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All Electrical School with GSHP in Quebec
Preliminary Results

Vasile MINEA

Workshop on Canadian Heat Pumps & Refrigeration Activities

Montreal, May 10, 2004

Hydro-Quebec Contribution

- Sector: Commercial, Institutional & Industrial
- Field: Heat Pumps & Refrigeration
  - R&D and Demonstration Projects (LTE)
  - Technical Support to HQ's Customers
  - Expert Advices to:
    - HQ's Representatives in Regions
    - Architects & Building Owners
    - Design Engineers, Manufacturers & Contractors
  - Diffusion of Information & Promotion
    - Show-cases
    - Conferences & Workshops
    - IEA – Heat Pump Program (Annex Projects)
  - HQ's Energy Efficiency Program

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All Electrical GSHP School

- Partners
  - School Board (50 Schools)
    - Previous Experience in Efficient Energy Projects
    - Favourable & Competent Technical Service
  - Local Design Engineering Firm
    - Good Past Experience with GSHP
  - Laboratoire des Technologies de l'Énergie (LTE), Hydro-Quebec
    - More than12 years Involving in such Projects
    - Contribution to the System Design
    - Energy Analysis (over12-month Period)

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Objectives

- Built a High Energy Efficiency, All Electrical School
  - Without Any Fossil Combustible
  - "Green School" (consistent with *Kyoto Protocol* (Quebec: 99% Hydroelectricity)
  - Serving as a Show - Case
- Determine the System Performance vs. Quebec & School Board's Average Specific Energy Consumption
- Promote the Efficient GSHP Heating & Cooling Systems in a Cold Climate

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Building – École du Tournant

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Building

- Occupancy: maximum 200 Students
- Two Floors & a Partial Penthouse
  (Mechanical & Electrical Rooms)
- Ground Surface: 1 300 sq.m.
- Total Floor Surface: 2 764 sq.m.
- Uses Solar Energy

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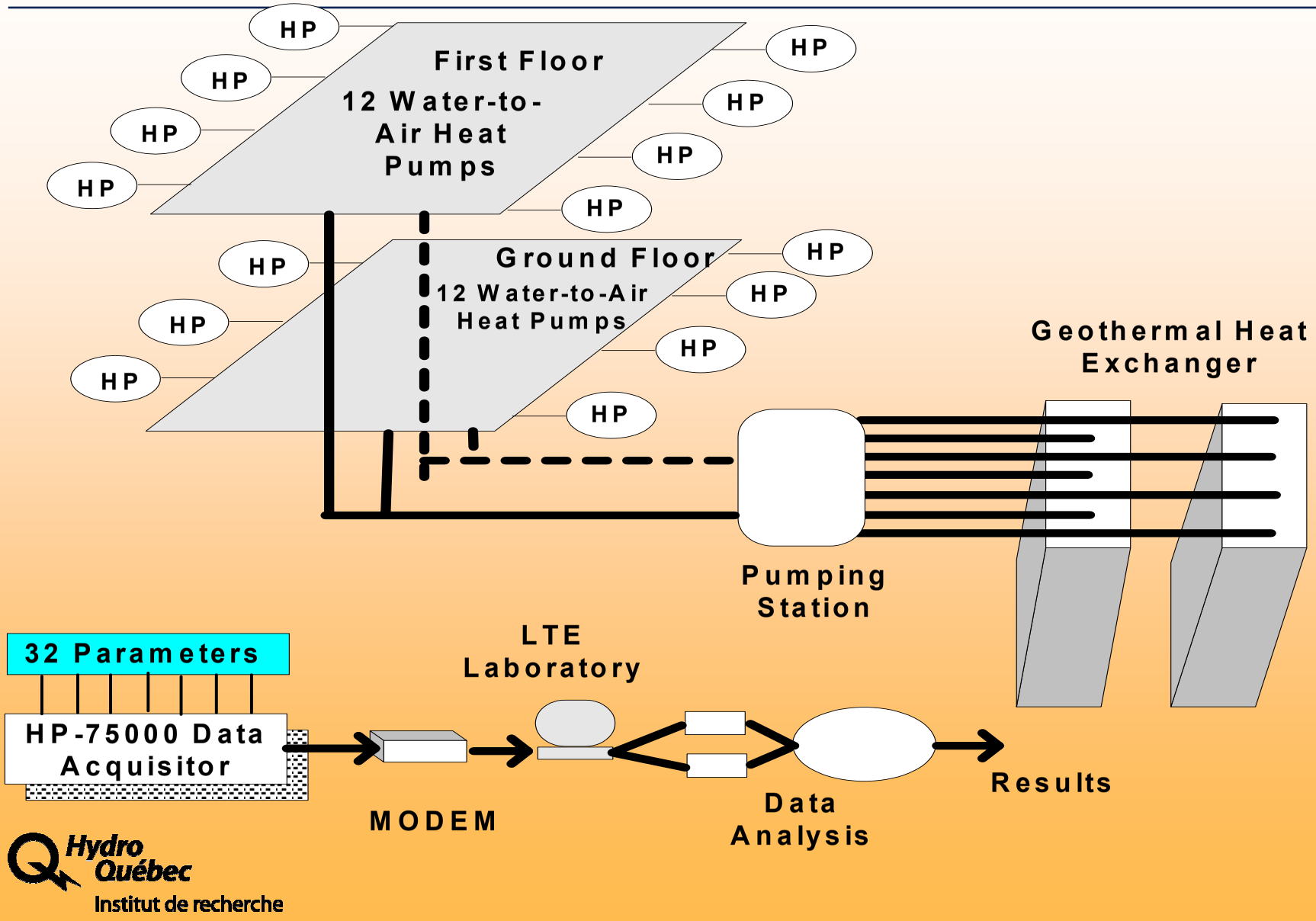
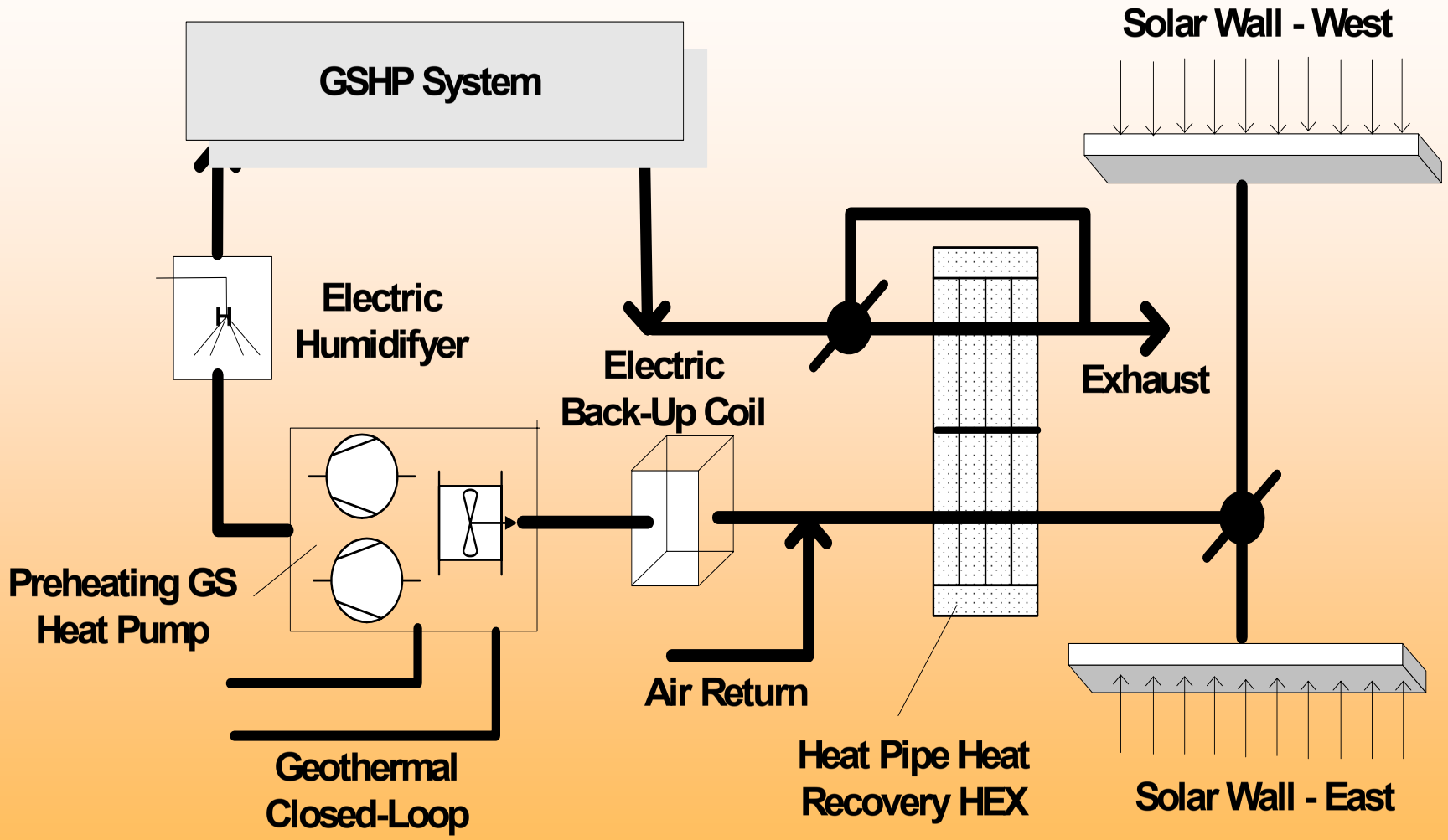
Geothermal System

- Simple Configuration
- Ground Heat Exchanger: 18 vertical Wells (125-m Depth Each)
- 25 Geothermal Heat Pumps
  - 0.75 to 10-ton
  - Total Capacity 58 tons
- Outdoor Air Preheating System
  - Two Solar Walls (East – West)
  - Exhaust Air Heat Pipe Heat Recovery HEX
  - 10-ton Ground-Source Heat Pump
  - 110-kW Electrical Back-Up Coil
- 32 Measured Parameters

System Configuration



Outdoor Air Preheating



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Solar Wall – East Side

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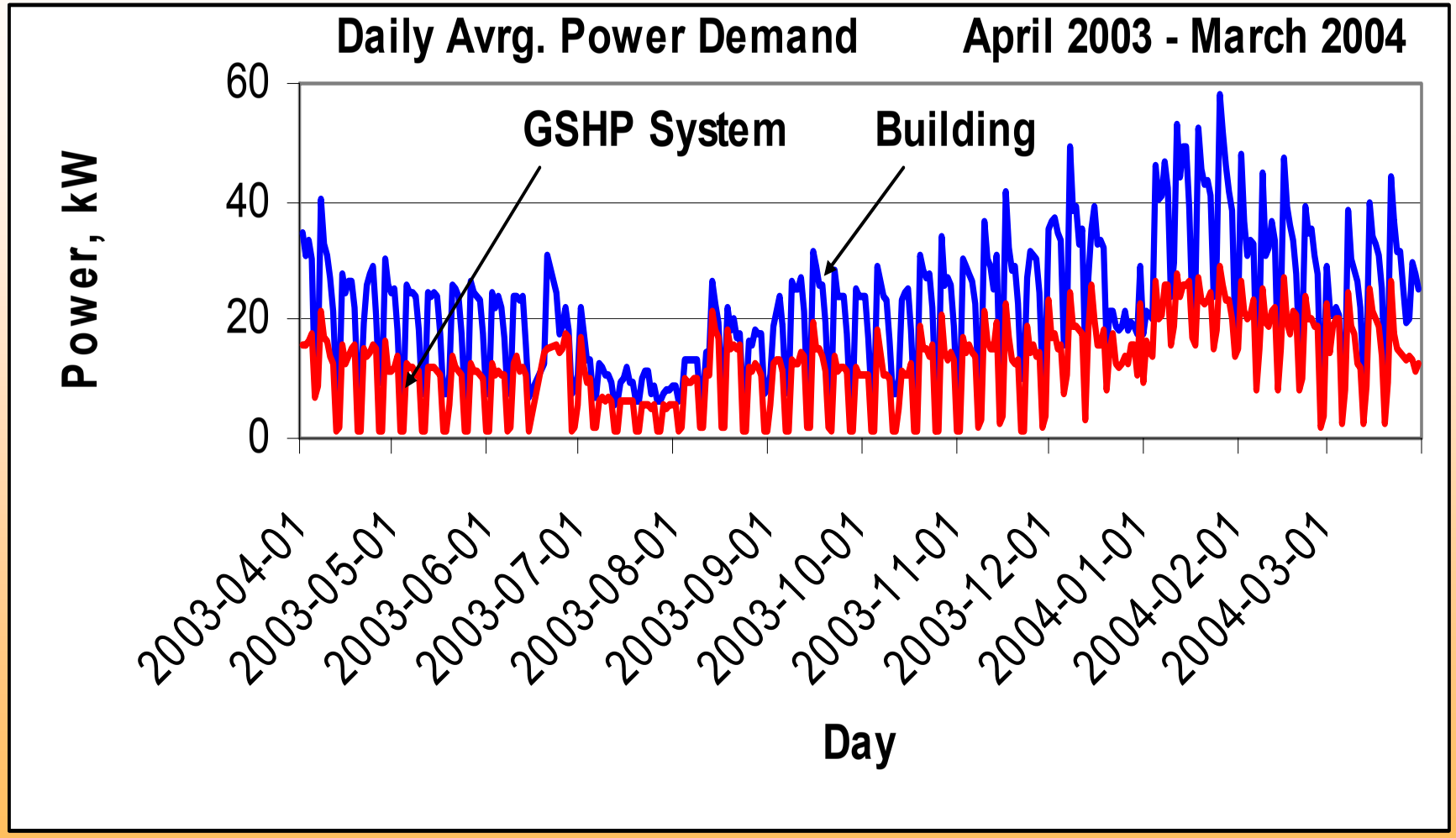
Preliminary Results
Daily Average Power Demands



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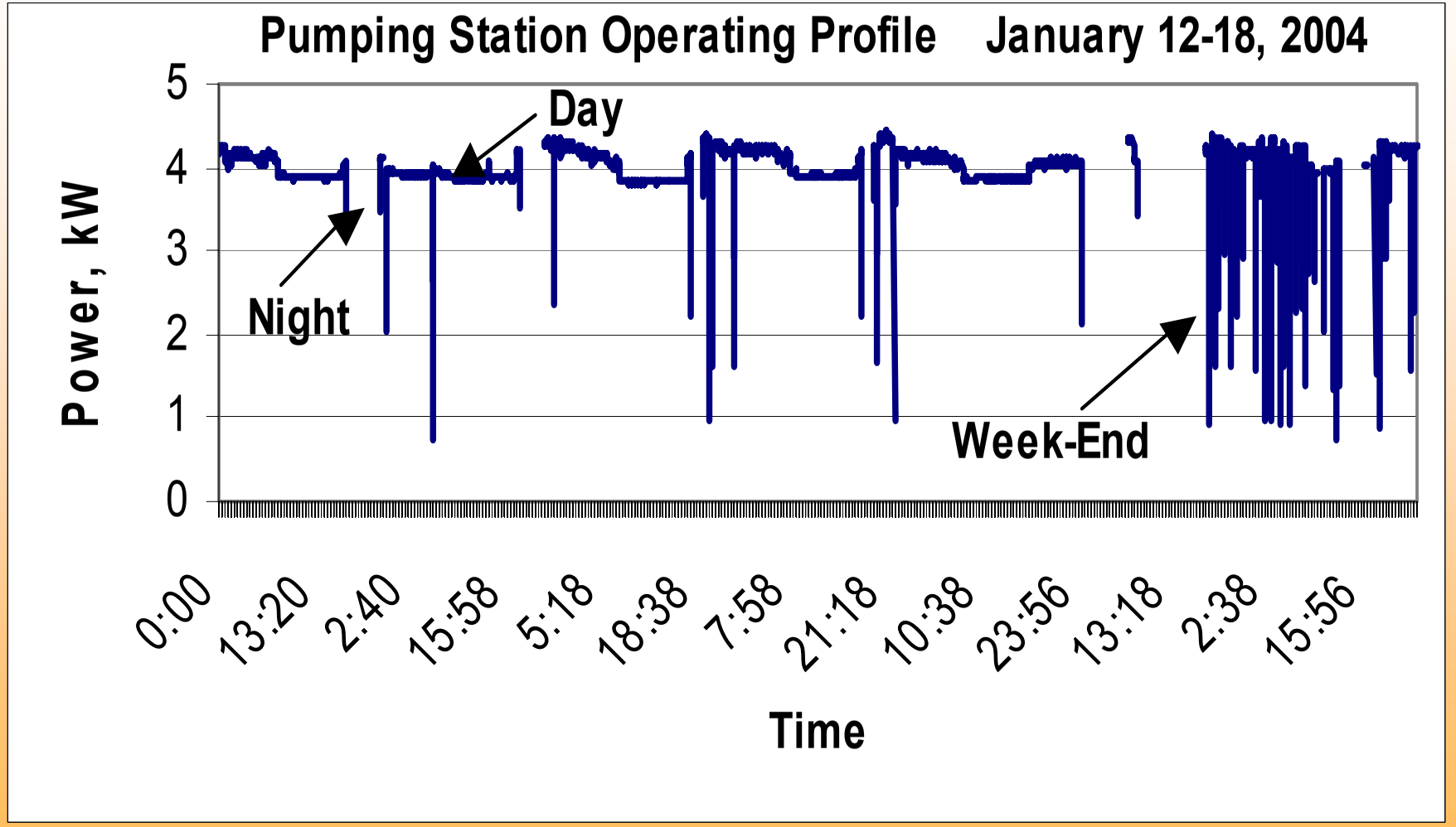
Winter: System Operating Profile



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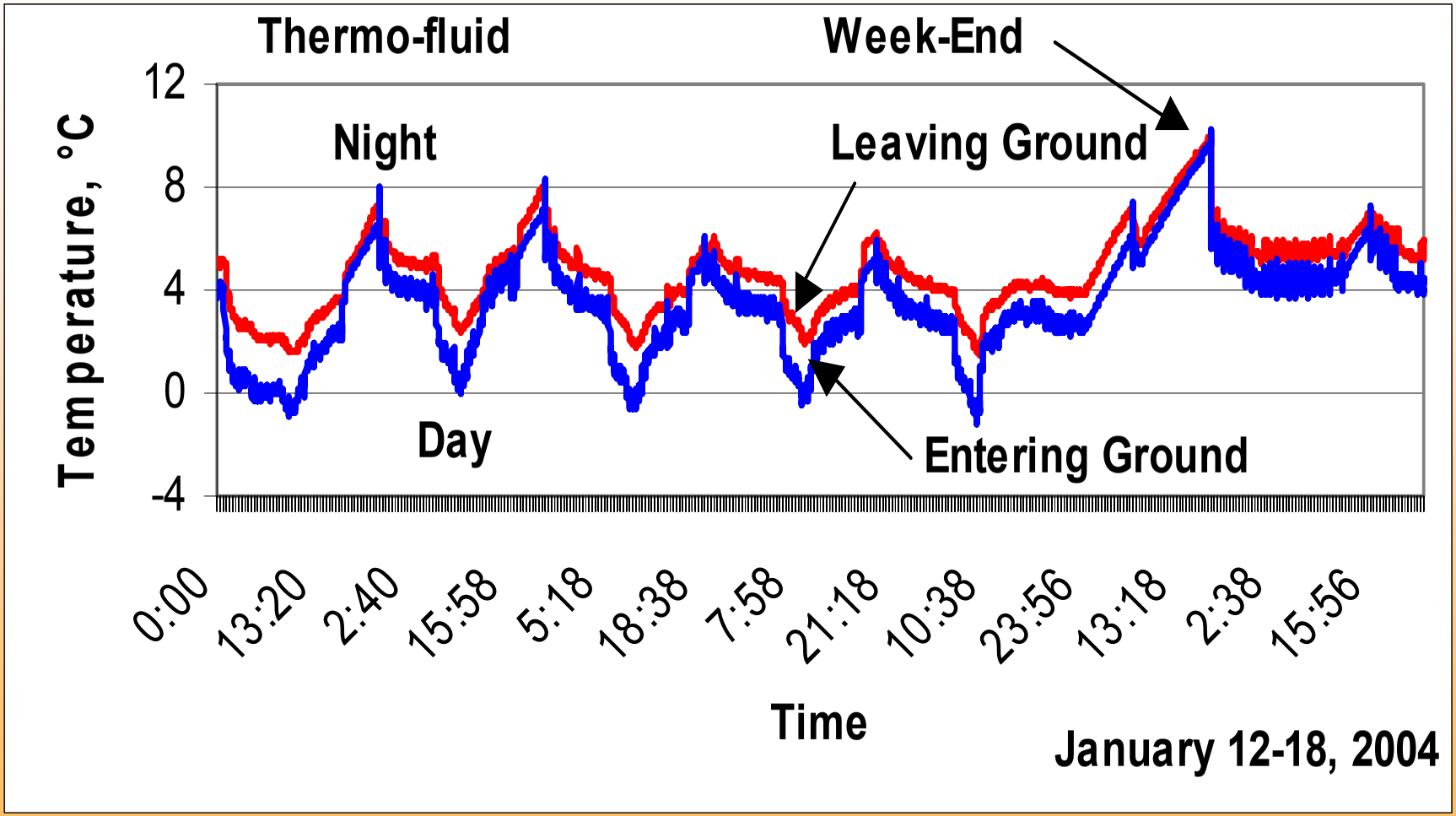
Example: Thermo-fluid Temperatures



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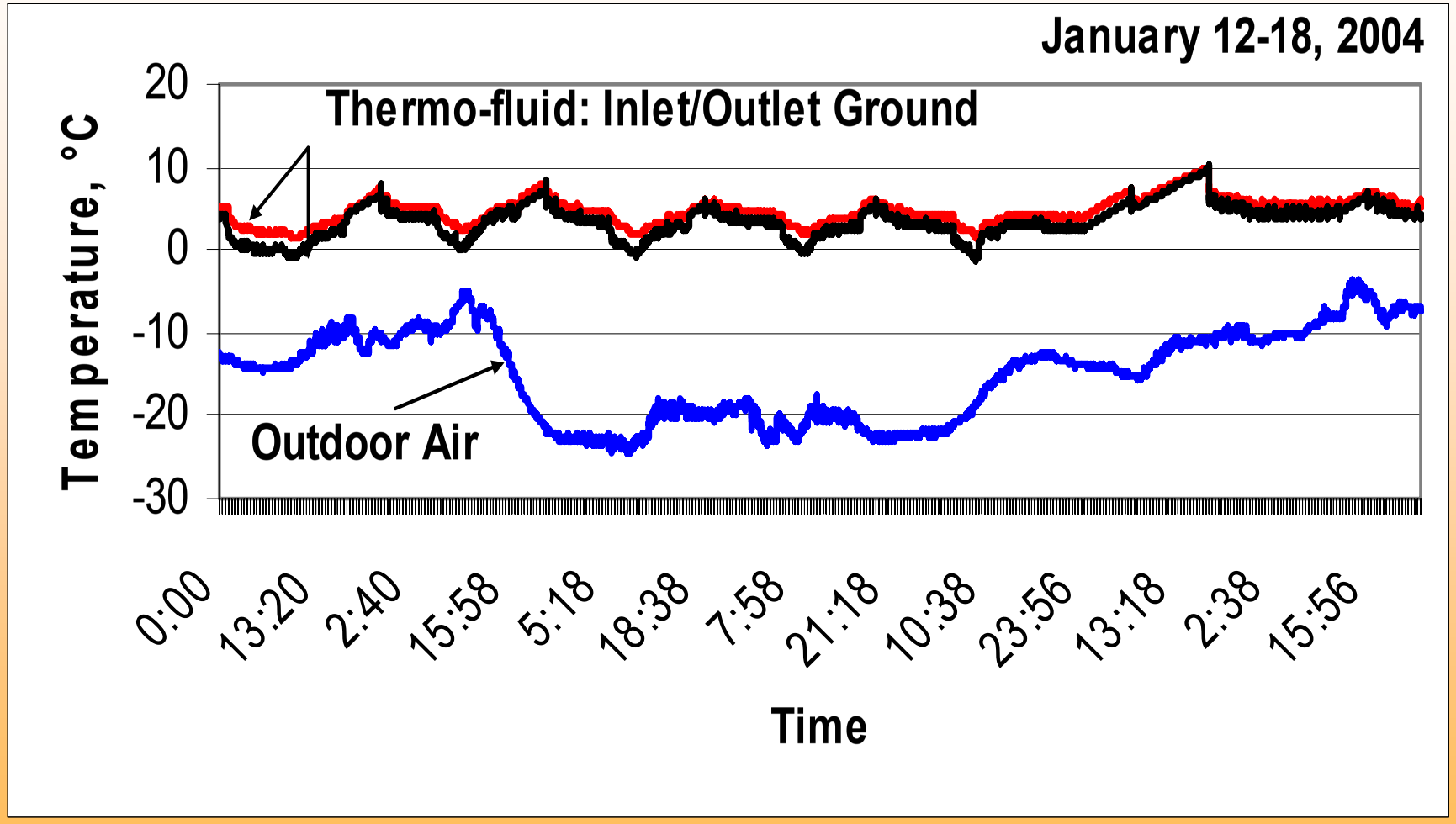
Example: Thermo-fluid vs. Outdoor Temp.



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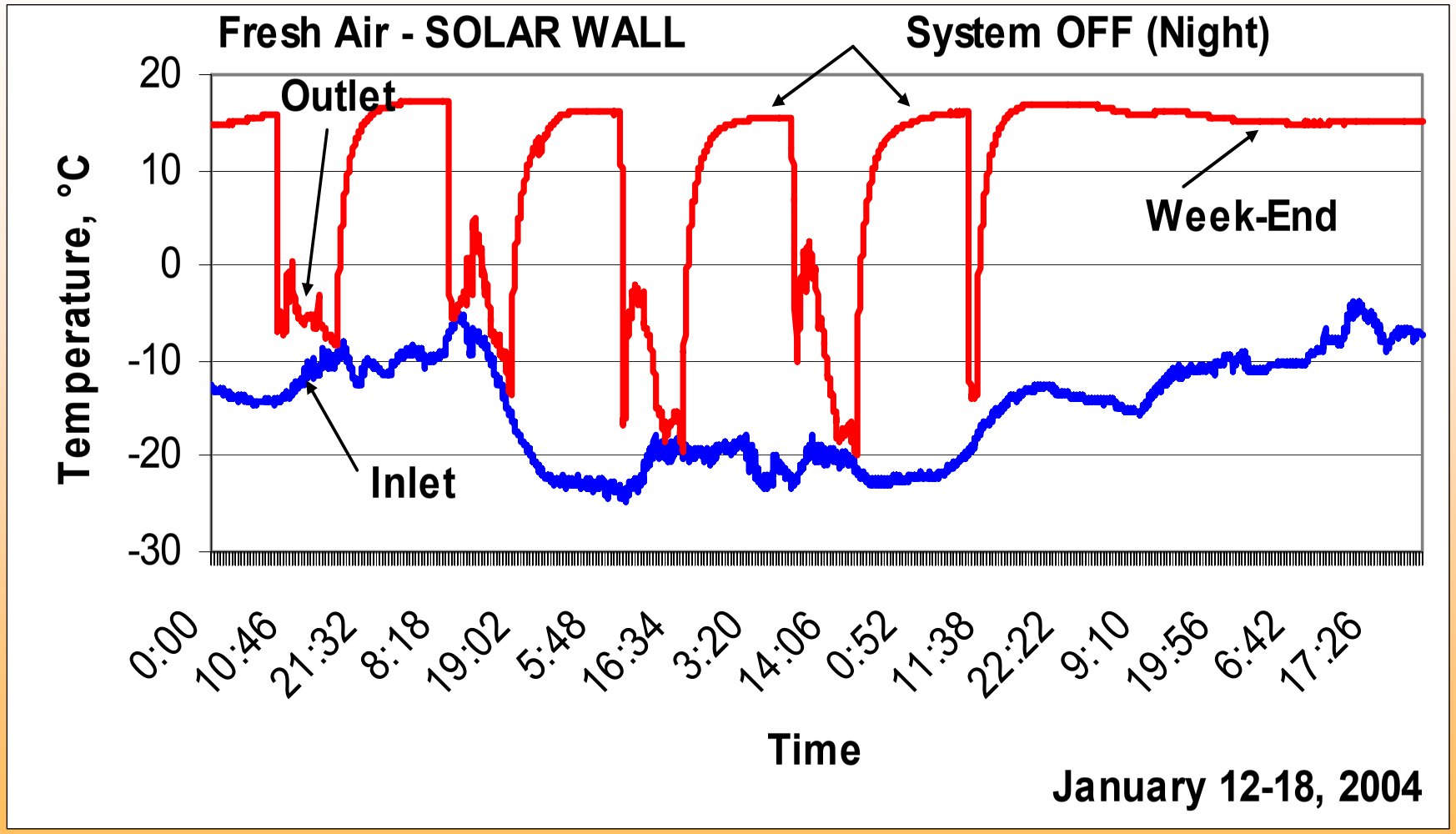
Winter: Fresh Air – SOLAR WALL (East Side)



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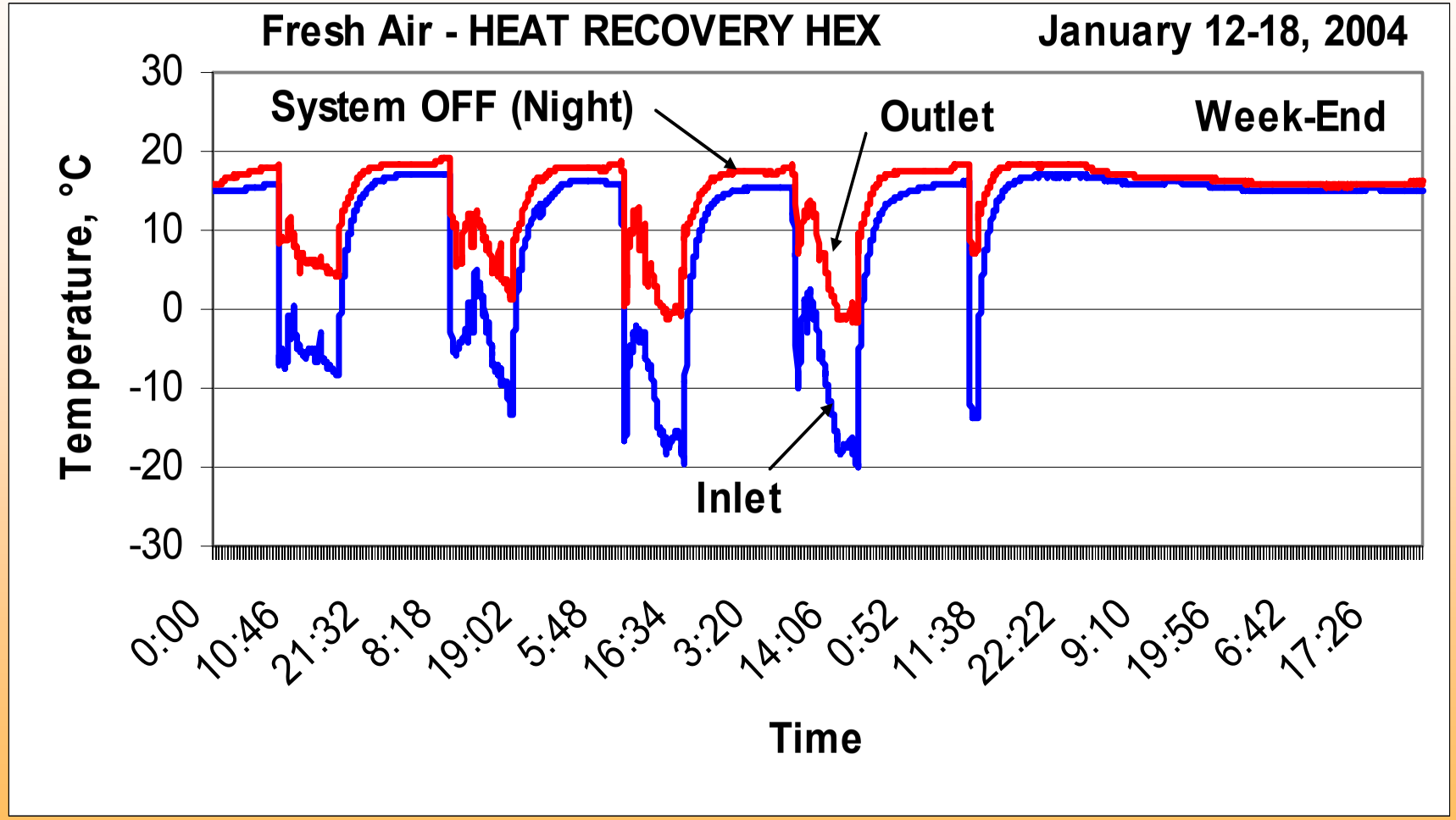
Winter: Fresh Air
HEAT RECOVERY HEX



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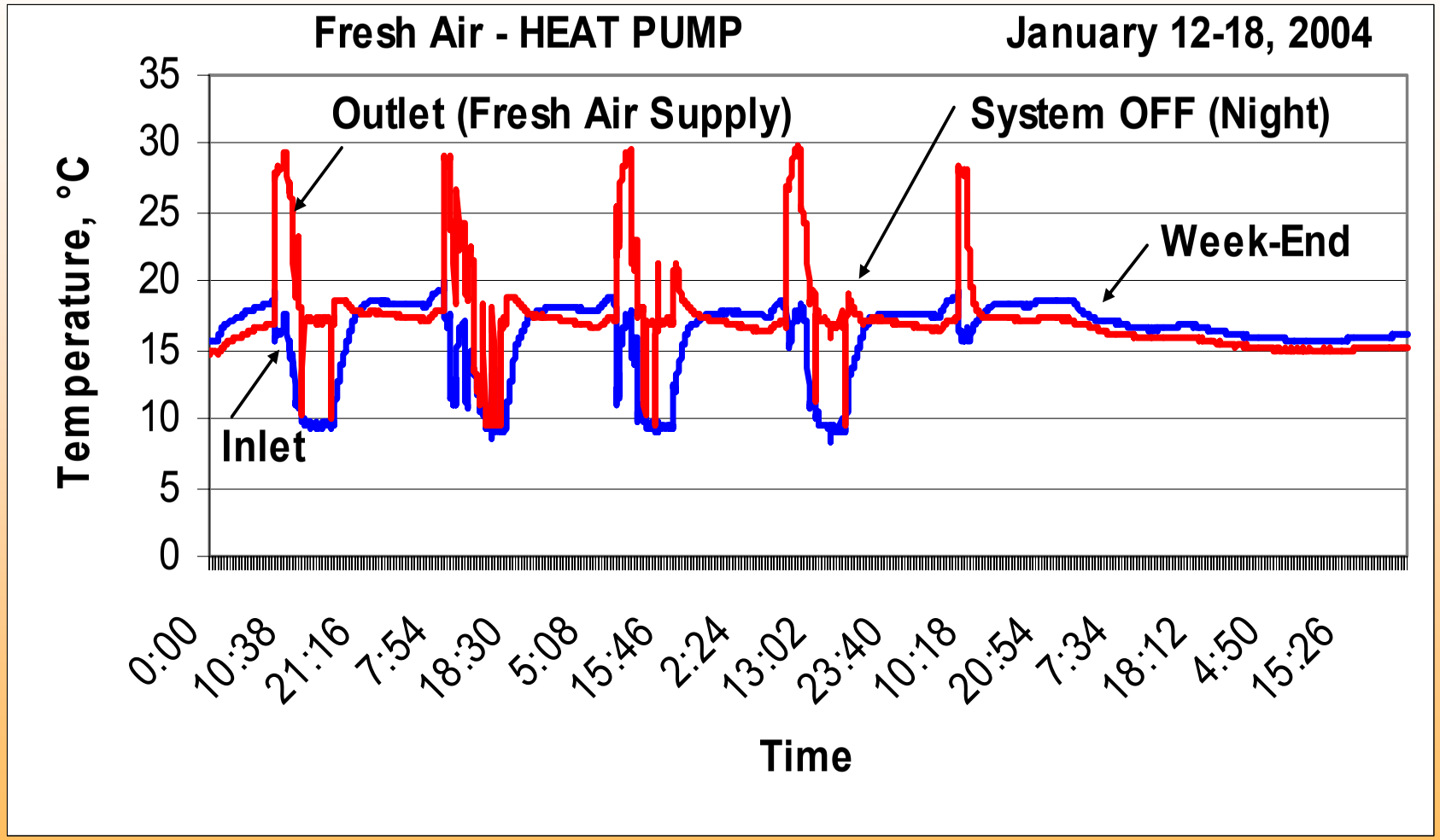
Winter: Fresh Air
Heat Recovery HEAT PUMP Temp.



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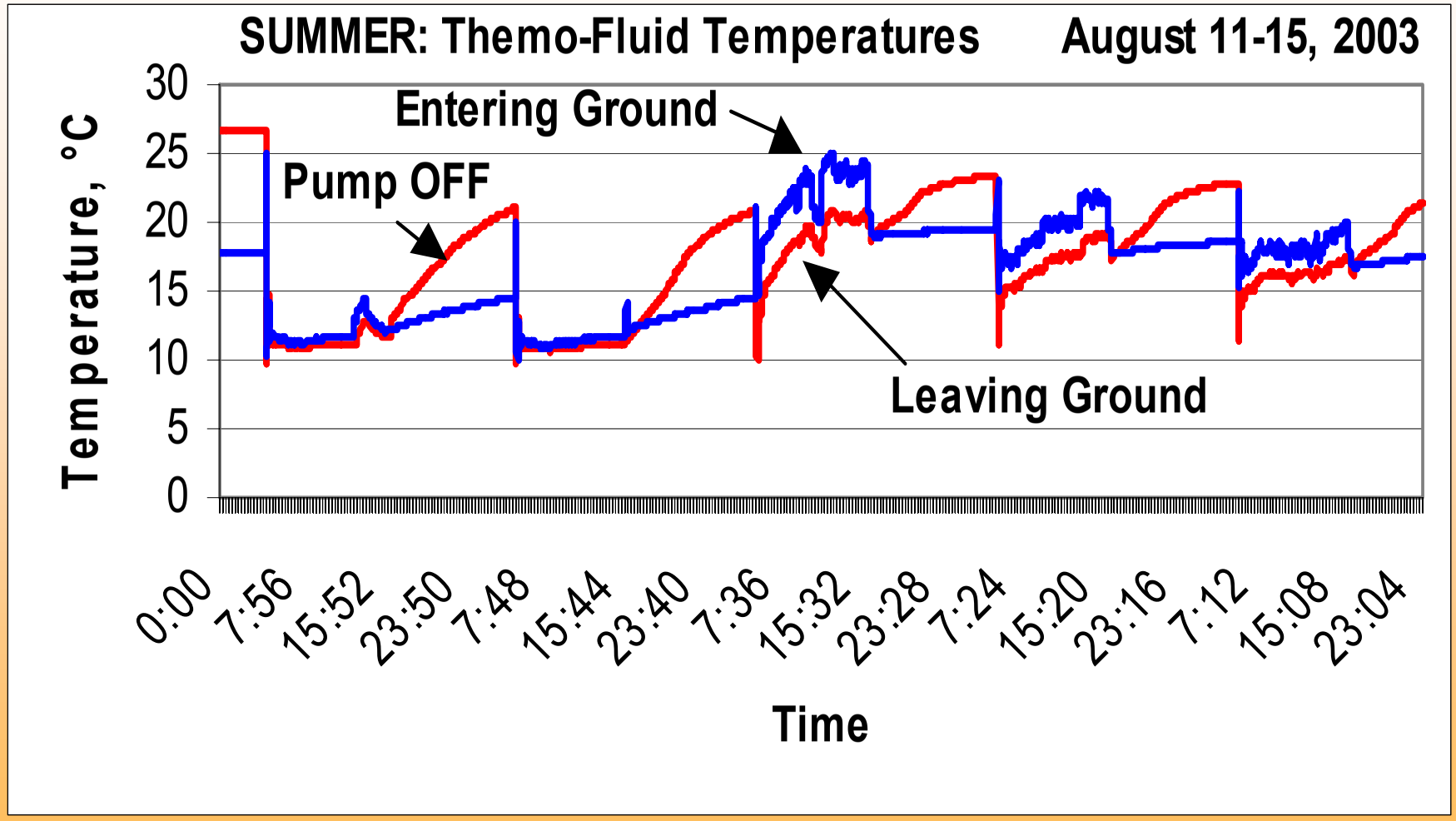
Example: Very Hot Summer Week



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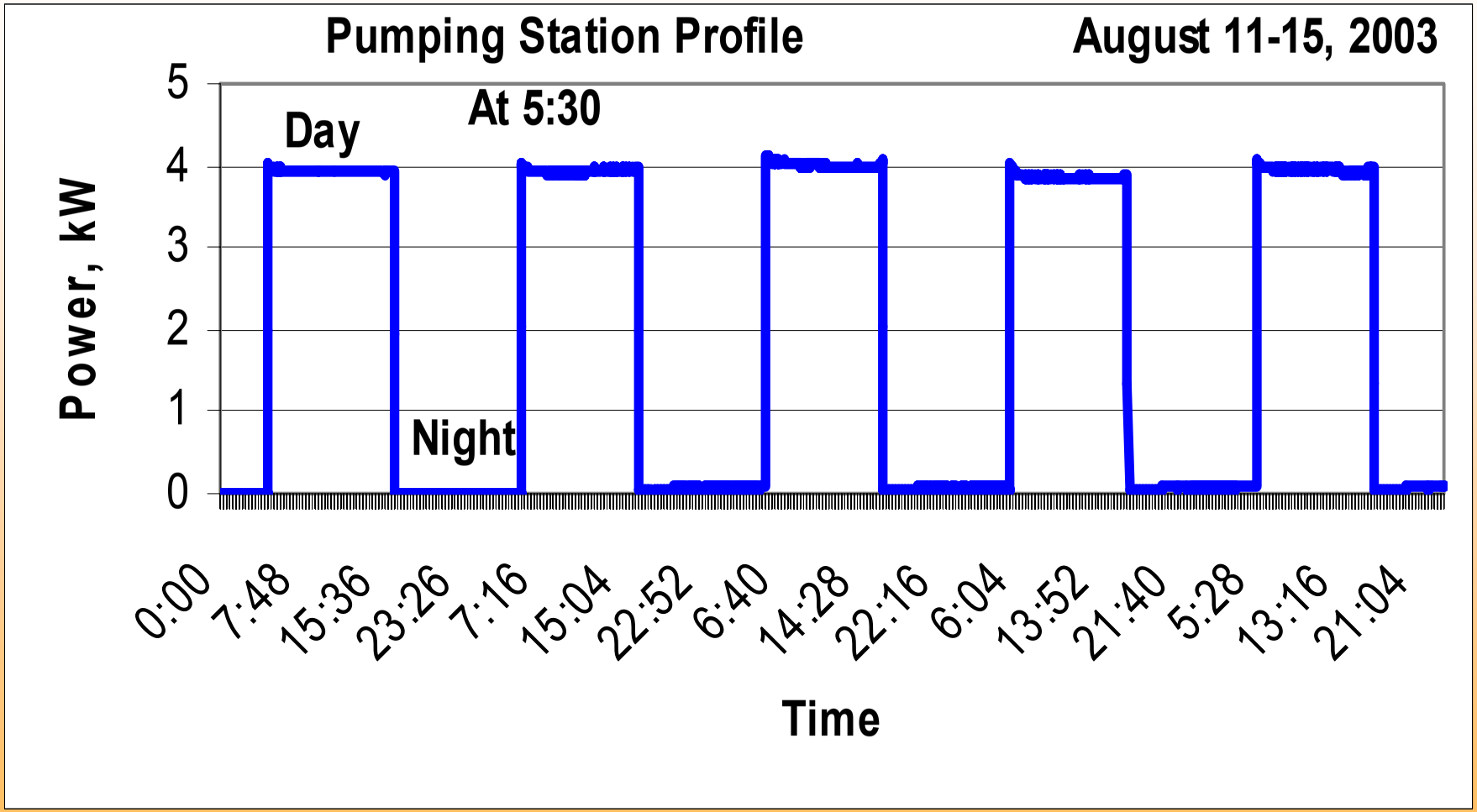
Very Hot Summer Week



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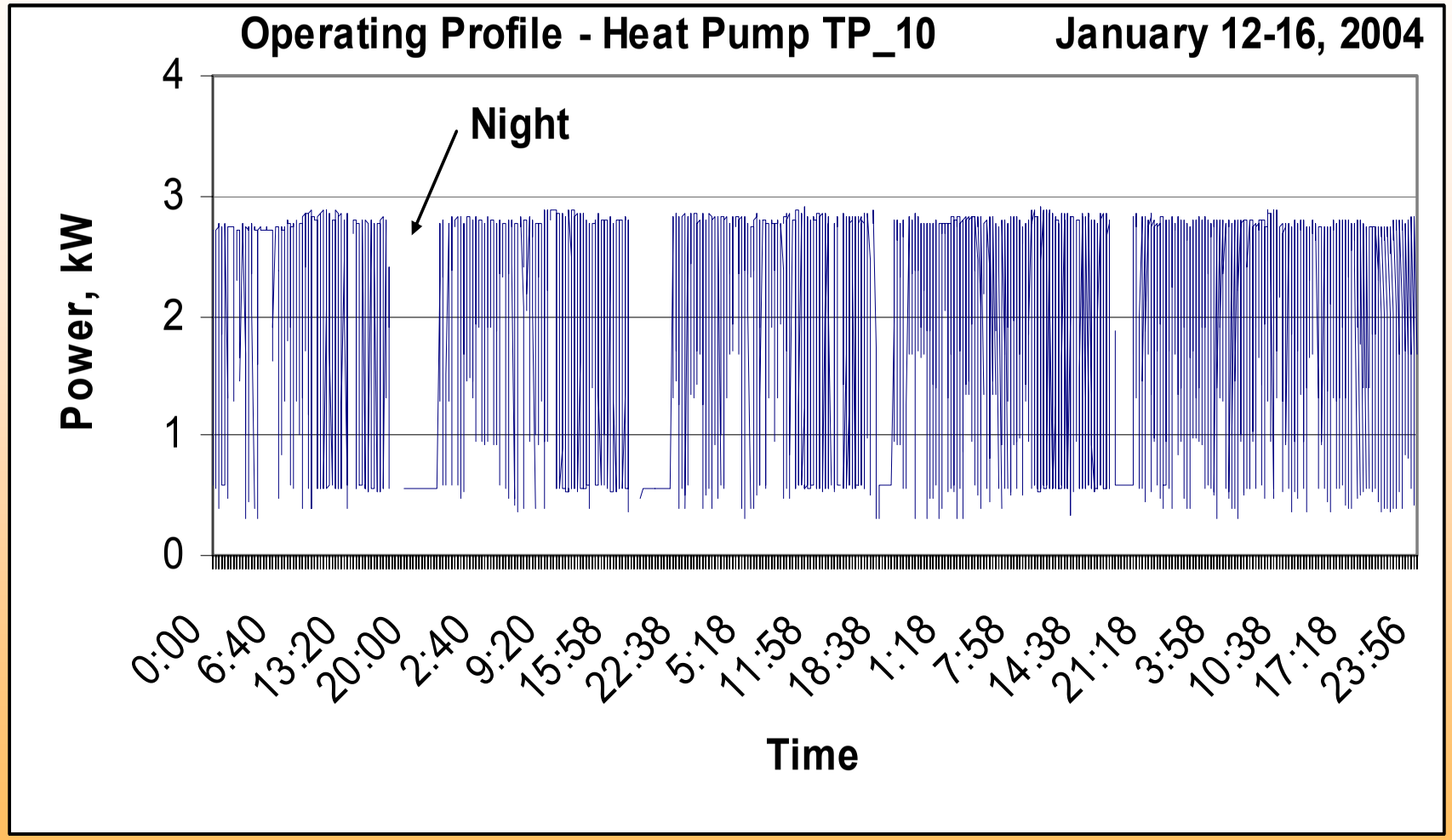
Example - Operating Profile Heat Pump TP_10 (Classroom)



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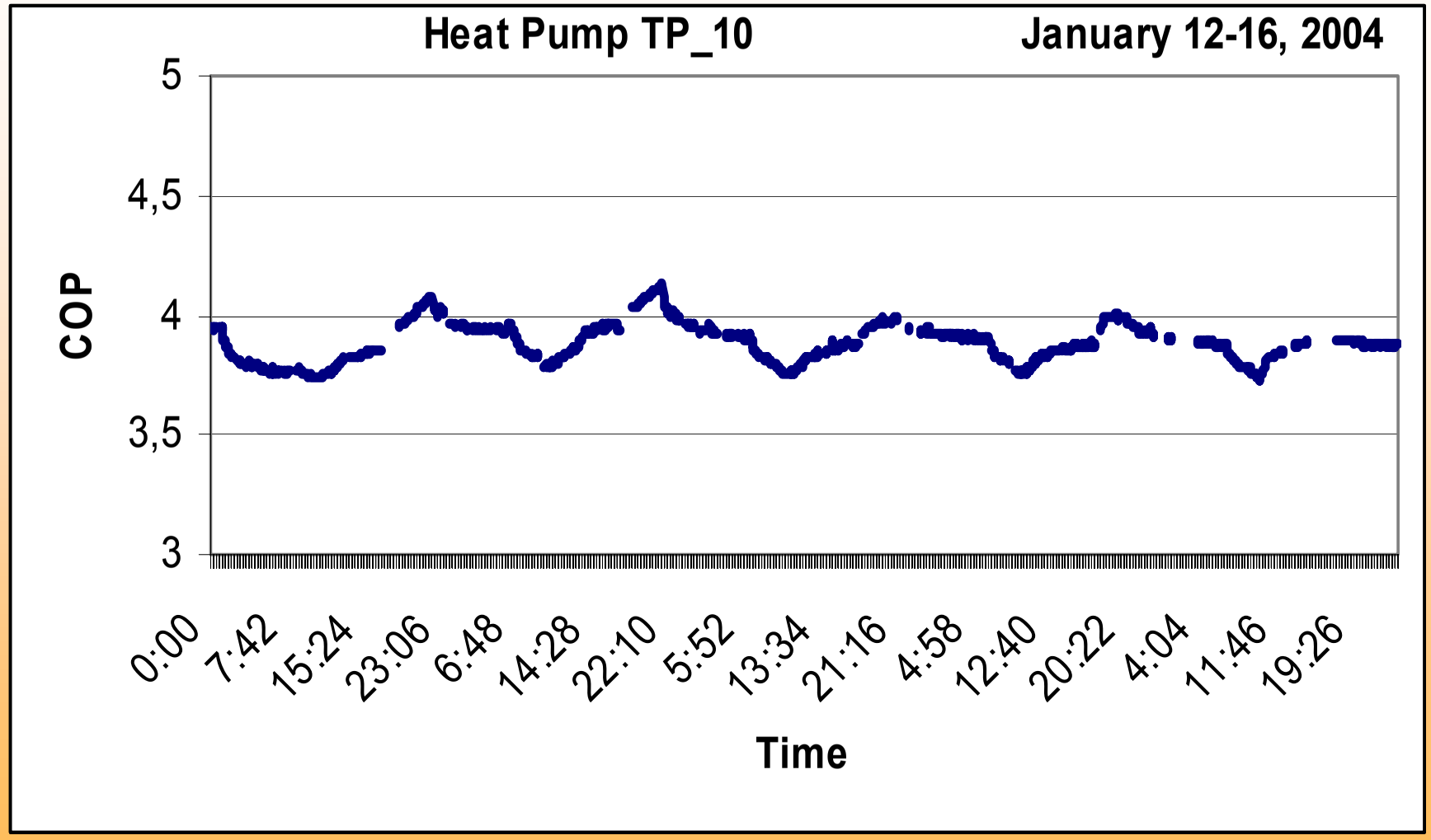
Example: Coefficient of Performance Heat Pump TP_10 (Classroom)



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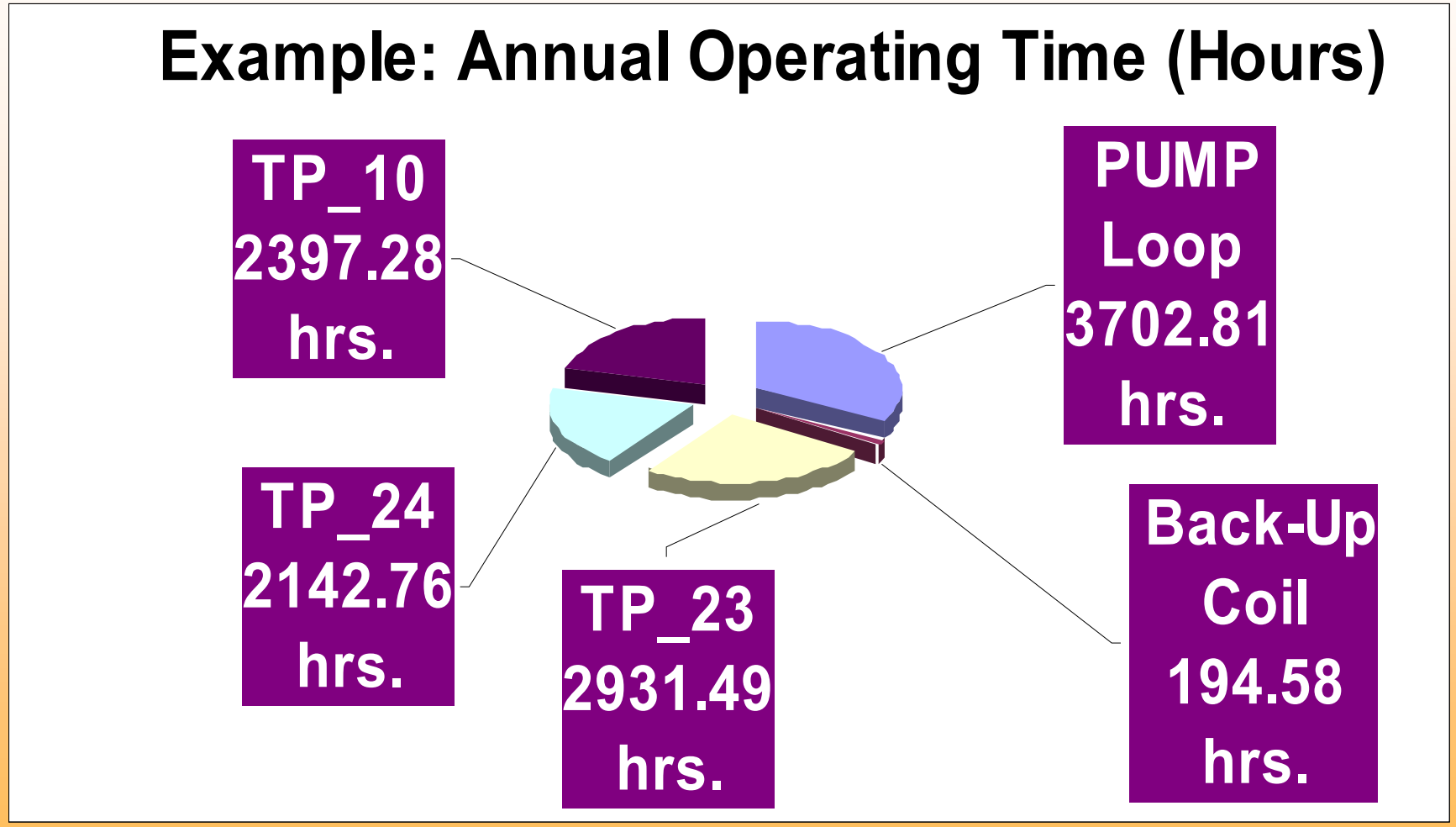
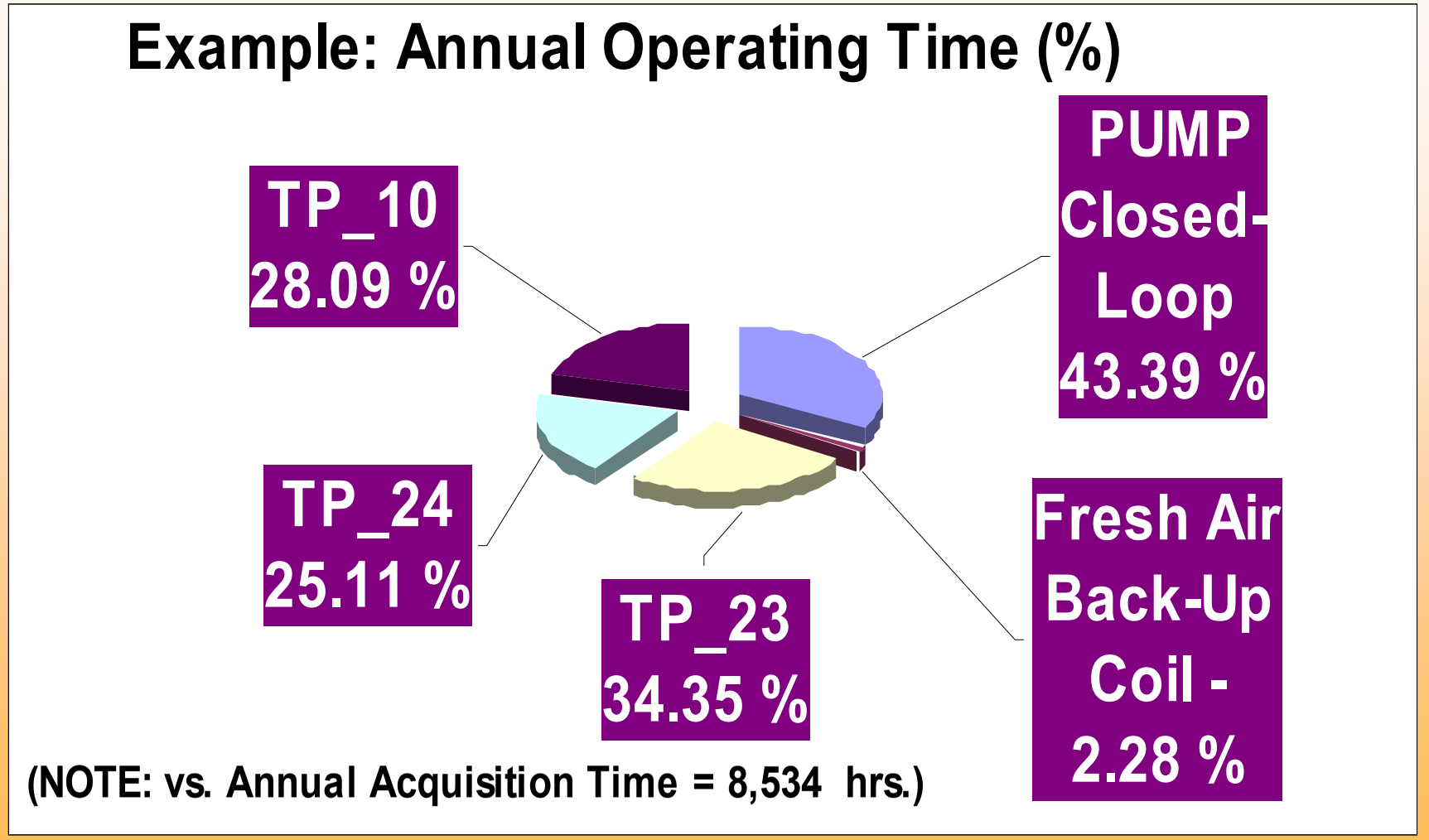
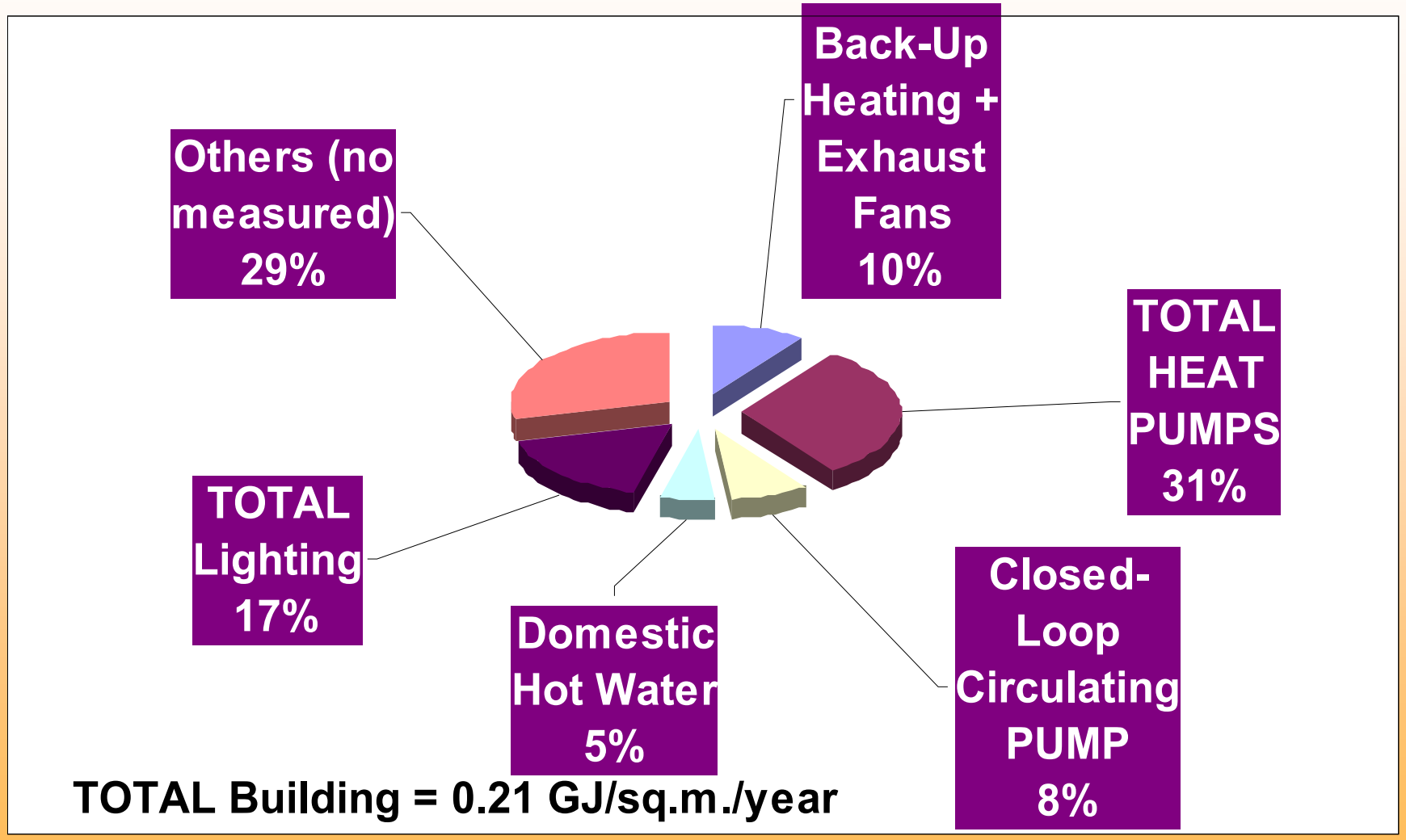
Example: Annual Operating Times (hours)



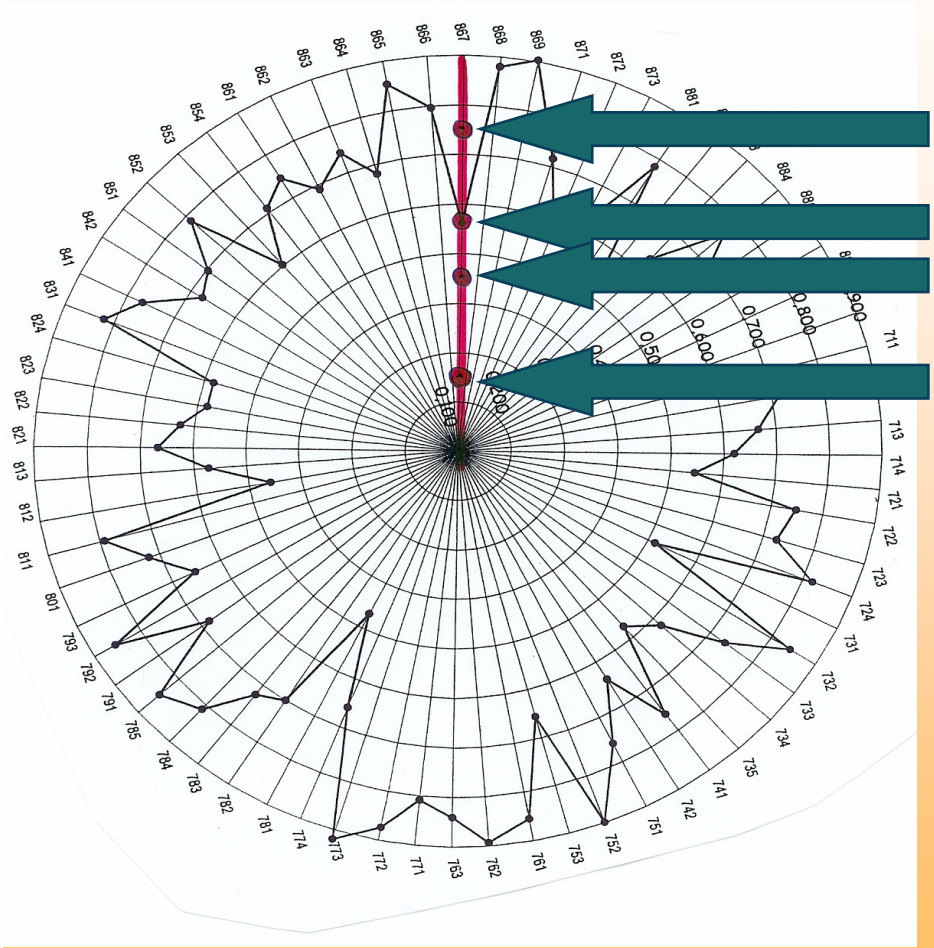
Example: Annual Operating Times (%)



Annual Energy Consumption Balance



Specific Energy Consumption



Average Quebec: O.75 GJ/m²/year

Average School Board: O.57 GJ/m²/year
Other Heat Pump Systems: O.45 GJ/m²/y

School *Du Tournant* (measured): O.21 GJ/m²/year

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CONCLUSIONS

- **New, Energy-Efficient School**
  - Annual Specific Energy Consumption - 0.21 GJ/sq.m./year
  - 72 % Reduction vs. School's Quebec Average
  - 63 % Reduction vs. School Board Average
- **GSHP System**
  - Simple Configuration
  - Ground-Source Heat Exchanger - Well Designed
  - Efficient Central Control by the System Owner
  - 43.4 % Annual Operating Rate (Heating & Cooling)
  - Heat Pump's COP (Heating Mode): 3.5 – 4.8
- **Successful Show-Case in a Cold Climate**

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