Energy Management of the Refrigeration Systems at Zurich Airport

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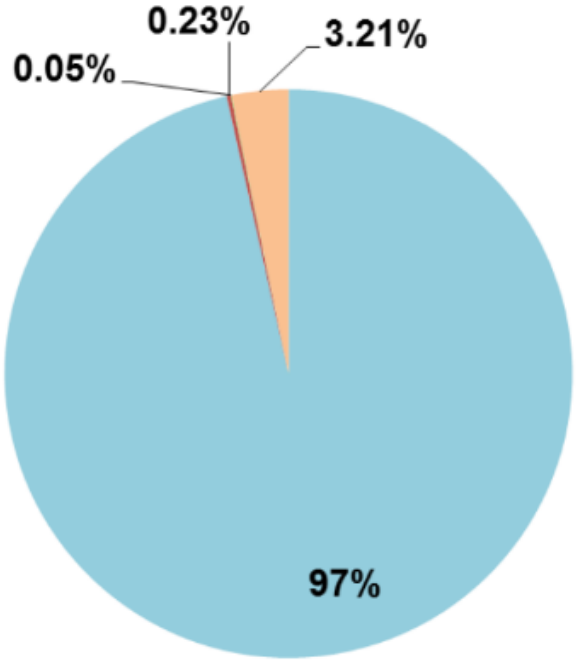
Overview

Content:

- General Information
- Refrigeration concept
- EMS program
- CS program
- Three projects for energy efficiency
- Conclusion / Outlook

Transport Hub: Switzerland's Gateway to the World

CO_2 Emissions at Zurich Airport



- Aircrafts (flights)
- Check-in and handling
- Airport maintenance
- Airport infrastructure (heating and electricity)

Application of Refrigeration Systems

Used for air conditioning and commercial systems (process cooling):

- Terminals, docks, retail, restaurants, offices, and hotels
- Data centers, electrical room, and technical plants
- Ground support equipment for aircrafts

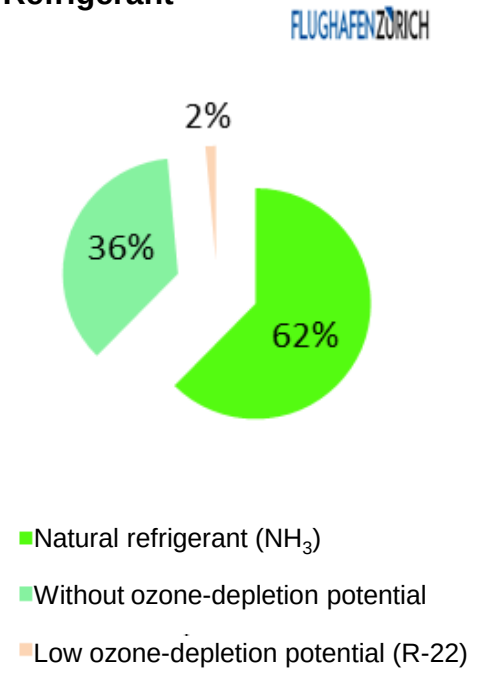
NH_3 in Large Refrigeration Systems

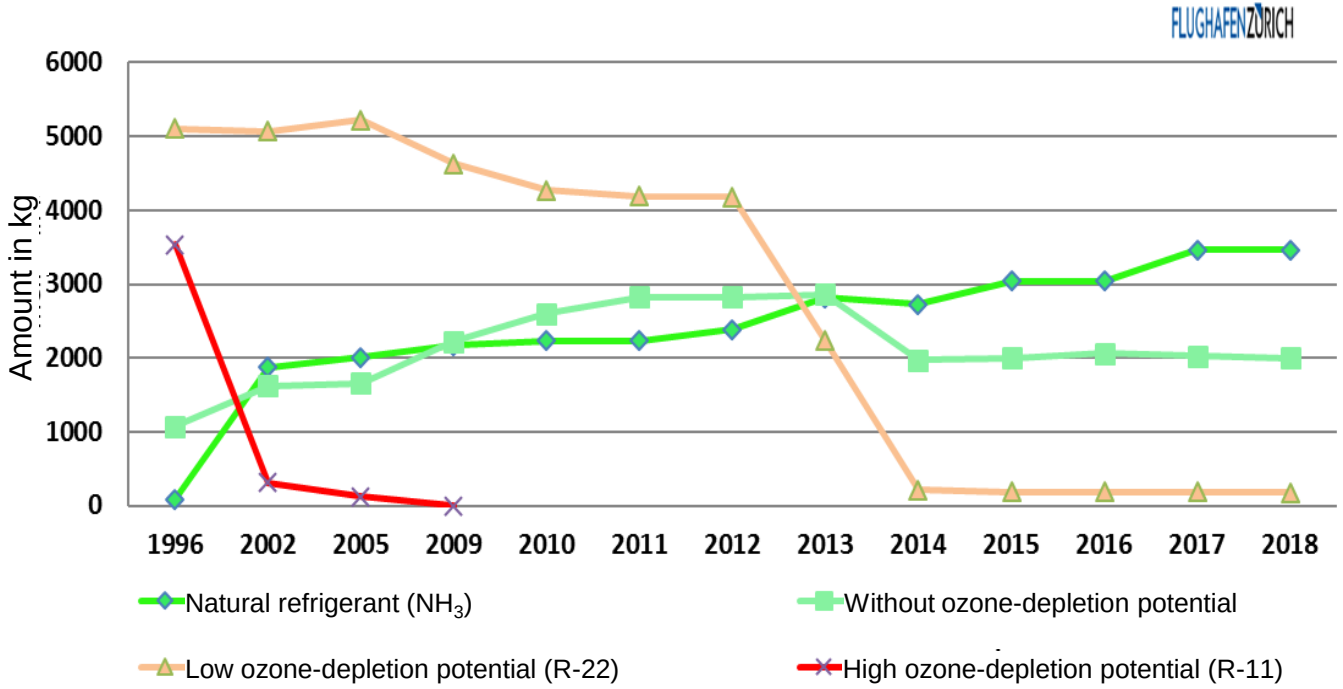
Prefered refrigerant for large systems at Zurich Airport is NH_3:

- Natural product with no negative greenhouse effects
- Low refrigerant cost
- Long lifecycles of chillers due to robust industrial construction
- Longterm experience with good system efficiency

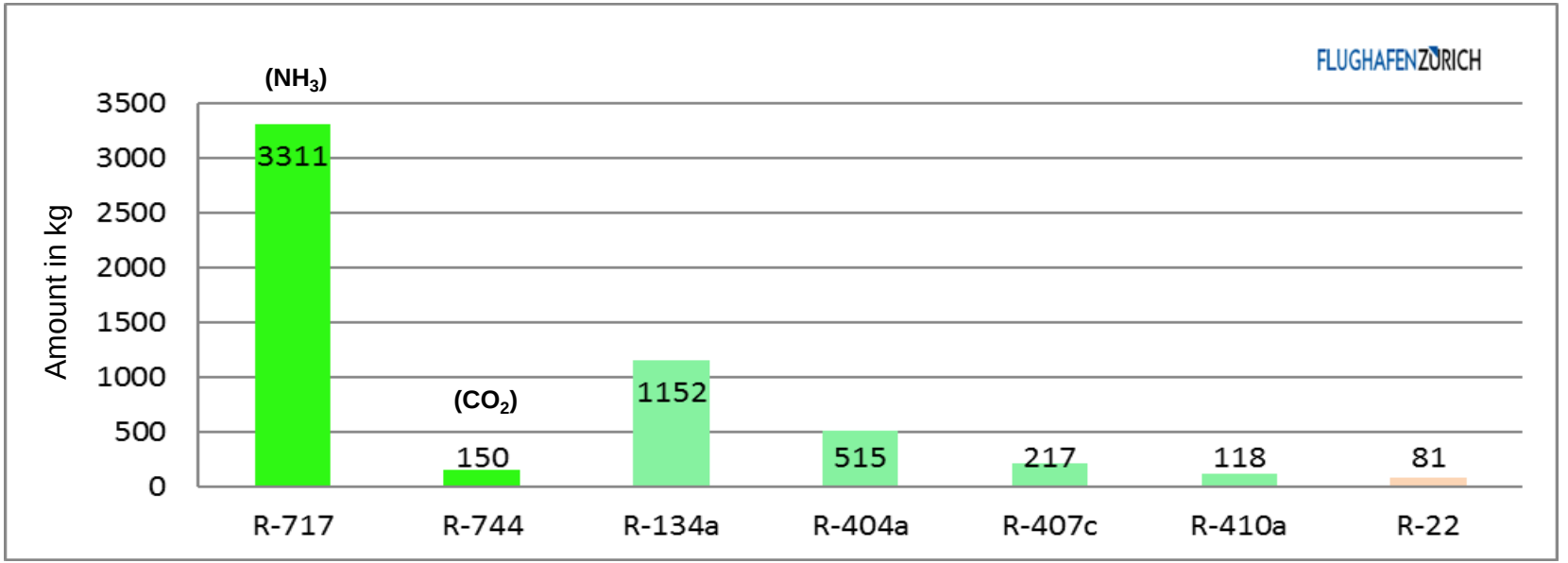
Change of Refrigerant Usage Over Time

Refrigerant





Stock of Refrigerants in 2018



Load [kW]	30'000	24'750	40	2'700	700	500	420	120
CH > 100kW	**34**	29	-	3	2	-	-	-
CH < 100kW	**128**	3	1	31	8	37	36	12

Main Equipment in Refrigeration Systems

Different compressor types…

…but **mostly screw compressors** due to lower operating costs

Concept of Chilled Water Generation / Distribution

Consolidation of chilled water production with fewer, bigger networks for –

- Less safety technology;
- Lower energy and operation costs;
- Less power redundancy.

Approaches for efficient operation with –

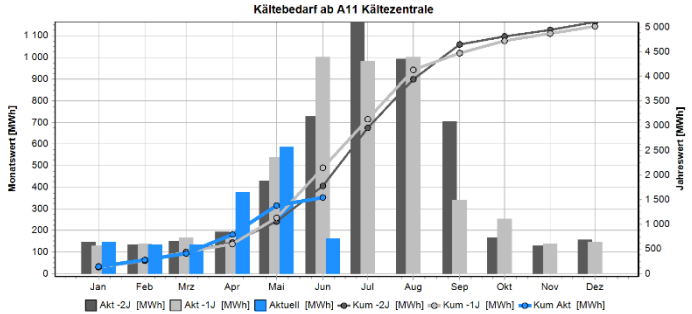
- High chilled water system temperatures;
- Hot water generation via heat recovery;
- Variable speed fans and pumps.

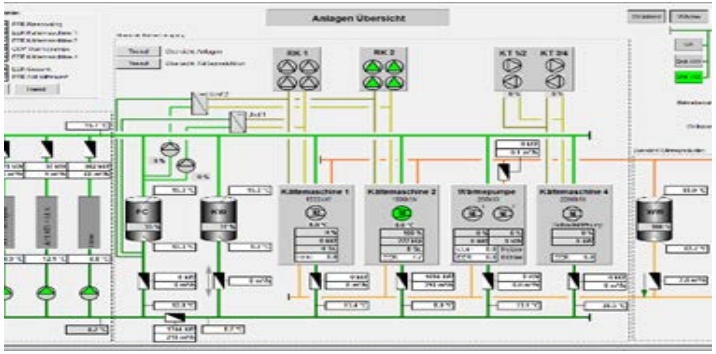
Energy management system (EMS):

- Monthly and annual reports
- Detailed analysis of measuring points
- Reporting of key indicators and notification in case of unusual diversions

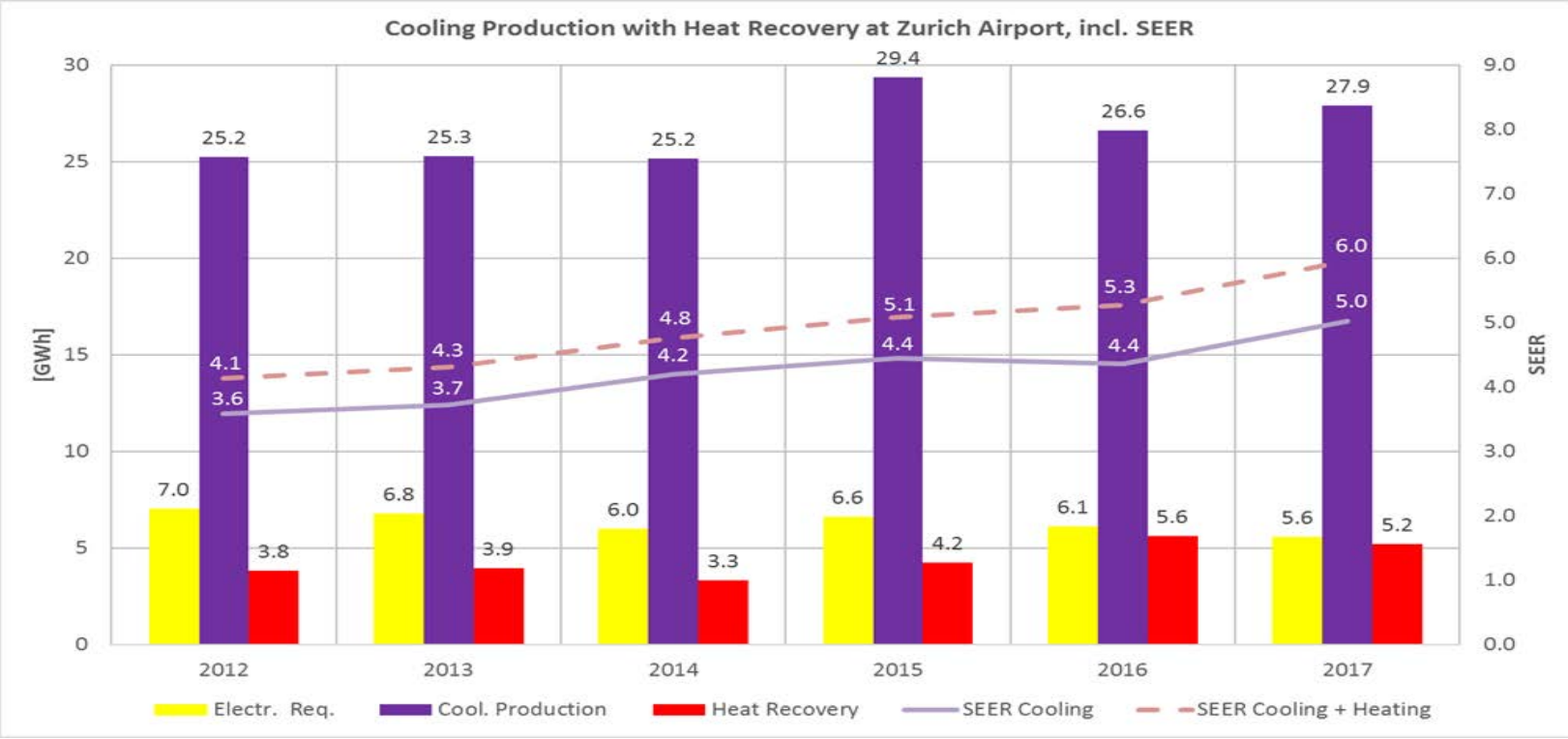
Control system (CS):

- Monitoring of operation, system optimization
- Displaying key performance indicators
- Trend data logging

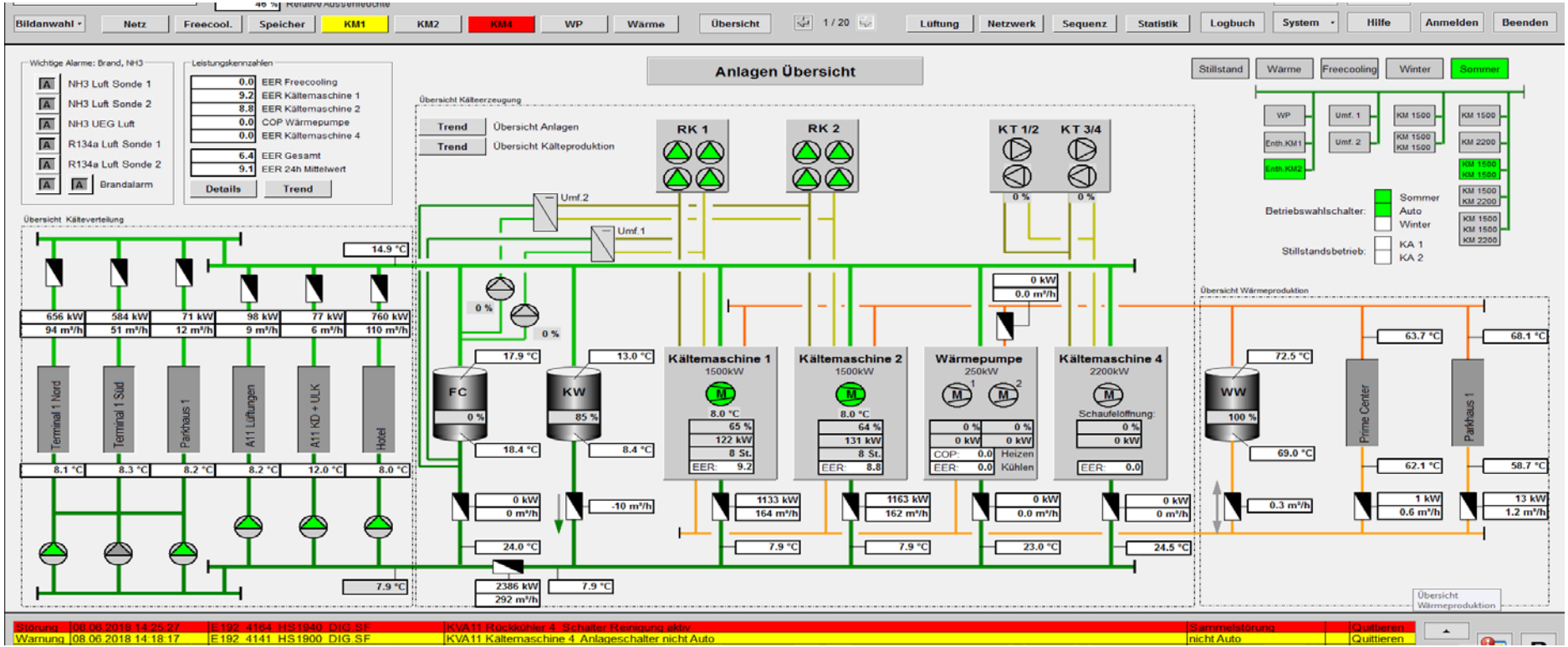




Energy Management System for Data Processing



Control System for Live Overviews / Adjustments



Control System for 24-Hour Data Trend Logging

Three Examples for Optimized Ennergy Efficiency

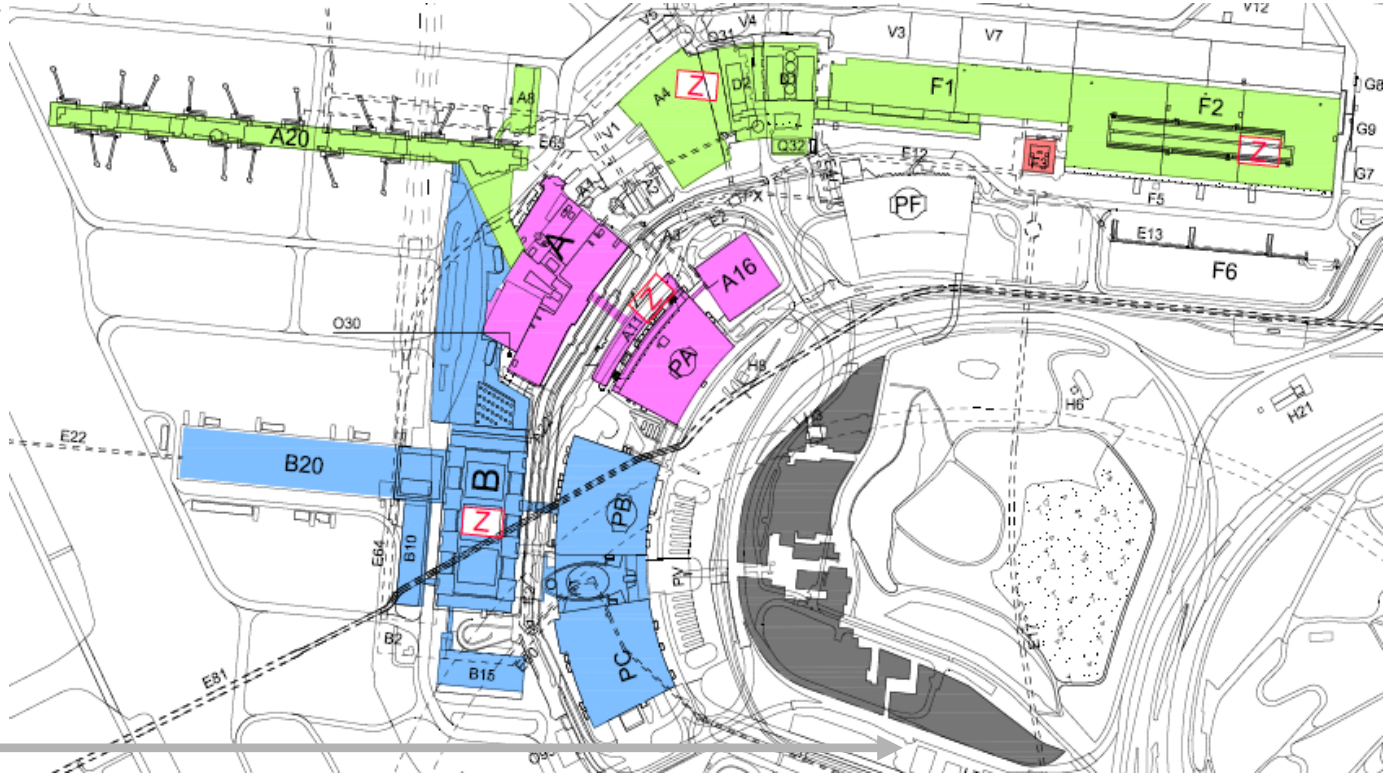
Project 1: Chiller System, Plant A4
supplying 120'000 m^2, NH_3 (R-717)
4.5 MW cooling, 450 kW heating;
built in 2014

Project 2: Chiller System, Plant A11
supplying 90'000 m^2, R-134a + NH_3
5.2 MW cooling, 260 kW heating;
built in 1992/2006, replaced in 2015

Project 3: Chiller System, Plant B
supplying 220'000 m^2, NH_3; 12 MW
cooling; built in 2000, refurb. in 2017

Heat Pump / Chiller System – Dock E
supplying 55'000 m^2, NH_3;
2.5 MW cooling, 700 kW heating;
built in 2002

Heat Pump / Chiller System – The Circle
supplying 180'000 m^2, NH_3
7.2 MW cooling, 4.8 MW heating,
under construction



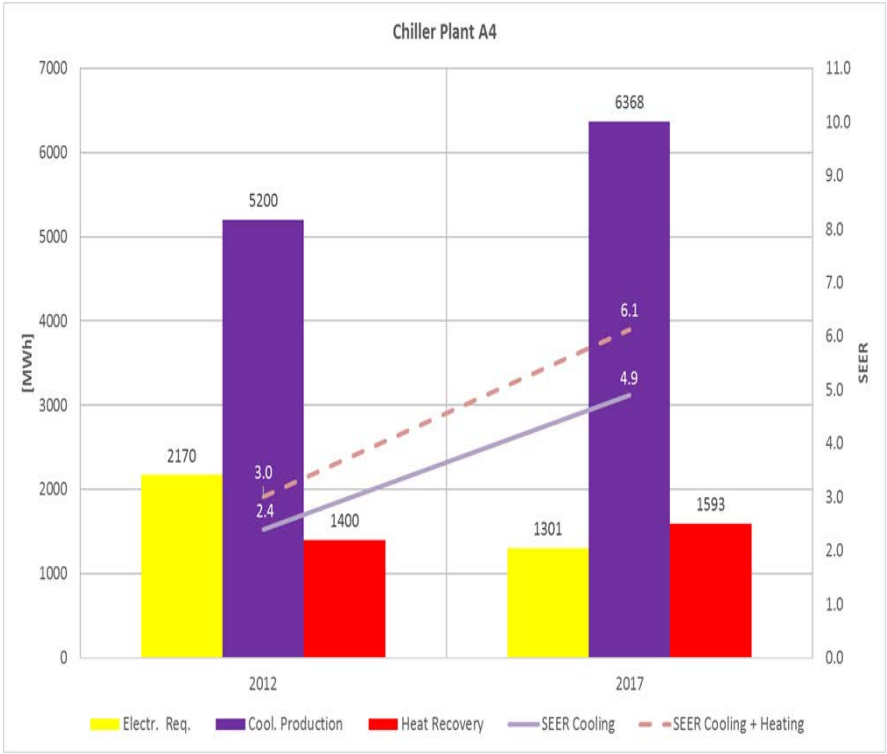
Project 1: Consolidated Refrig. Plants / Common Network, 2014

Overview:

- Demolition of 30 chillers using 4 types refrigerants, 4 CW circuits, and dry coolers
- Installation of 4 new chillers and 1 heat pump in a consolidated system, using NH_3, VFDs and hybrid cooling towers

Overall improvements:

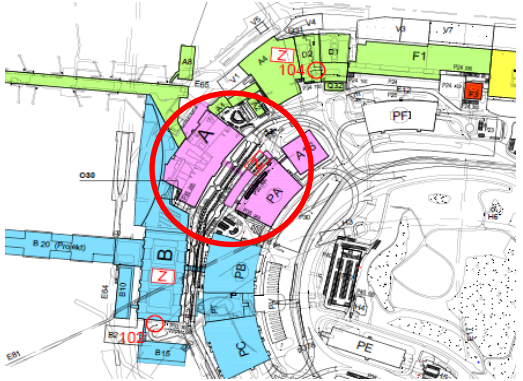
- Efficiency increase ≈ 100%
- Electrical savings ≈ 40%

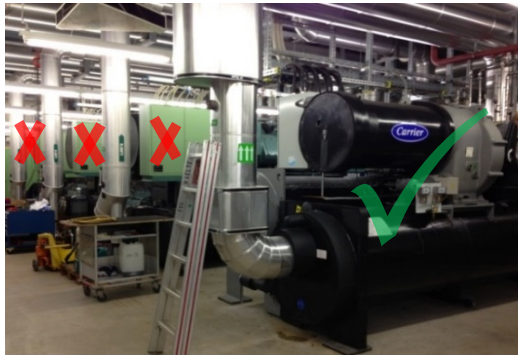


Project 2: Replacement of R22 Refrigerant in Plant A11 (2015)

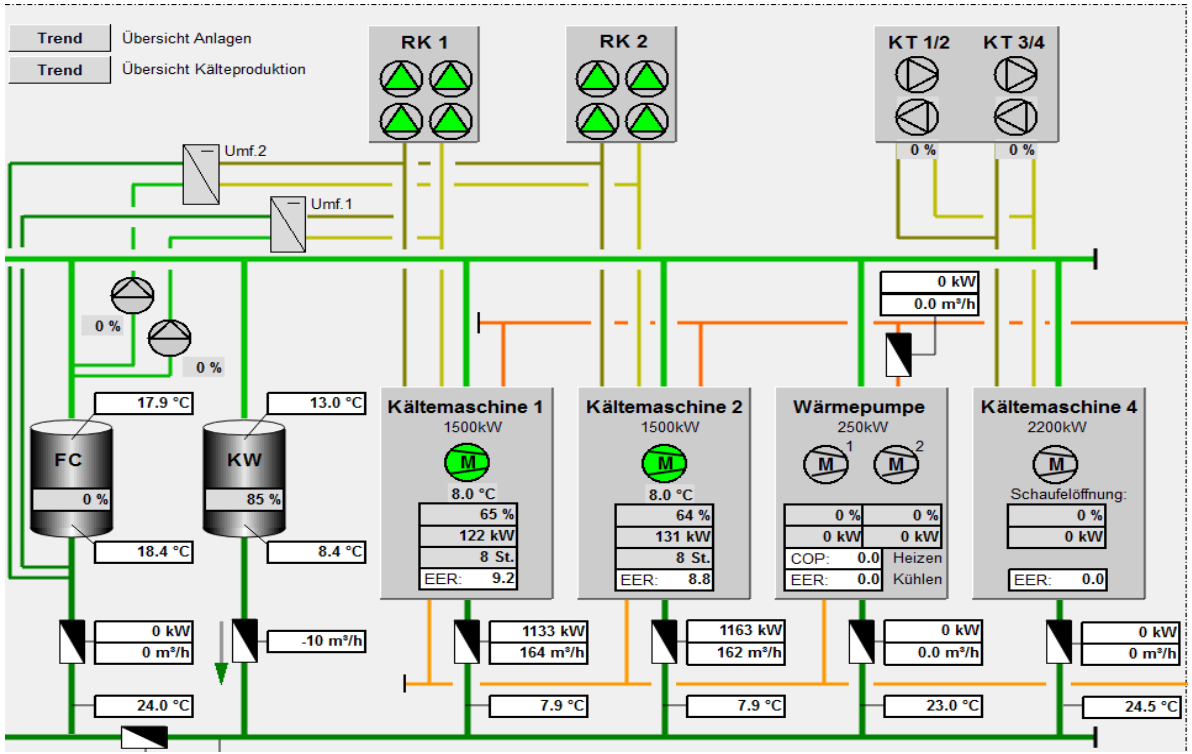
Overview:

- Replacement of control system and hydraulic auxiliary drives
- Installation of heat pumps and air compressors for heat recovery
- Connection of existing R-134a turbo compressor to an avaporative cooling tower
- Replacement of 3 chillers (R-22) by 2 piston compressors (NH_3) equipped with IE4 motors, VFDs, and hot gas deheaters





Project 2: Control System of New Chillers in Plant A11

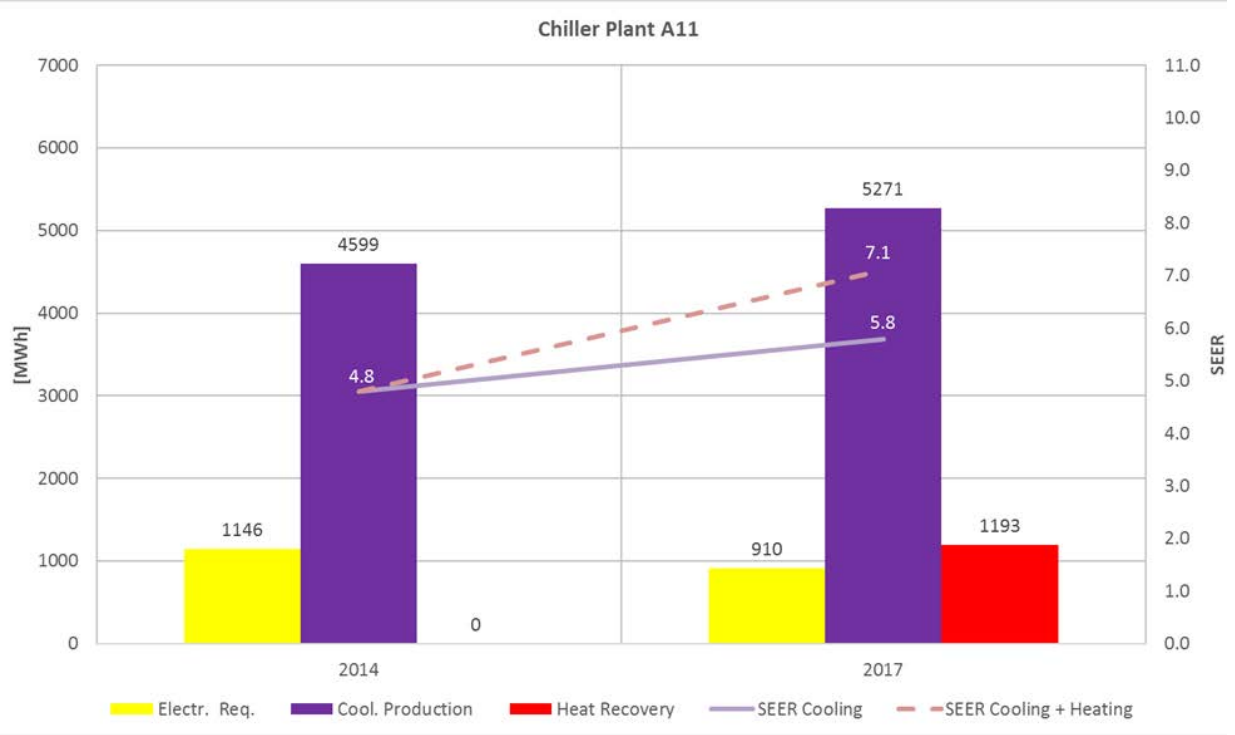


Project 2: Energy Analysis of the New Chillers in Plant A11

Overall improvements:

- Efficiency increase ≈ 45%
- Electrical savings ≈ 30%

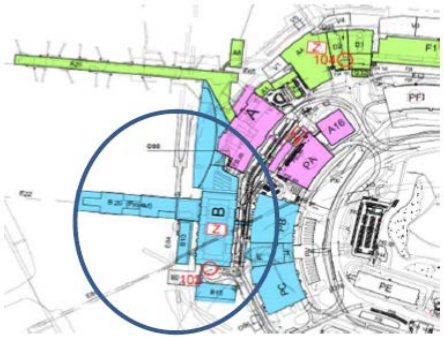
(Up to 80% of two buildings can be heated via heat recovery)



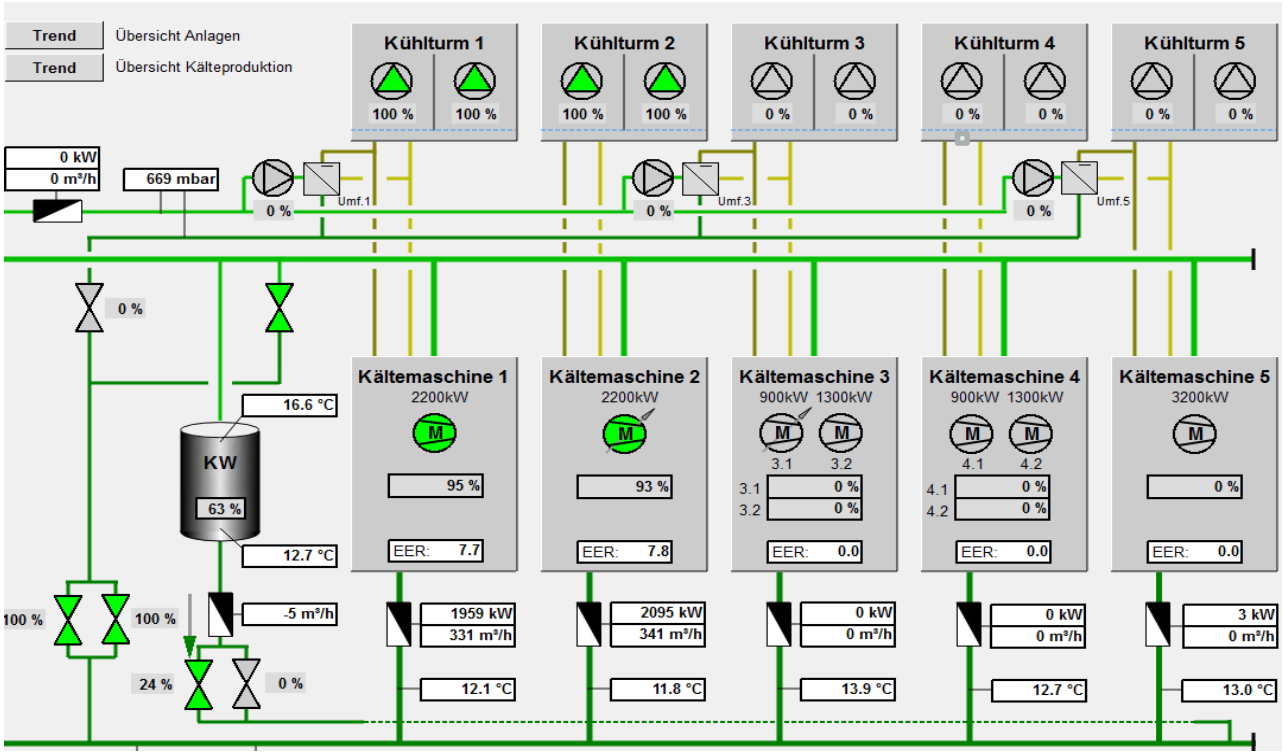
Project 3: Refurbishment of Chillers in Plant B (2017)

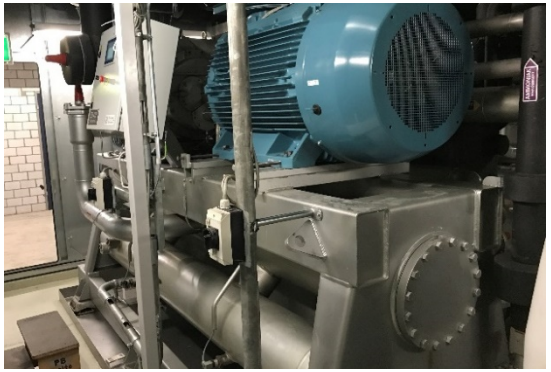
Overview:

- Replacement of control system and hydraulic auxiliary drives; also using some IE4 and approx. 50 VFDs
- Retrofit and optimization of free cooling in evaporative cooling tower systems
- Refurbishment of 5 screw chillers (2 equipped with 2 new compressors) and 10 cooling towers



Project 3: Control System of the Refurbished Chillers in Plant B

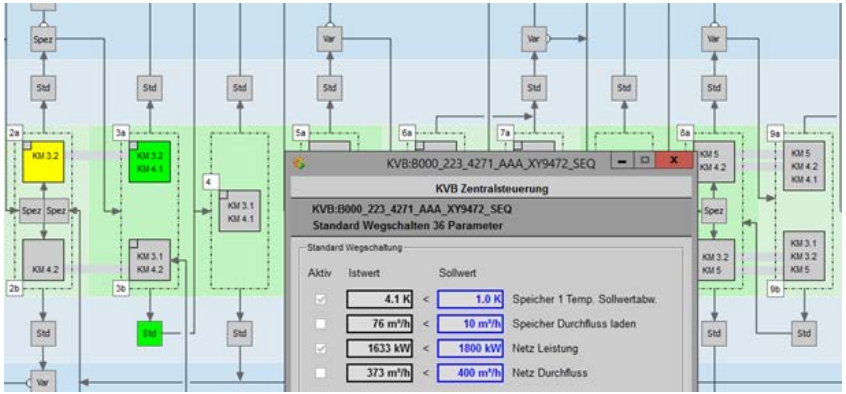




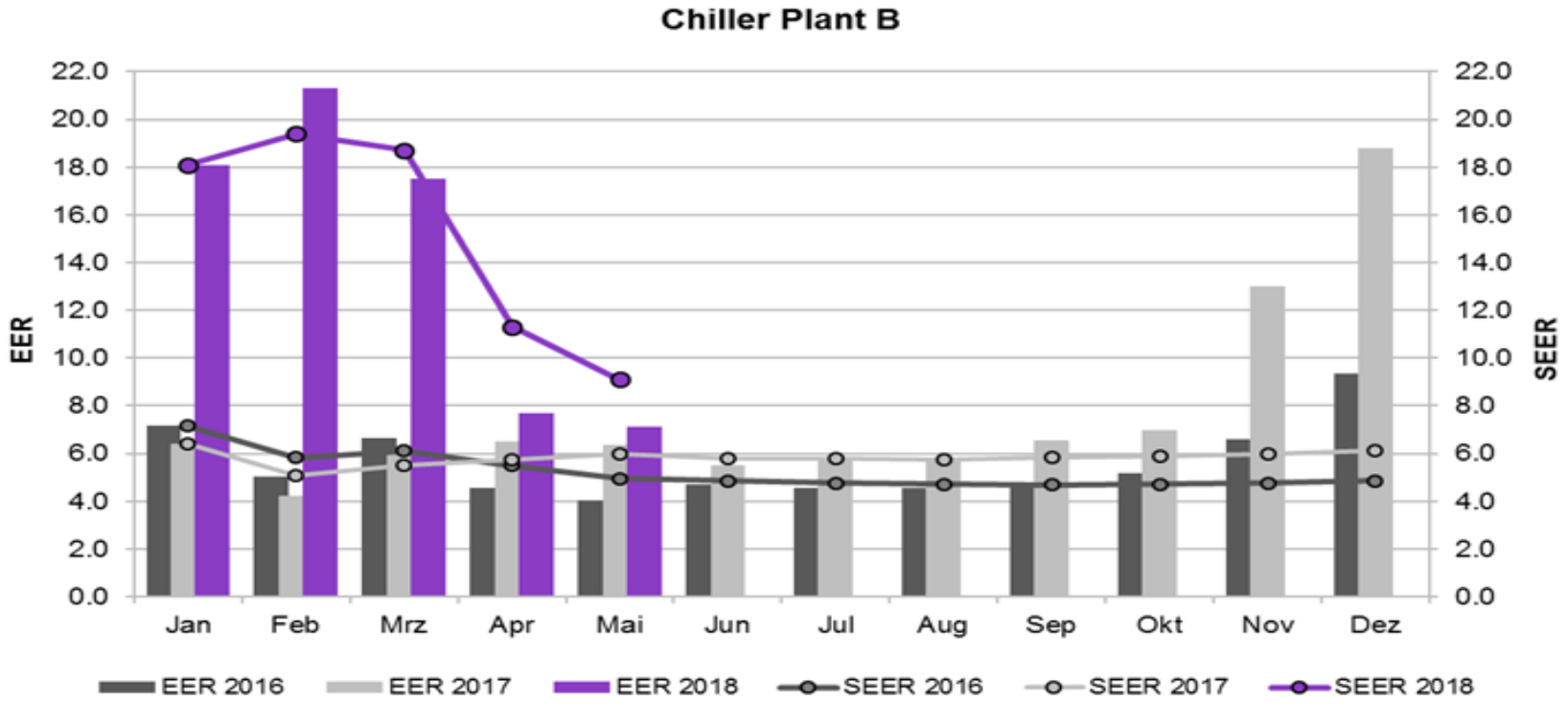
Project 3: Further Optimization Features in Plant B

Additional features of chiller load management

- **Return flow mixing** – between an outside temperature of 20 to 26°C, optimized chiller loads at full operation, despite a very small CW temperature difference) by lowering of chiller flow temperature
- **Mixed operation** – up to an outside temperature of 20°C, optimized chiller loads in intermitting operation with the help of buffer stores while using 100% free cooling in parallel



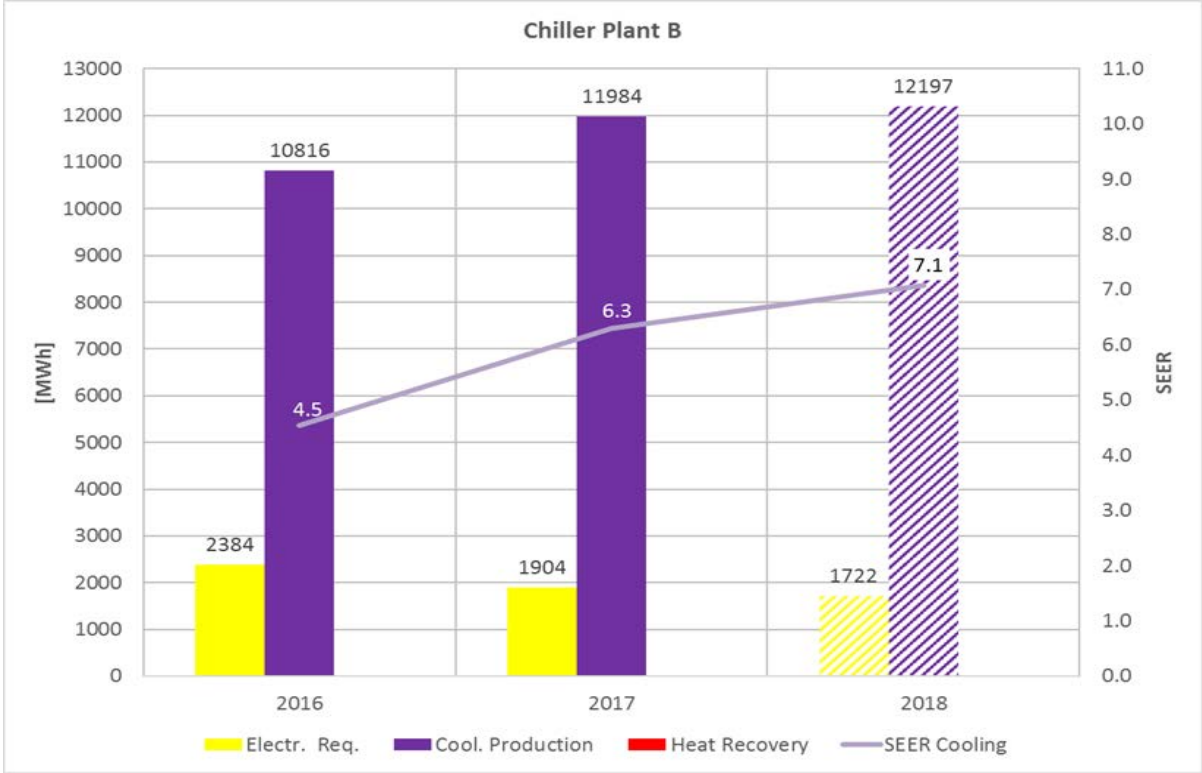
Project 3: Optimization of Free Cooling Process in Plant B



Project 3: Energy Analysis of the Refurbished Chiller in Plant B

Overall improvements:

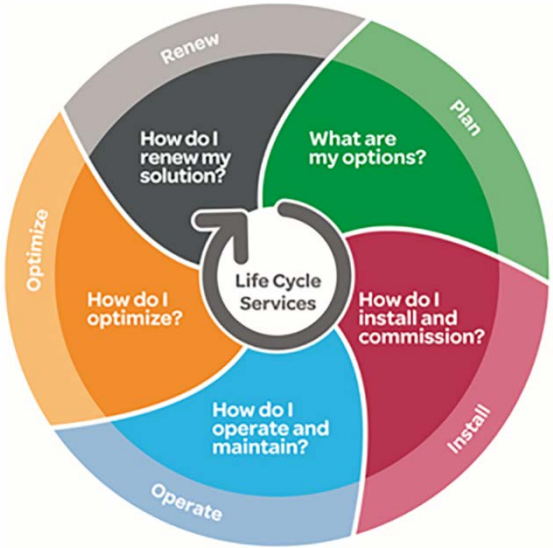
- Efficiency increase ≈ 50%
- Electrical savings ≈ 30%



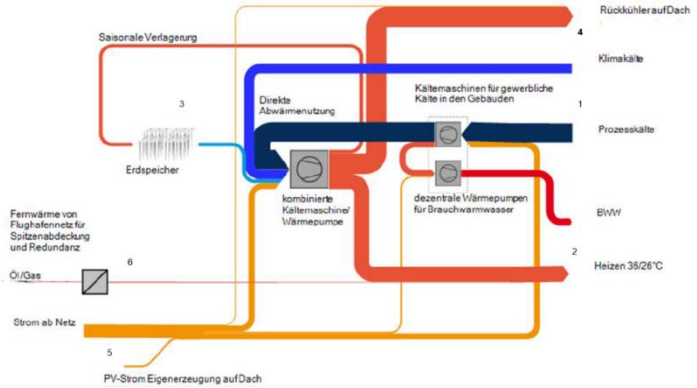
Conclusion

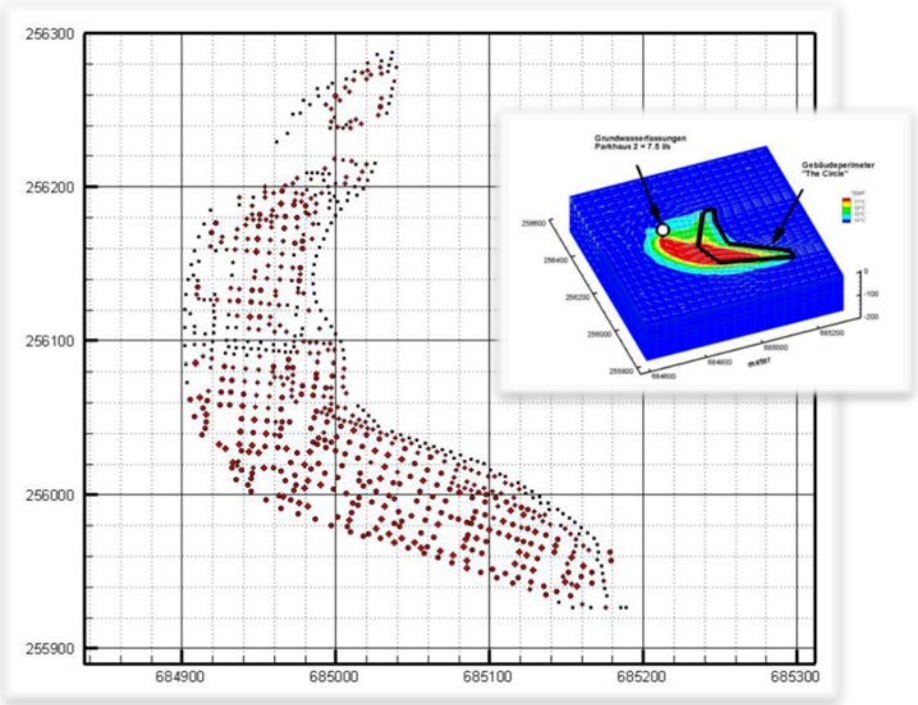
Success factors in the energy management of the refrigeration systems:

- Quality products, right hydraulic
- Good installation and commissioning
- Optimization of chiller systems in the first 2 years with flexibility for adjustments and detailed analysis of operation
- Cooperation amoung players in the life cycle services
  - Engineering
  - Operator
  - Maintenance
  - Optimization Specialist
  - Management



Outlook: Management of the Refrigeration System at «The Circle»





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