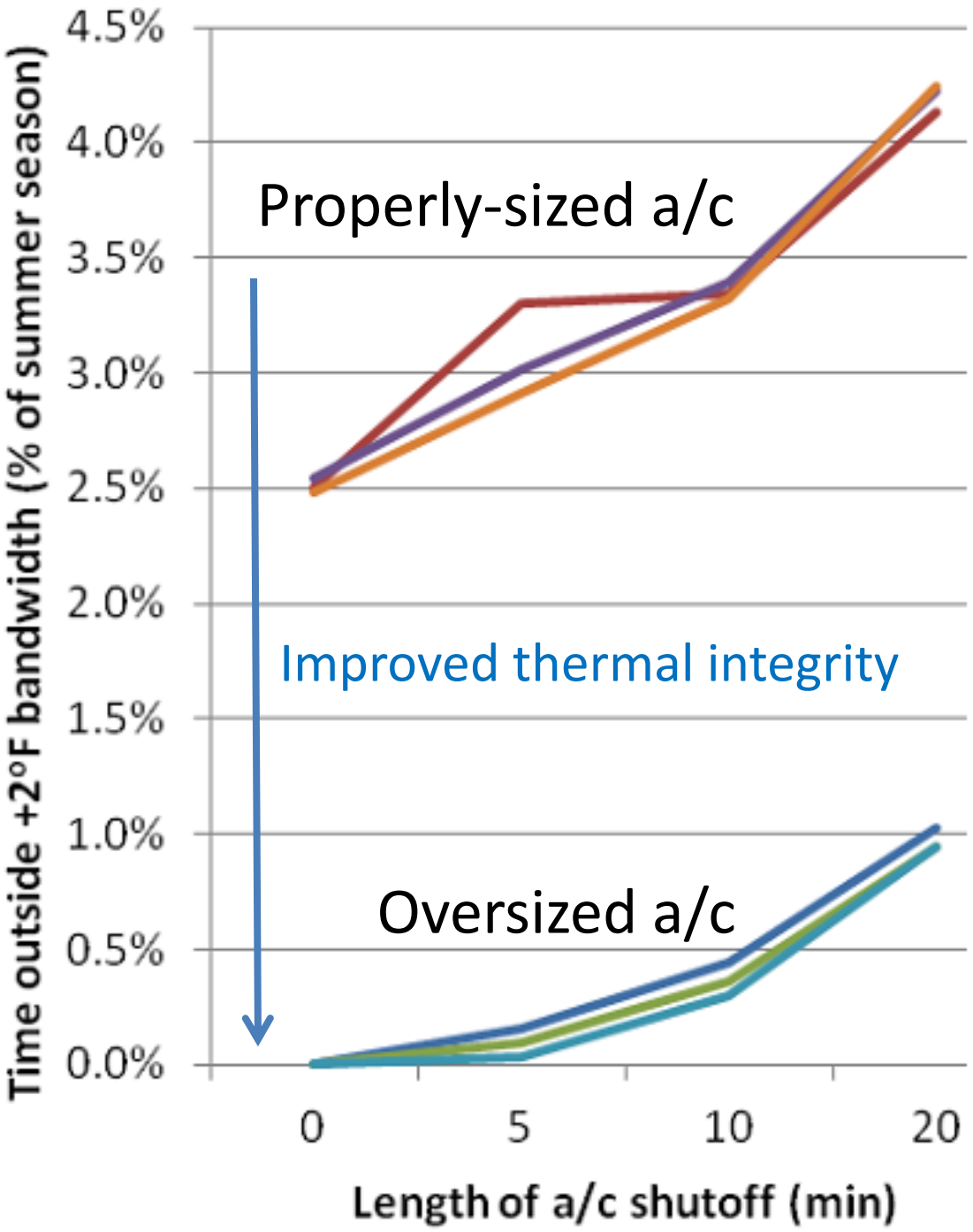


Effect of demand response event on seasonal time outside a/c design bandwidth



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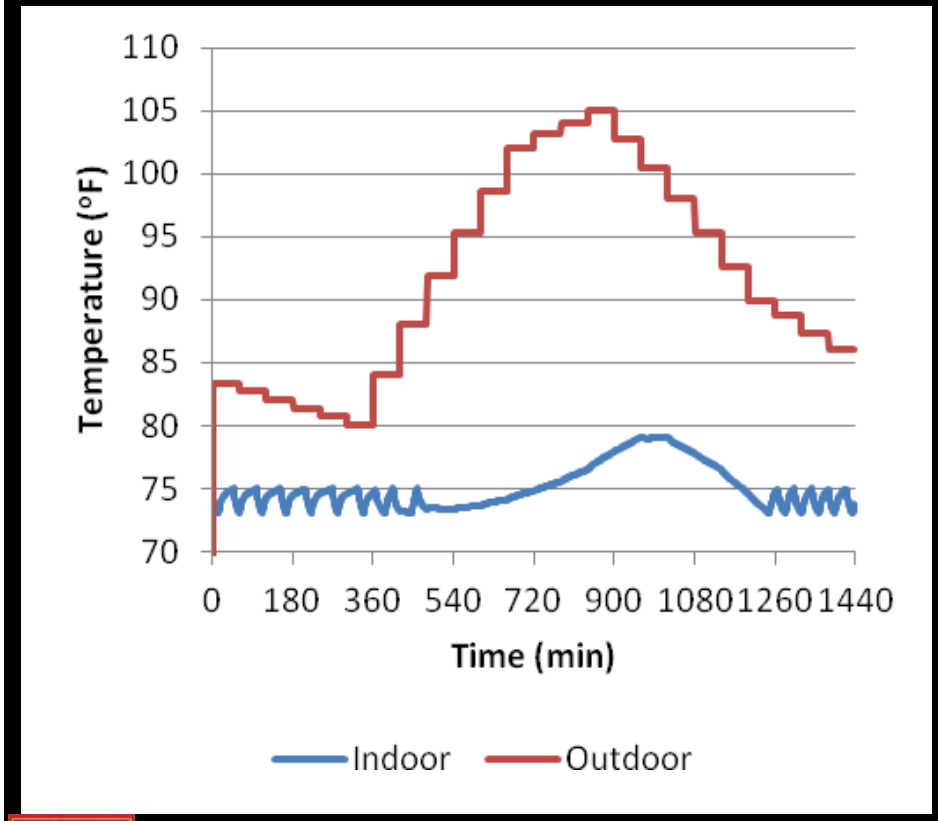
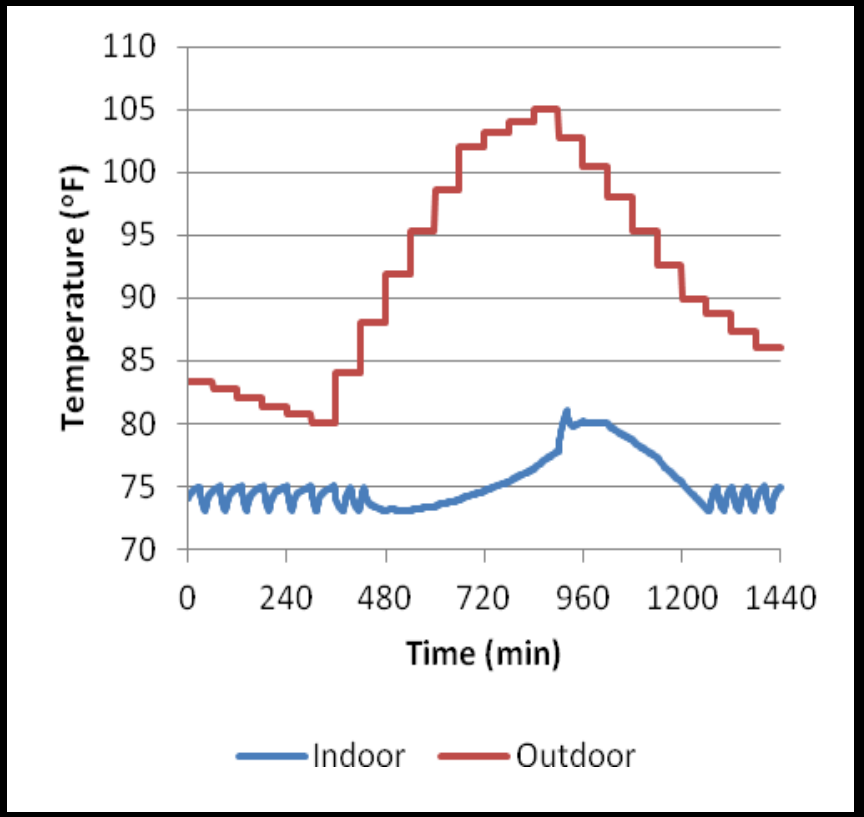
. Indoor and outdoor temperatures
hottest (105°F) summer day
good thermal integrity
properly-sized a/c.

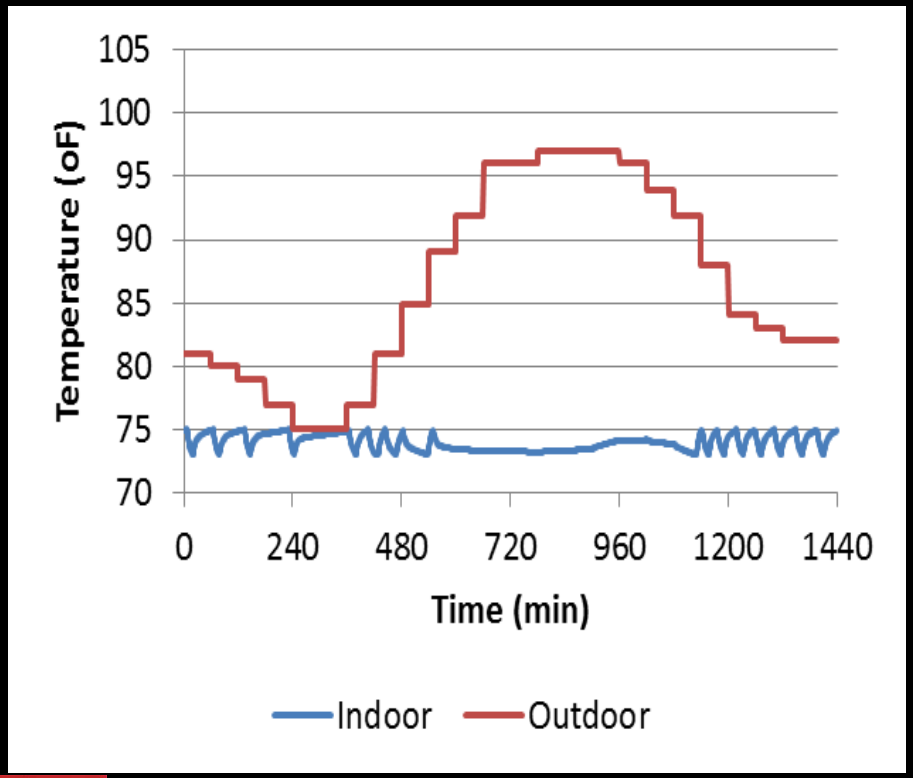


No demand response event

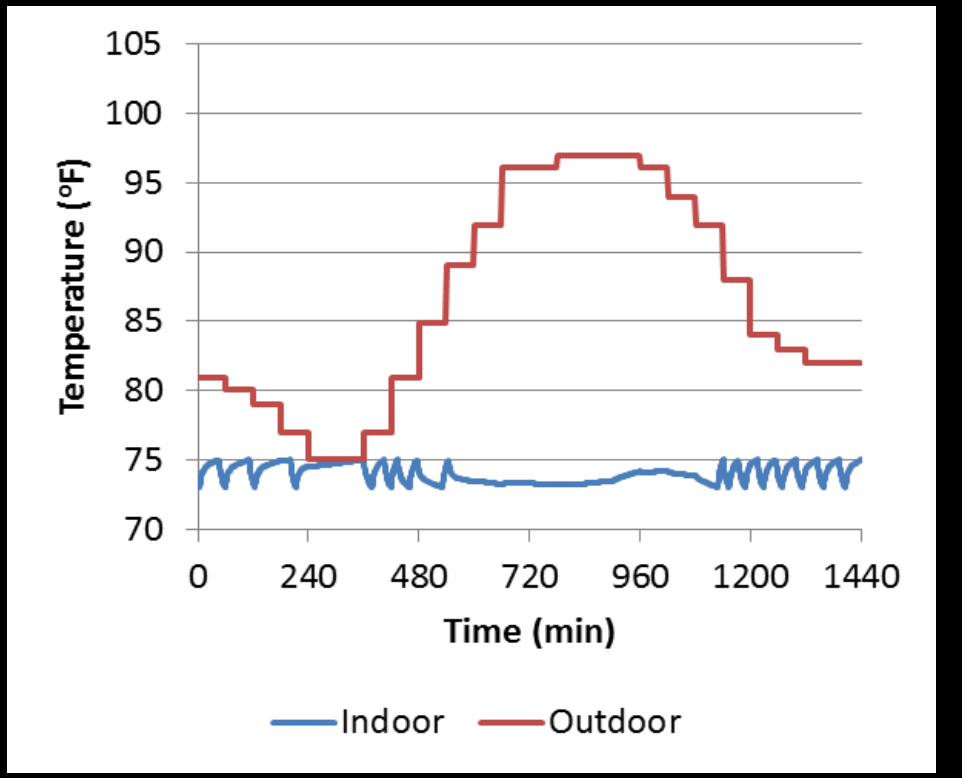


20 minute a/c cycling

. Indoor and outdoor temperatures cooler (97°F) summer day good thermal integrity properly-sized a/c.

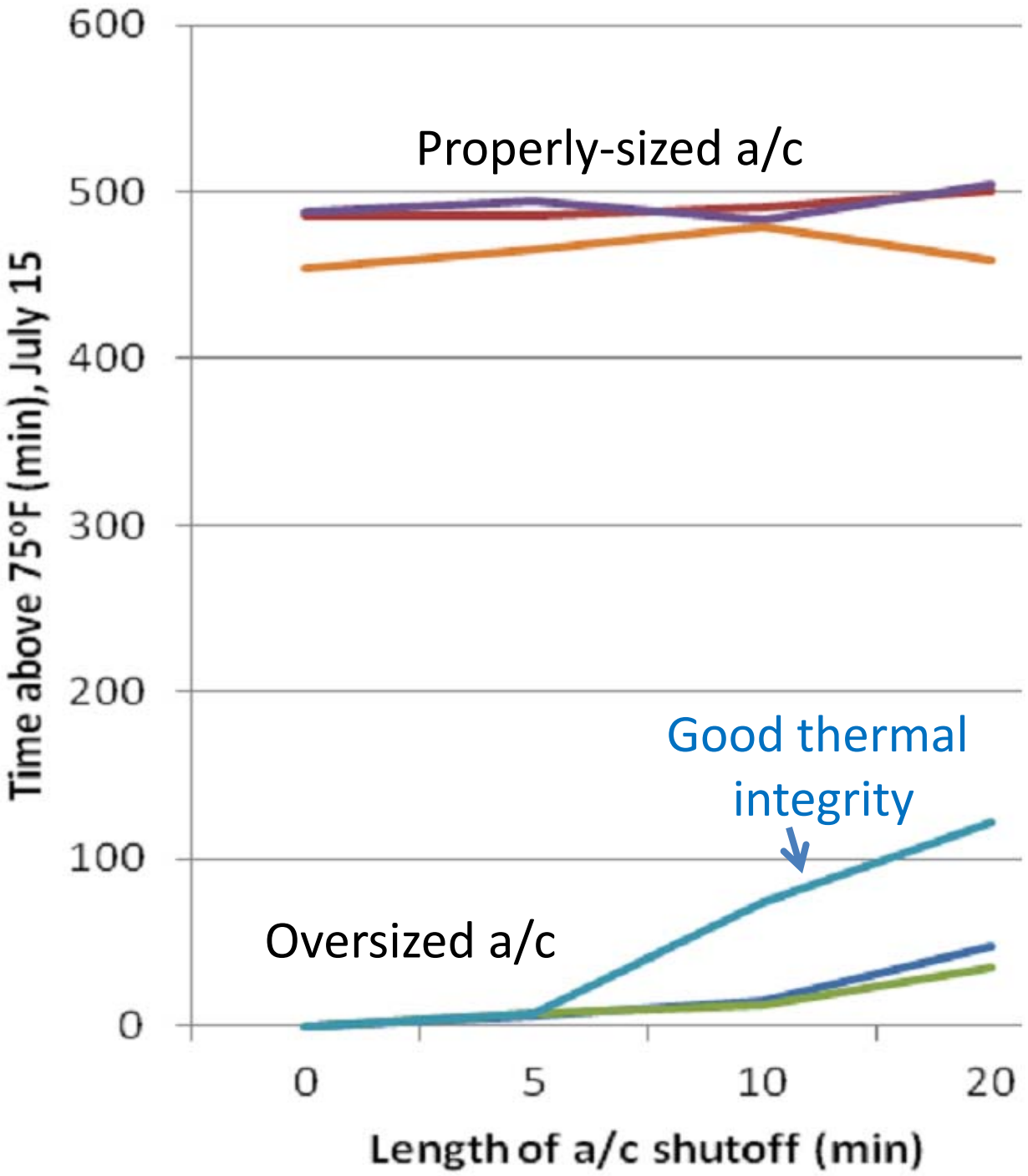


No demand response event

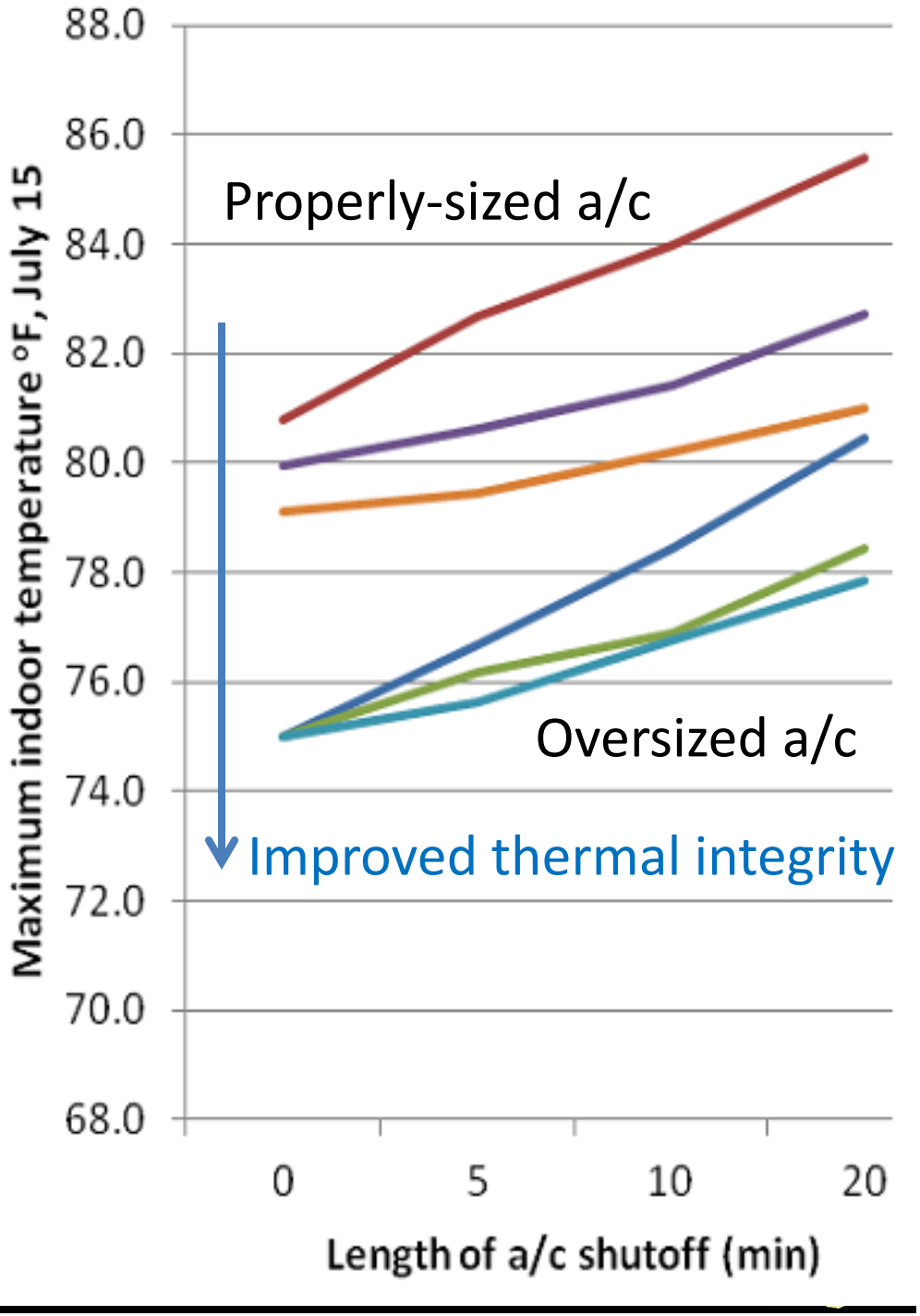


20 minute a/c cycling

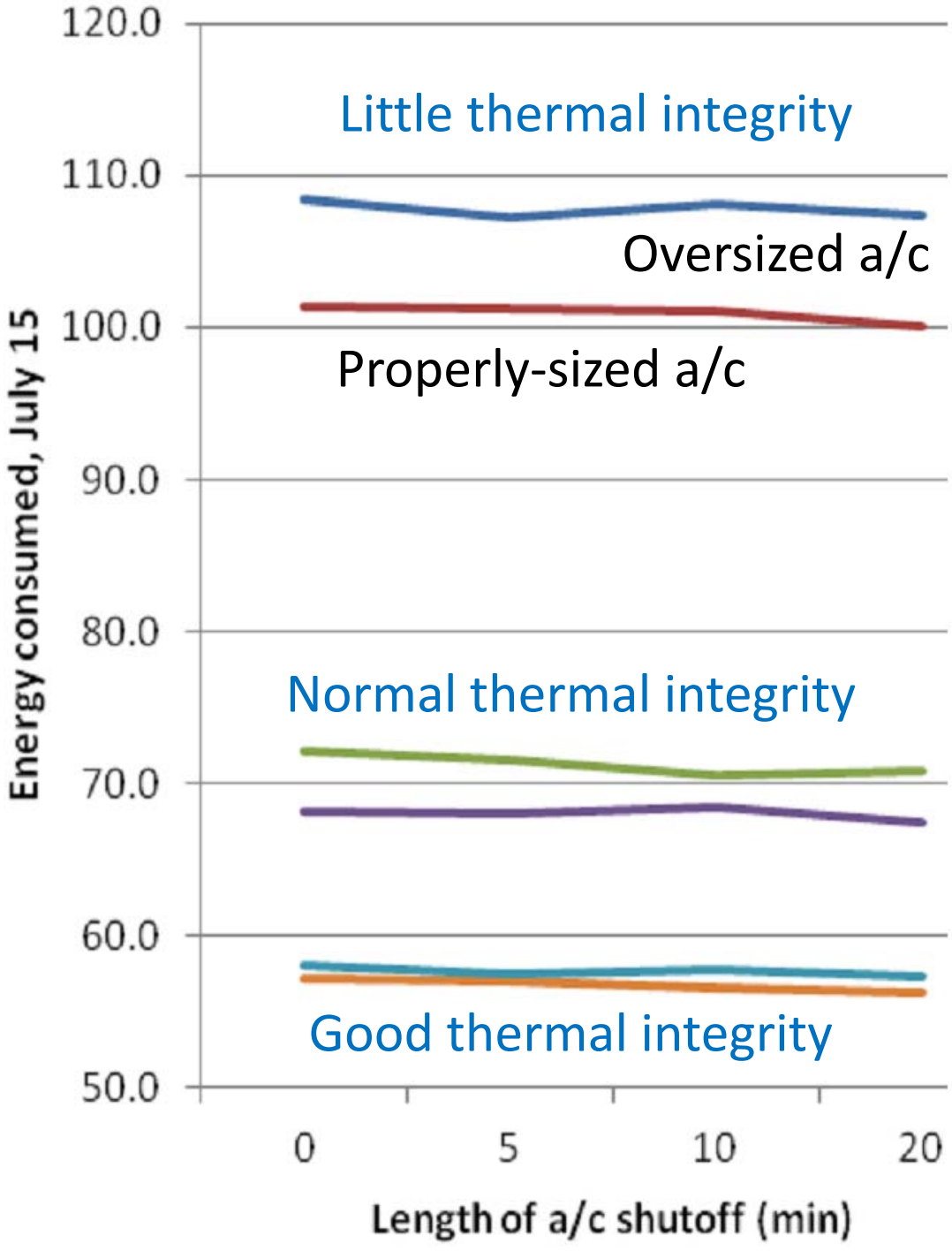
Effect of demand response program on time above 75°F, peak summer cooling day



Effect of demand response program on maximum indoor temperature, peak summer cooling day



Effect of demand response program on residential energy use, peak summer cooling day



Conclusions

- Demand response degrades occupant comfort
- Longer events produce worse occupant comfort
- Results vary significantly with thermal integrity and a/c size
- Changes to occupant comfort may affect participation
- Changes to a/c size and thermal integrity by participants in a demand response program will change available demand reduction.
- Thermal integrity and a/c size should be considered in the design of demand response programs.