Landcare Research
Manaaki Whenua

Design versus Performance: Lessons from monitoring an energy-efficient commercial building in operation

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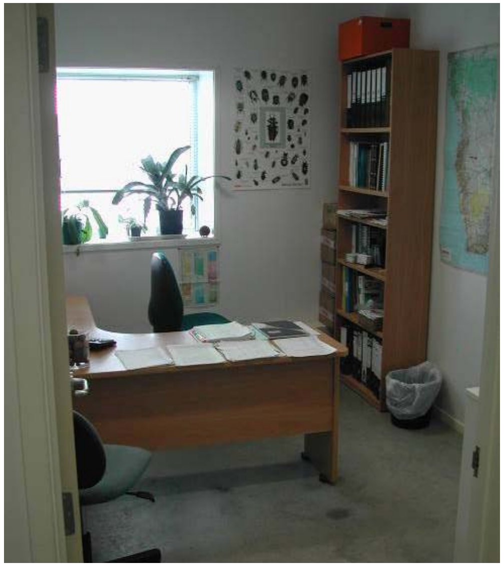
What is inside the Landcare Research Building?



Offices

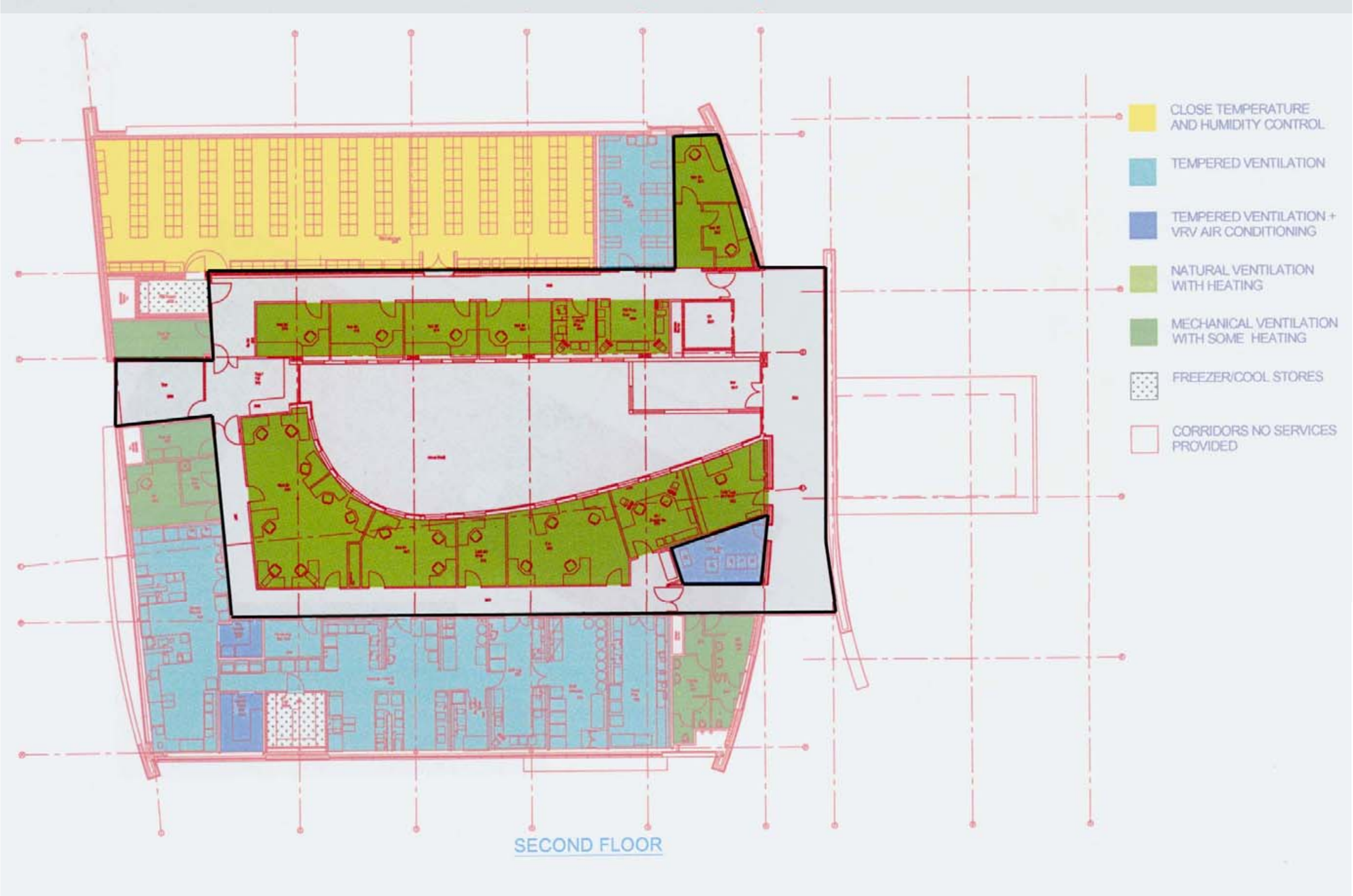
Climate-Controlled
Glasshouses

Laboratories

National
Collections

The design intends to reduce space conditioning energy by:

1. Targeted mechanical servicing automated with a BMS
2. Waste heat recovery
3. Maximising passive conditioning



The building has two simulated energy consumption benchmarks for comparison

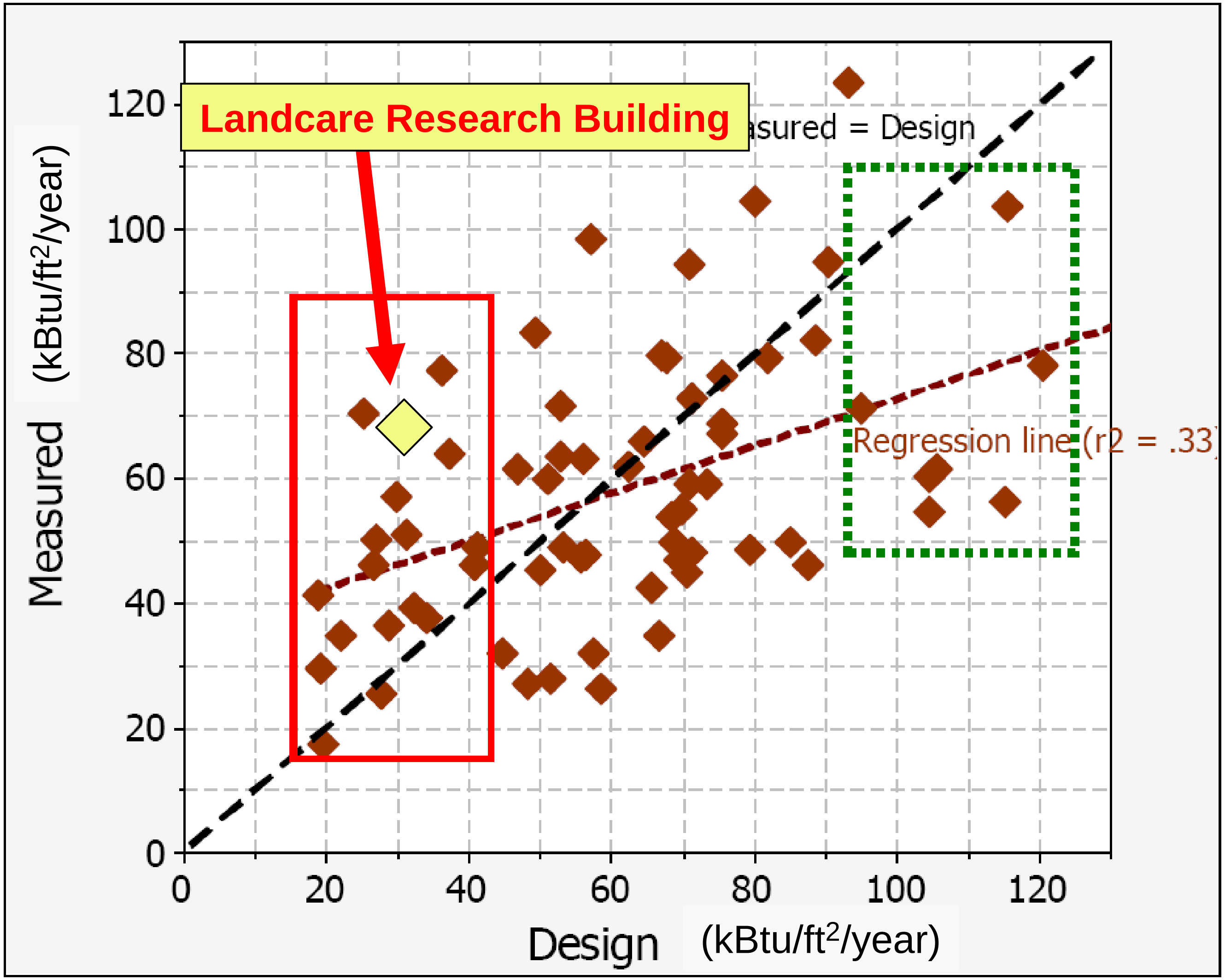
DESIGN ASPIRATION

1. E-20 design modelling software – 99 kWh/m^2/year
   - Operational schedule: NZS 4243:1996 – Office Building
   - Lighting = 10 W/m^2
   - Equipment & Plug = 5 W/m^2
   - Special Equipment Loads
     - Electron Microscope = 1.7 kW
     - Virology Machine = 2.25 kW

"CONVENTIONAL" BUILDING

2. Vale et al. (2006) – 257 kWh/m^2/year
   - Based on Australian Commonwealth building averages
     - Office Space: 256 kWh/m^2/year
     - Laboratories: 291 kWh/m^2/year
     - Climate controlled archives: 194 kWh/m^2/year

Energy performance in operation varies



Source (graphic): Turner and Frankel (2008)

Results – Overall building and comparable benchmarks

Building	Energy Use Intensity $kWh/m^2/yr$
Landcare (Tamaki) Building (design simulation)	99
Landcare (Tamaki) Building (model of conventional bldg) [a]	257
Landcare (Tamaki) Building (Year ending 26 October 2007)	197
Landcare (Tamaki) Building (Year ending 1 July 2008)	217

Building	Location	Energy Use Intensity $kWh/m^2/yr$
Landcare (Fleming) Building (Year Ending 1 July 2008)	Lincoln, NZ	171
Landcare (Palm Nth) Building (Year Ending 1 July 2008)	Palmerston North, NZ	170

COLOUR KEY

SIMULATED CONSUMPTION

MEASURED CONSUMPTION

Building	Location	Energy Use Intensity $kWh/m^2/yr$
Pharmacia Building Q [b]	Skokie, Illinois, USA	417
US EPA Region 7 Science/Technology Center [b]	Kansas City, Kansas, USA	855
Georgia Public Health Laboratory [b]	Decatur, Georgia, USA	1130

Sources: [a] Vale et al. (2006) [b] US Dept. of Energy (2008)

Baseload electricity is the key source of the energy consumption increase relative to expectations…

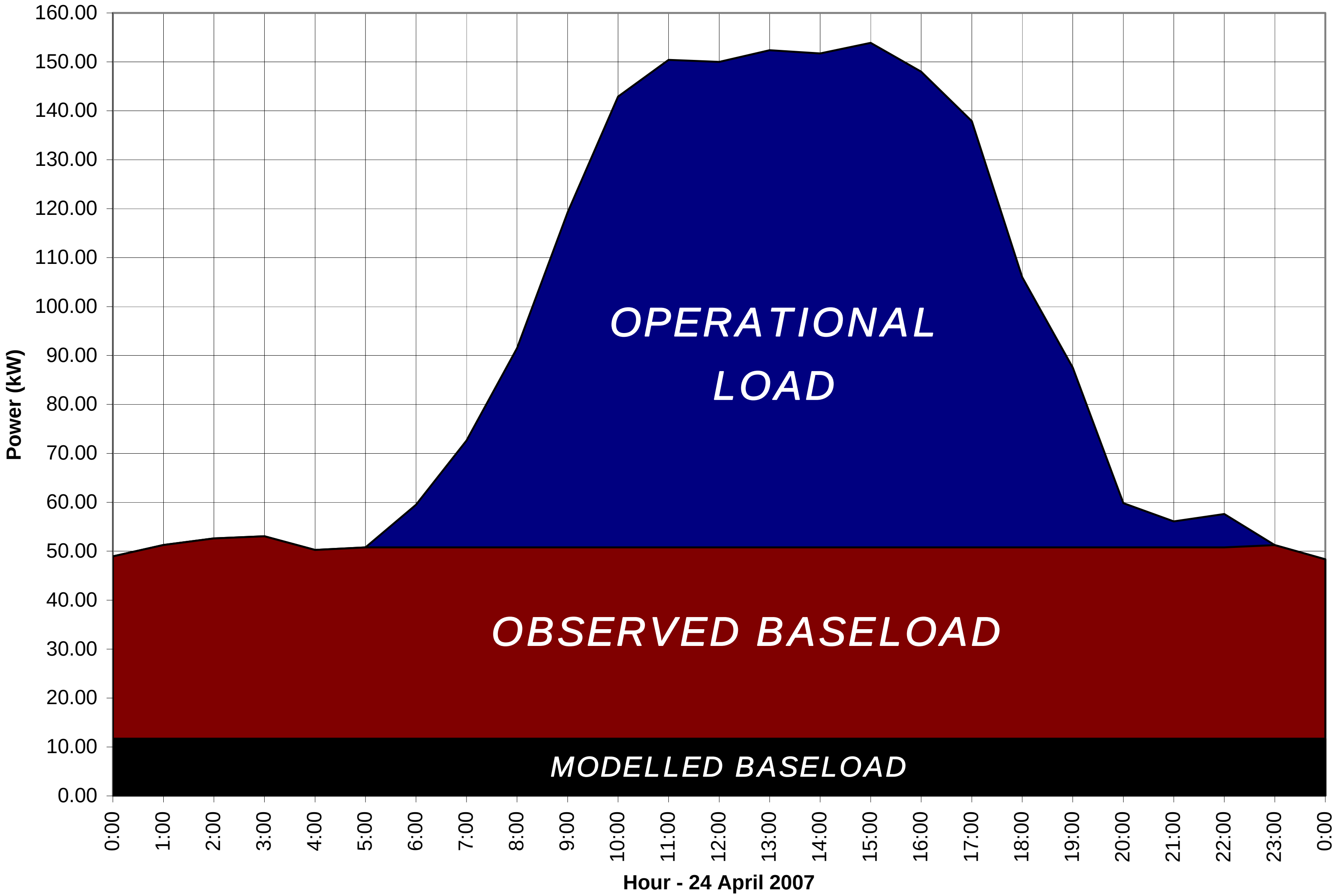
Year Ending	Total Energy Use Intensity	Gas	Operational Electricity	Baseload Electricity
Design Model	99	5 (Excludes hot water)	48–96 (seasonal)	**24**
1 July 2008	217	19	63	**135**

… and the cause of the continuing increase

Year Ending	Total Energy Use Intensity	Gas	Operational Electricity	Baseload Electricity
26 October 2007	197	20	63	**114**
1 July 2008	217	19	63	**135**

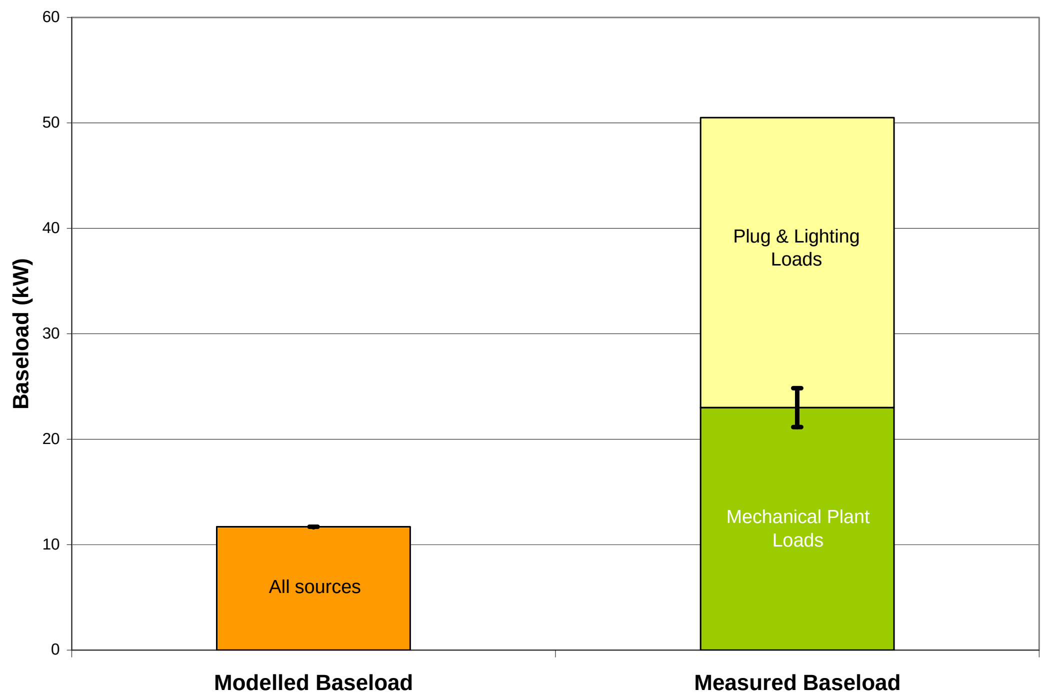
All units in $kWh/m^2/year$

Power Consumption - 24 April 2007



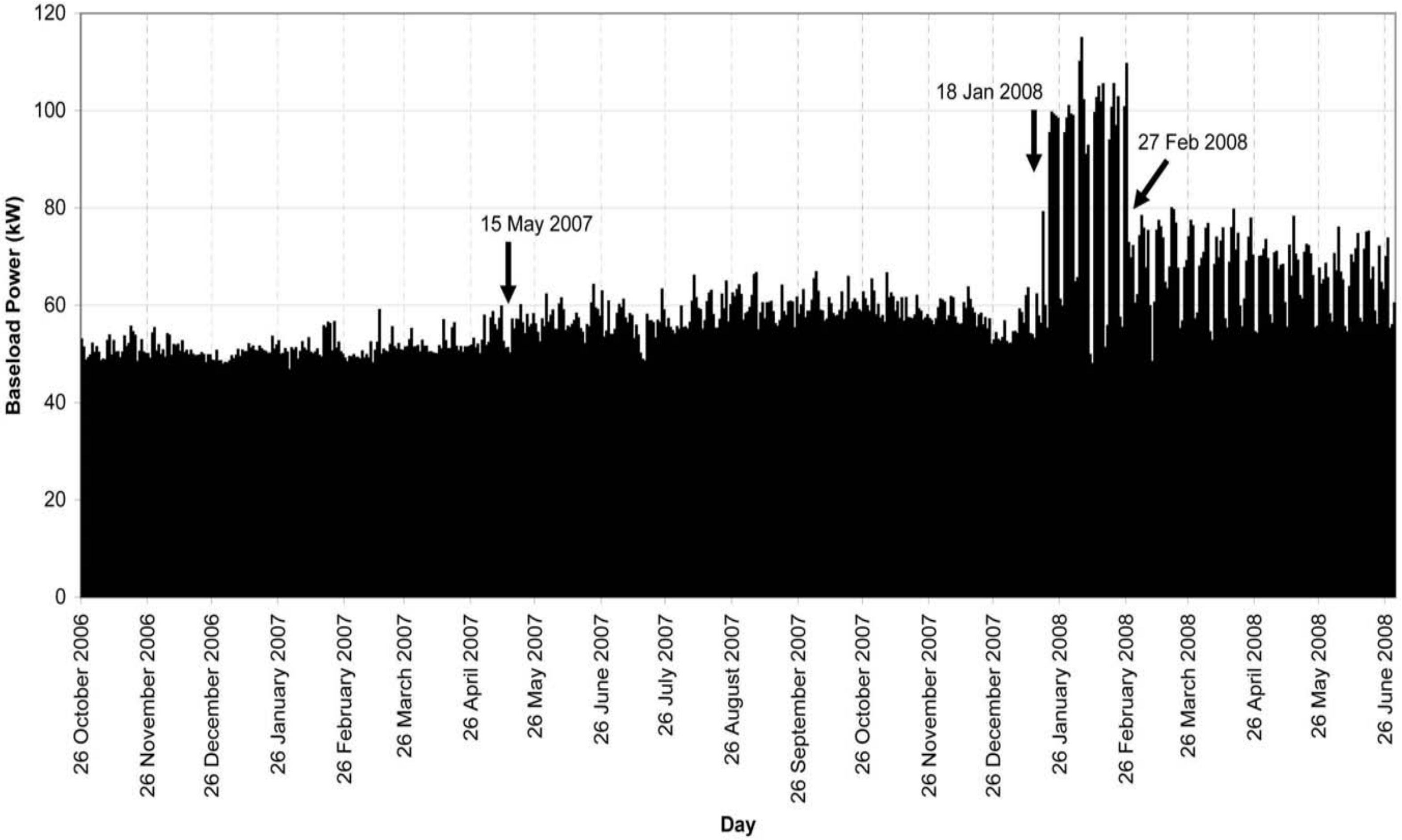
Key sources of the building's observed baseload

Source	Measured baseload* (kW)	% of total observed baseload
Plug and Lighting Loads	25-30	50-60%
Roof Mechanical Plant	21-25	40-50%
Design Expectation (whole-building)	11.7	



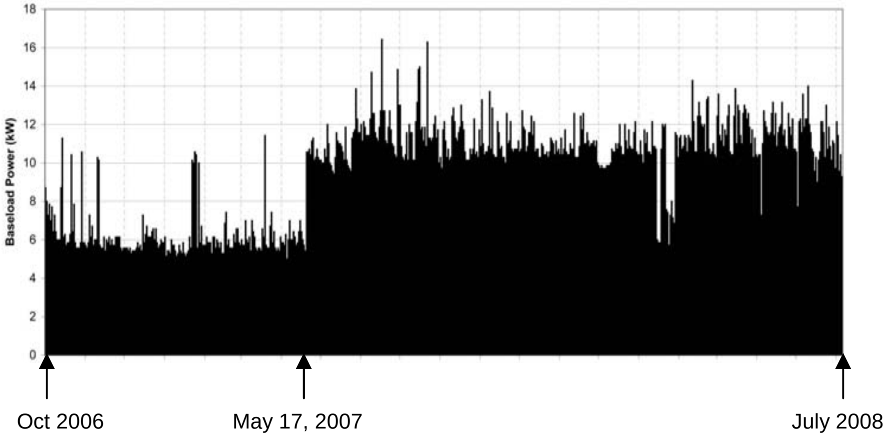
* Prior to 17 May 2007

Despite knowing that baseload energy consumption is unexpectedly high, it continues to increase



In May 2007, a complex piece of equpment was left powered “ON” as an economically rational decision…

Ground Floor Plug & Lighting Loads

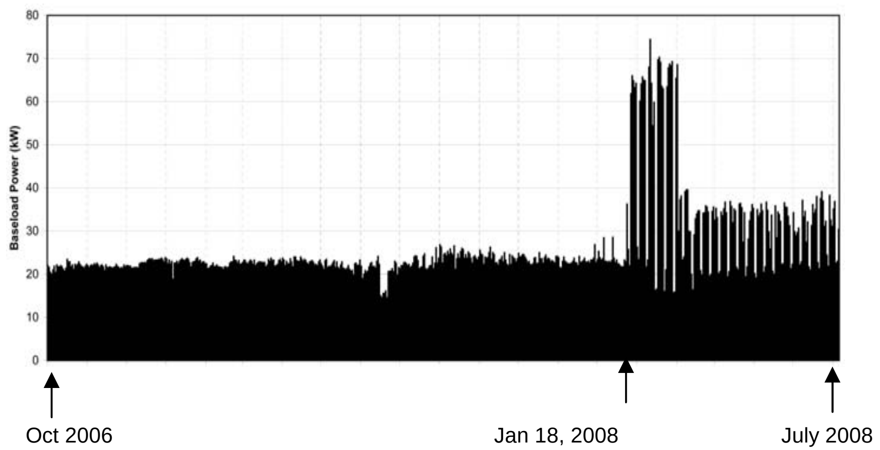


Electron Microscope

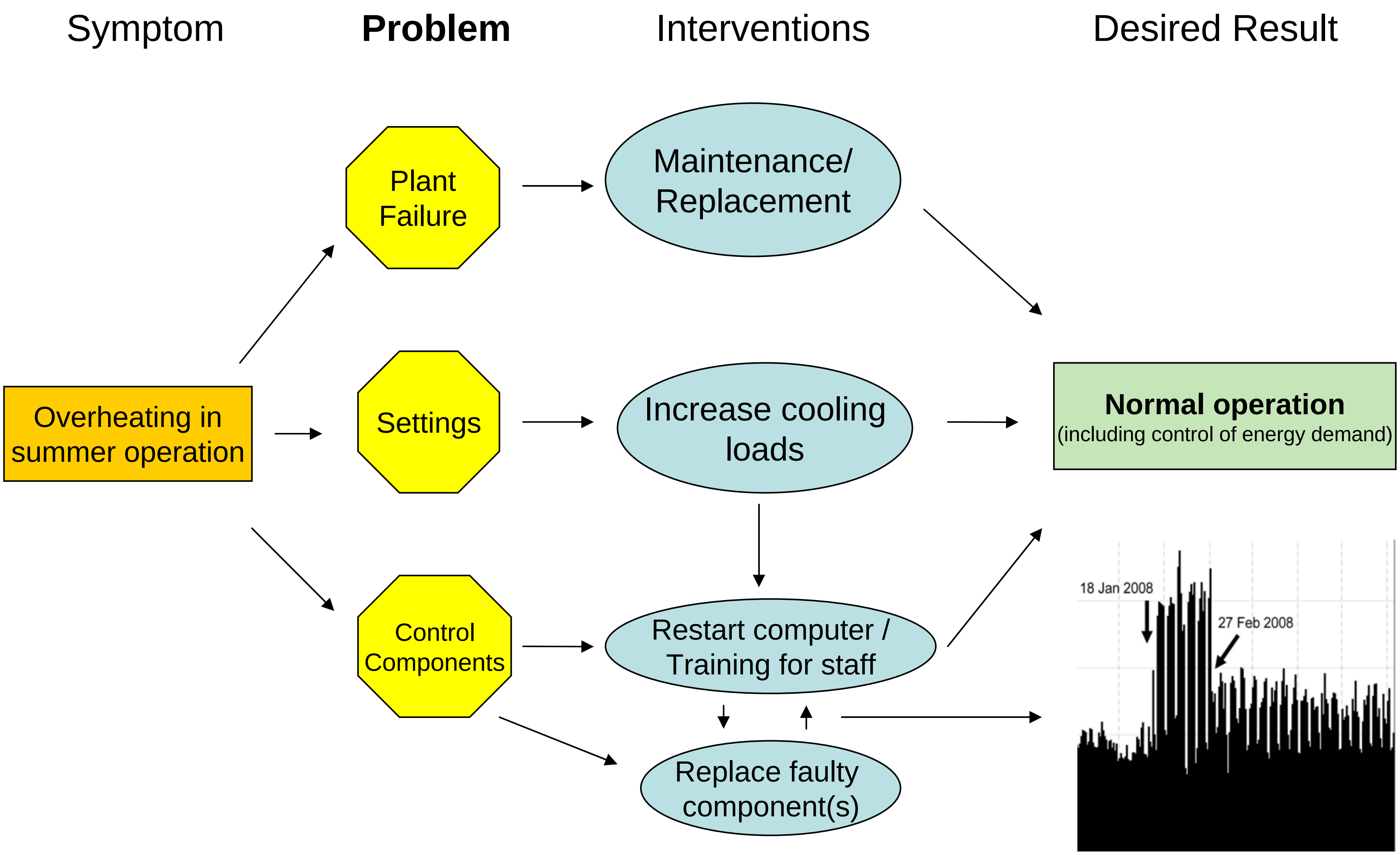
Approx. 5 kW observed baseload beginning 17 May 2007

…and in January 2008, a brief power cut likely caused a sensor failure

Roof Mechanical Plant



Implications of automation for energy efficiency on building managers



Overall Conclusions & Implications

AUTOMATION and ENERGY EFFICIENCY

- Automation adds complexity to failure troubleshooting
- Building Managers respond to problems using human logic, not computer logic
- Risk: Greater potential for best-practice AND greater potential for unmanageability

ENERGY MODELLING of COMPLEX BUILDINGS

- Critical how designer and client work together

AWARDS for EXCELLENCE in ENERGY EFFICIENCY

- Base on measured, not modelled, data
- Competition for measured results is a potential tool to integrate energy-efficient design and operation