The first large-scale cold water store in Germany: Operational experiences.

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EUROHEAT & POWER

34th Euroheat & Power Congress: "Climate talks, climate action – DHC leading the road to Copenhagen" 25 and 26 May 2009 in Venice, Italy
Workshop C: Cooling tomorrow

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- 2004-2005: Feasibility evaluation for empowerment of Combined Heat and Cool and Power Cycle by means of Cool TES in large supplying systems
- 2005-2009: Pilot project for the optimization of large-scale systems on the base of combined Heat and Cool and Power Cycle by means of Cool TES
- Financial support
  - Federal Ministry of Economics and Technology (BMWi)
  - Represented by Project Management Organisation Jülich (PTJ)
- Project partners
  - Utility Company Chemnitz Stock Corporation (construction and operation)
  - University of Technology Chemnitz (R&D, monitoring)
- Contractors
  - AIC Ingenieurgesellschaft für Bauplanung Chemnitz GmbH (Engineering)
  - RAC-Rohrleitungsbau Altchemnitz GmbH (General contractor, construction, piping)
  - Siemens Building Technologies GmbH & Co. oHG (Automation, technical management)
  - Farmatic Anlagenbau GmbH (Tank construction)
  - and another

Bundesministerium für Wirtschaft und Technologie

Projektträger Jülich Forschungszentrum Jülich

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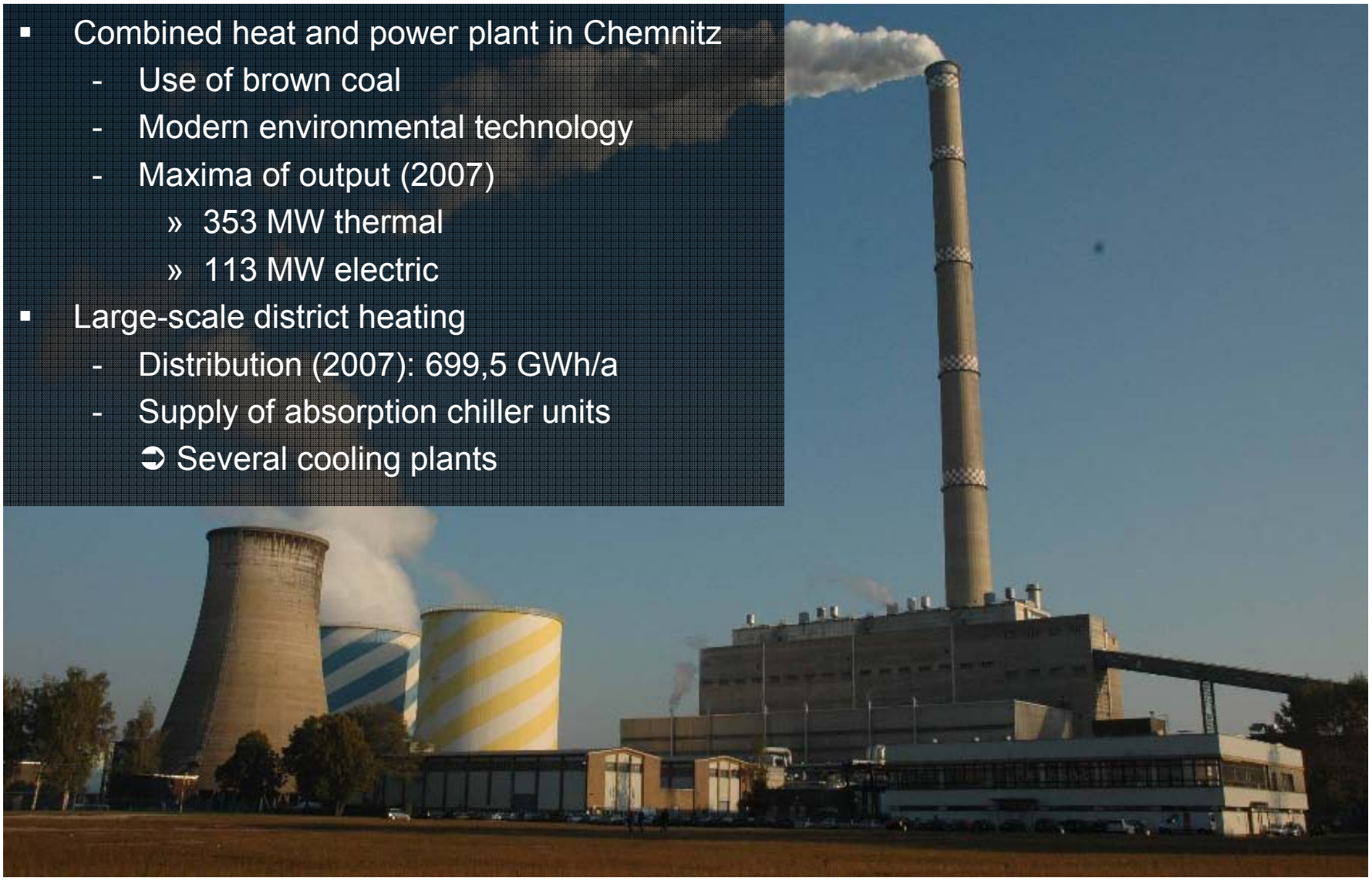
- Problem 1: Surplus of heat in summertime
  - Cogeneration
  - Sun
- Problem 2: Thermal driven chiller units
  - High investments cost
  - High operational cost
  - Cheap waste heat
- Solution: Cool TES // Short-time storage
- General goals
  - Better use of waste heat with Absorption Chillers ➲ Heat surplus during summertime
  - Improvement of efficiency of Combined Heat and Cool and Power Cycle
- Special goal: Refitting the system in Chemnitz with a Cool TES ➲ Energy efficient, economical and ecological solution

Combined heat and power plant “Chemnitz North II”

Absorption chiller unit 500 kW

- Combined heat and power plant in Chemnitz
  - Use of brown coal
  - Modern environmental technology
  - Maxima of output (2007)
    - » 353 MW thermal
    - » 113 MW electric
- Large-scale district heating
  - Distribution (2007): 699,5 GWh/a
  - Supply of absorption chiller units
  - ➲ Several cooling plants



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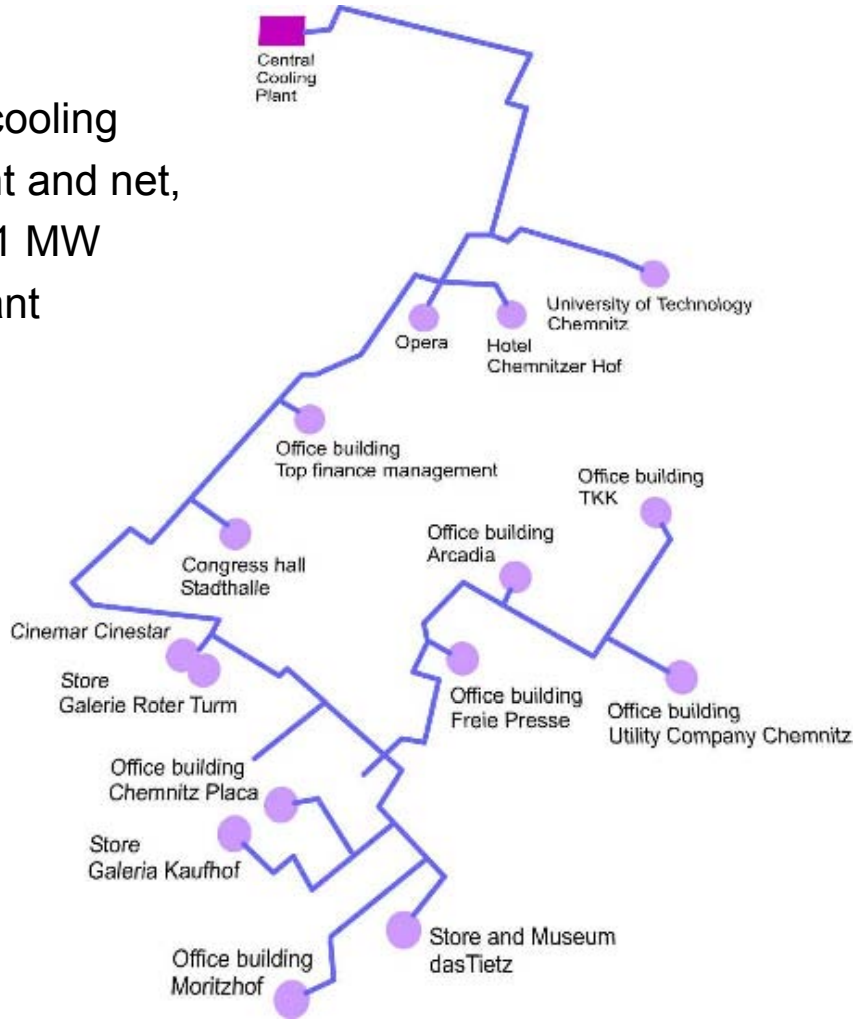
- History // Development of city centre
  - 1968: Decision of town council for district cooling
  - 1971-1973: Building of central cooling plant and net, generation with R12 centrifugal chillers, 8.1 MW
  - 1993: Reconstruction of central cooling plant
- Today // Central cooling plant
  - H_2O-LiBr Absorption chiller units (AbC): 2 x 1800 kW, 1x 500 kW
    ➲ Use of waste heat
  - Vapor compression chiller units (VCC): 3000 kW centrifugal, 1242 kW screw
    ➲ Use of electric power
  - Total cooling power: 8342 kW
- Today // Net
  - Total / Contract capacity: ca. 20 / 13 MW
  - Temperatures: 5…7 °C / 13 °C
  - Length: 4.2 km / Pipes: up to 600 mm diameter
  - Consumption: 93 % air conditioning, 7 % technological cooling



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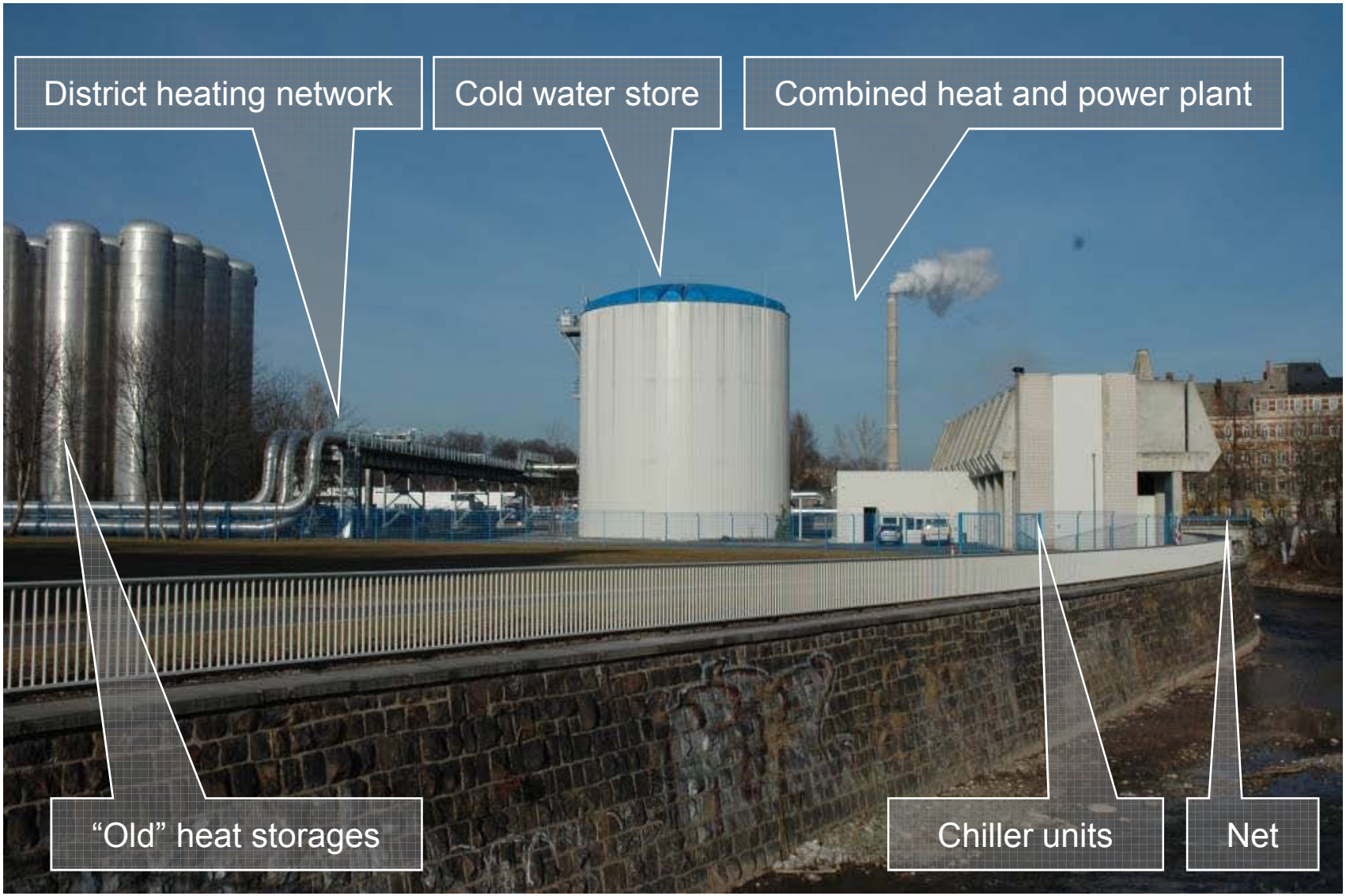

District cooling in Chemnitz // Central plant

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Opera

CUT / High Performance Computing / 1112 CPUs

Store “Galeria Kaufhof” (Glassy Store)

Congress Centre

District cooling in Chemnitz // Consumer

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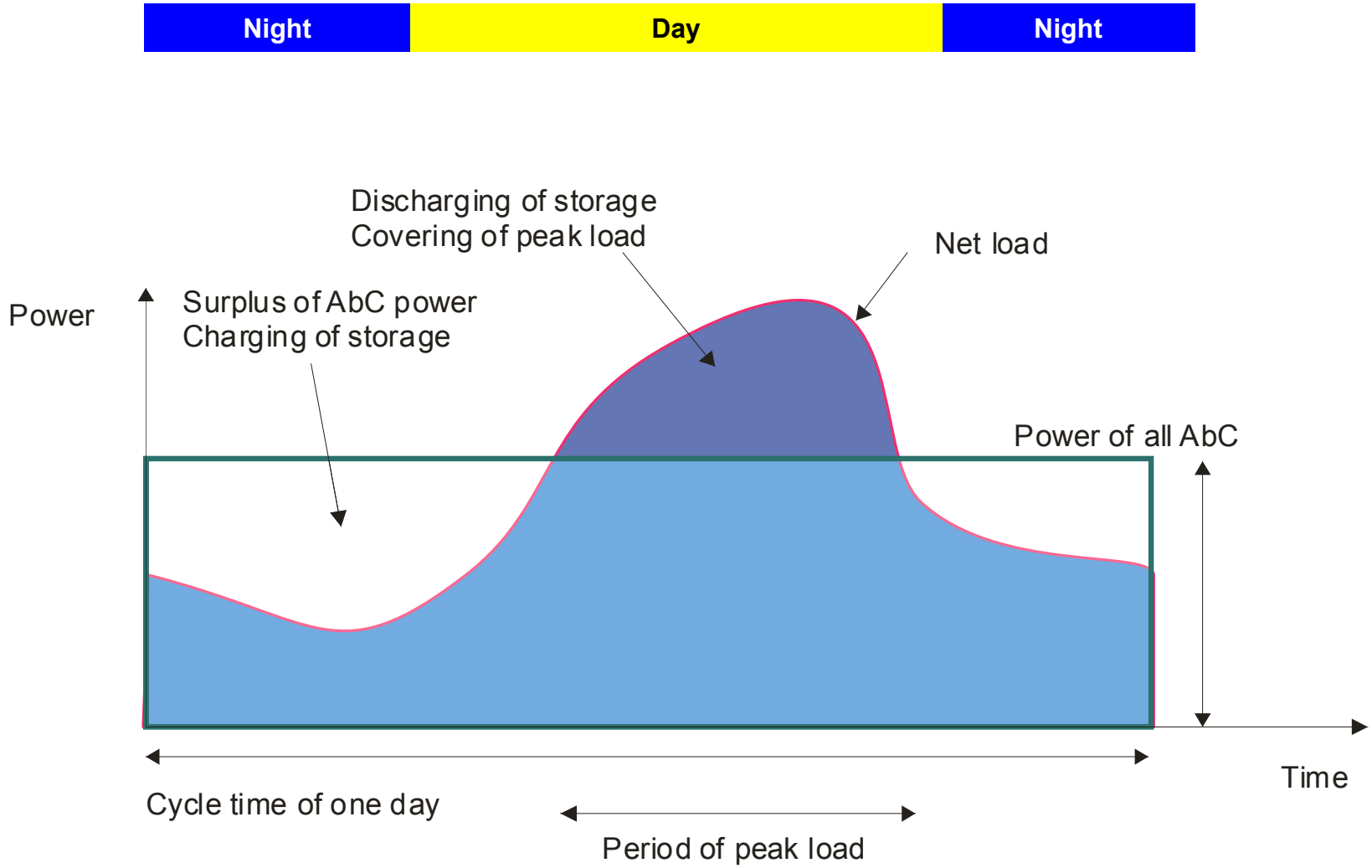

Principle of short-term storage // Peak load shifting

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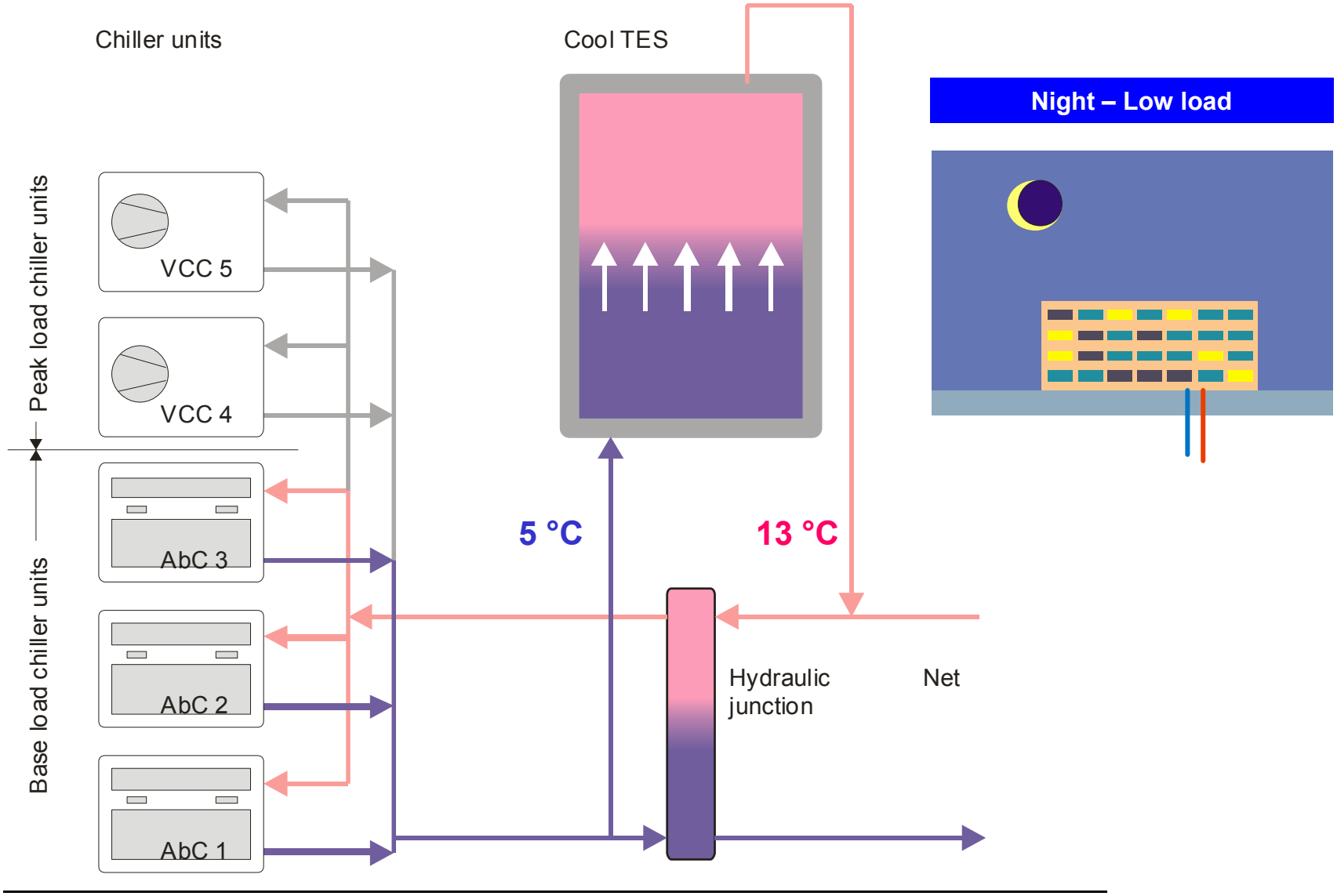

Operation of Cool Thermal Energy Storage (TES) // Charging

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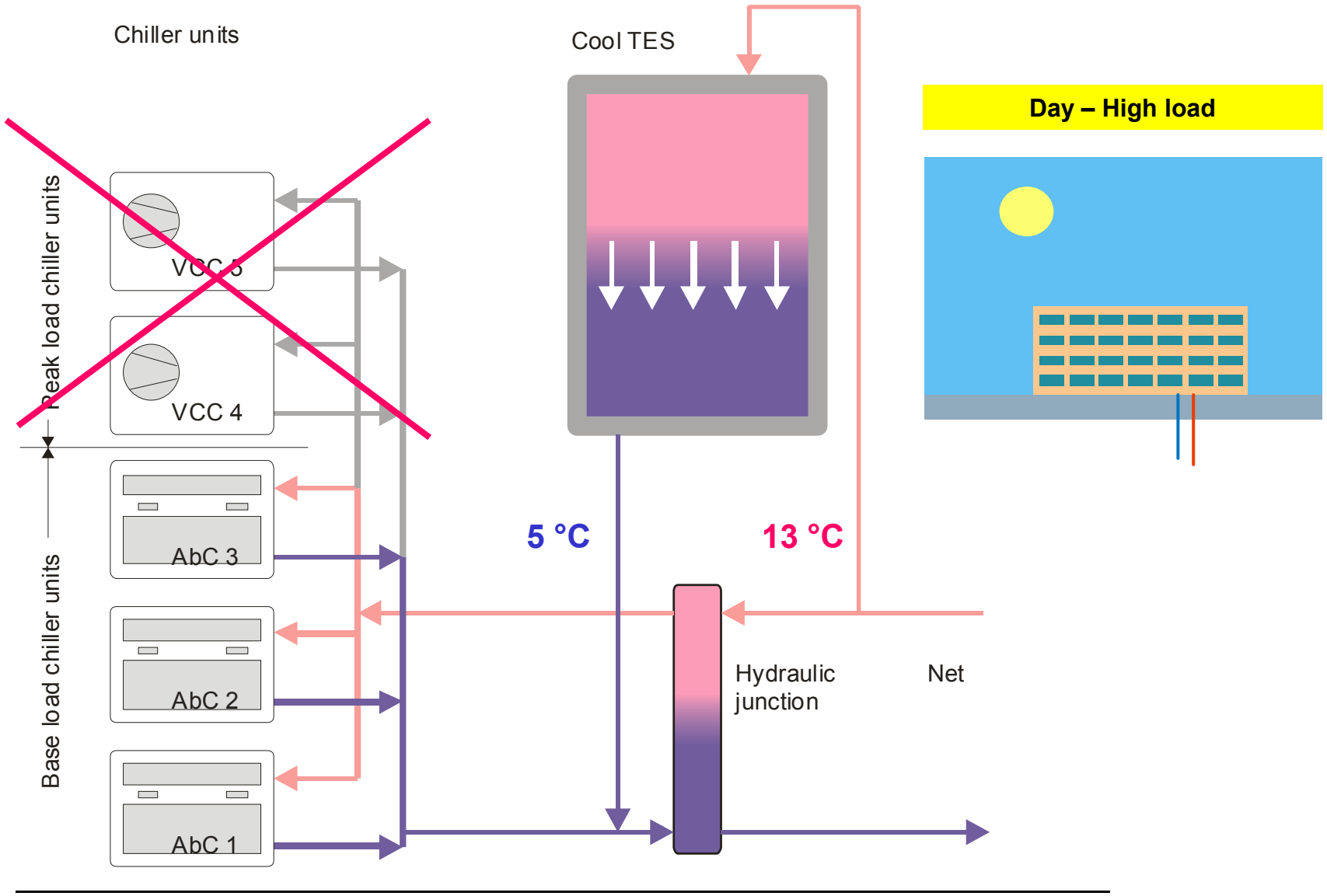

Operation of Cool Thermal Energy Storage (TES) // Discharging

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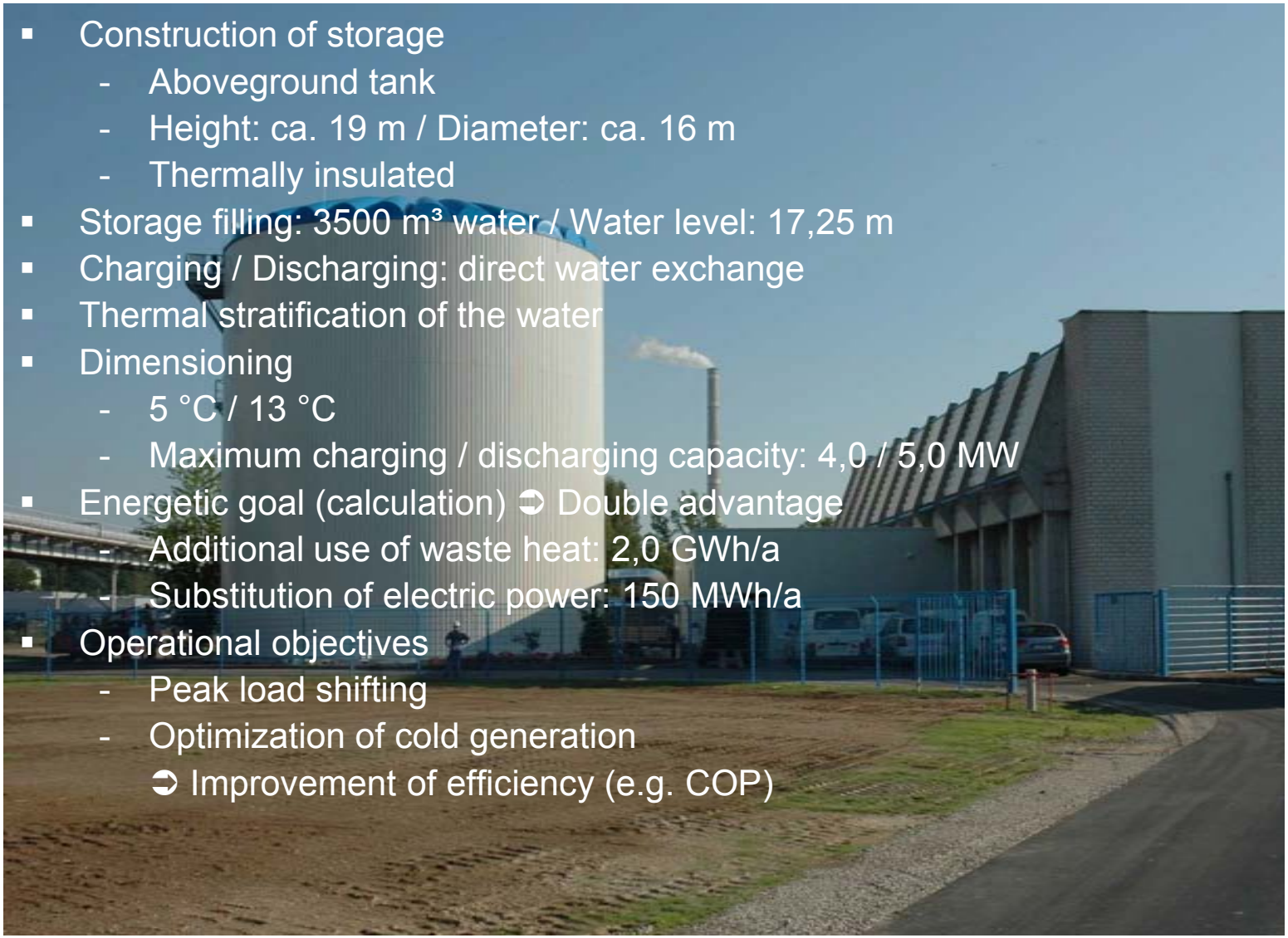
- Construction of storage
  - Aboveground tank
  - Height: ca. 19 m / Diameter: ca. 16 m
  - Thermally insulated
- Storage filling: 3500 m³ water / Water level: 17,25 m
- Charging / Discharging: direct water exchange
- Thermal stratification of the water
- Dimensioning
  - 5 °C / 13 °C
  - Maximum charging / discharging capacity: 4,0 / 5,0 MW
- Energetic goal (calculation) ➲ Double advantage
  - Additional use of waste heat: 2,0 GWh/a
  - Substitution of electric power: 150 MWh/a
- Operational objectives
  - Peak load shifting
  - Optimization of cold generation
    ➲ Improvement of efficiency (e.g. COP)

- Main challenges of the project
  - Integration of cold water store in the complex system

    ➲ Necessity of optimal system operation
  - Low storage losses
    - » Internal losses ➲ good stratification
    - » External losses
  - Limitation of cost
- Monitoring
  - Verification of hypotheses
  - Supervision of operation:

    July 2007 – December 2009
  - Separation of control system and monitoring system
- Presentation of monitoring results

First test of charge of store during at a night shift

Control room, monitoring (left), management of plant (right)

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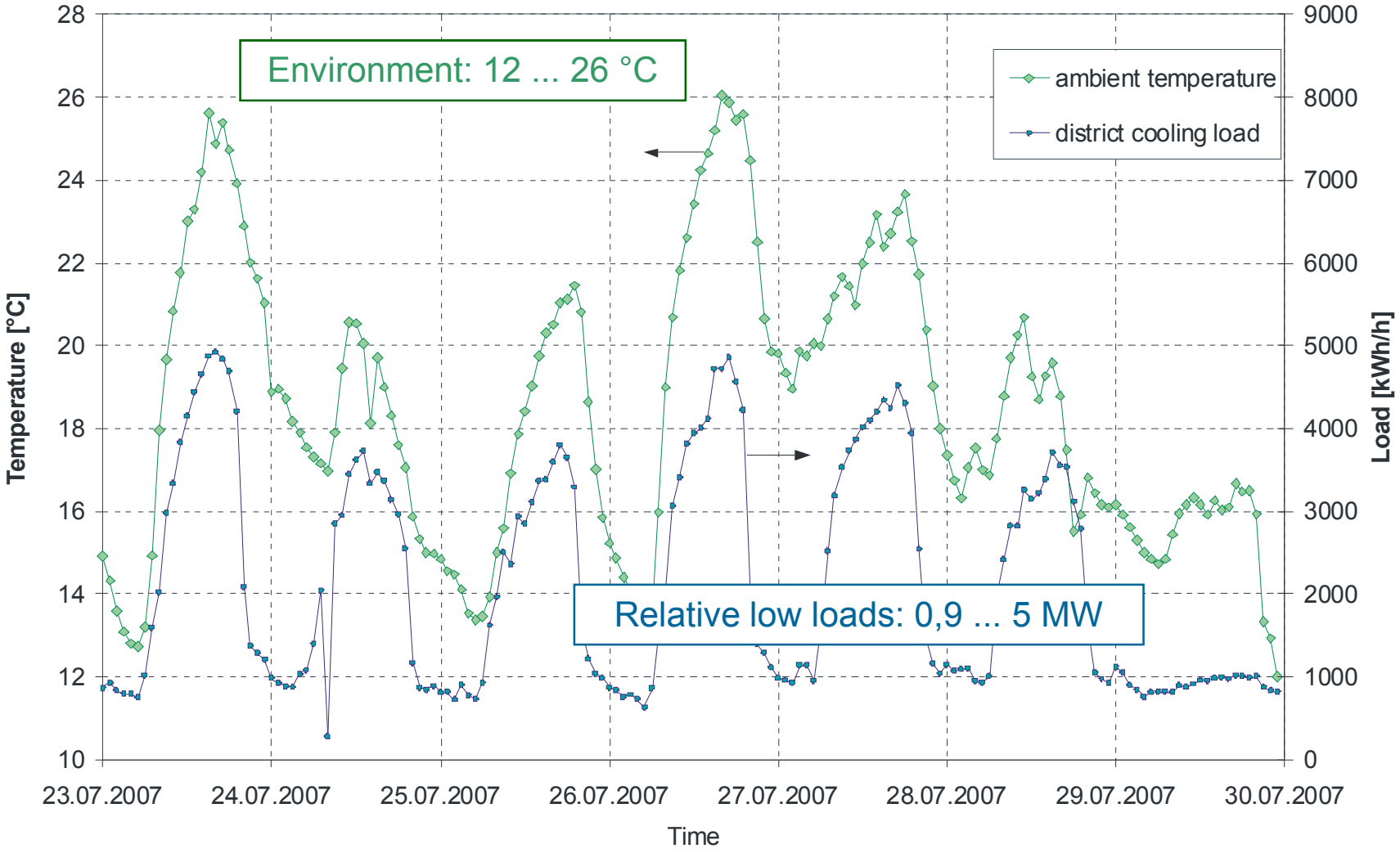

Ambient temperature and district cooling load
in the 30th calendar week 2007

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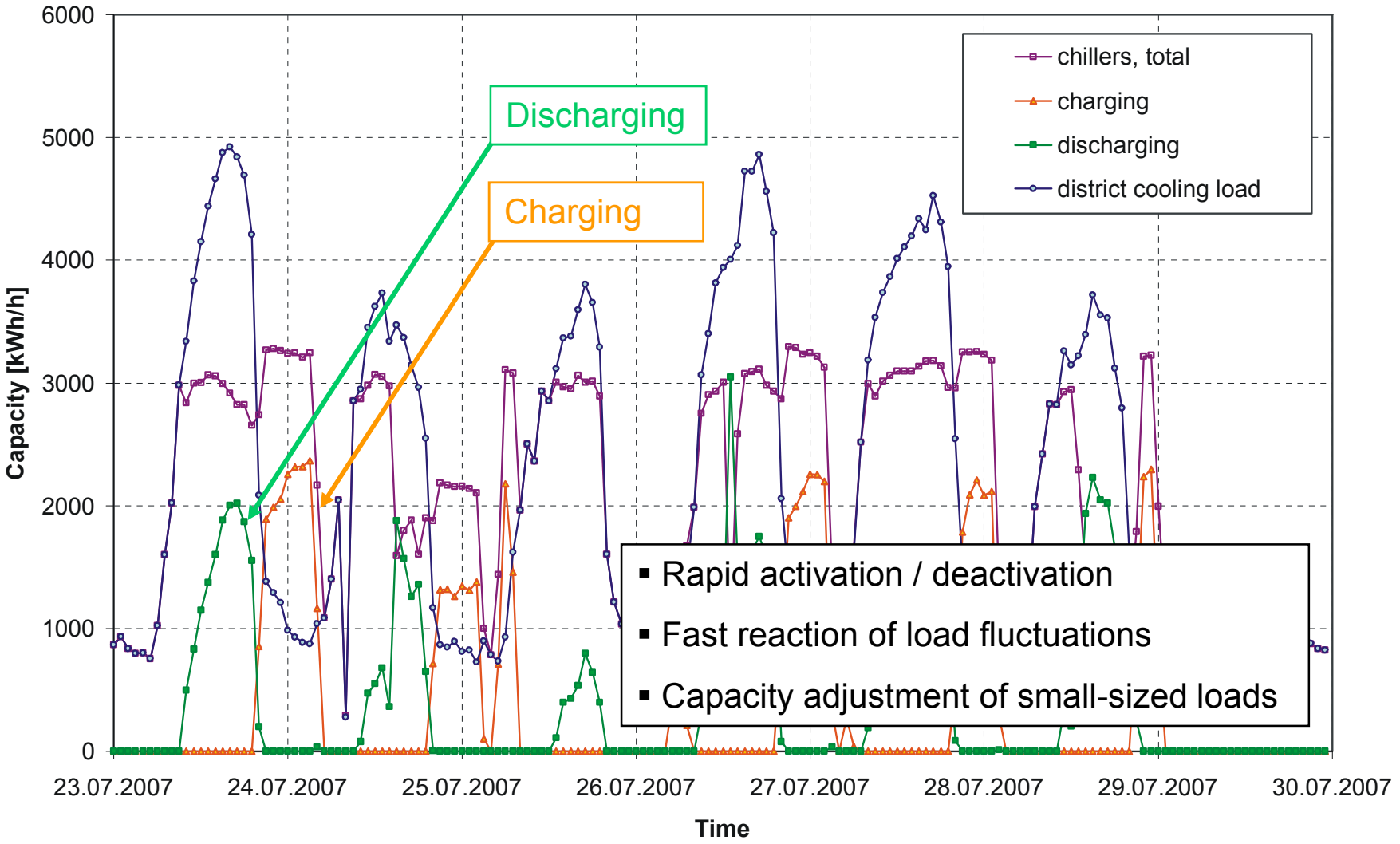

Performances of chillers, storage and net

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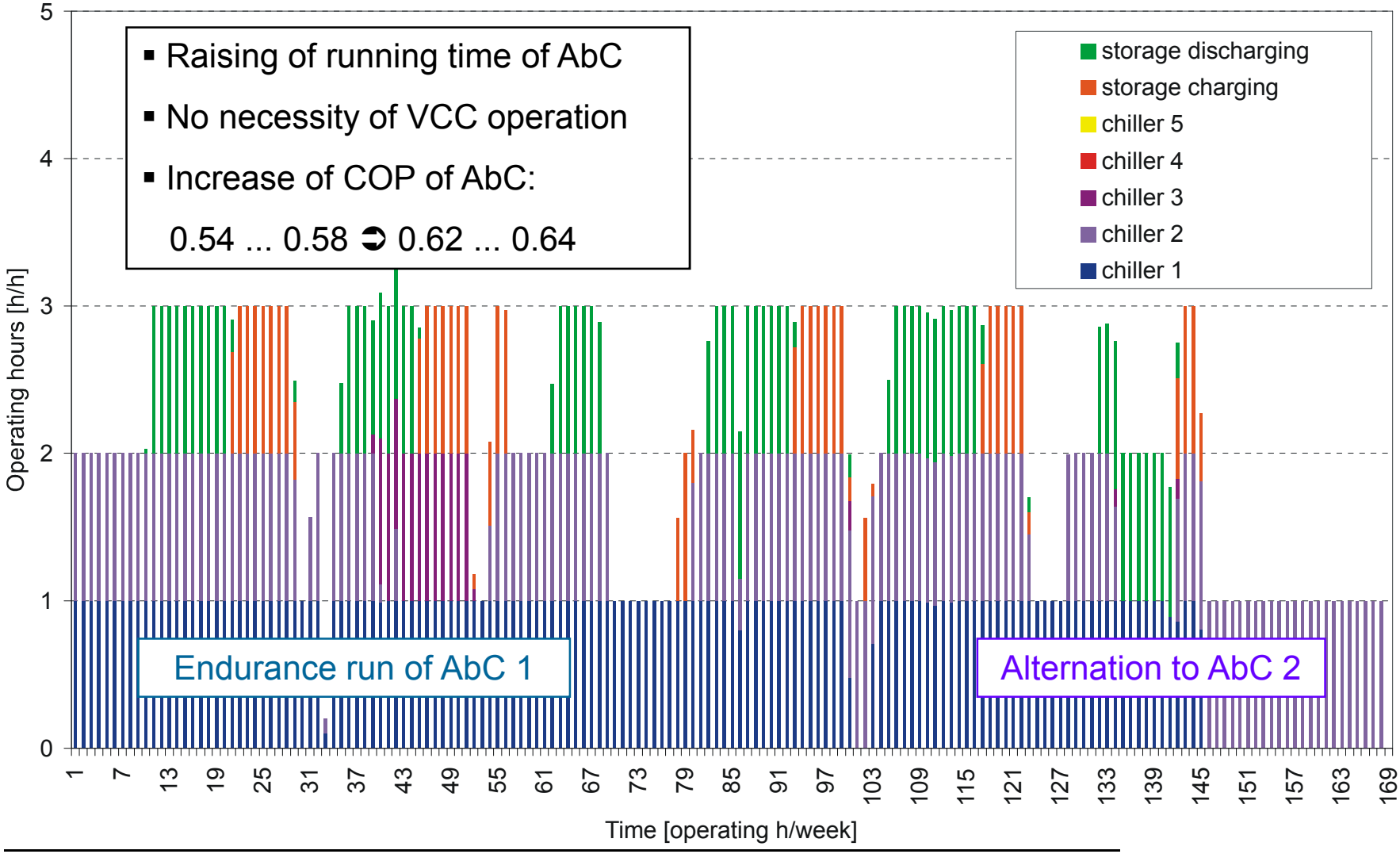

Running time of chillers and storage

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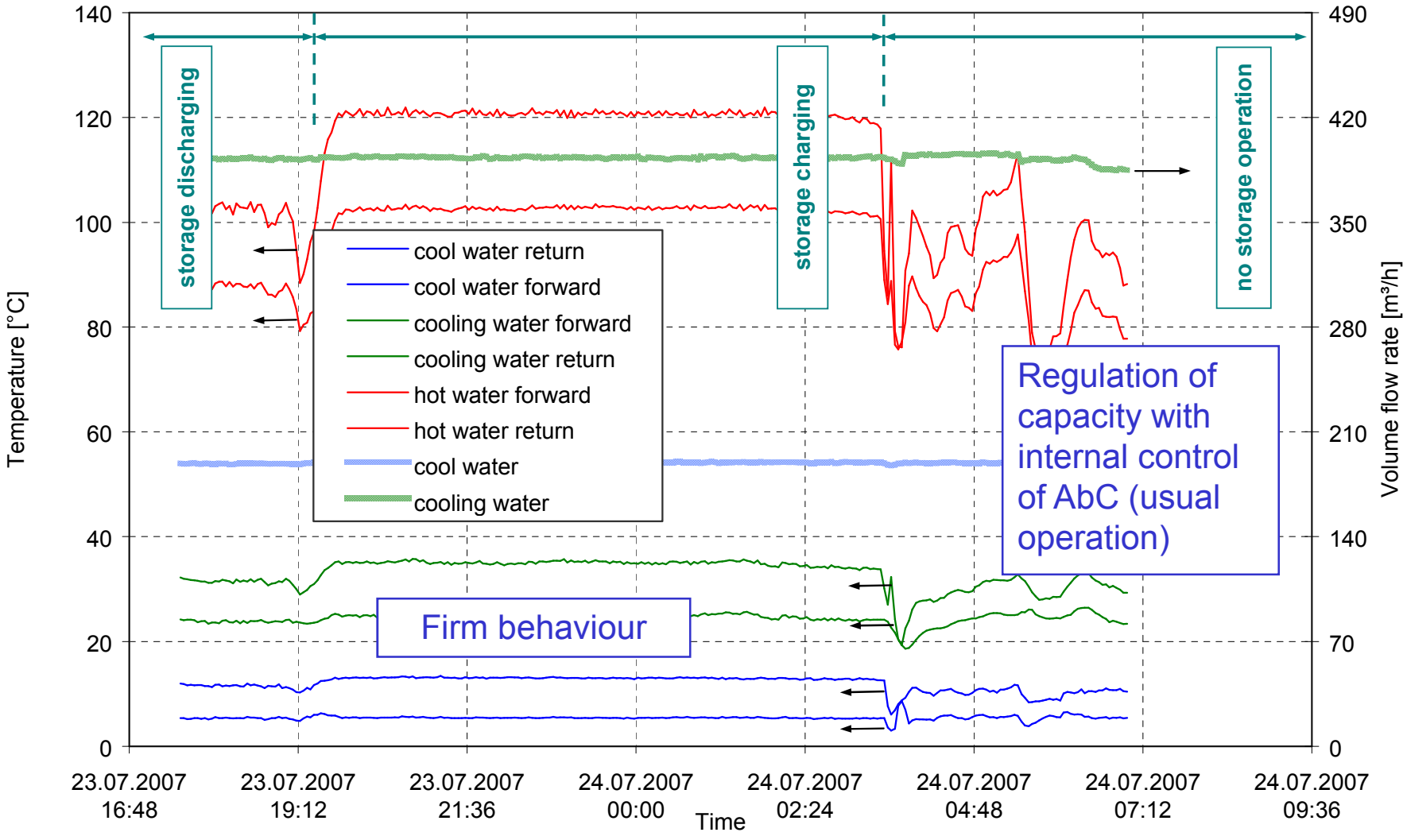

Operational mode of AbC 1 with and without storage operation

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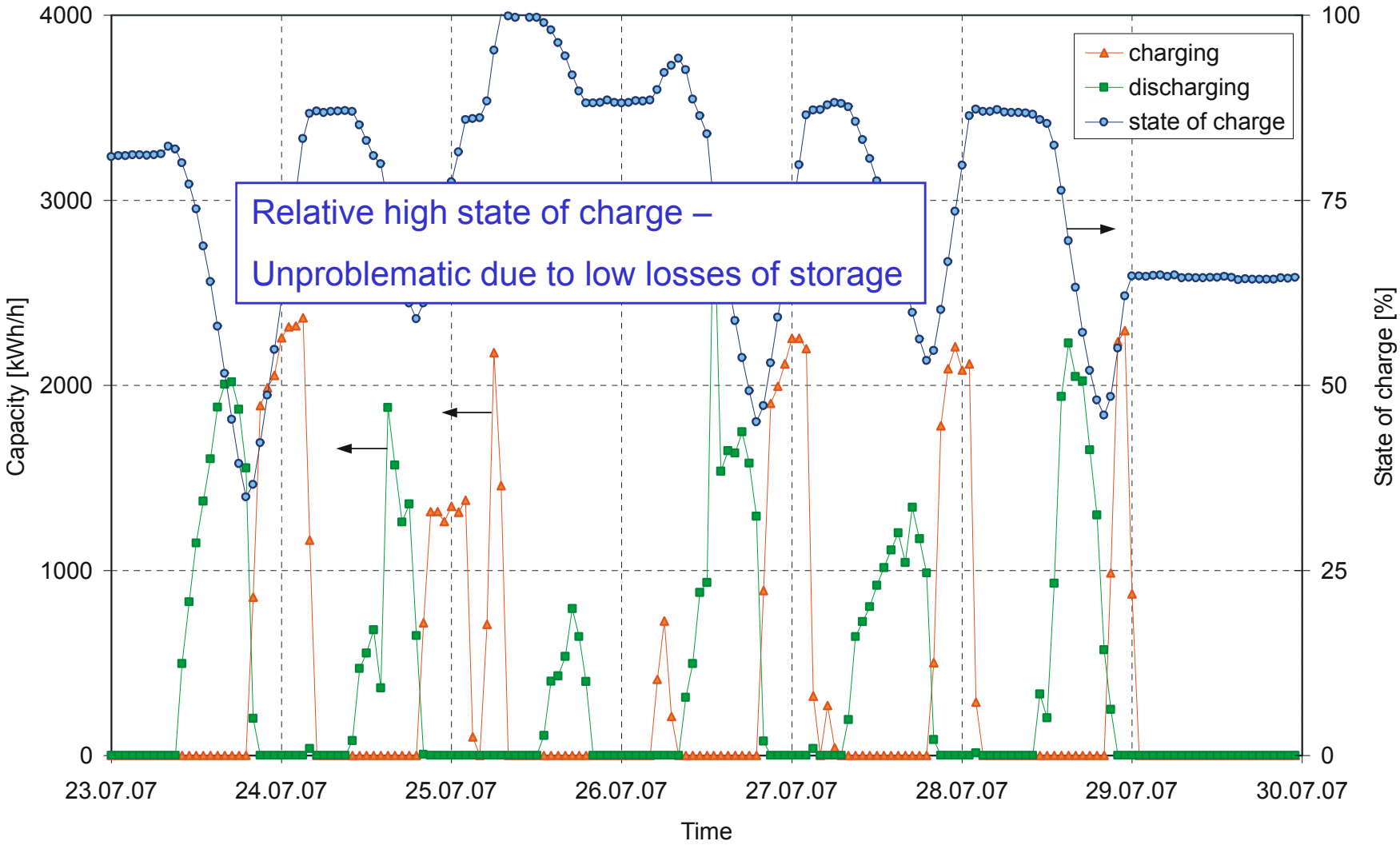

Charge and discharge cycles and state of charge

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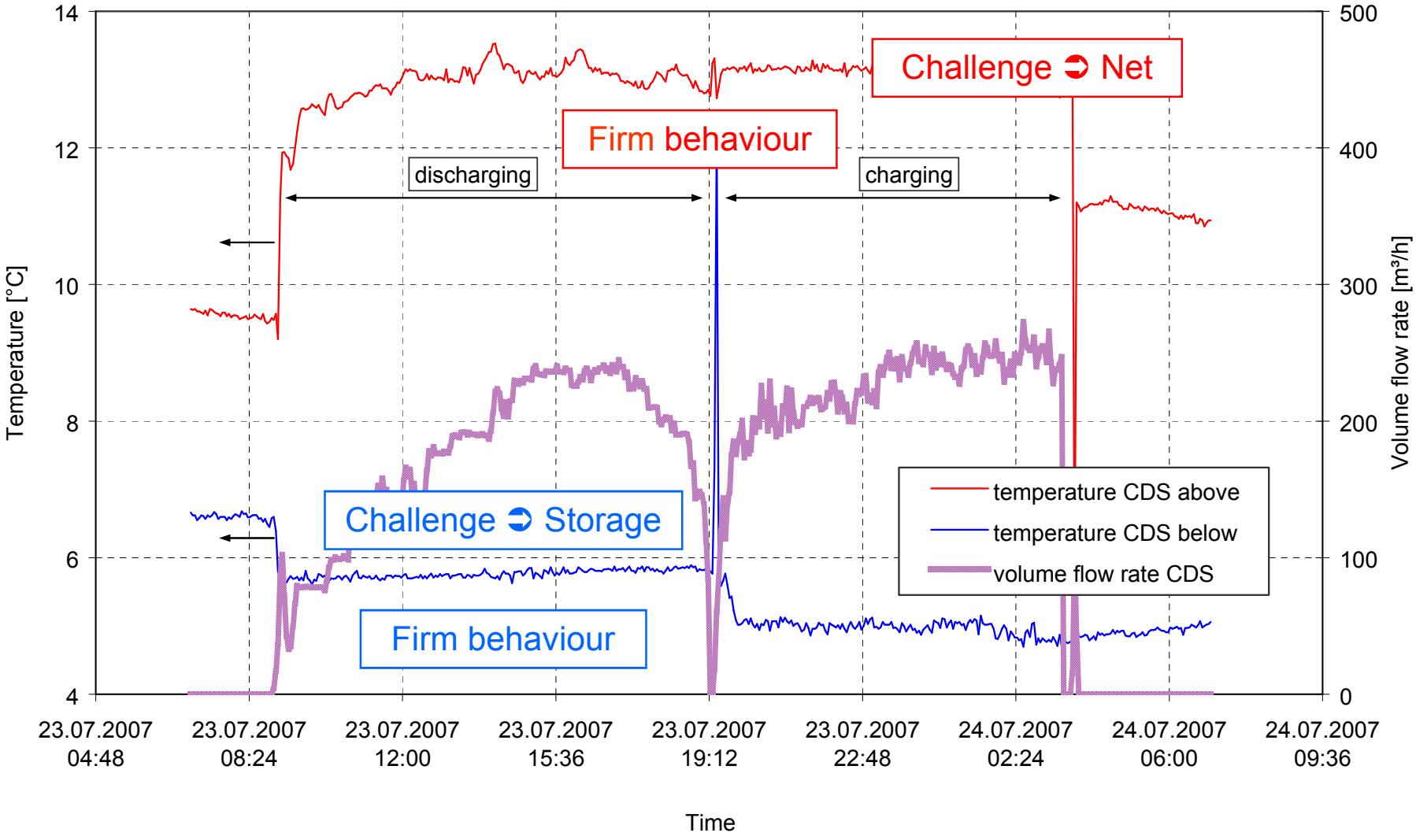

Typical charge and discharge cycle in mid load range // Boundary conditions of charge and discharge system (CDS)

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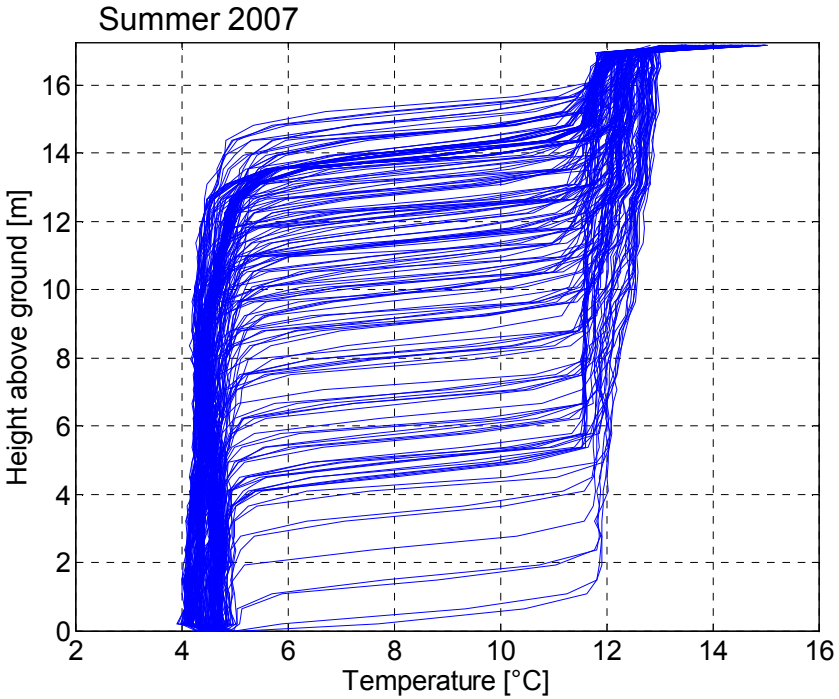

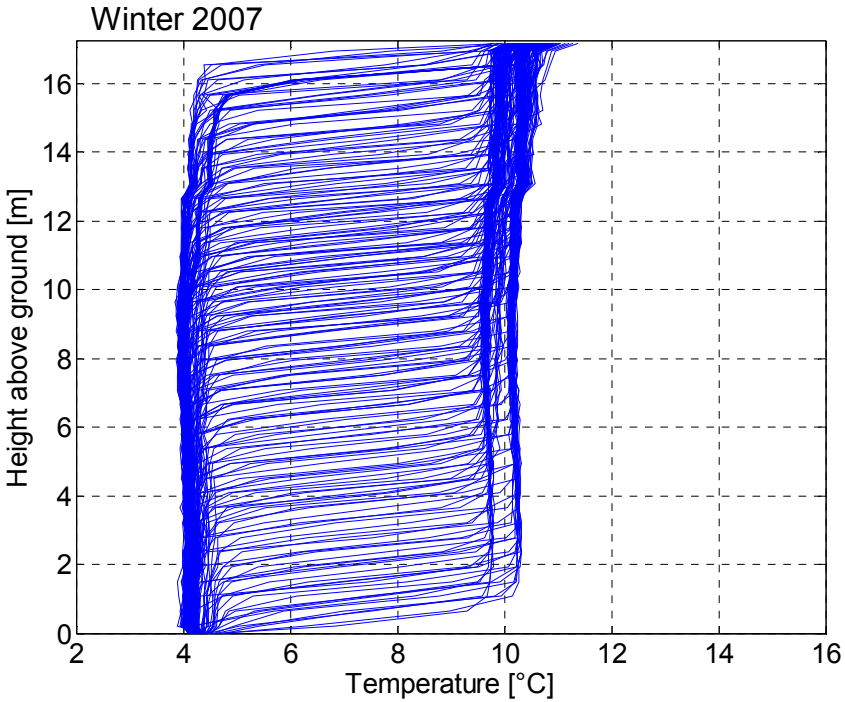

- Reserve of cold water concerning peak load shifting
- Rare regeneration of thermocline
- Growing of thermocline up to ca. 2 m ➲ Low losses upward
- Adherence of temperatures in the net supply (5 °C) and return (13 °C) ➲ Importance for operation, capacity of storage, effective transport of water

- Operation of one AbC
- Cyclic charging and discharging for compensation capacity of chiller unit and low net loads
- Thin thermocline with ca. 1 m
- Descent of net return temperature ➲ Typical behaviour at nets
- High exploitation of capacity

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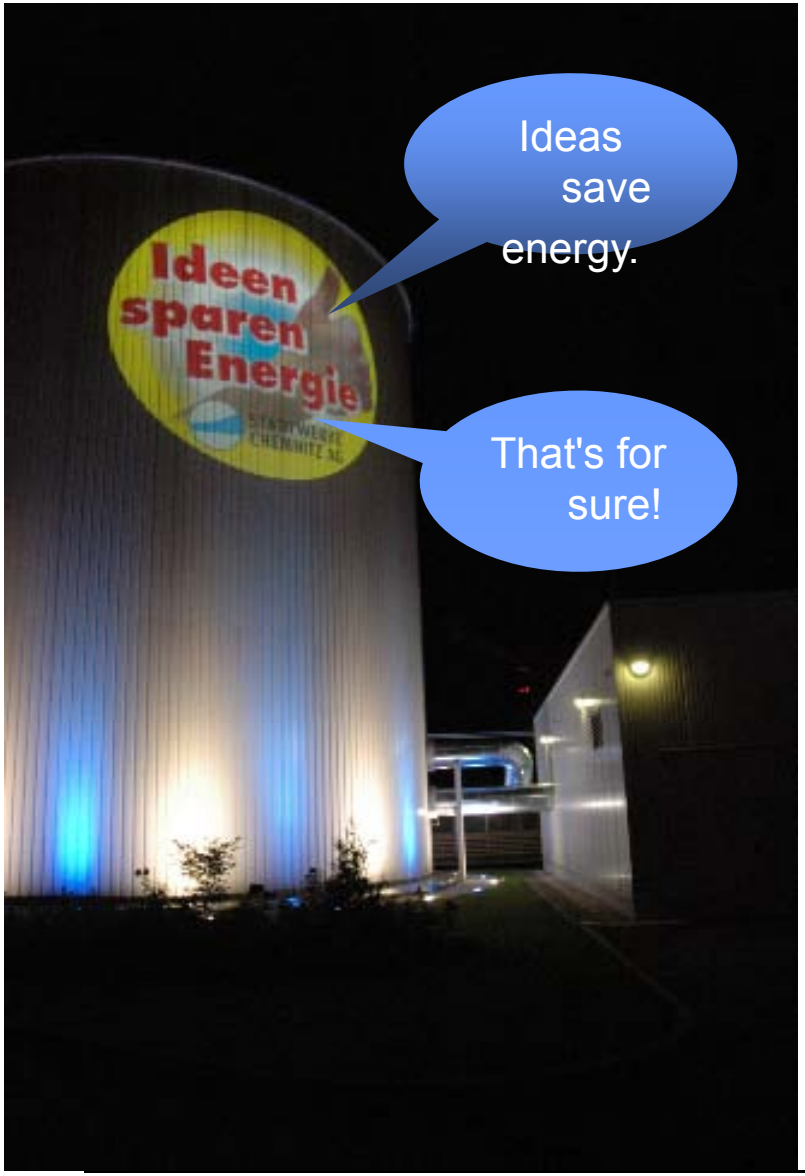

- Results of operation in 2008
  - Degree of storage efficiency: 99,6 %
  - Use of AbC: 99,2 %
  - Substitution electric power: 112 MWh
  - Additional use of waste heat: 718 MWh
- Wide problem-free storage
  - Low losses
  - Good stratification
  - CDS with high capacity
  - 100 % availability
  - Emergency operation (maintenance of chiller units)
- Potential for optimisations
  - Minimisation of admixture at the hydraulic junction
  - Operation of AbC

The storage by night …
Aesthetic, promotion and operational results for 2008

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Silence, safety and a nice store in the night by chance of good hardware and team.

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