Energy Efficiency

by Analysis & Management

AMAP Colloquium
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perpendo Energie- und Verfahrenstechnik GmbH

perpendere (lat.) – to investigate, to examine, to consider carefully
perpendo – I investigate, I examine

Who we are:

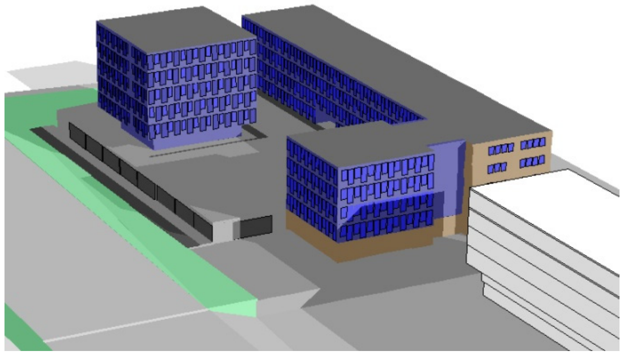
- the energy specialists for analysis & optimisation of complex issues
- highly qualified engineers from various different disciplines
- experience of more than 500 projects in commerce and industry

What we do:

- Energy Design – For new developments or extensions
- Energy Efficiency Analysis – For existing sites and processes
- Energy Management – Design, controlling and benchmarking
- Sustainability – Carbon footprinting and emissions reduction

Energy Design – For new developments or extensions

Knowing at an early stage if an idea will work – simulation is the way to be sure

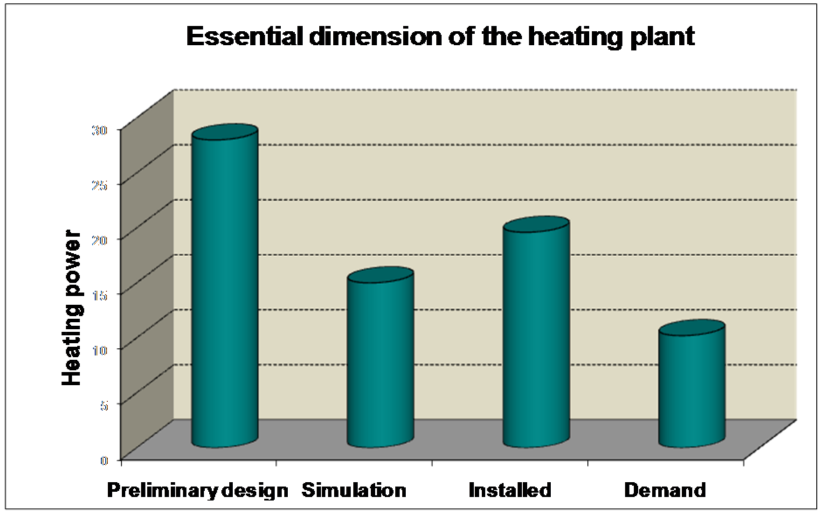


Typical aims of using simulation tools:

- minimising energy costs
- ensuring thermal comfort
- avoiding unwanted operating conditions

Benefits of using simulation tools:

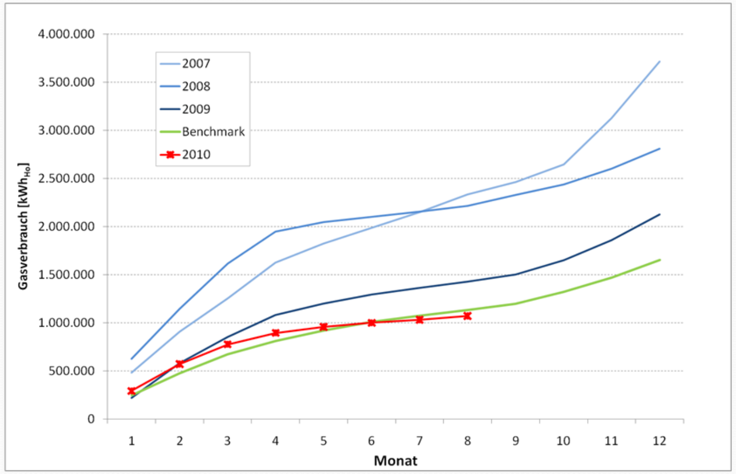
- optimisation of material usage and the need for technical equipment (sizing)
- minimising investment costs
- high planning reliability by using detailled analyses
- evaluation of life cycle costs



Energy Efficiency Analyses – Methods for Optimisation

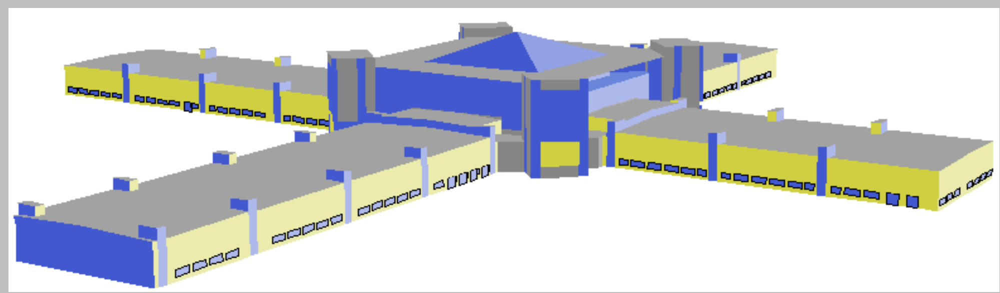
Data-based analysis

- logging, handling and evaluation of existing energy data
- increasing transparency of status-quo

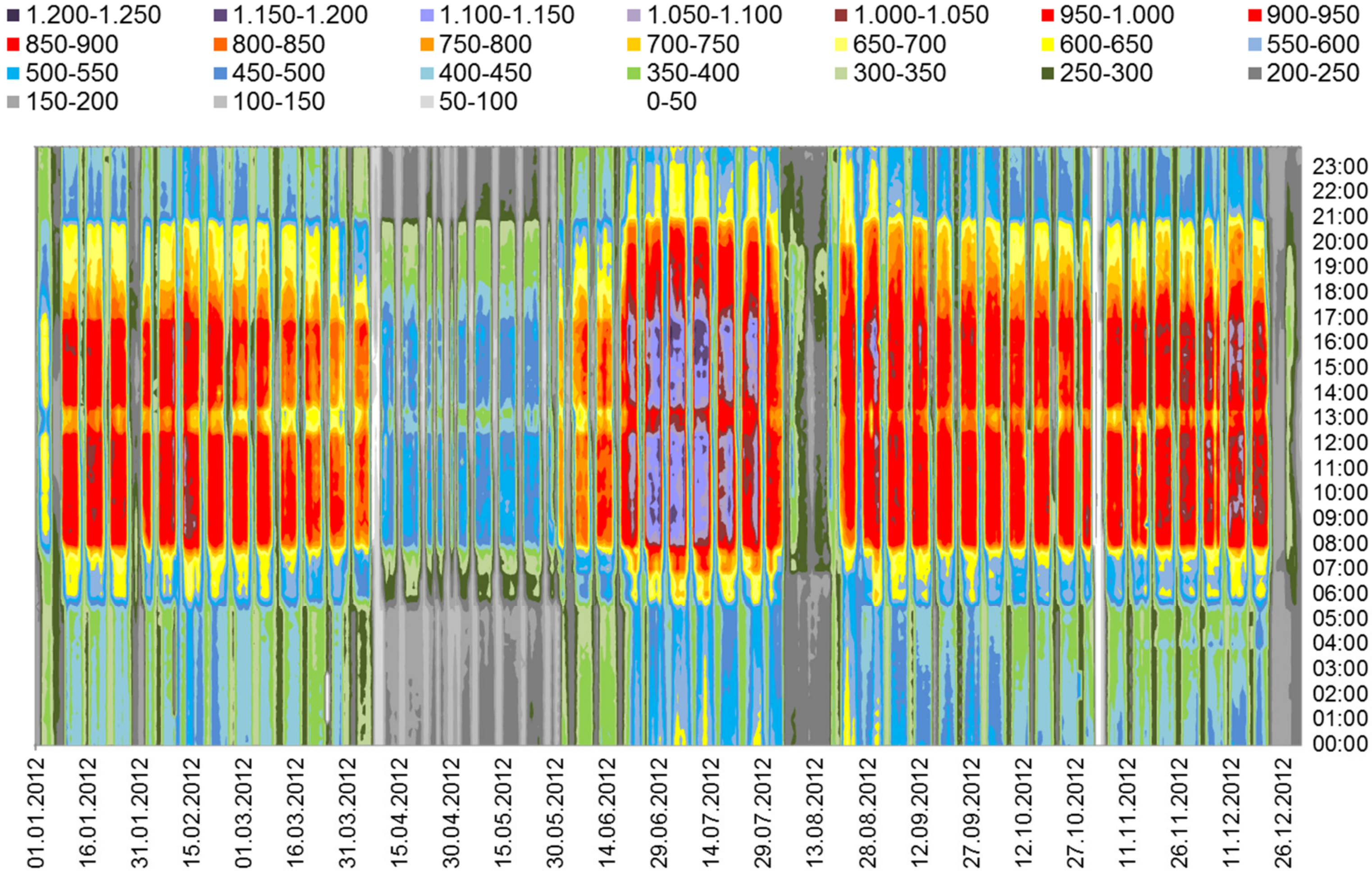


Model-based analysis

- quantification of quantities not-measured
- forecast of modifications or measures („what if“)

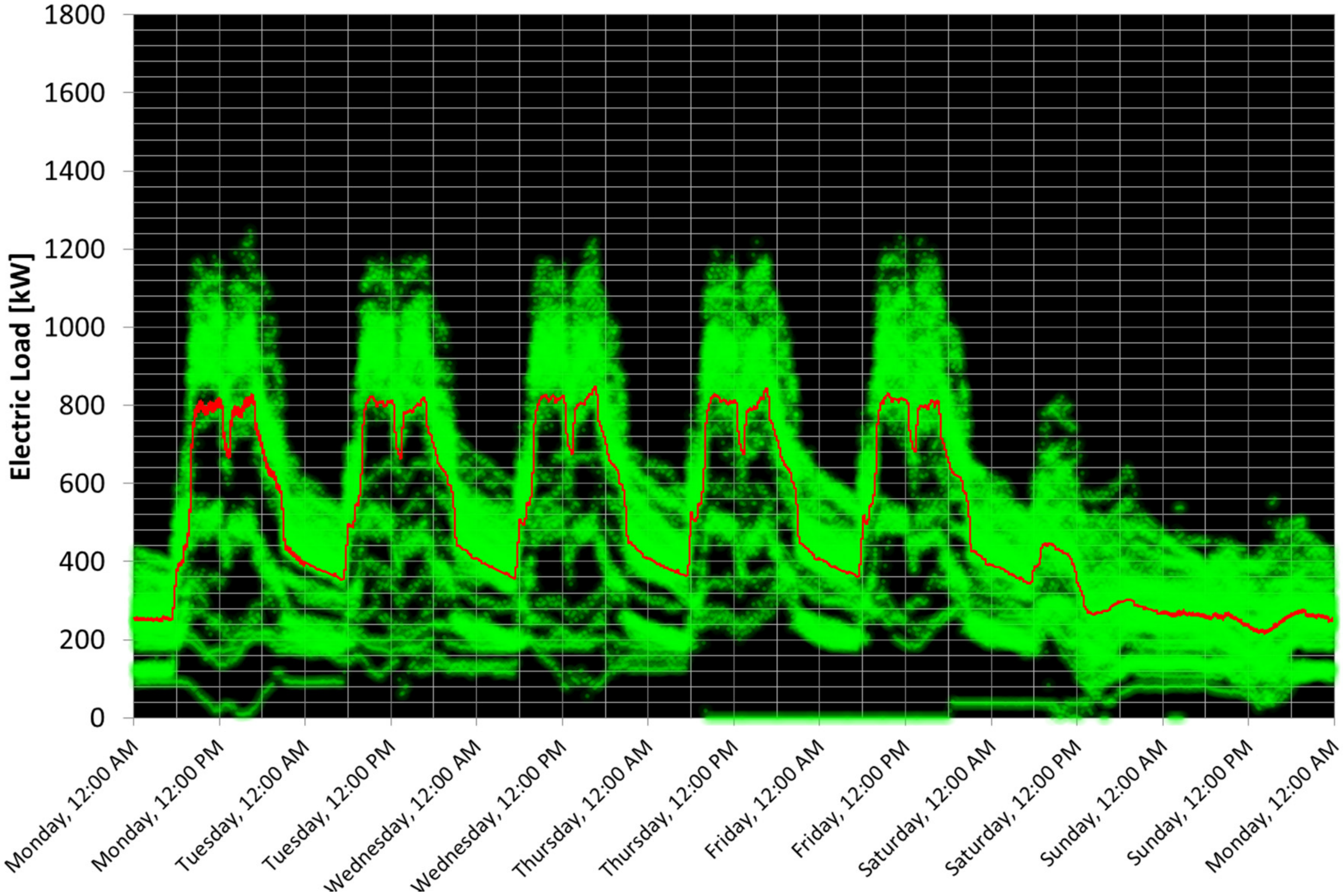


Energy Efficiency Analyses – Spectralanalysis of Electricity Demand



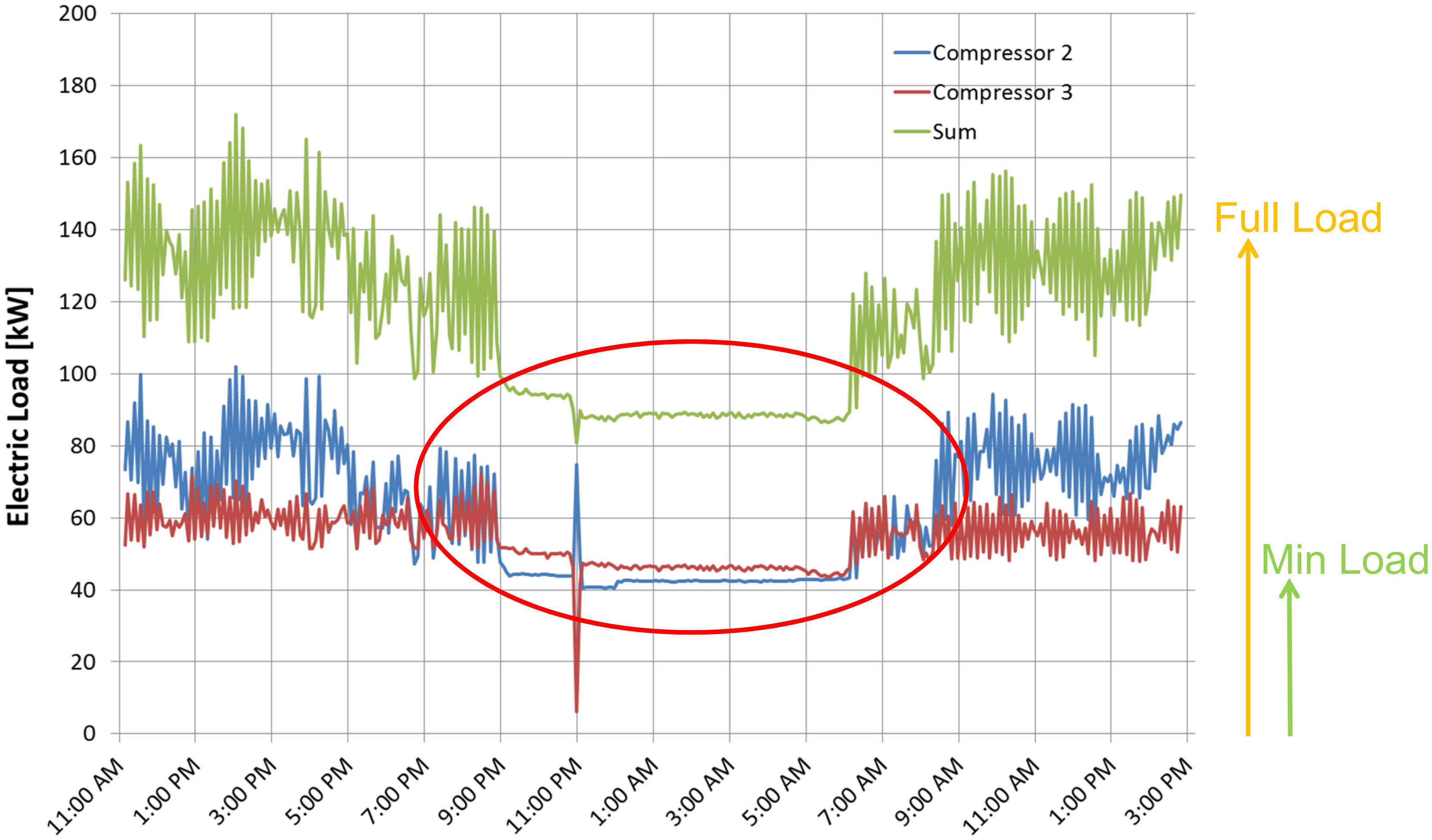
Based on electricity supplier load data.

Energy Efficiency Analyses – Weekly Electricity Load Curves



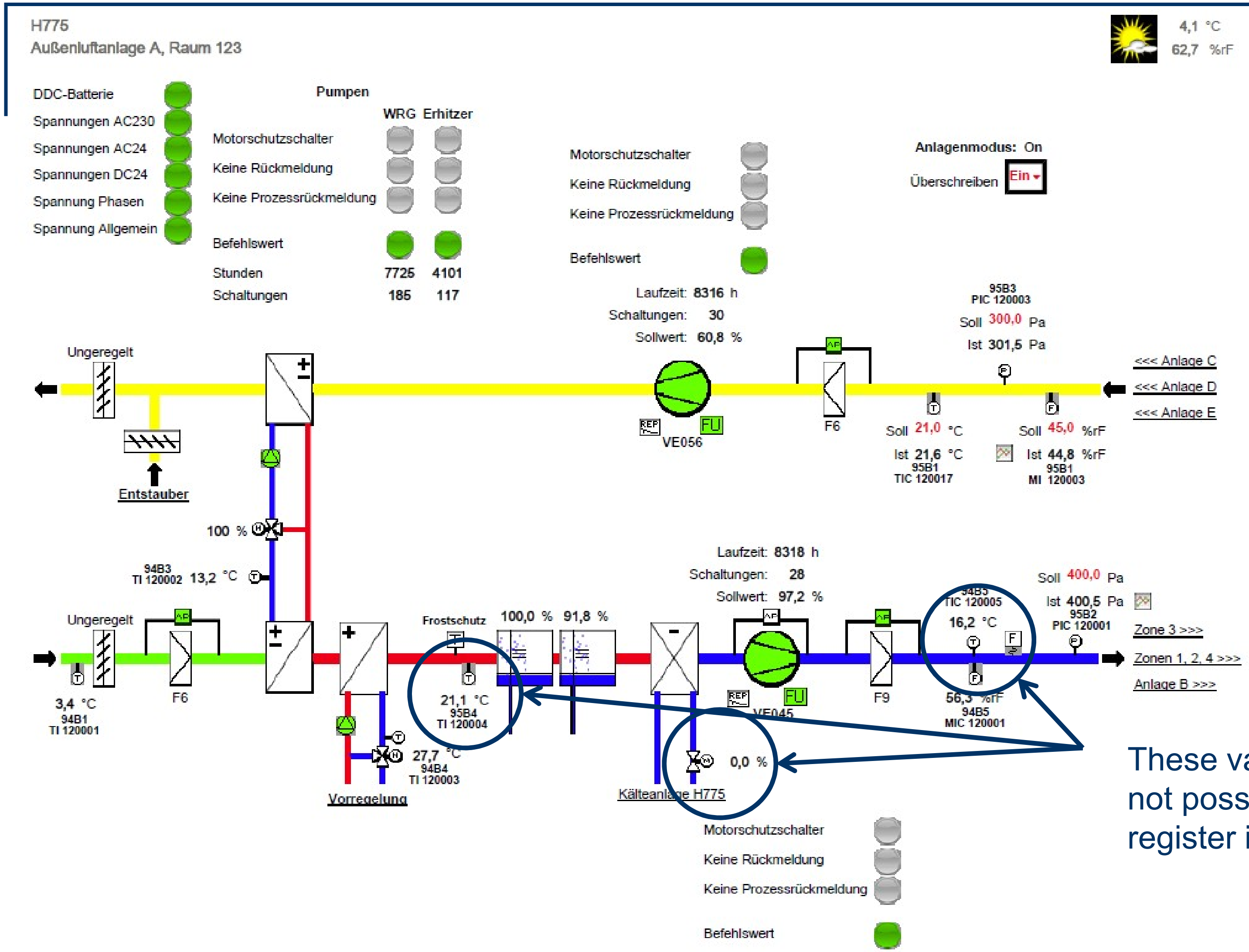
Based on electricity supplier load data.

Energy Efficiency Analyses – Measurements



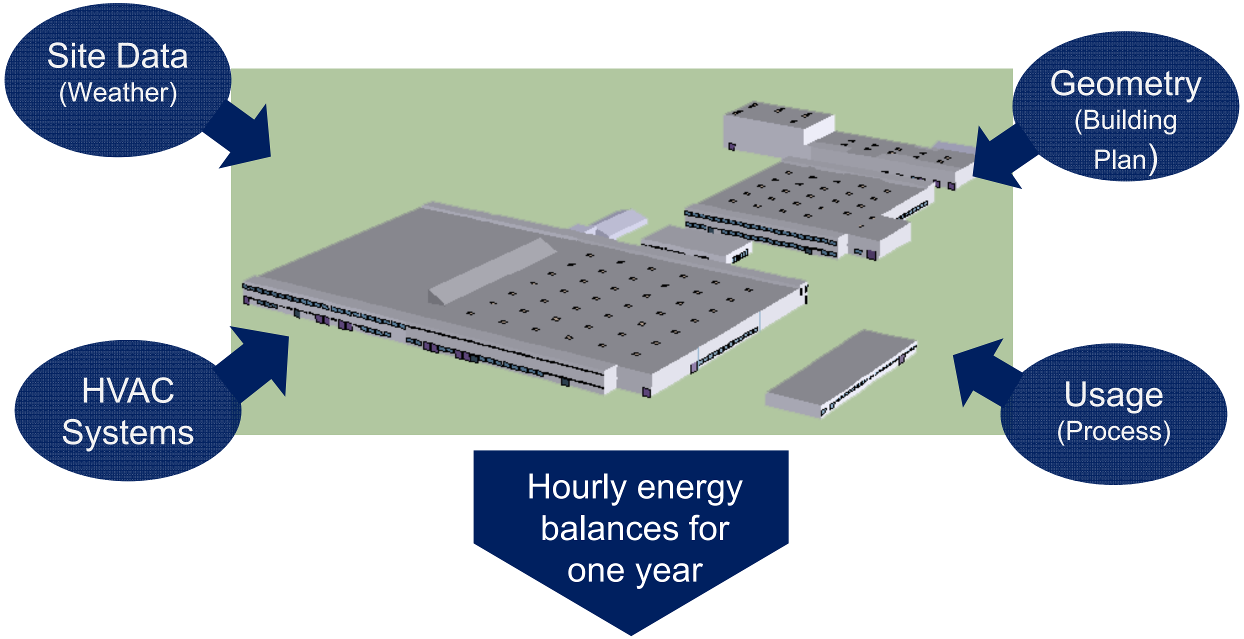
Single Compressor rated at 136 kW on load. Min Load Variable Speed 30 %

Energy Efficiency Analyses – BMS Display of a HVAC System



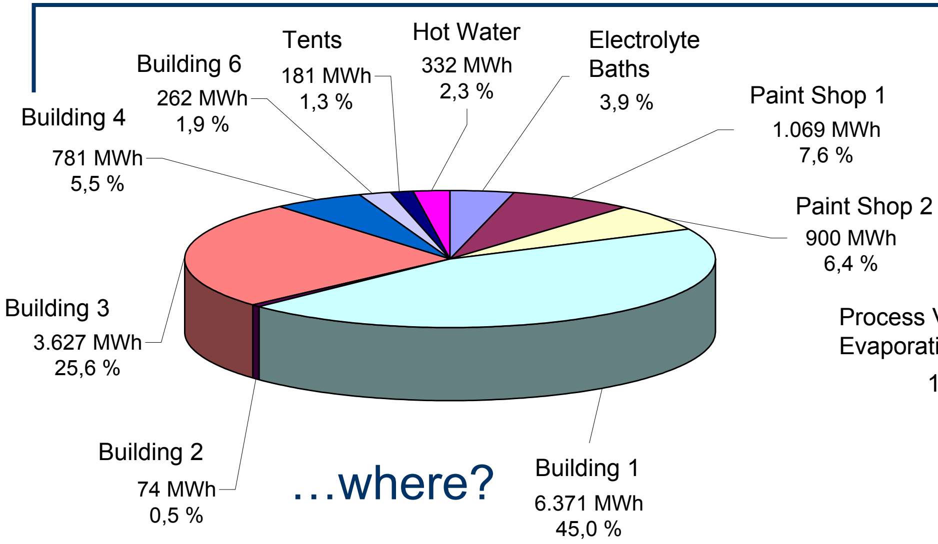
These values are physically not possible if the cooling register is closed.

Energy Efficiency Analyses – Simulation Based Analysis



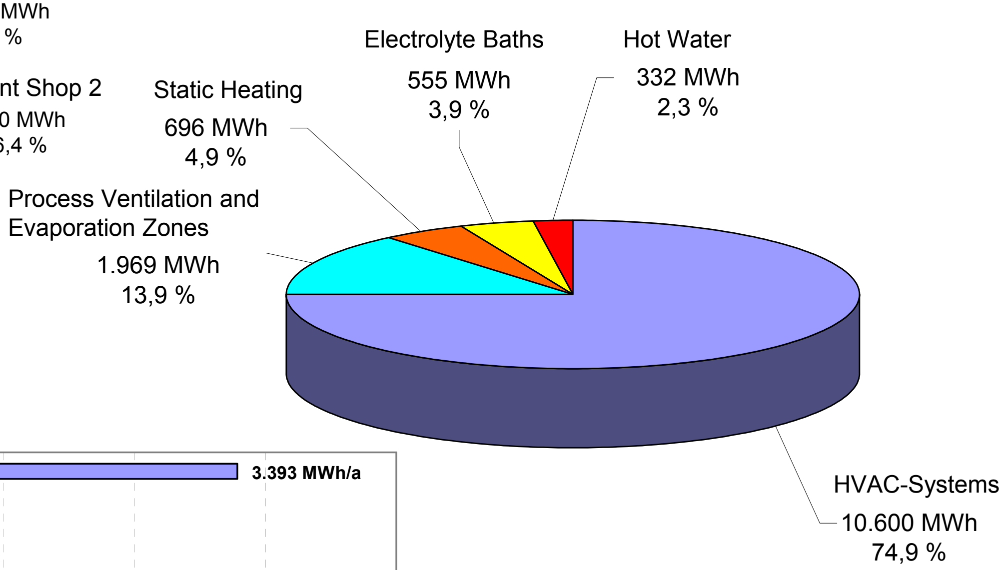
- Breakdown of the energy demand to single consumer groups
- Interaction between the energy consumers
- Identification of unusual or unwanted operational conditions
- Quantification of the benefit of saving measures
- Forecast of the energy demand under changed operating conditions
- Design basis for the development of an energy controlling system (➔ Benchmarks)

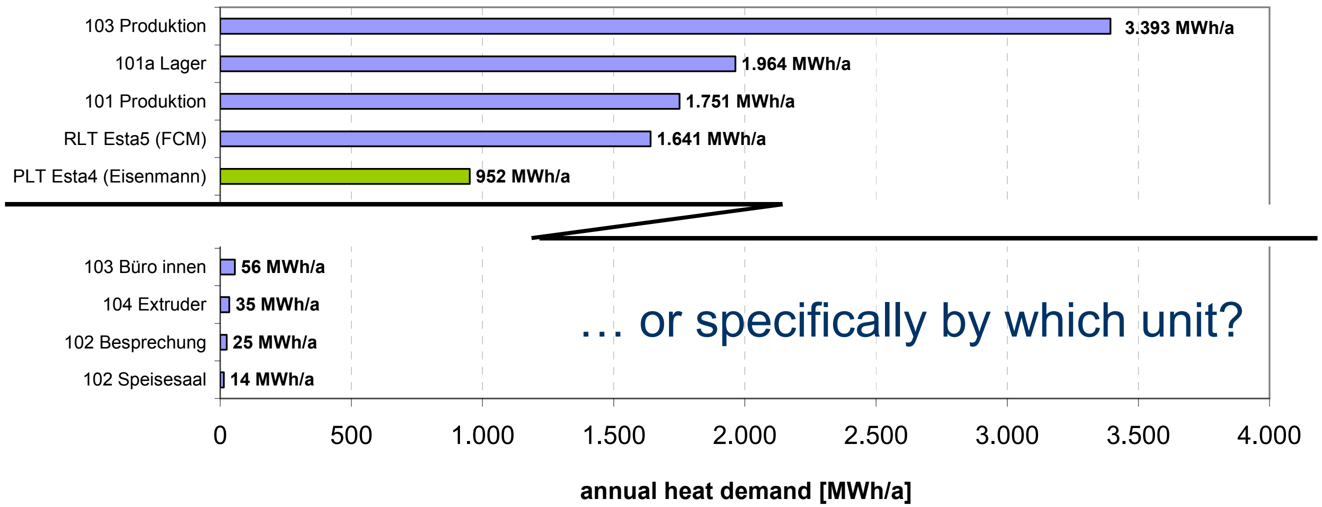
Energy Efficiency Analyses – Evaluation of the Current State: Heat Consumption



…where?

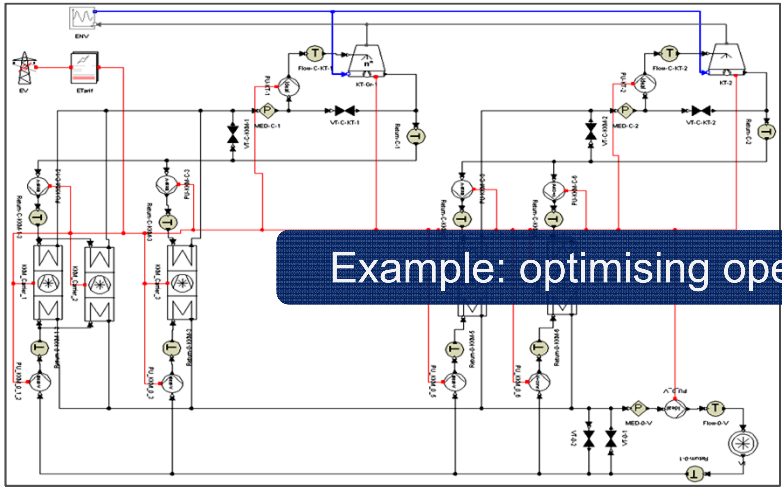
…what is it used for?

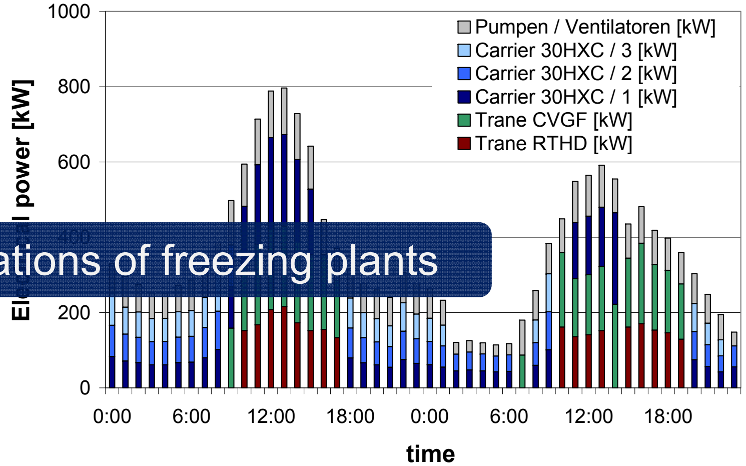




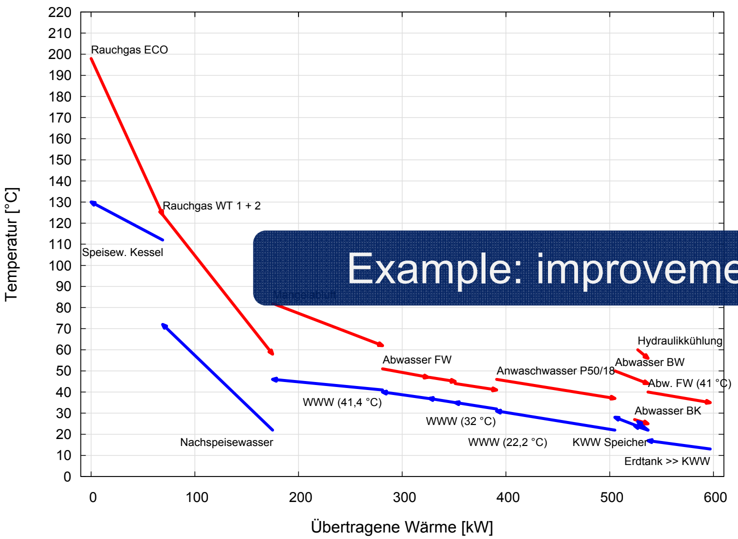
… or specifically by which unit?

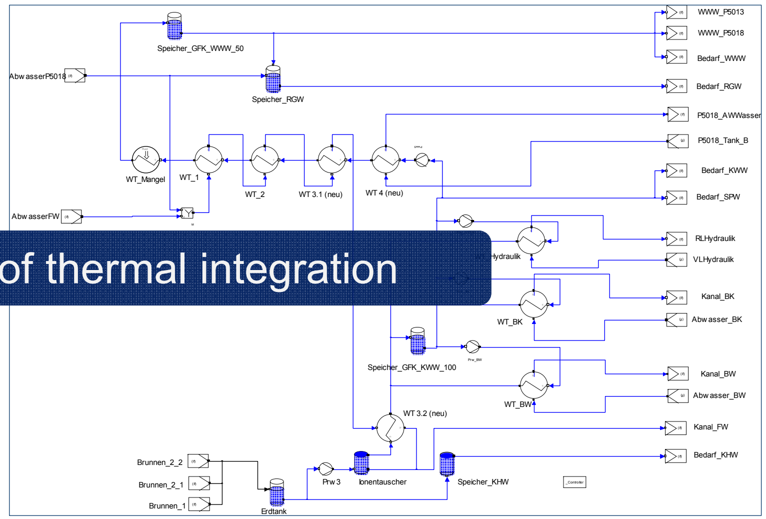
Energy Efficiency Analyses – Further Simulation Instruments





Example: optimising operations of freezing plants





Example: improvement of thermal integration

Energy Efficiency Analyses – Fields of Application for Simulations

Buildings

- dynamic building and plant simulation (heating, ventilation and air conditioning)
- light simulation for determination of daylight proportion
- building element simulation for optimisation of individual constructions
- computational fluid dynamics (CFD)

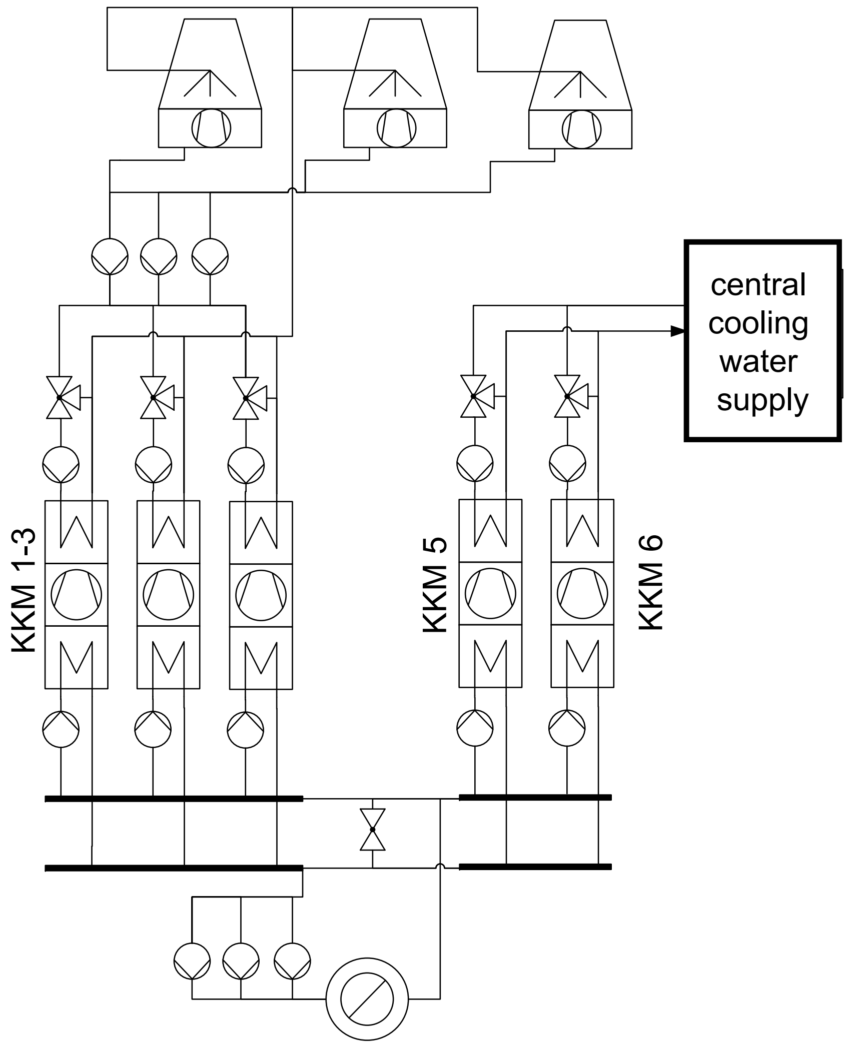
Processes and facilities

- optimisation of facility plants (heat / cooling energy, vapor, compressed air, ...)
    - operation strategies
    - sequential switching
    - dynamic load adjustement
    - cogeneration and trigeneration, heat pumps
- thermal integration
- waste heat utilization and heat recovery

Optimisation of a Chilling System

The setting:

- 5 cold water chillers (KKM)
- 3 of identical type
- 2 independent cooling tower systems
  - Group of 3 cooling towers
  - Central cooling water supply
- Central cold water distribution network



Key data:

- Required cooling: 350 … 3.400 kW
- Annual demand: 9,7 GWh/a

Chilling System Optimisation: Control Strategy

Commitment control of the chillers based on the actual chilling power delivered:

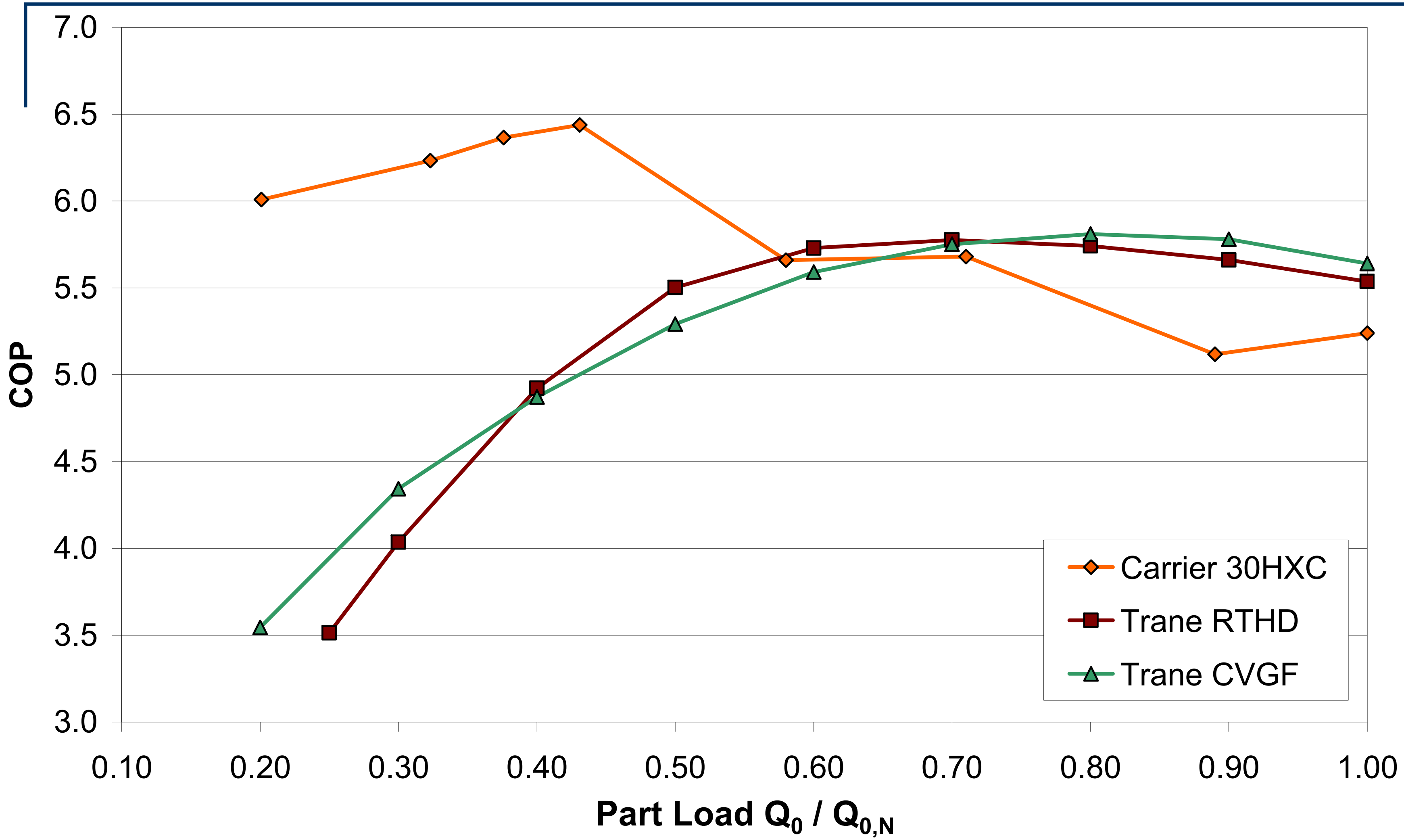
Switch-on condition for the next chiller: 95 % capacity of the chillers in operation exceeded for 10 min

Switch-off condition for the last chiller: 85 % of the available capacity undercut for 15 min

Switching sequence	Carrier 30HXC / 1	Carrier 30HXC / 2	Carrier 30HXC / 3	Trane RTHD	Trane CVGF
Summer	2	3	4	5	1
Winter	1	3	4	2	5

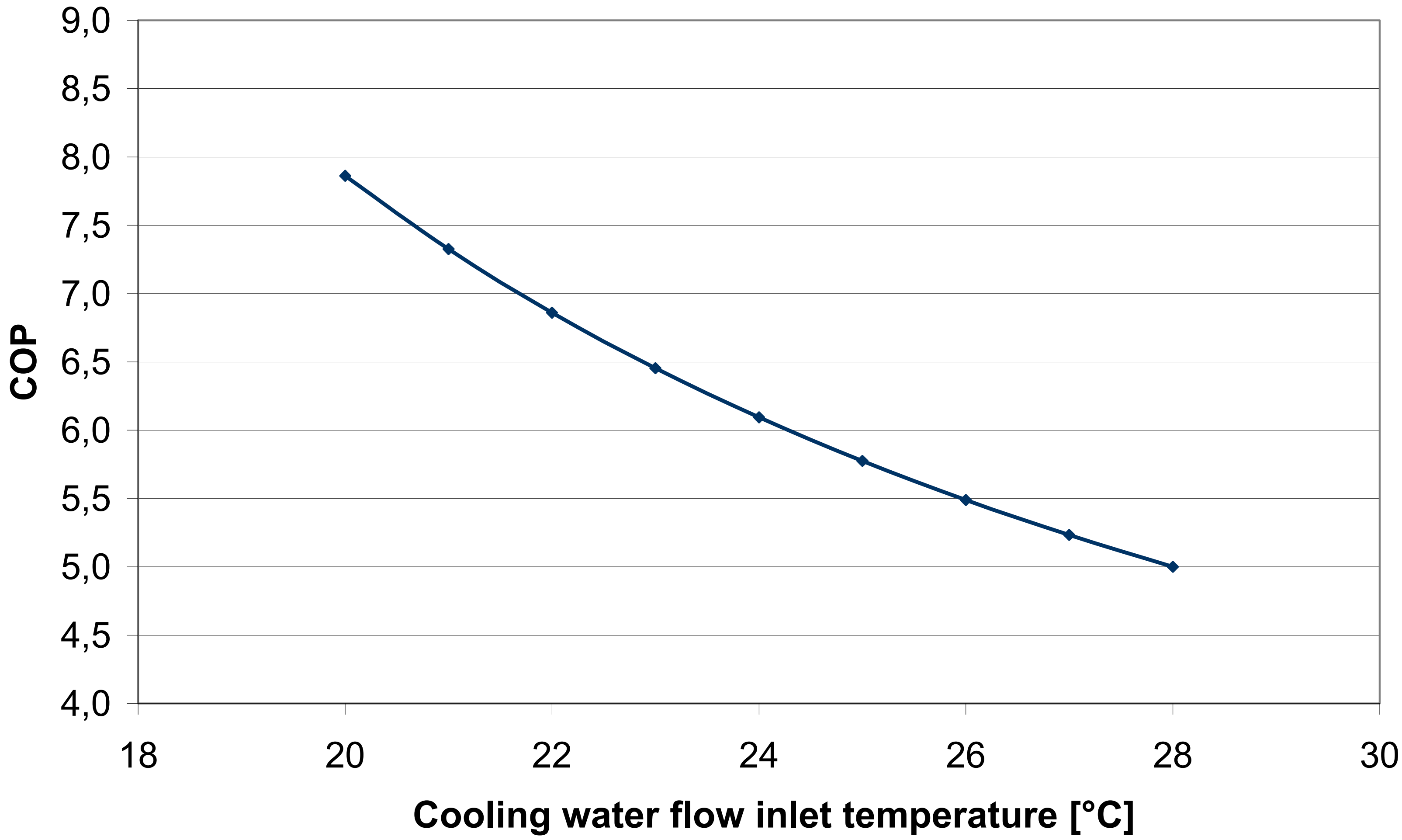
=> Question: Is this switching sequence the optimal choice?

Chilling System Optimisation: Part Load Efficiency of the Chiller Types



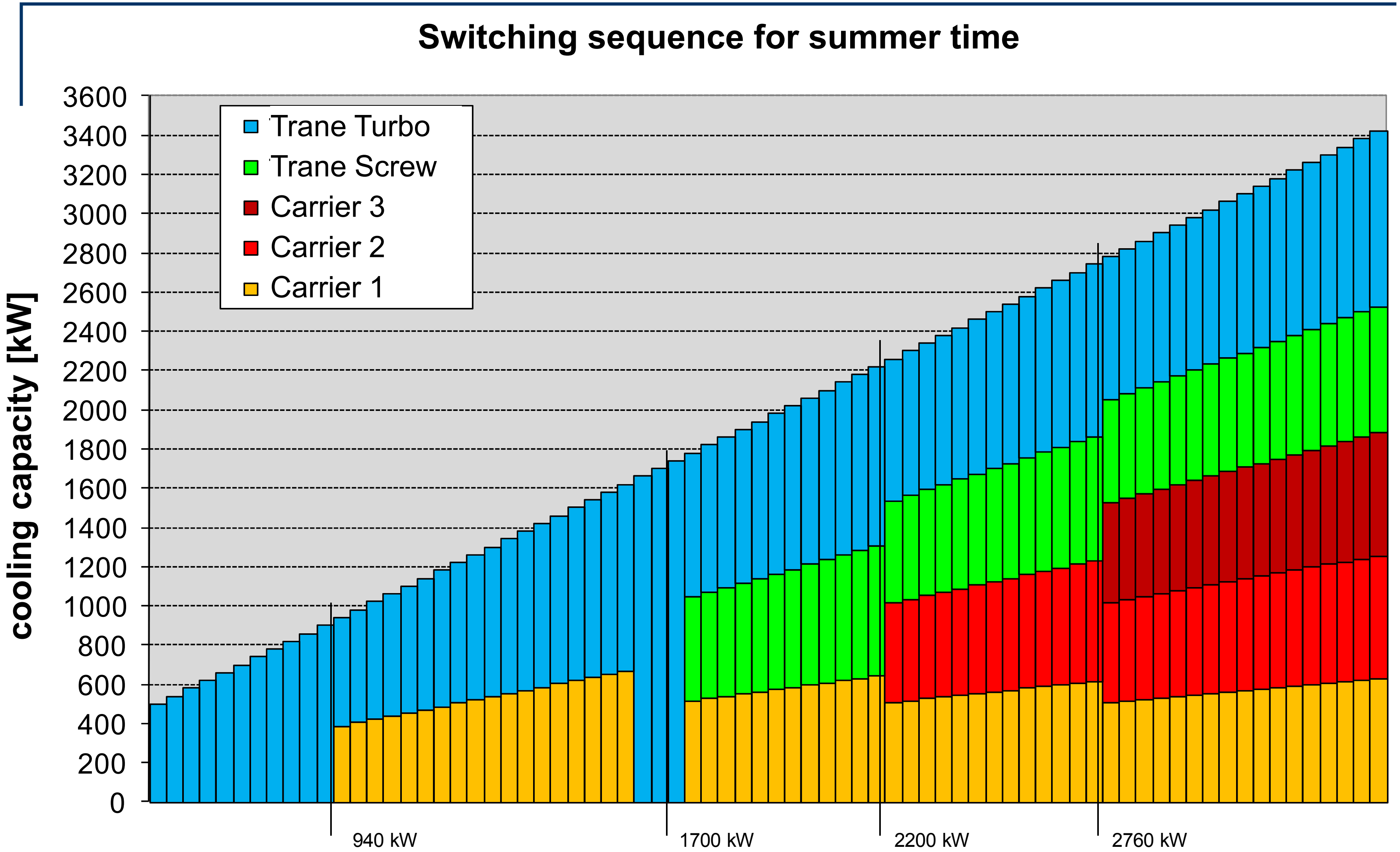
Cold water: 6 / 12 °C, Cooling water: 26 / 32 °C

Chilling System Optimisation: Dependency of the COP on the Fluid Temperatures



Cold water 6/12 °C, COP at 6/12 °C – 28/32 °C = 5, ξ = const.

Chilling System Optimisation: Switch on / off conditions



Chilling System Optimisation: Results

Measures:

- Changing to optimised switching sequences
- Swap condenser side pumps for evaporator side pumps
- Adapt the cooling water temperature set point

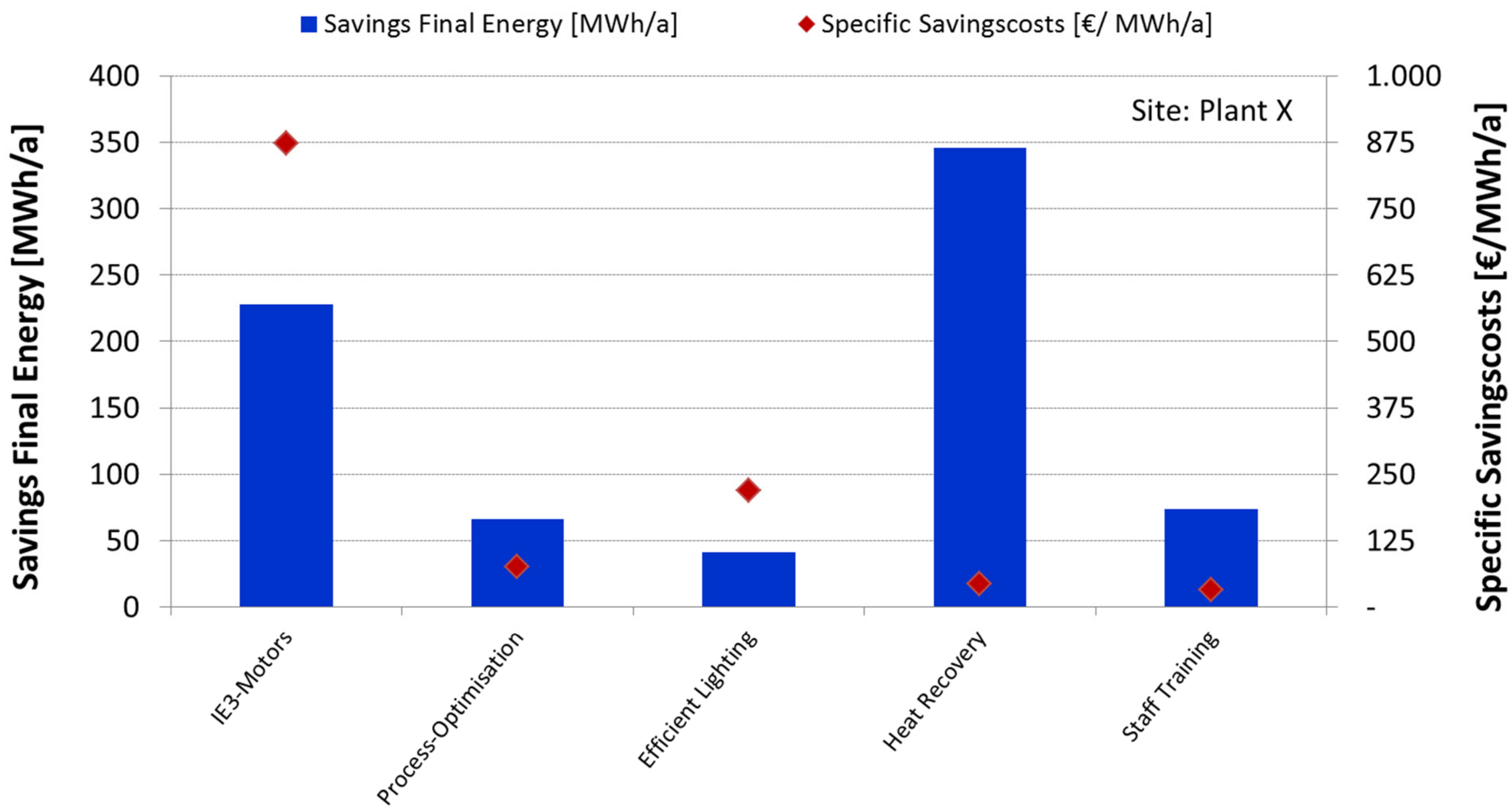
Costs:

- Low implementation costs (programming of the existing metering system and installation work for the pumps)

Effect:

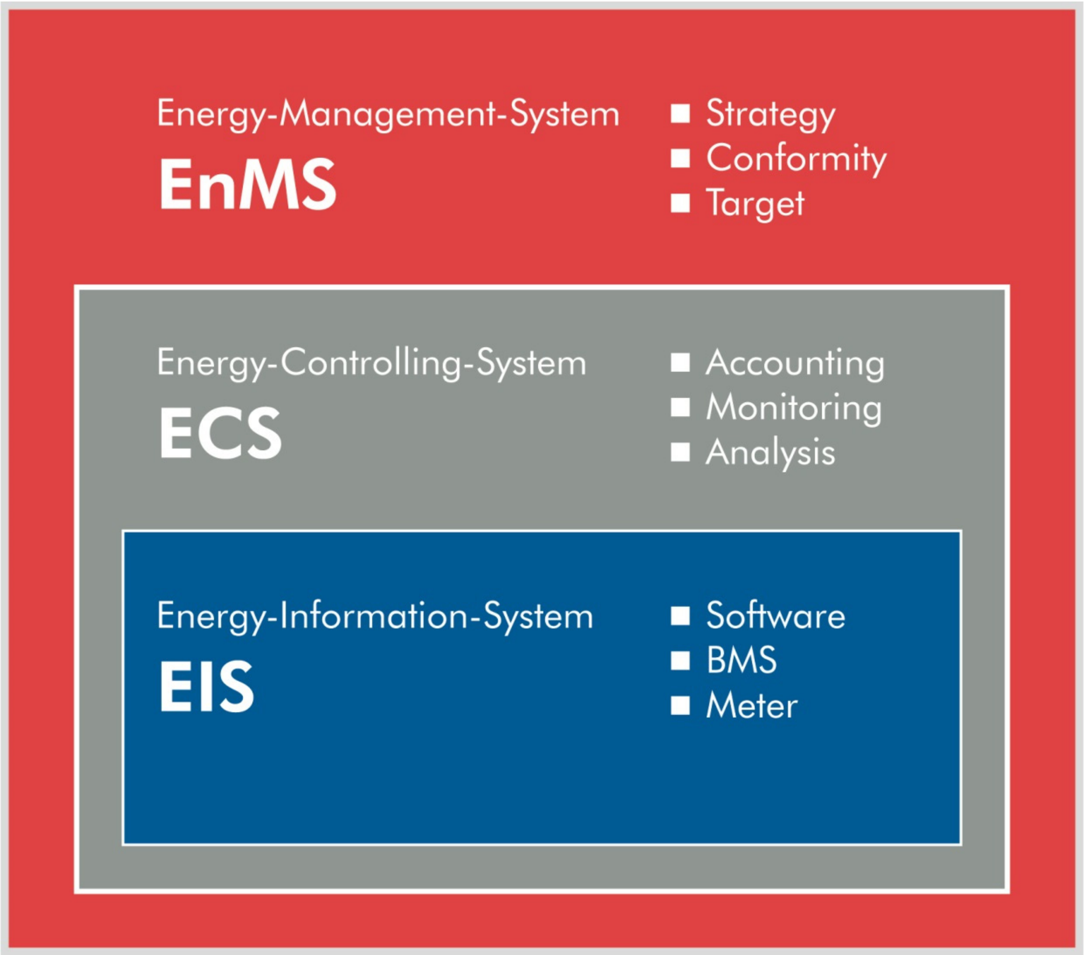
- Reduction of power consumption by 730 MWh/a (36 %)
- Savings of 32.500 €/a

Energy Efficiency Analyses – Techno-Economic Measures

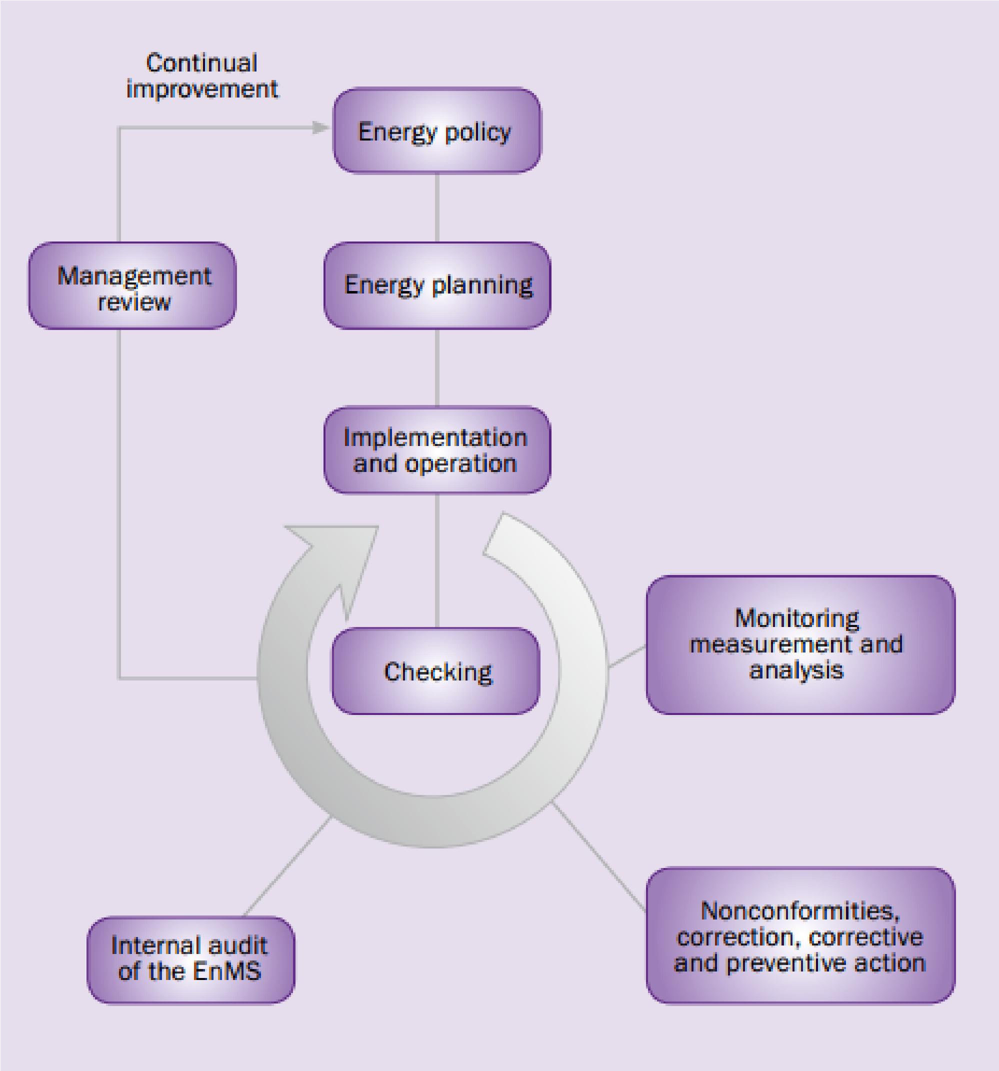


Sum Savings Final Energy: 755 MWh/a - Specific Savingscosts: 305 €/ MWh/a

Energy Management – Interacting Systems



Energy Management – ISO 50001 Framework



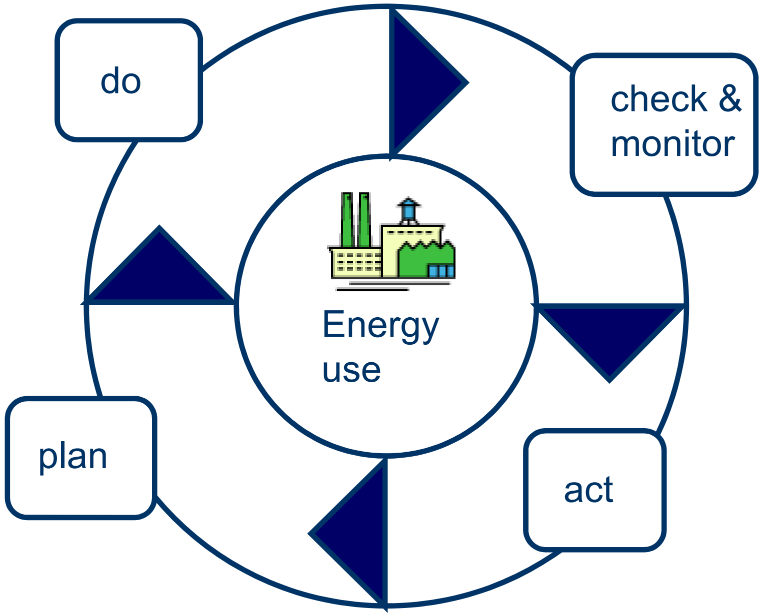
Source: www.iso.org

Energy Management – Continuous Cycle

Proven Approaches
on a regular basis

Energy Reports
- Status-quo is evaluated
- Feedback is given
- Make recognition possible

Energy Forum
- Workshop discussions
- Department-head meeting
- Jour-Fix
- Internal audit



Important Aspects

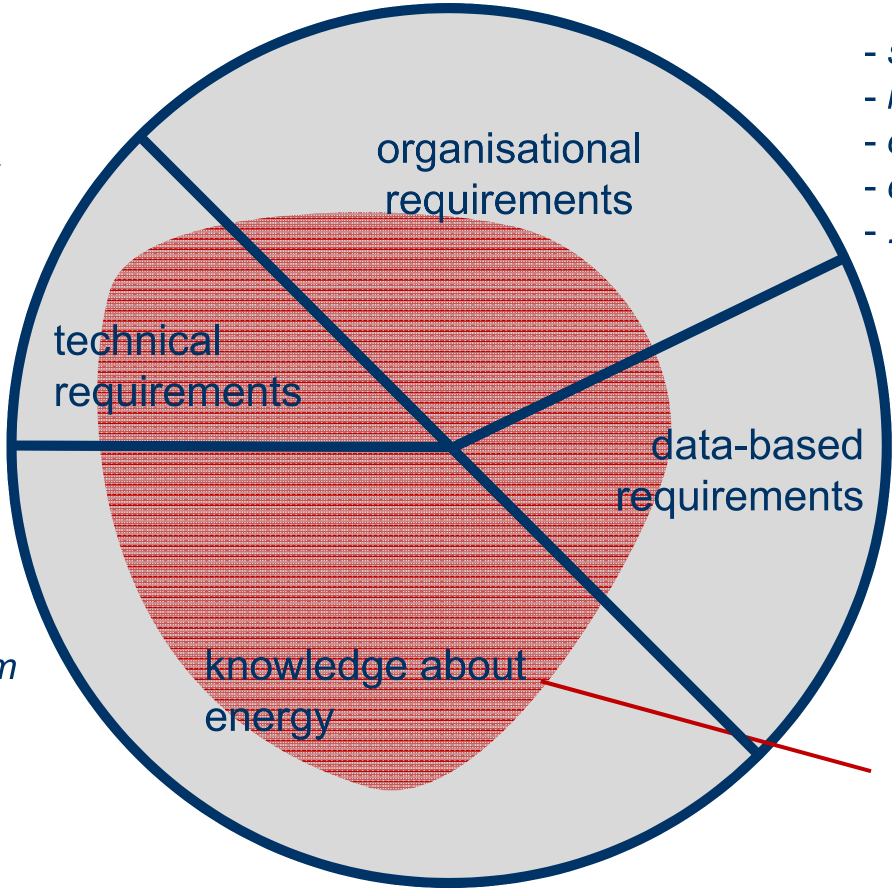
- Less documents – more content
- Less EnPI's – more interpretation
- Less instructions – more conversations

Energy Management – Design and Implementation

An efficient energy management has diverse requirements – which are different for each company

- *meter structure*
- *sensor technology*
- *central control technology*
- *…*

- *strategy*
- *responsibilities*
- *operating cycle (workflow)*
- *data access*
- *...*

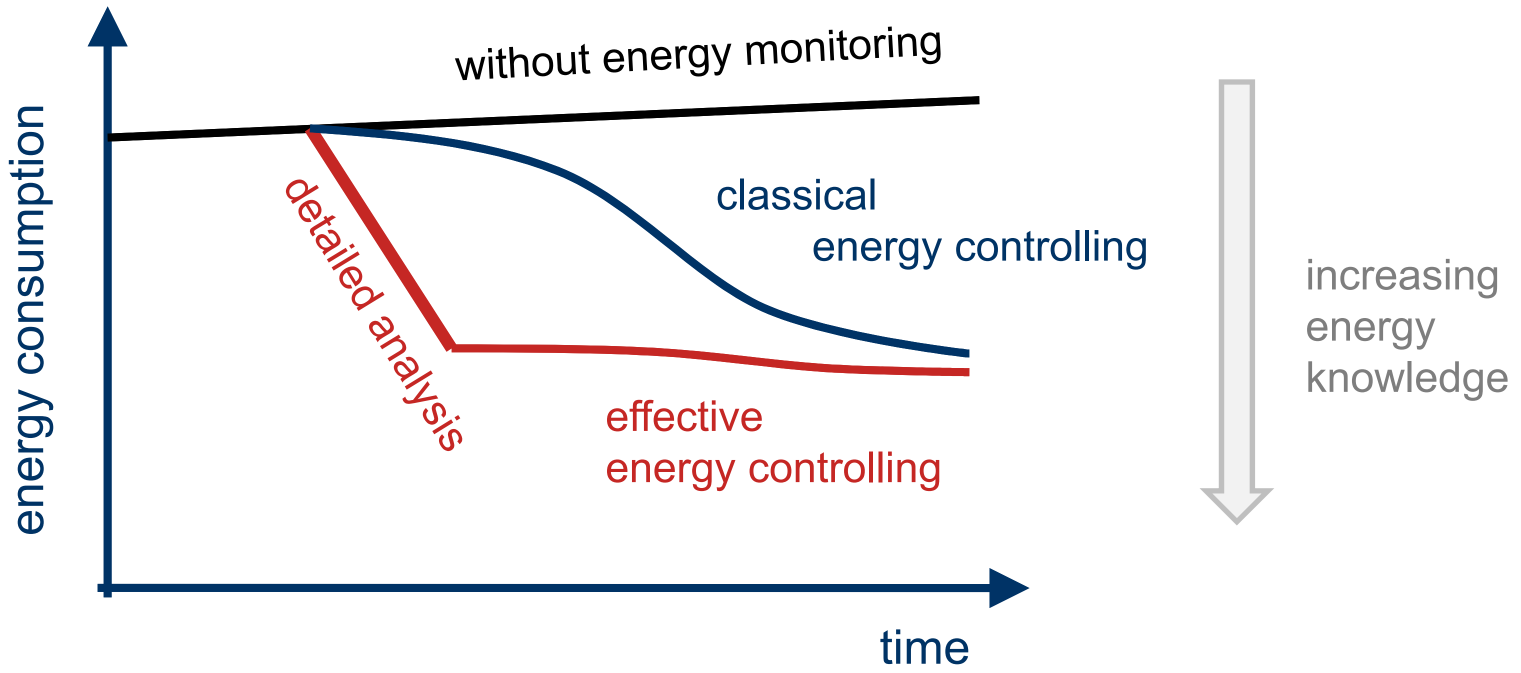


- *software*
- *interfaces*
- *data management*
- *reporting*
- *…*

- *energy flow diagram*
- *energy aspects*
- *energy goals*
- *savings listing*
- *…*

Adapted to individual needs

Energy Controlling – Different Approaches to Increase Energy Efficieny



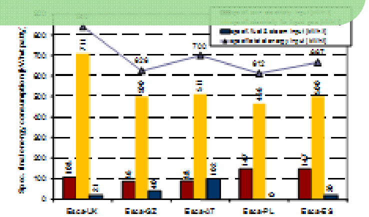
Advantage of a detailed analysis:

- gain in time
- lower installations costs for the EIS

Energy Controlling – Provide Coordinated Information

Key Indicators:
- Cost development
- Target achievment

Management



Controlling

Consumption Data:
- Billing data
- Product energy costs

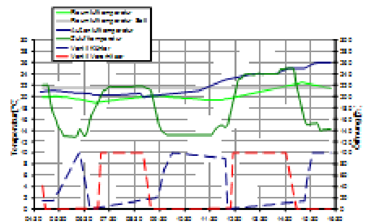
		Okt.	Nov	Dez	Jan	Feb	Mrz	Apr	Mai
KS	Kostenstelle	qm	qm	qm	qm	qm	qm	qm	qm
56	Sozialräume	131,0	132,0	144,0	147,0	127,0	137,0	111,0	100,0
02	Allgem. Werkdienst								
06	Schlosserei	536,0	432,0	443,0	304,0	337,0	348,0	373,0	409,0
07	Elektrowerkstatt	39,0	58,0	192,0	224,0	165,0	97,0	27,0	45,0
10	Fuhrpark Planwagen	64,0	43,0	46,0	52,0	51,0	46,0	47,0	57,0
13	Fuhrpark Silorfahrz.								
15	Produktionsleitung	3,0	2,0	2,0	2,0	2,0	2,0	2,0	2,0
16	Labor	4,0	2,5	3,0	3,0	3,0	3,0	2,0	2,0
17	Versuchsbäckerei	2,0	1,5	1,0	1,0	1,0	1,0	1,0	1,0
14	Techn. Einkauf	2,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
24	Getreide-Silo/-Lager								
41	Reinig.1 u. Mühle	536,0	432,0	443,0	304,0	337,0	348,0	373,0	409,0

Historic Data:
- Data for analysis

Energy Manager

Staff

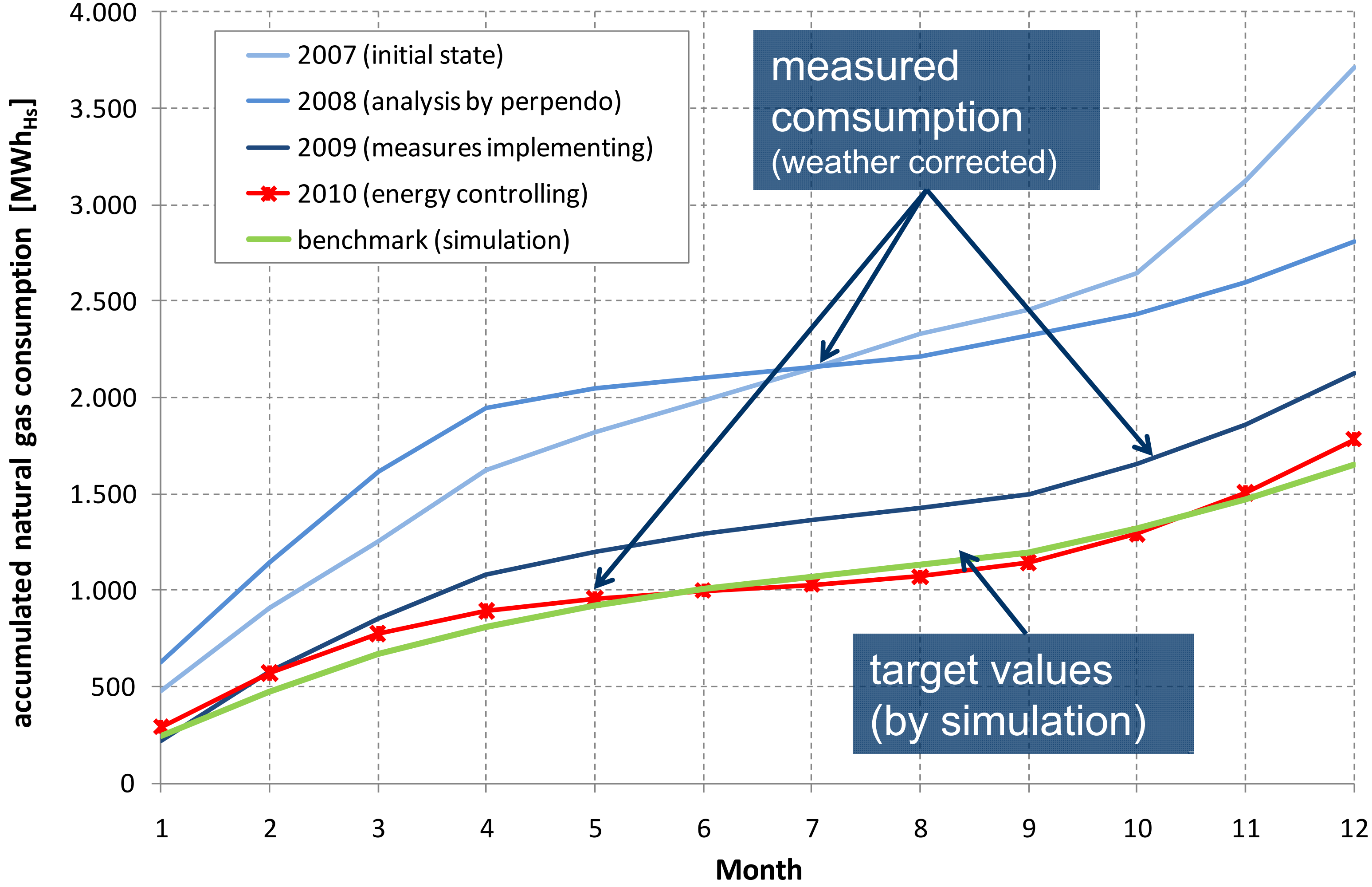
Consumption Information:
- Current values
- Alarms



Data Preparation

Data Acquisition Field Level

Energy Controlling – Example of Reporting



Energy Controlling – Specification of Benchmarks & EnPI

A. Historical characteristics:

Consumption figures from previous years

Difficulty: Modifications and new construction are not considered.
Potential savings are not revealed.

B. Comparative characteristics:

Consumption figures of comparable sites

Difficulty: Site-specific features are not considered.
Comparable real estate often does not exist.

Consumption figures per production unit

Difficulty: Characteristics only exist for some sectors and specific production methods.

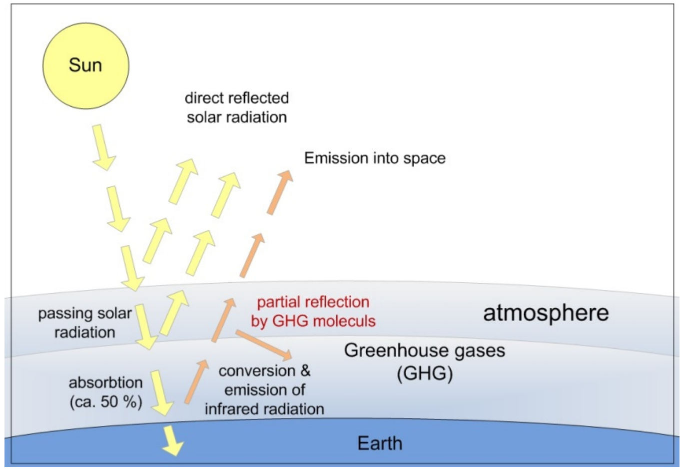
C. Calculated characteristics:

Determination of theoretical ideal values

Difficulty: Theoretical boundaries are sometimes only known for parts.
Model development is time-consuming.

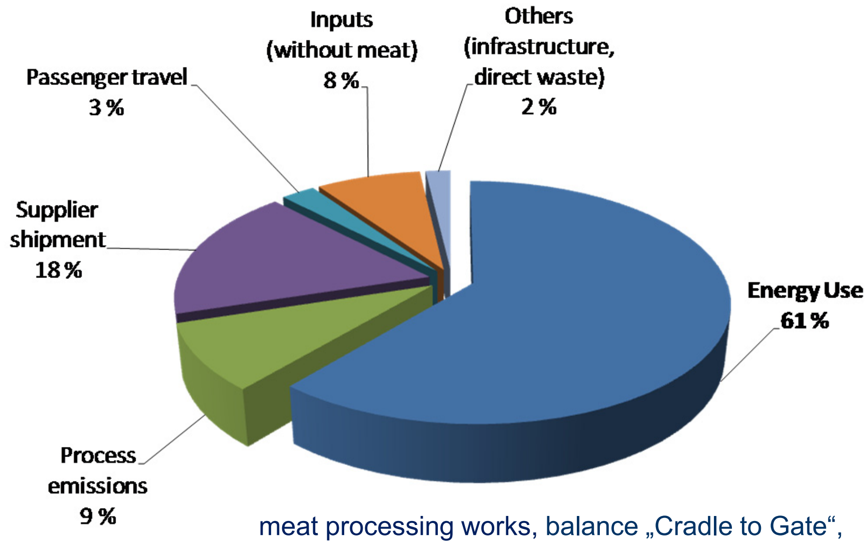
Sustainability – Carbon Footprint and Emissions Reduction

Avoiding emissions begins with knowing the sources



Target

- balancing of greenhouse gas emissions according to GHG-protocol
  - product carbon footprint
  - company carbon footprint



meat processing works, balance „Cradle to Gate“, without emissions resulting from meat generation

Procedure

- determine of appropriate allocations
- consider the supply chain
- elaborate reduction potentials
- advanced experience with food processing

Thank you for your attention!

Your Contact:

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