VAV Systems

Design, Performance and Commissioning Issues

Load Dynamics – Load Side

Instructor:

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Senior Engineer

Facility Dynamics Engineering

March 7, 2018

Load Varies A Lot

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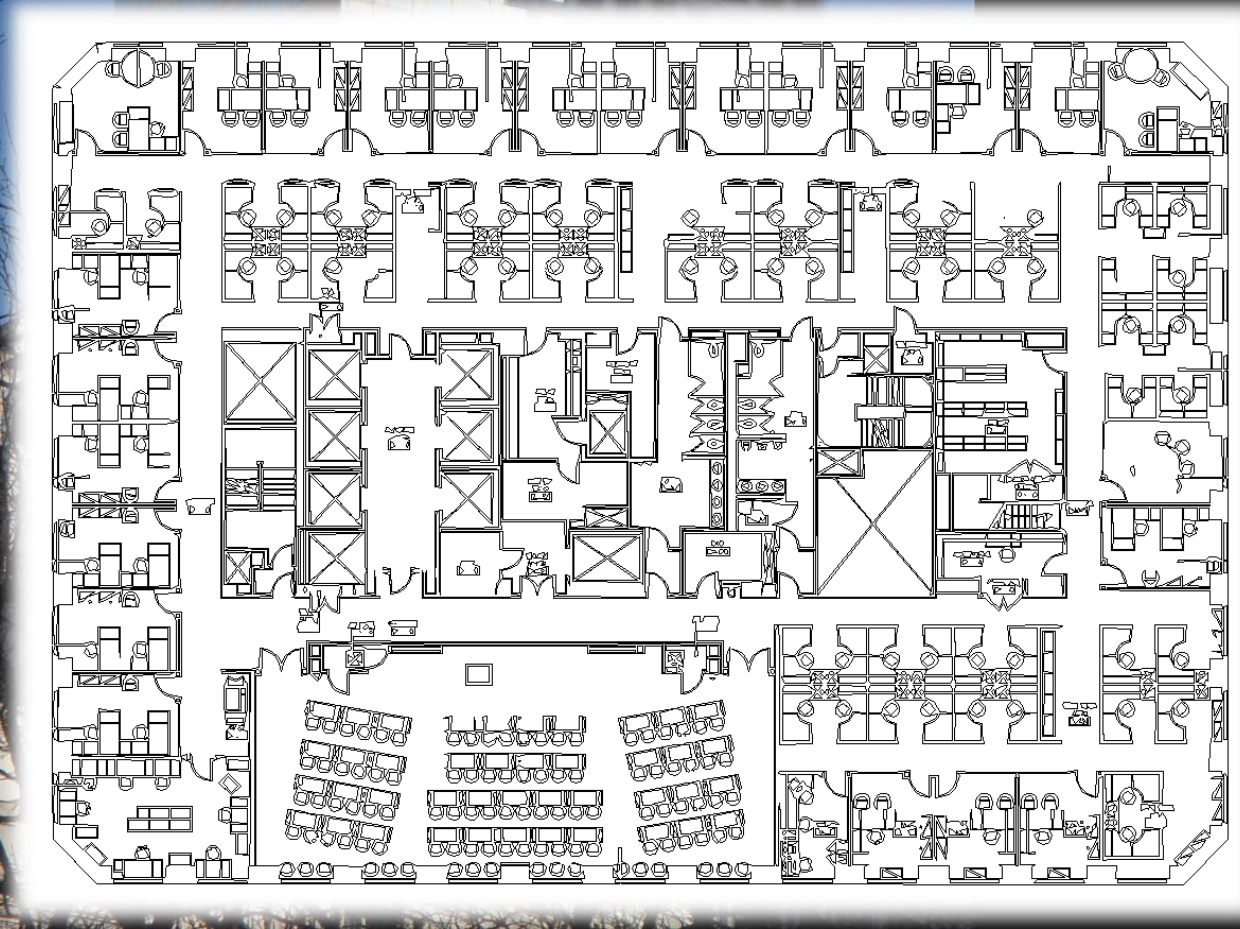

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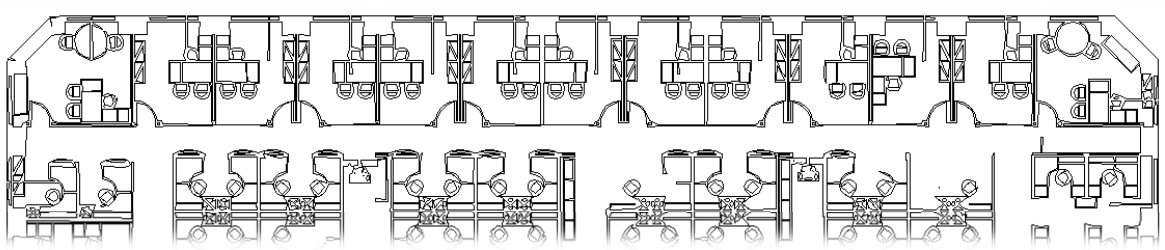
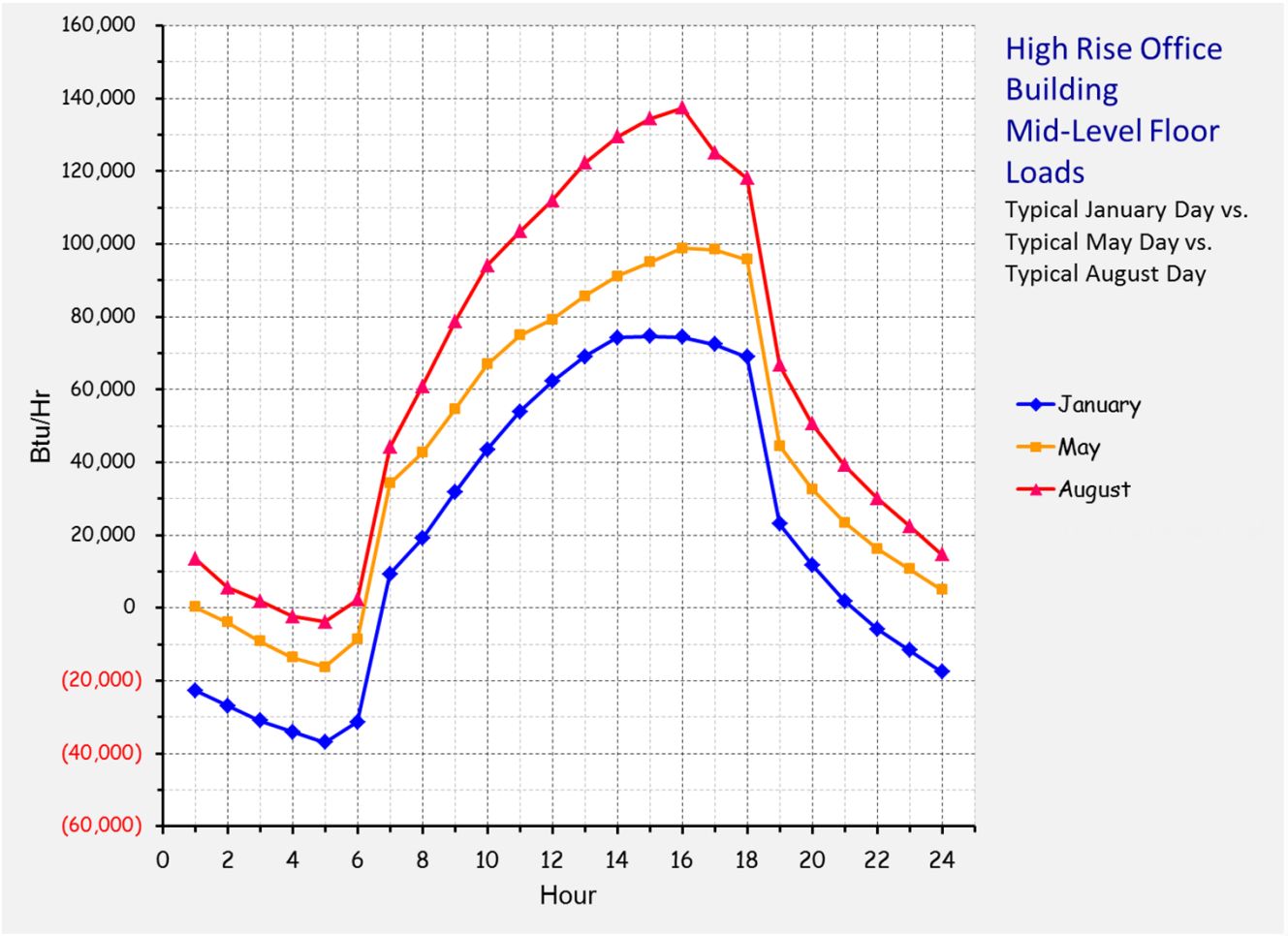




The Cooling Requirements Vary with Time of Day and Time of Year

Load Dynamics

A Research Experiment by the FDE NW Research Lab

Dr. Riley Sellers; PhD CTK *LBNL CTPSC* *

Hobbes Sellers; Post Doc *Applied Chaos Theory*

* Doctorate of Philosophy - Canine Treat Kinetics - Lower Buchanan National Labs, Canine Treat Preservation Systems Center

Outside = Inside

A Research Experiment by the FDE NW Research Lab

The Experiment

- Use an environmental test chamber to assess the thermal response characteristics of different envelope configurations

Environmental Test Chamber

Outside = Inside

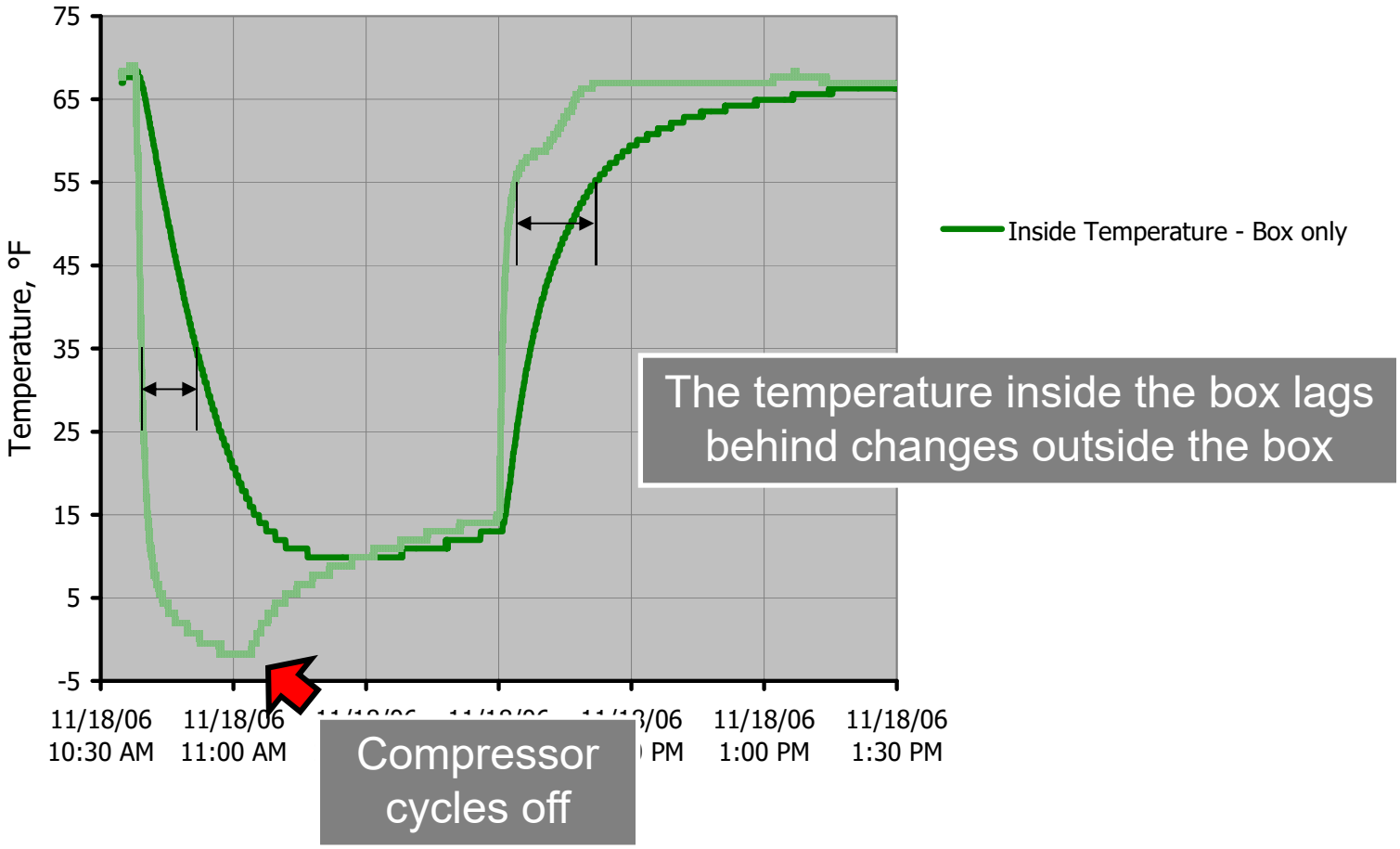
A Research Experiment by the FDE NW Research Lab

Envelope Configuration 1

- Cardboard box, no insulation

Envelope Configuration 1

Test Results – Envelope Configuration 1



Outside = Inside

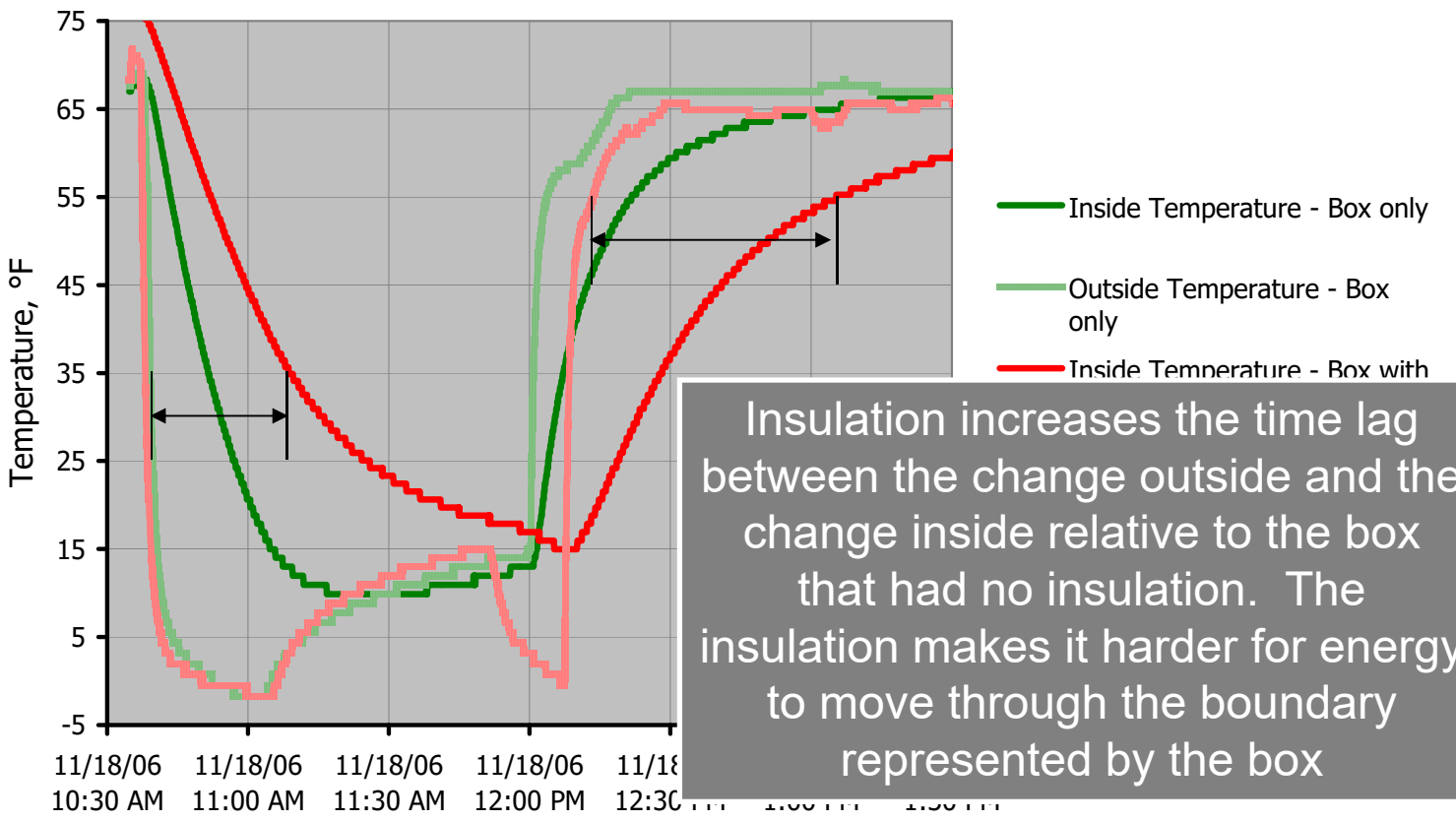
A Research Experiment by the FDE NW Research Lab

Envelope Configuration 2

- Cardboard box, insulated

Envelope Configuration 2

Test Results – Envelope Configuration 2



Insulation increases the time lag between the change outside and the change inside relative to the box that had no insulation. The insulation makes it harder for energy to move through the boundary represented by the box

Outside = Inside

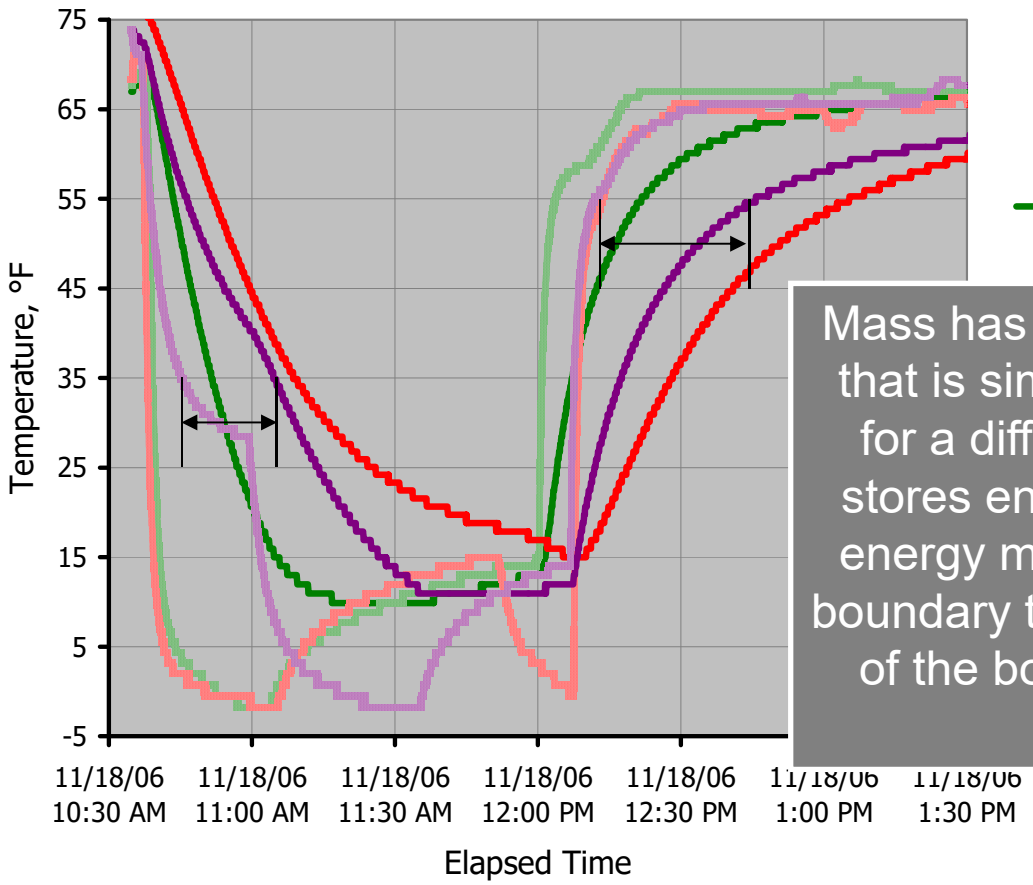
A Research Experiment by the FDE NW Research Lab

Envelope Configuration 3

- Cardboard box with rocks, no insulation

Envelope Configuration 3

Test Results – Envelope Configuration 3



Mass has an impact on the time lag that is similar to the insulation, but for a different reason. The mass stores energy, which means more energy must move across the box boundary to change the temperature of the box, all other things being equal

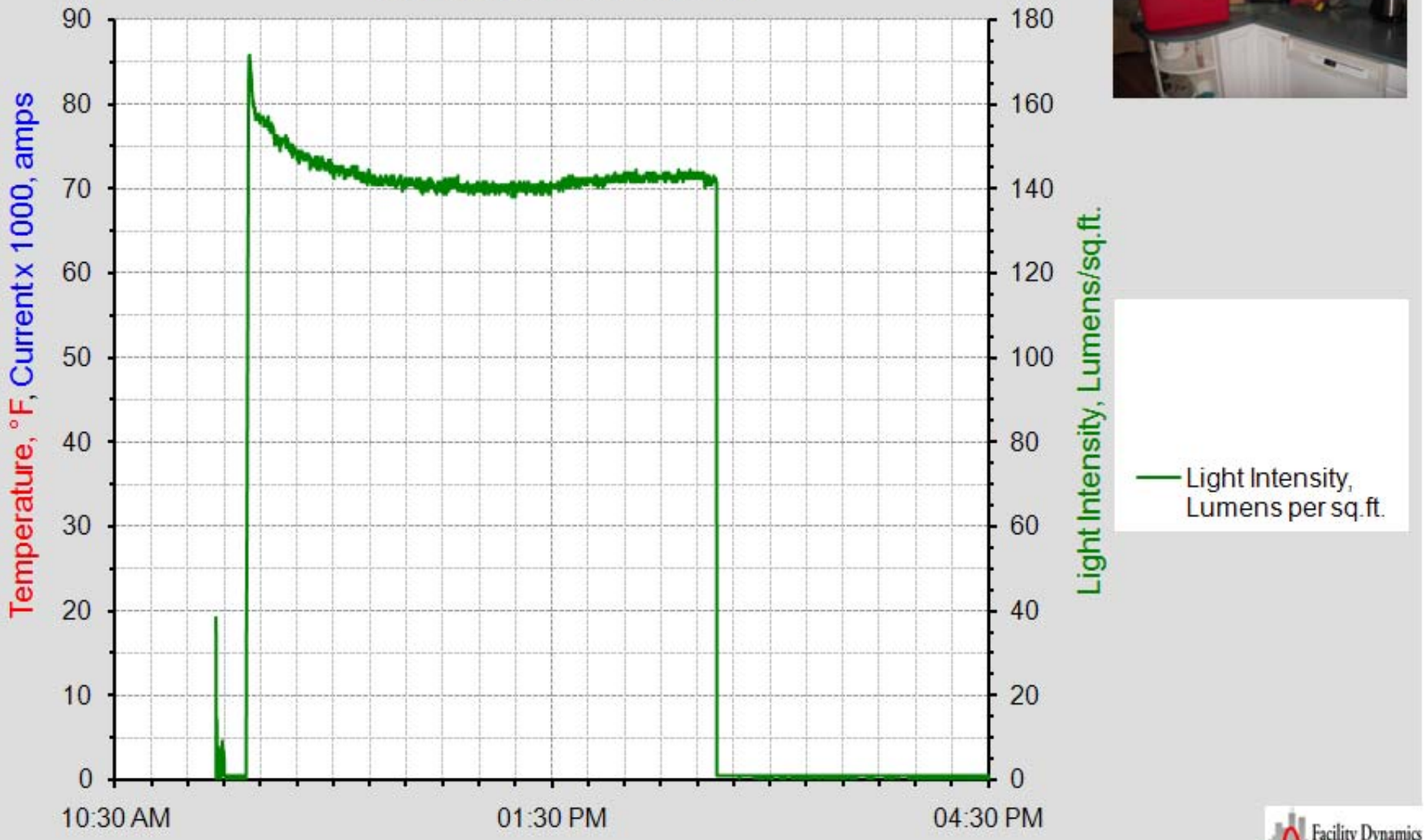
Internal Gains Have Lags Too


onset
HOBO


GEORGIA O'KEE
MORNING GLORY WITH
THE CLEVELAND MUSEUM
Cuisinart

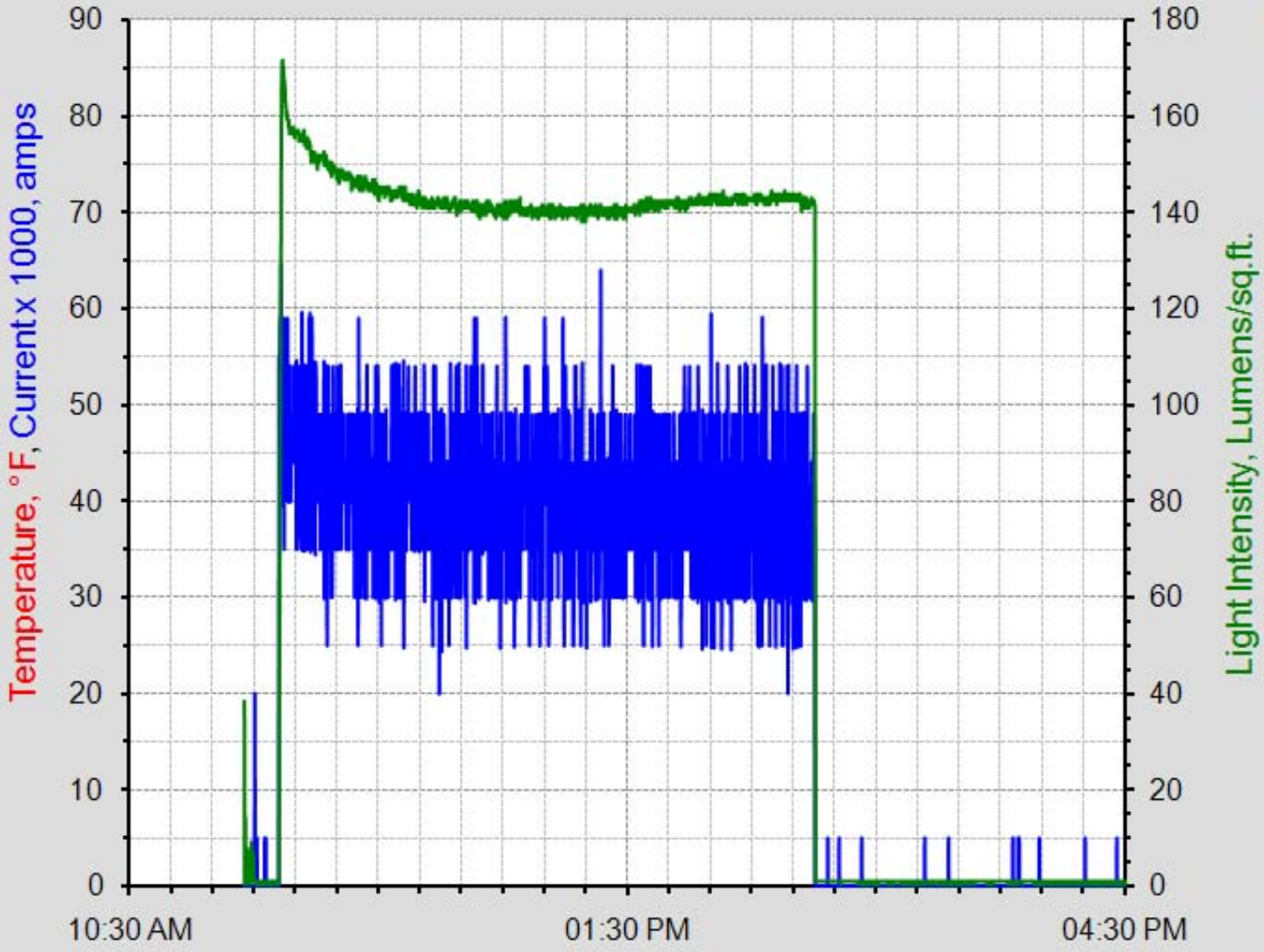
Temperature Inside an Insulated Enclosure

With and Without a Light On



Temperature Inside an Insulated Enclosure

With and Without a Light On

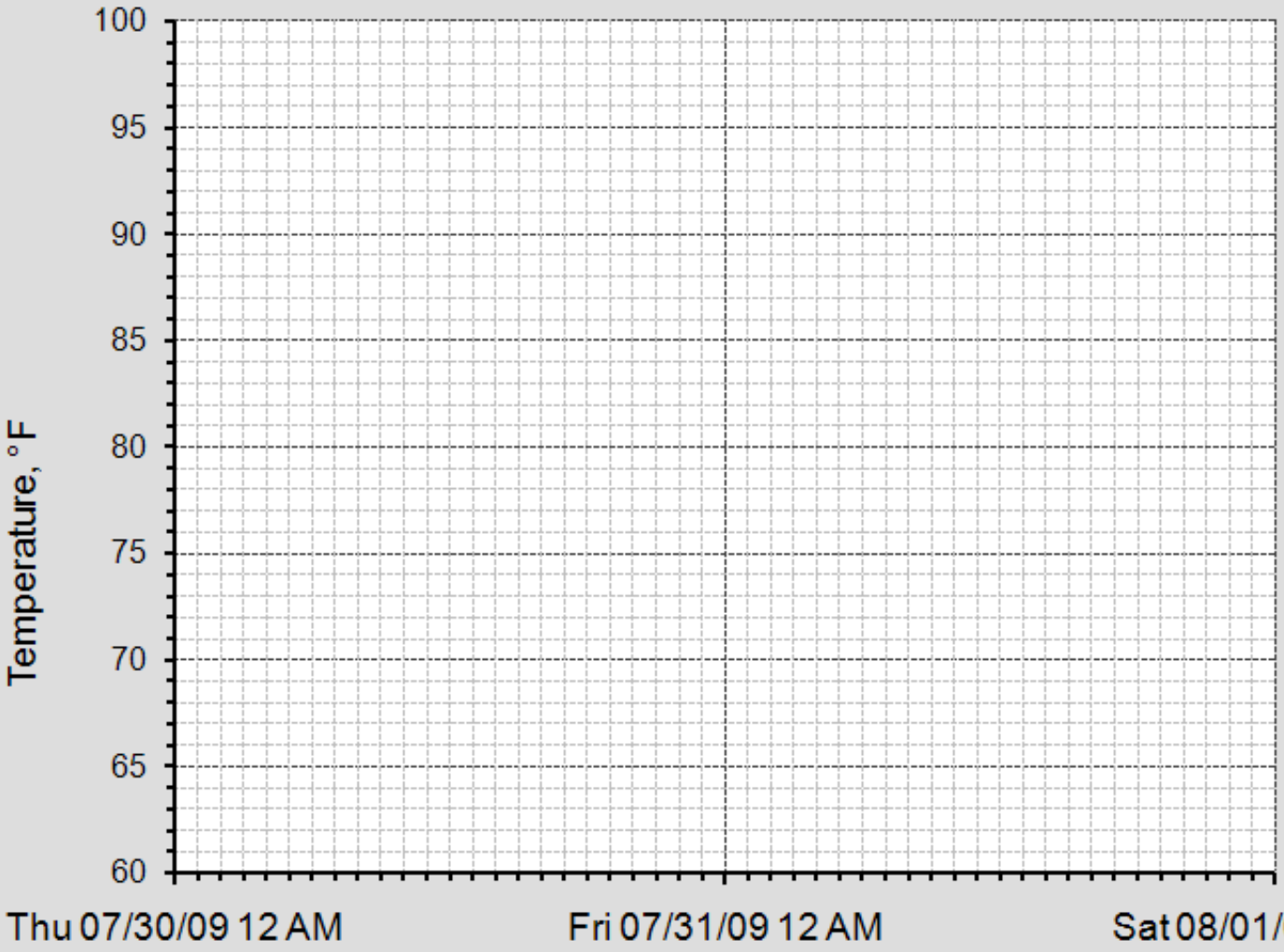


Even though power is consumed and light is produced instantaneously when the light is turned on, the temperature rise associated with the energy consumption lags the power consumption and light production

Everything Interacts with Everything, Even in a Simple Building

8560 North Buchanan, Portland, OR Summer Thermal Response

Portand 0.4% Cooling Design Condition - 90/67 °Ft_{db}/t_{wb}, 22°F Daily Range



Single story, light frame construction
Poured concrete basement
No air conditioning
Doors and windows open
Ceiling fans operating

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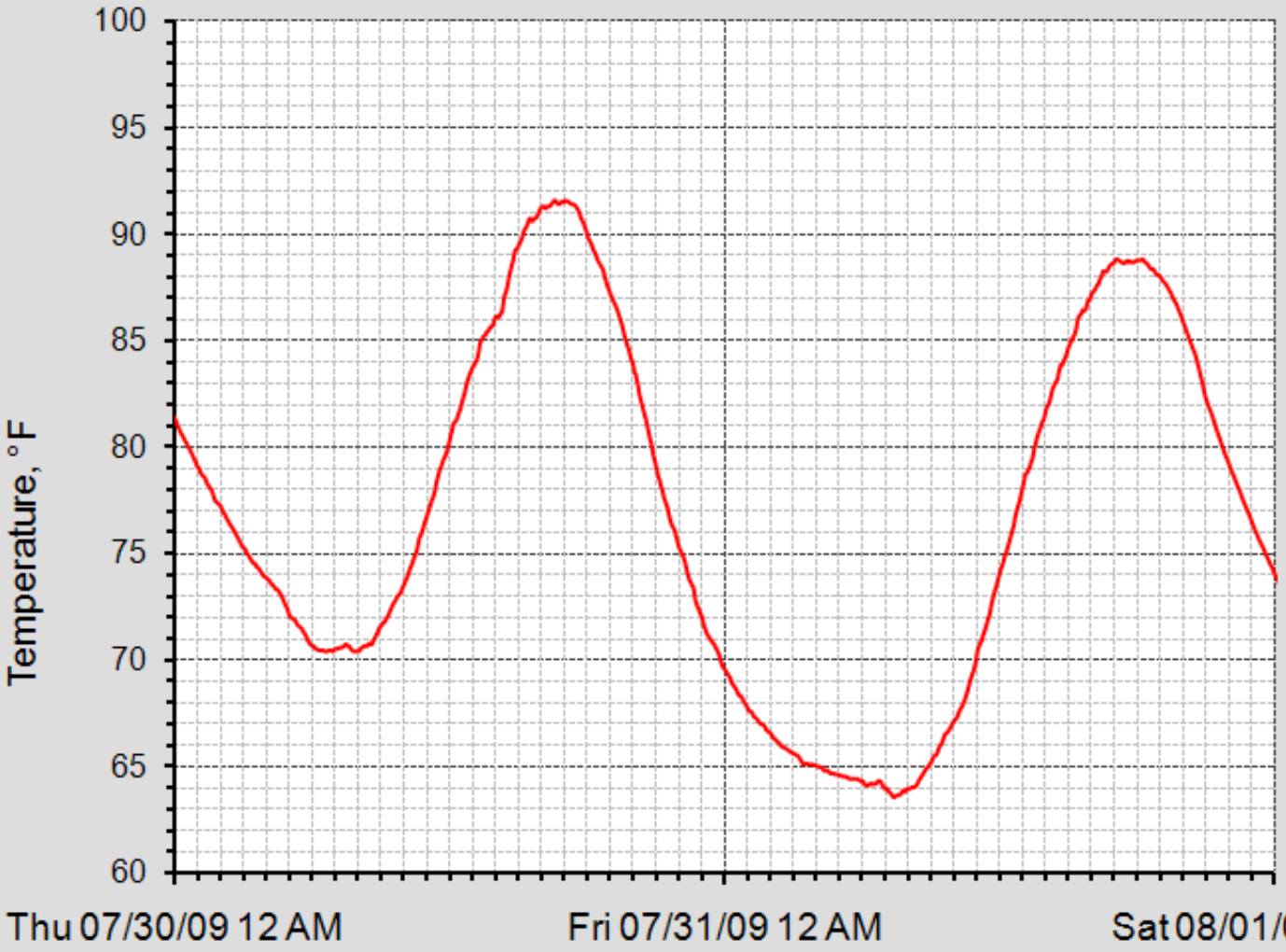
Portand 0.4% Cooling Design Condition - 90/67 °Ft_{db}/t_{wb}, 22°F Daily Range



Single story, light frame construction
Poured concrete basement
No air conditioning
Doors and windows open
Ceiling fans operating

Outdoor Temp.; North Side

8560 North Buchanan, Portland, OR Summer Thermal Response

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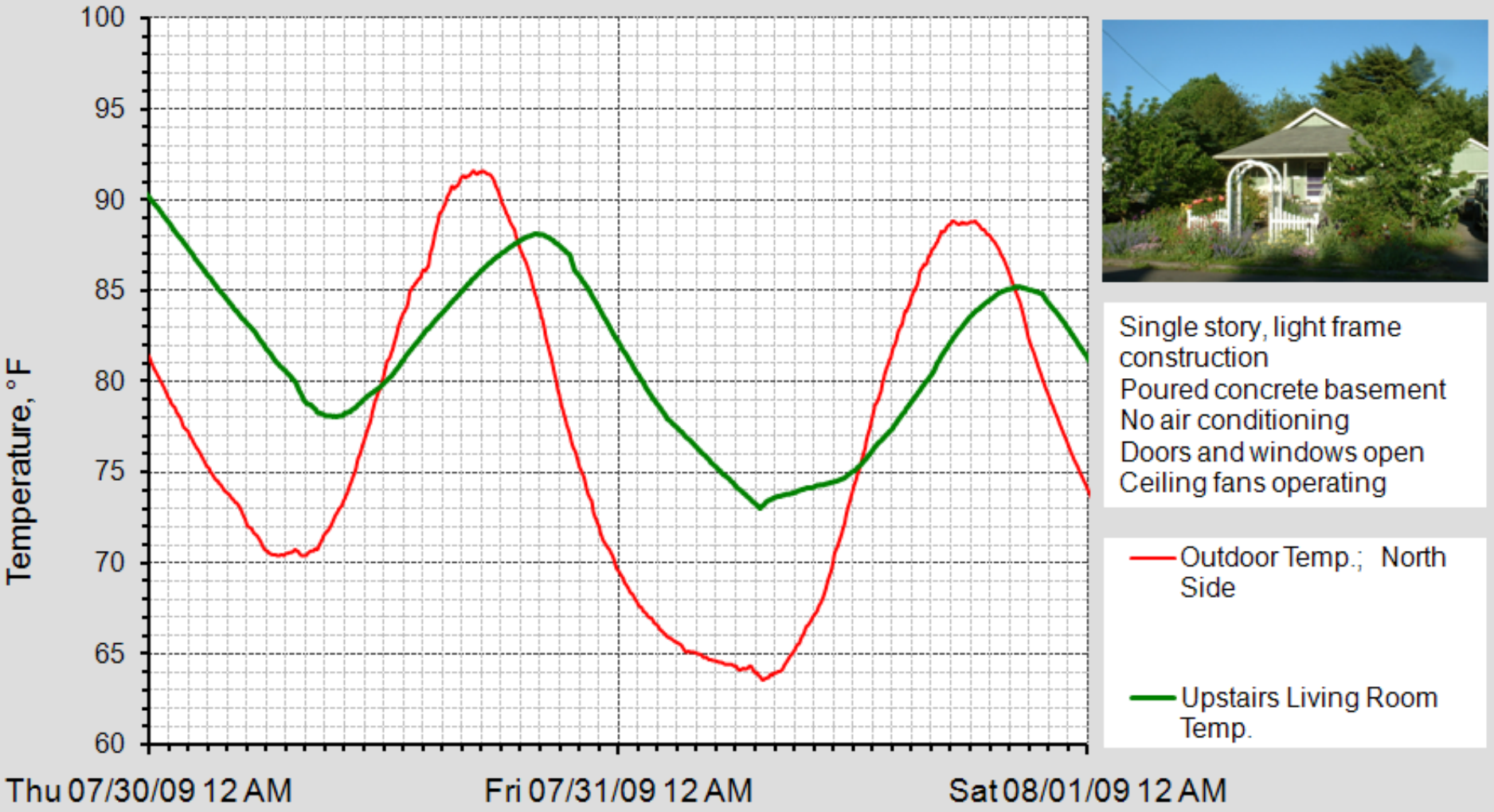


Single story, light frame construction
Poured concrete basement
No air conditioning
Doors and windows open
Ceiling fans operating

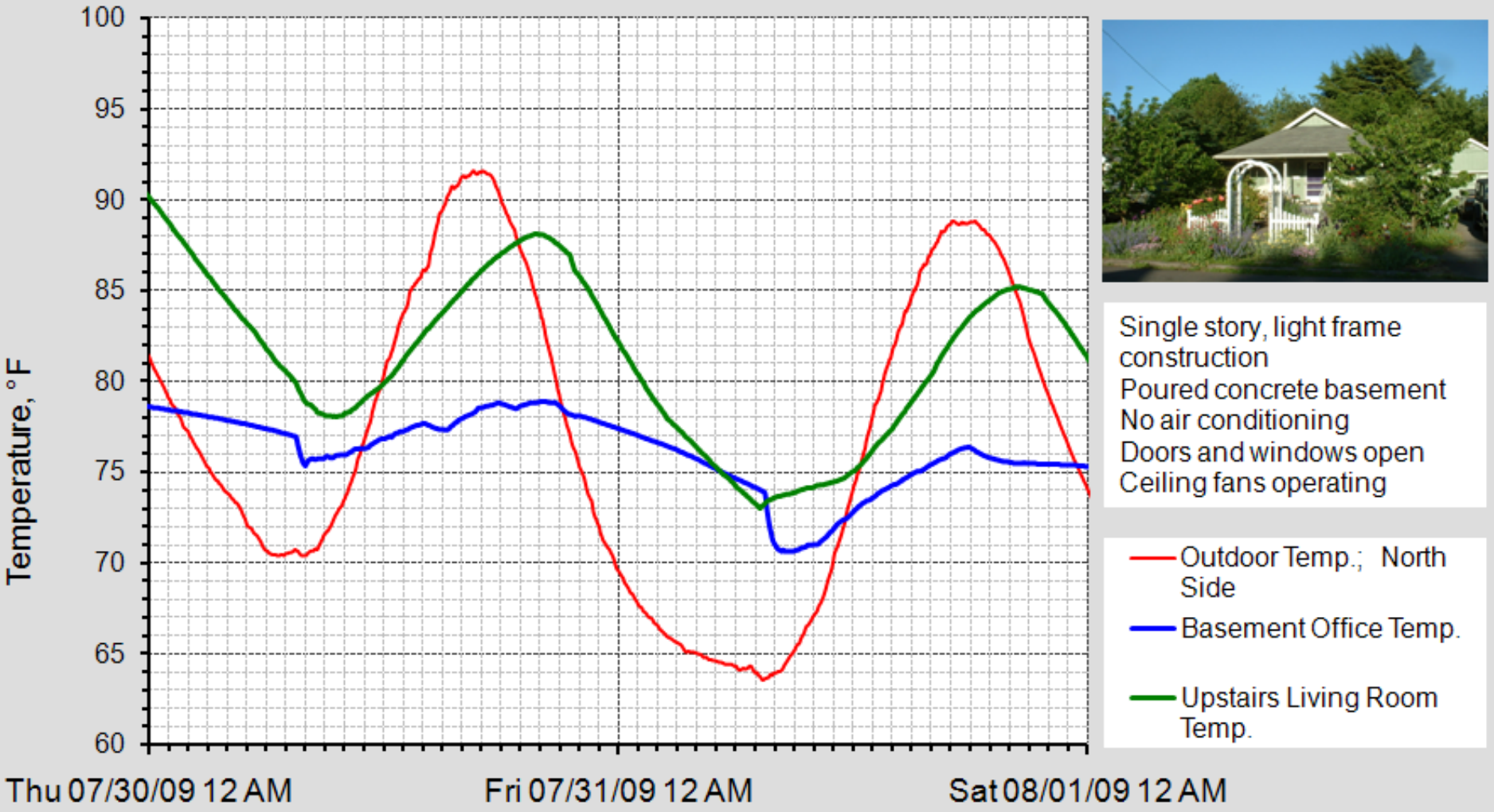
Outdoor Temp.; North Side

Upstairs Living Room Temp.

Facility Dynamics Engineering

8560 North Buchanan, Portland, OR Summer Thermal Response

Portand 0.4% Cooling Design Condition - 90/67 °Ft_{db}/t_{wb}, 22°F Daily Range

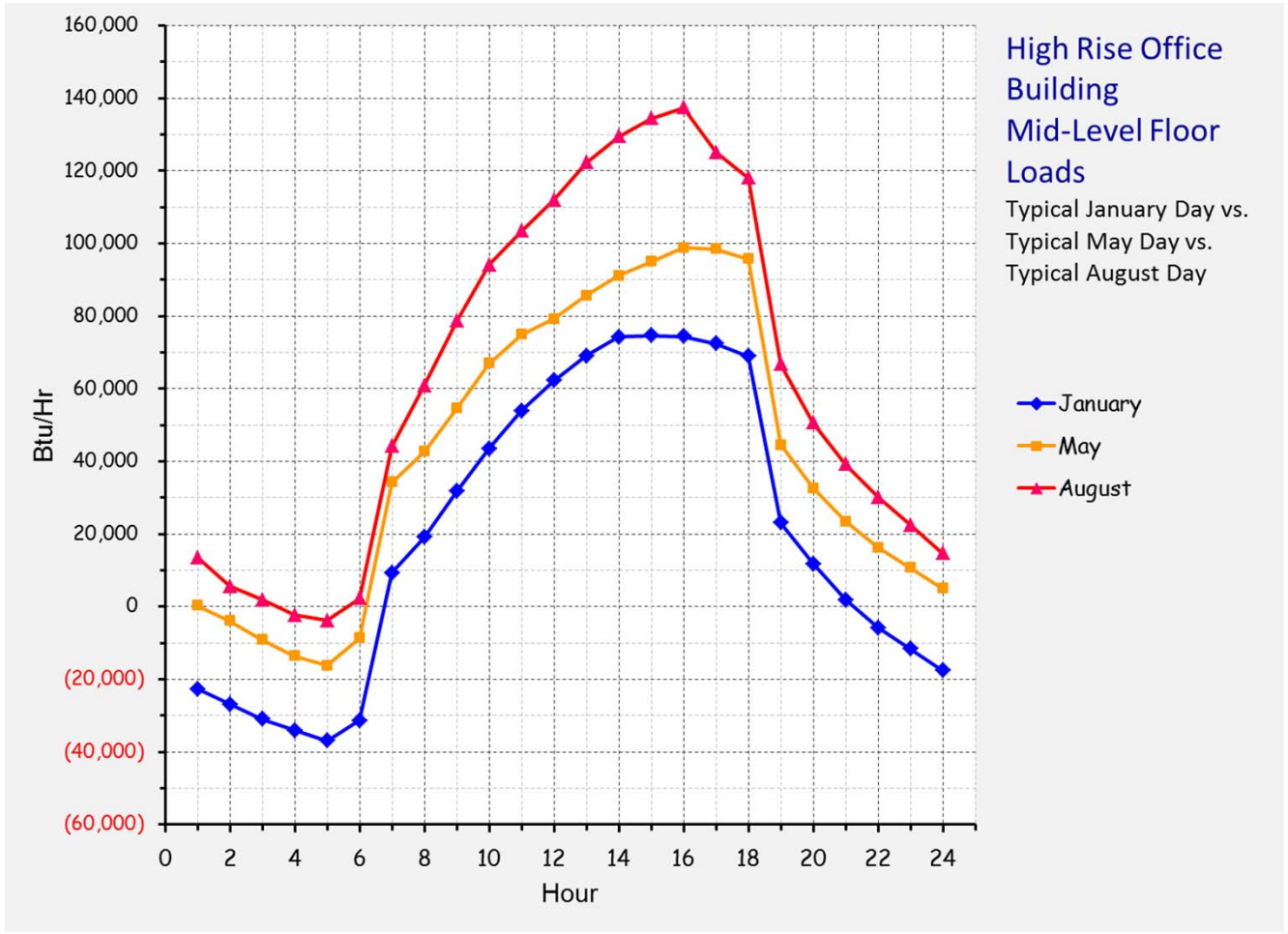


Single story, light frame construction
Poured concrete basement
No air conditioning
Doors and windows open
Ceiling fans operating

- Outdoor Temp.; North Side
- Basement Office Temp.
- Upstairs Living Room Temp.

Match the System Flow Rate to the Load

Simple in Concept; Challenging in Reality



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