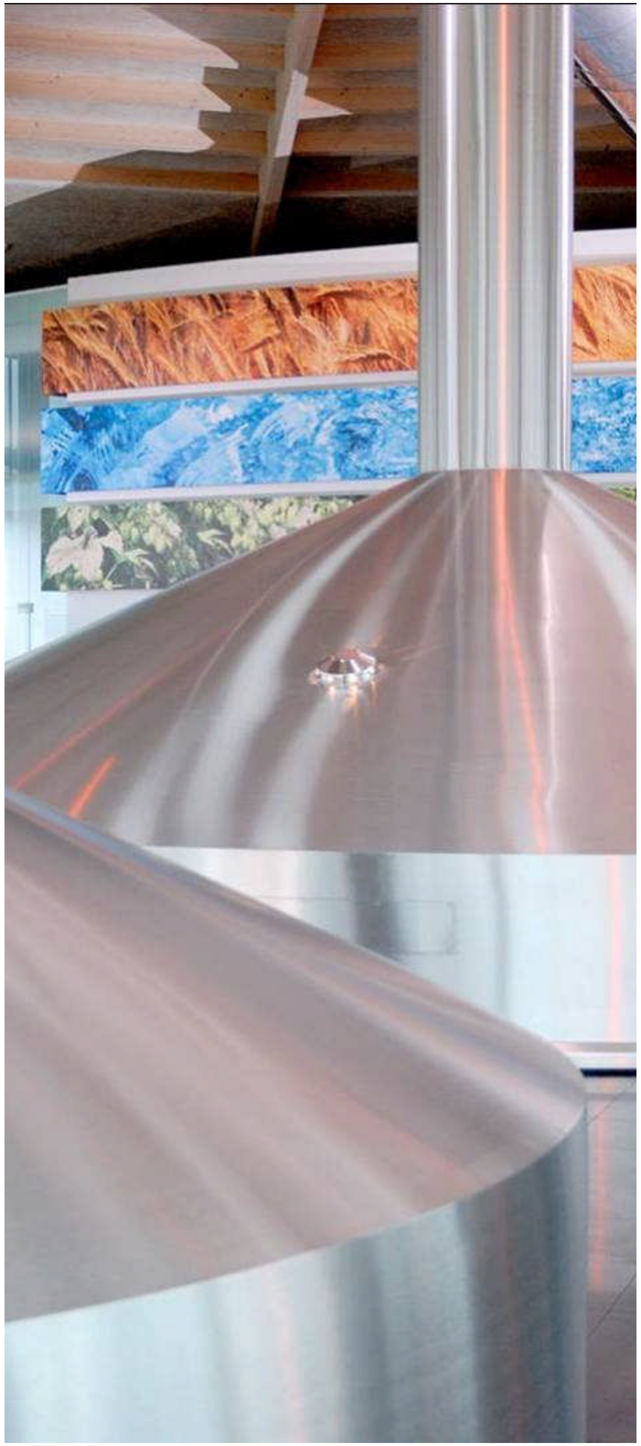


Saving Energy and Resources with BRAUMAT

Analysis and Options

(This is a summary of different presentations concerning energy and water. Thank you all!).

„

Save Energy and Resources with BRAUMAT

Key figures

3.7 hl water / hl beer

PINCH Analysis

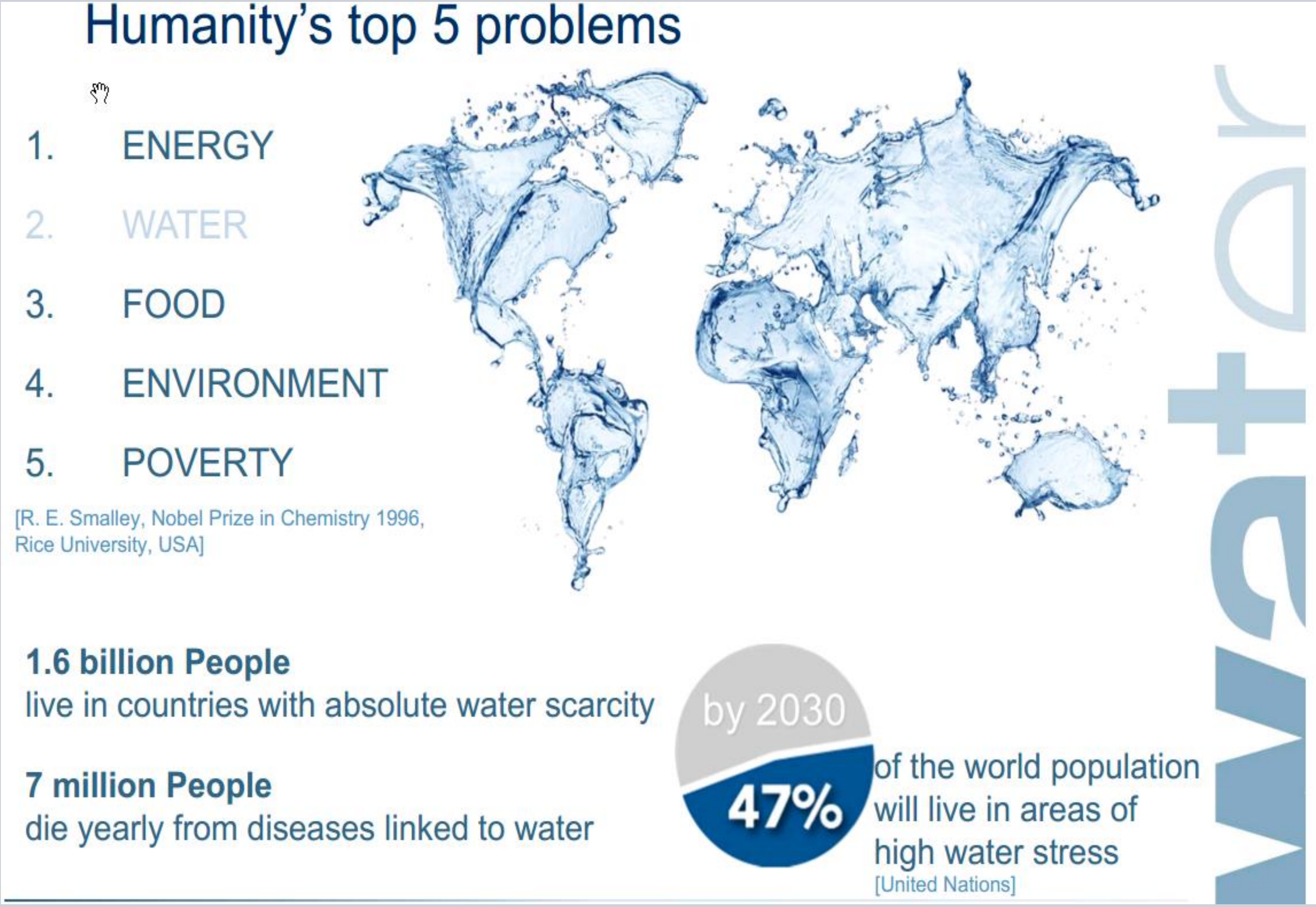
- Theoretical analysis of the energy flows
- Identification of heat and cold streams

Save Energy and Resources with BRAUMAT
Background

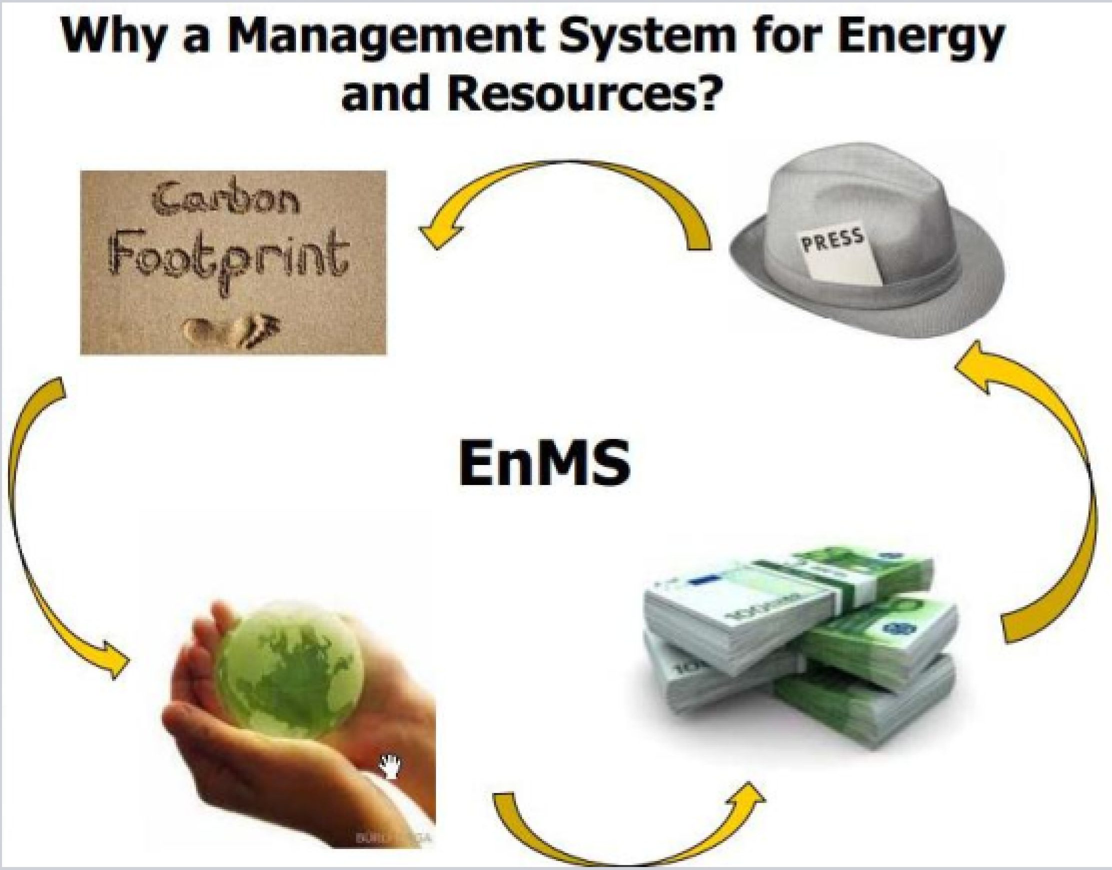
Reasons for an energy management system

- Reduce energy costs (94%)
- Improvement of production conditions (15%)
- Improvement of working conditions (20%)
- Increase the reliability (10%)
- Improve product quality (10%)
- Real estate appreciation (19%)
- Contribution to climate protection (48%)
- Protection against rising energy prices (55%)
- Image proft (10%)

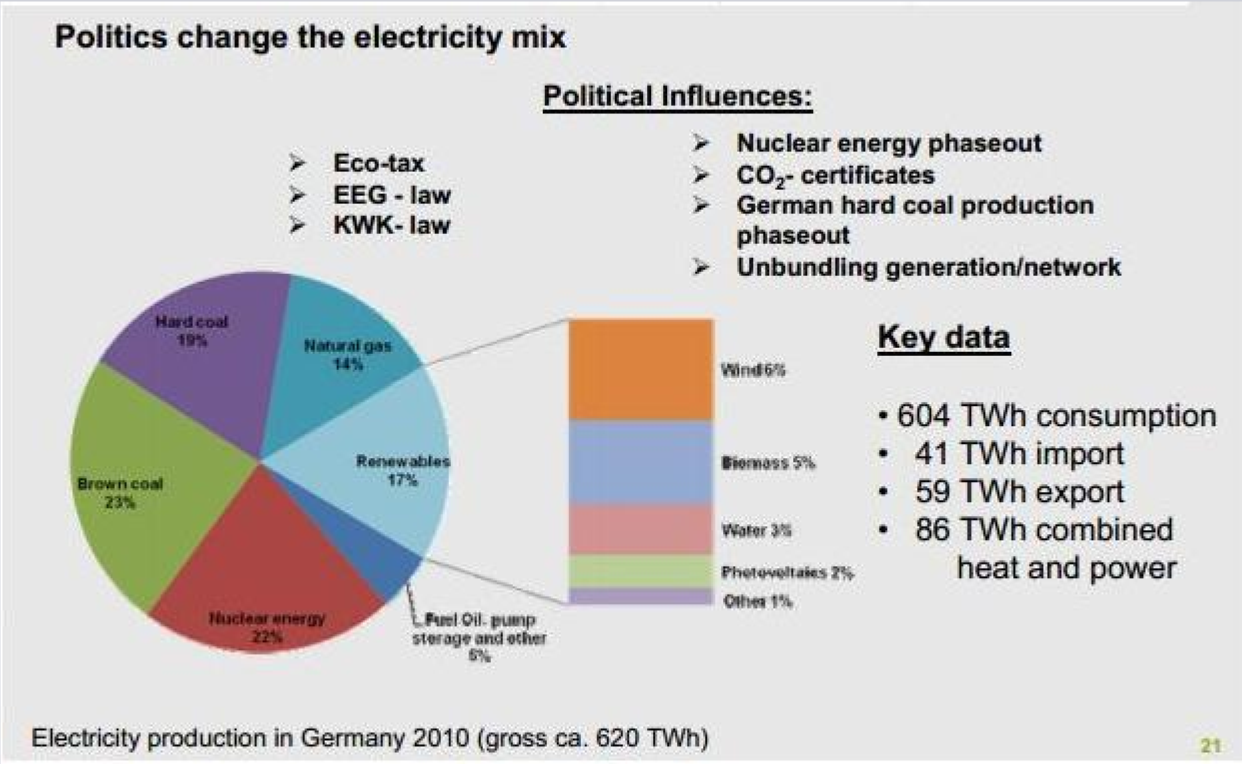
Top 5 problems



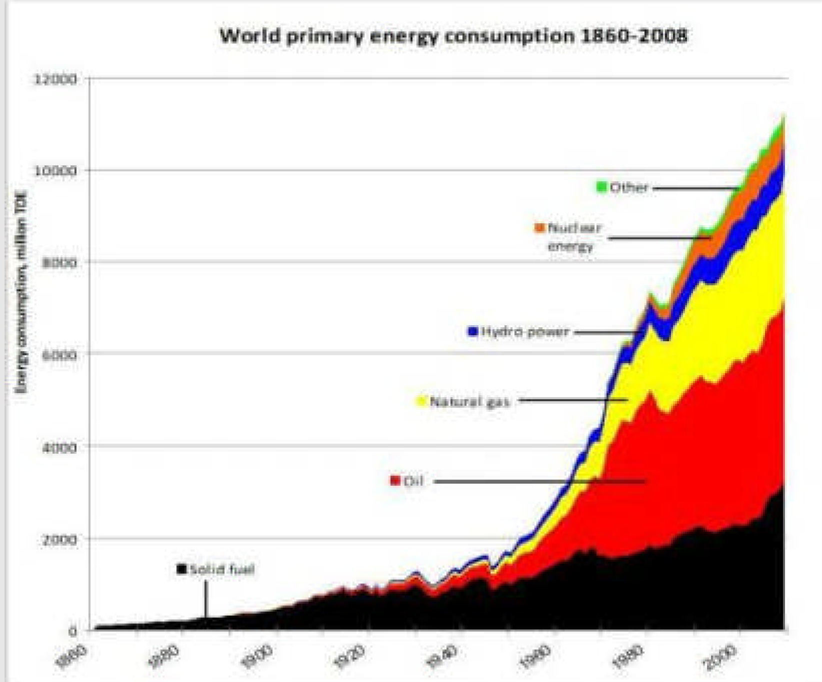
Why a energy-management System?



Political background



The world is hungry on energy



Source: Different statistics, last years BP-Statistics

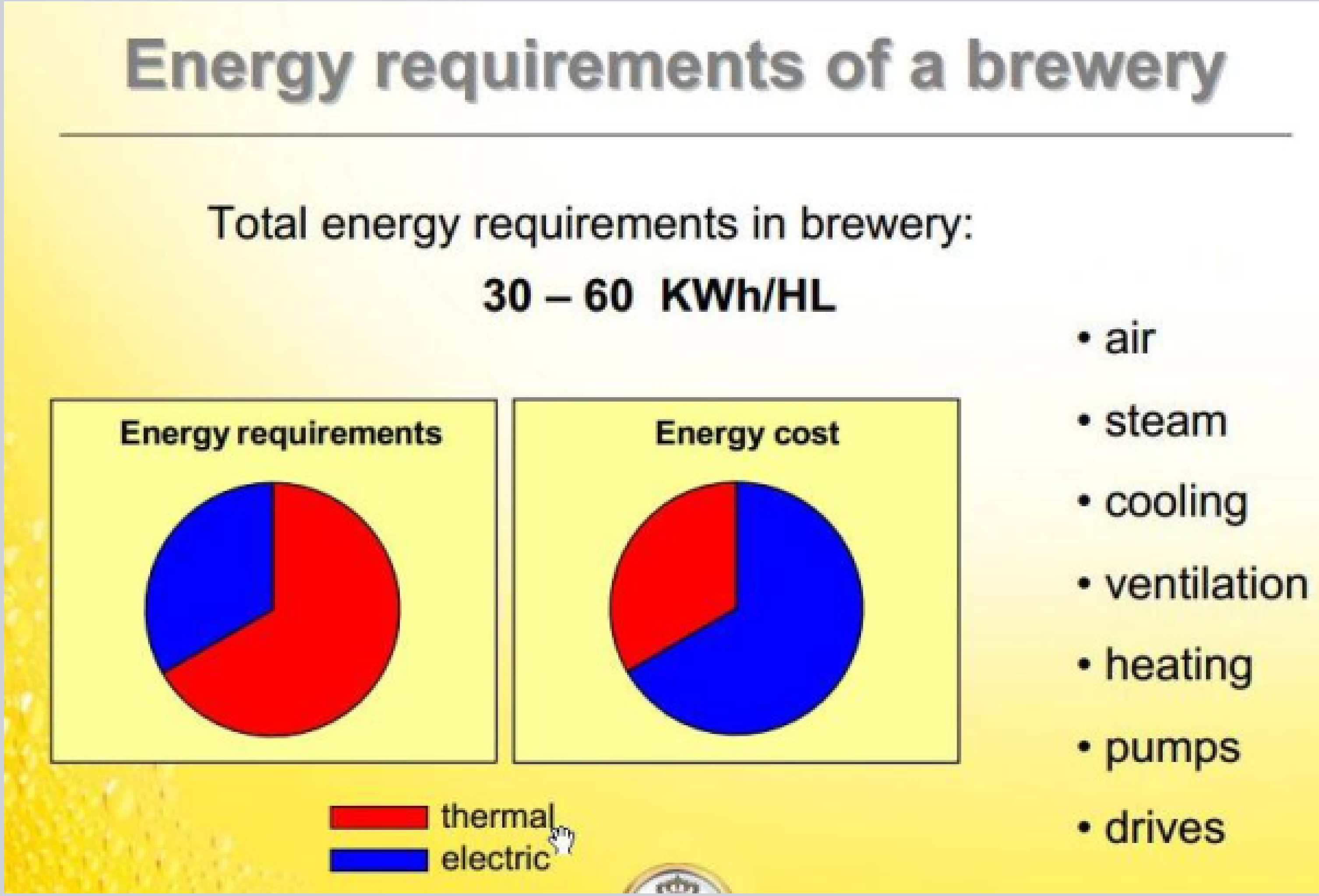
Contribution of selected countries and country groups to the world primary energy consumption

USA	20 %
EU – 27 – Germany	15 % 3 %
China	18 %
Japan	4 %
African Countries	3 %

The world is hungry on energy

5

Energy requirements

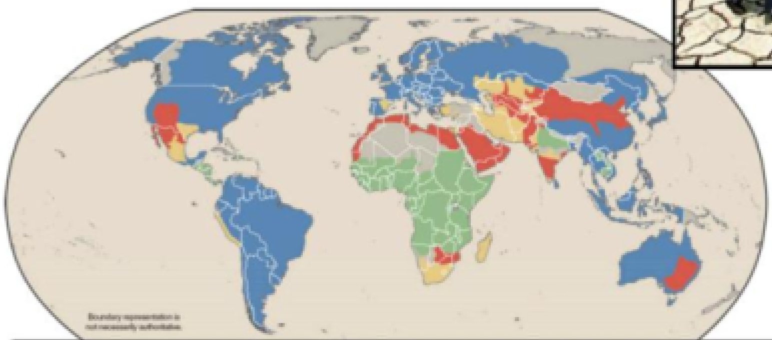


Water, a crucial issue!

“The next world war will be over water”

- 1.2 billion people (20% of the Earth’s population) lack access to safe drinking water
- 2.6 billion (40% of the world’s population) have little or no sanitation

Projected Global Water Scarcity, 2025

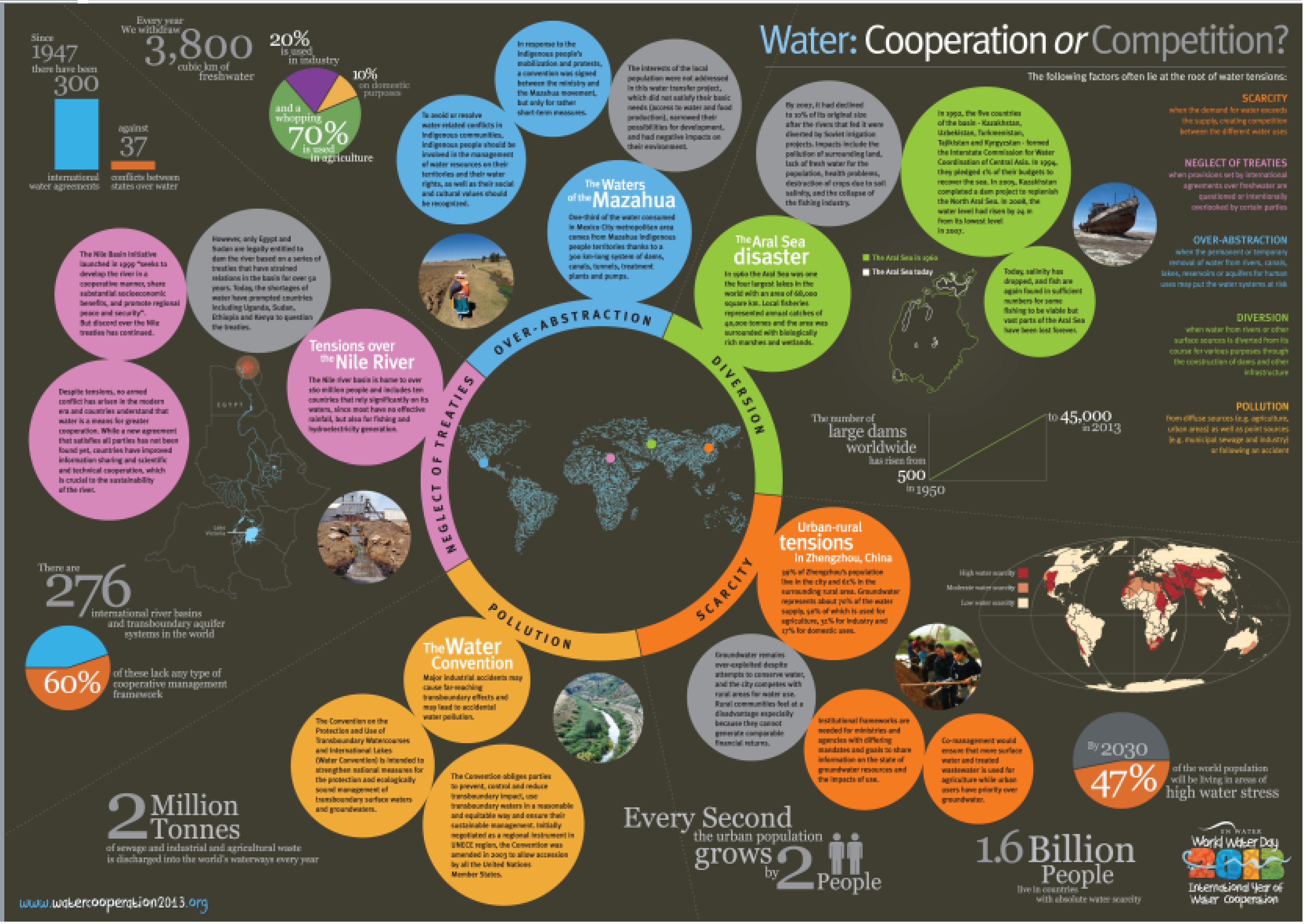


- **Physical water scarcity:** More than 75% of river flows are allocated to agriculture, industries, or domestic purposes. This definition of scarcity — relating water availability to water demand — implies that dry areas are not necessarily water-scarce.
- **Approaching physical water scarcity:** More than 60% of river flows are allocated. These basins will experience physical water scarcity in the near future.
- **Economic water scarcity:** Water resources are abundant relative to water use, with less than 25% of water from rivers withdrawn for human purposes, but malnutrition exists.
- **Little or no water scarcity:** Abundant water resources relative to use. Less than 25% of water from rivers is withdrawn for human purposes.
- **Not estimated**

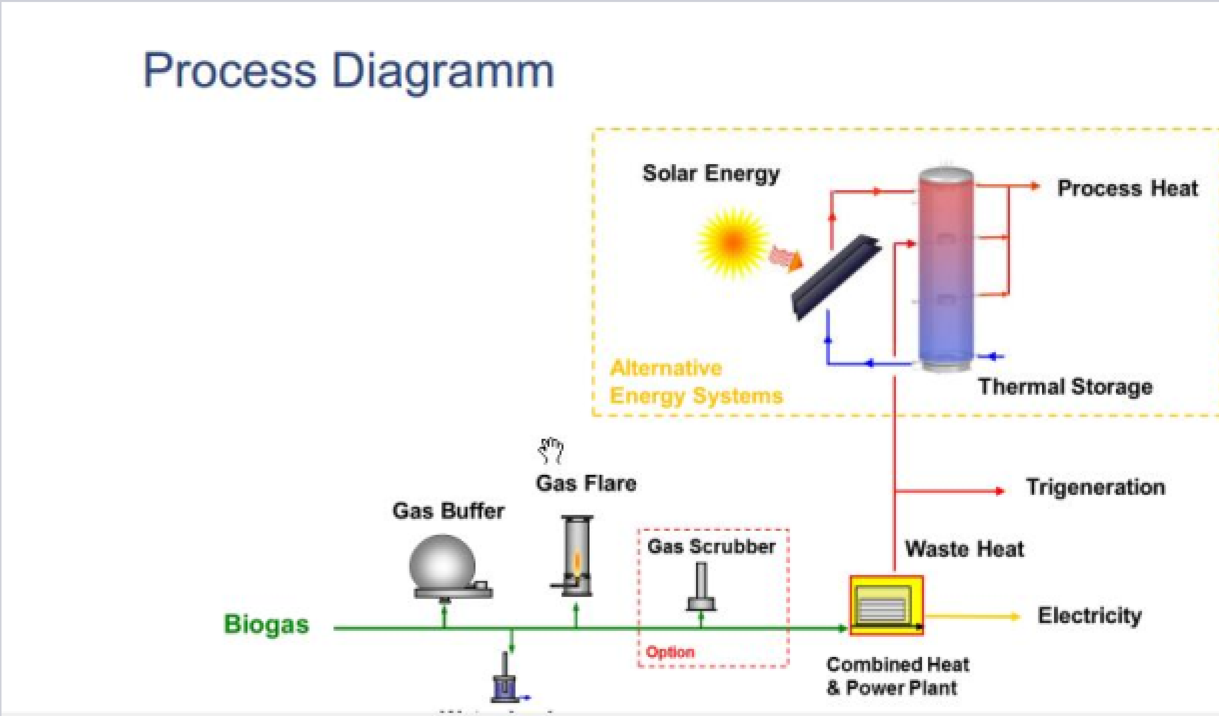
Source: International Water Management Institute.

National Intelligence Council, Global Trends 2025: A Transformed World, Government Printing Office, Washington, DC, November 2008

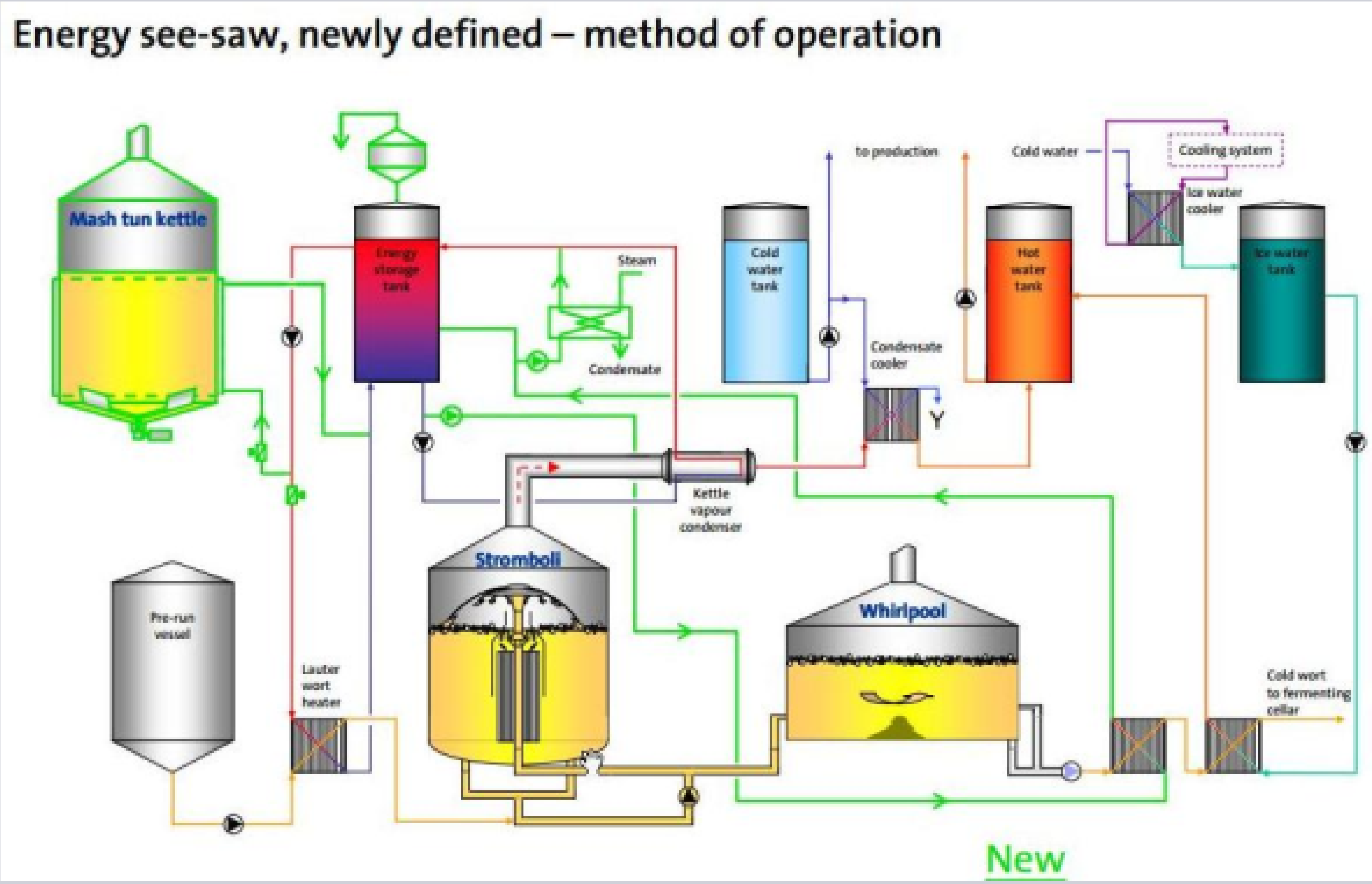
Water, cooperation or competition?



Different concepts: Solar, Biogas, Heat & Power-Plant

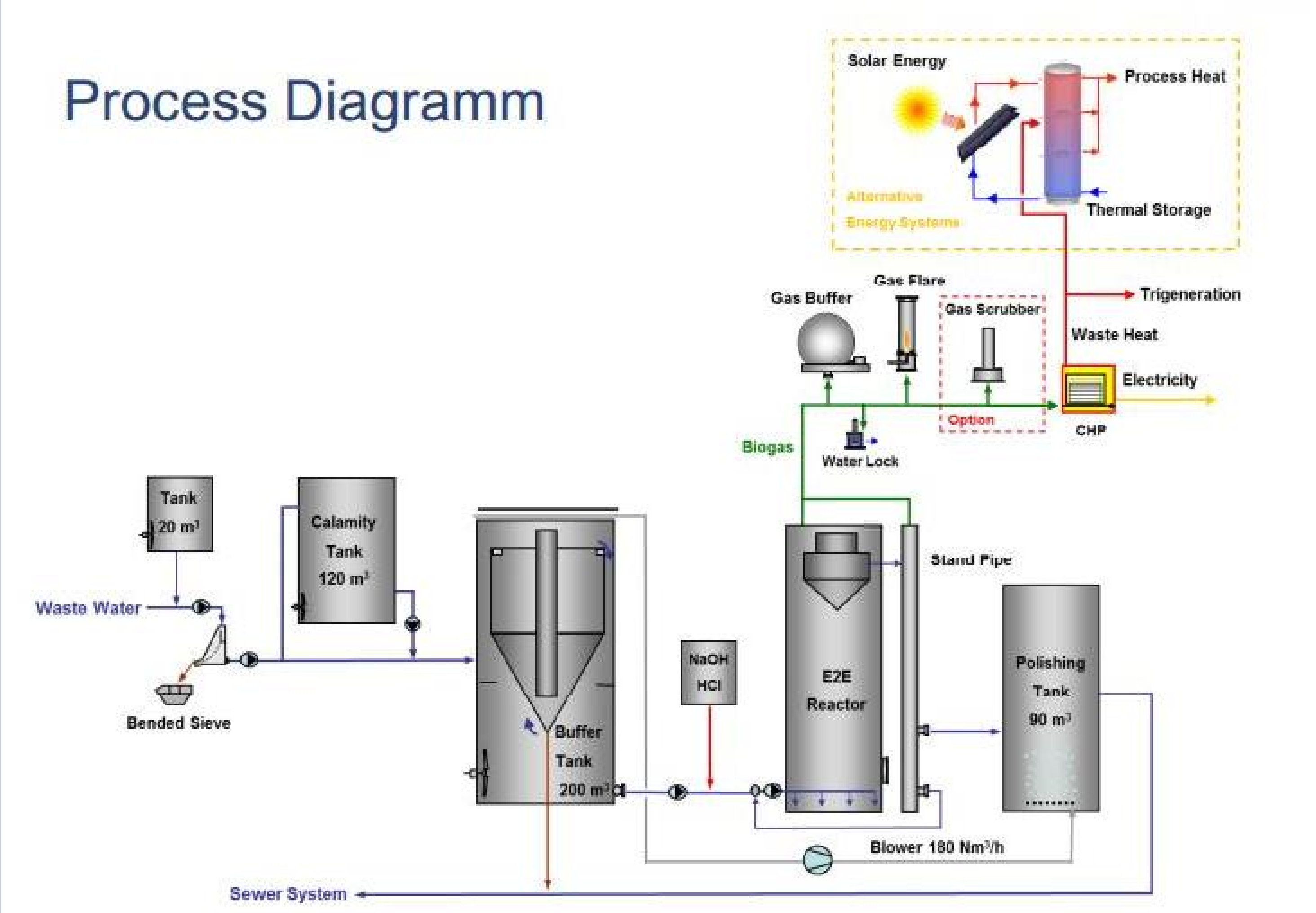


Energy see-saw

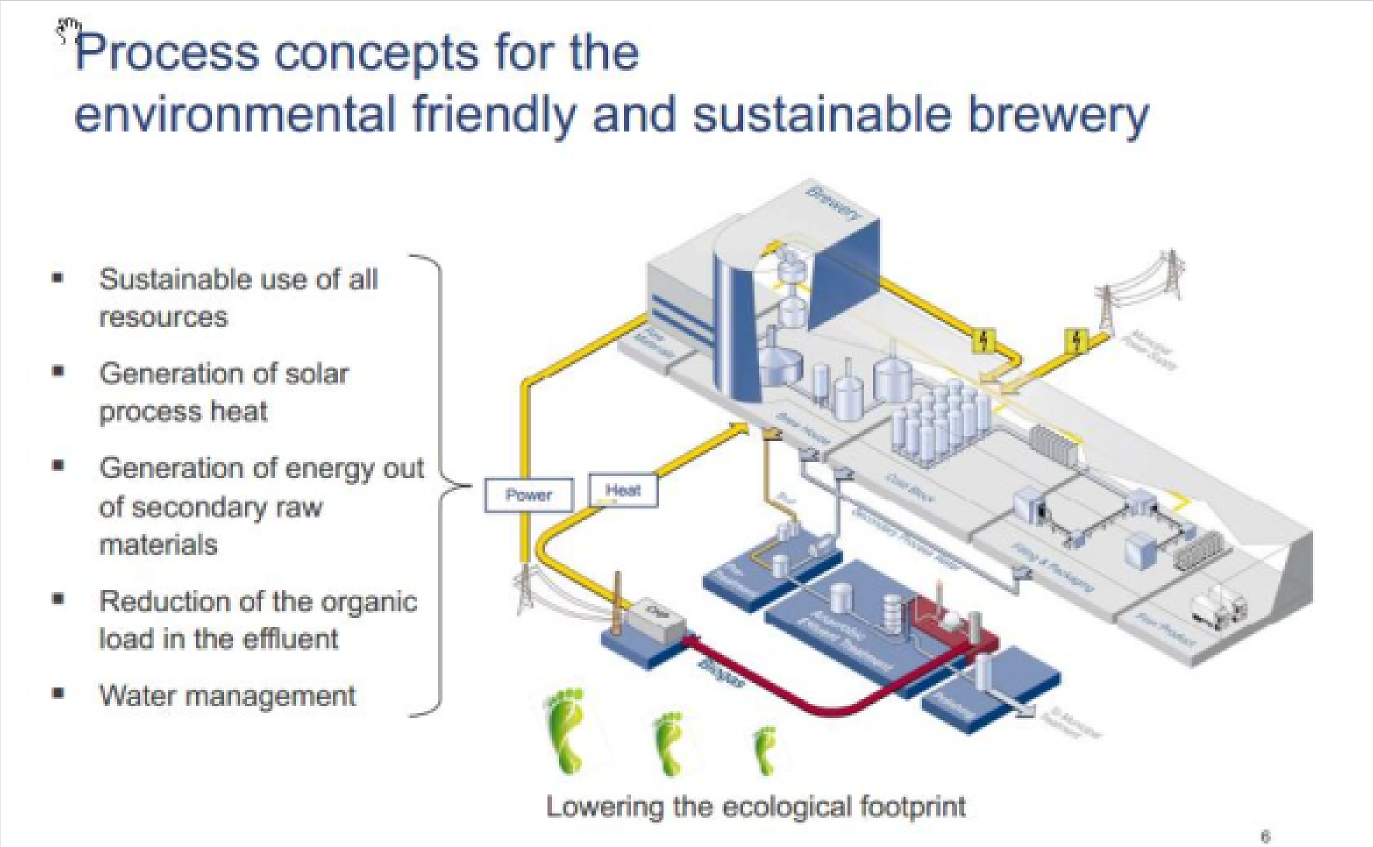


 V20

Using Solar energy



Sustainable brewery

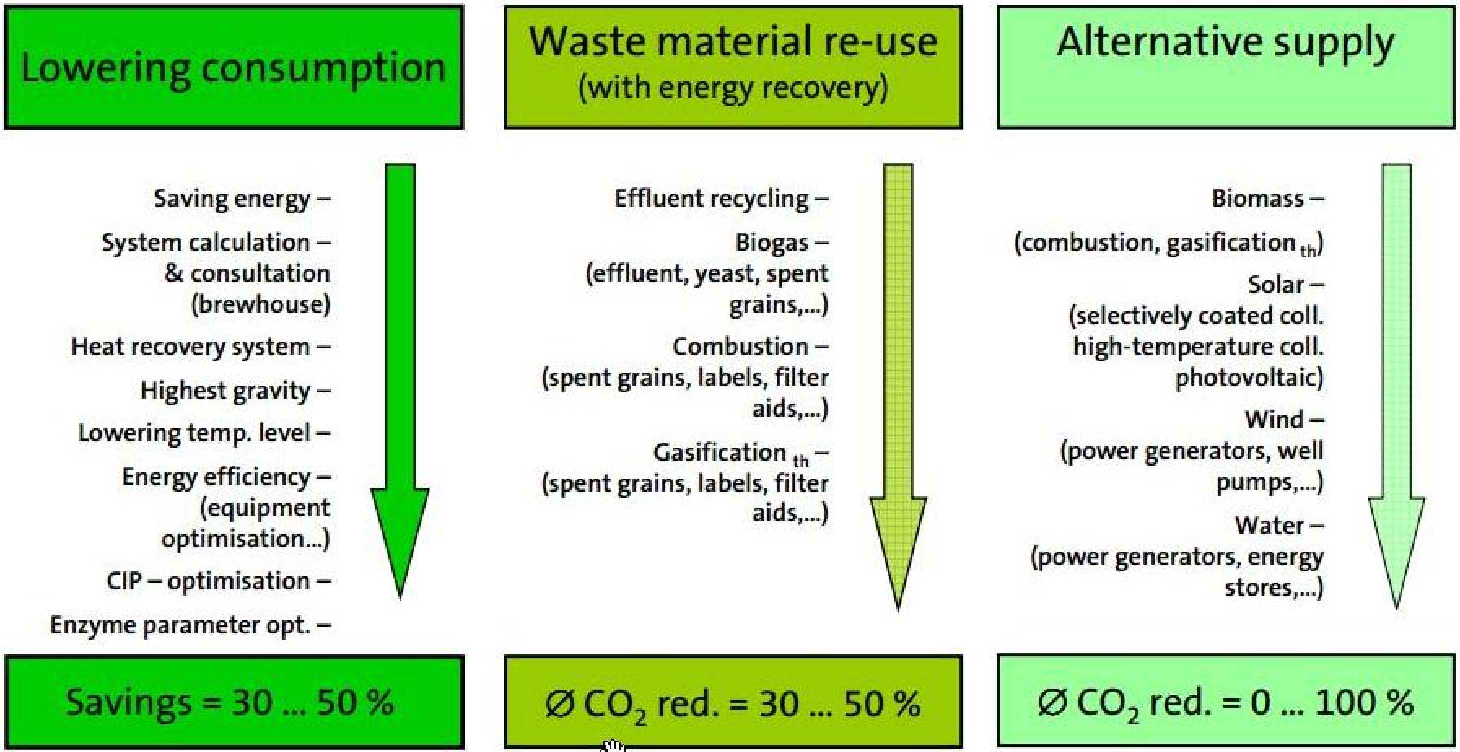


Primary energy and more

Primary energy and more – state-of-the-art technology and a bit better

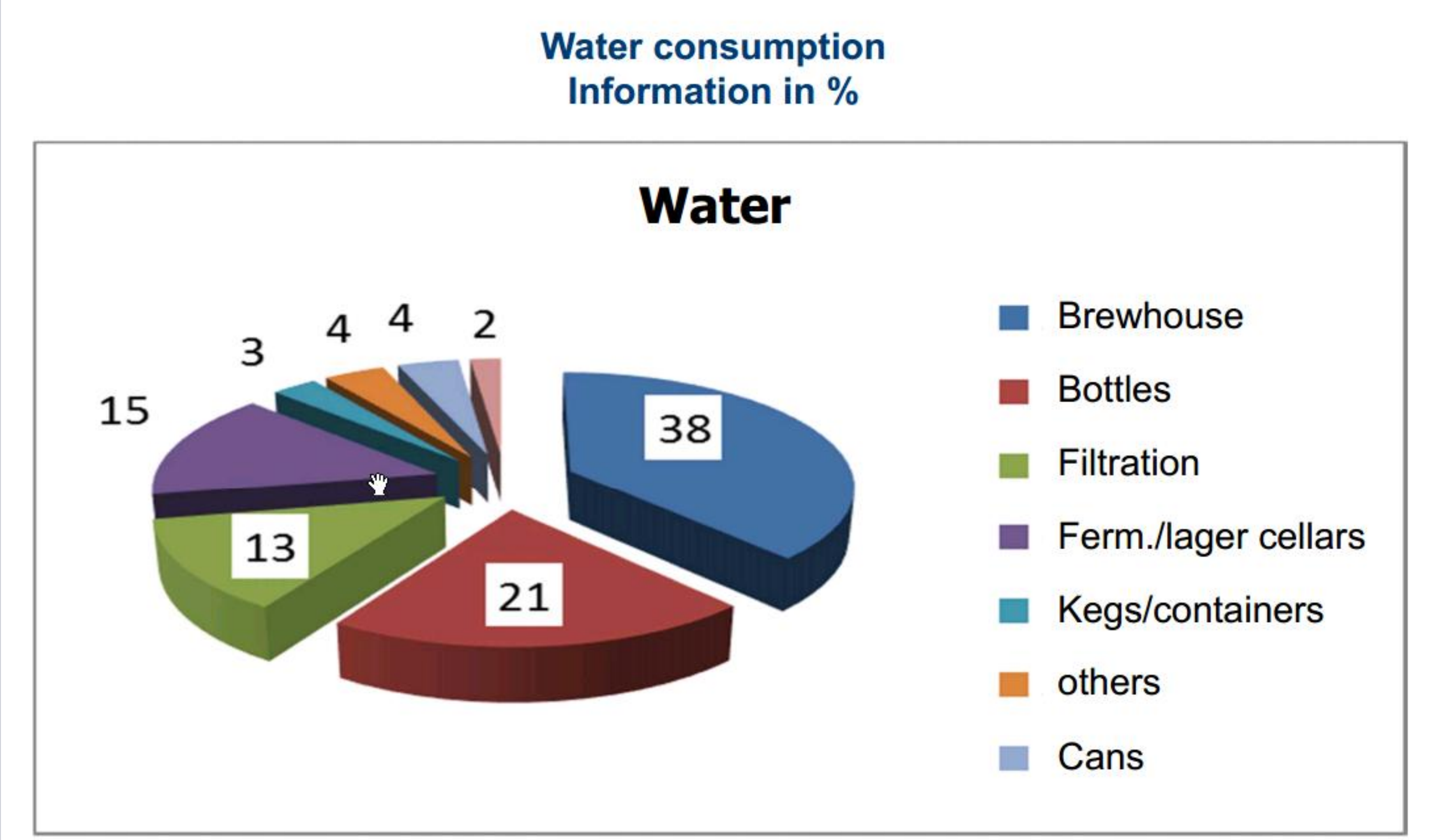
- Savings of electrical and thermal energy
- Installation of less electrical power
- Elimination of surplus hot water
- Optimised hot water management
- Avoidance of load peaks at the heating boiler
- Smaller heating boilers and cooling systems
- Introduction of energetic flexibility of the mashing-in temperature

Aspects

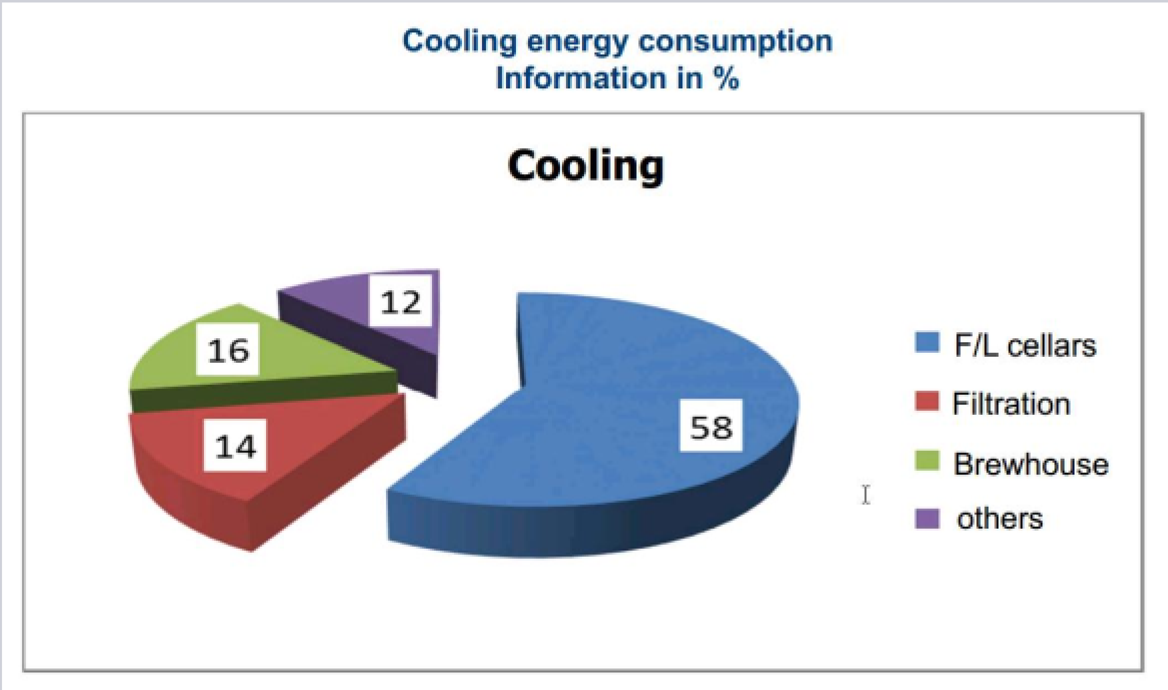


➡ Mainly influencing and lowering of media consumption at machine level

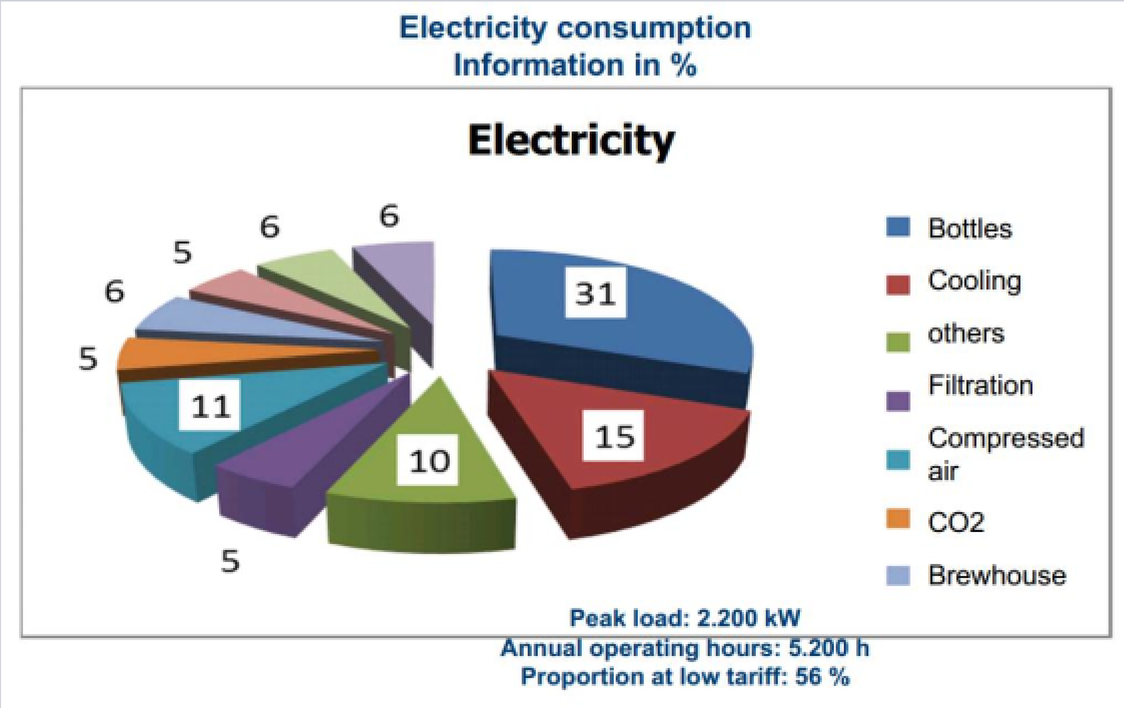
Water consumption



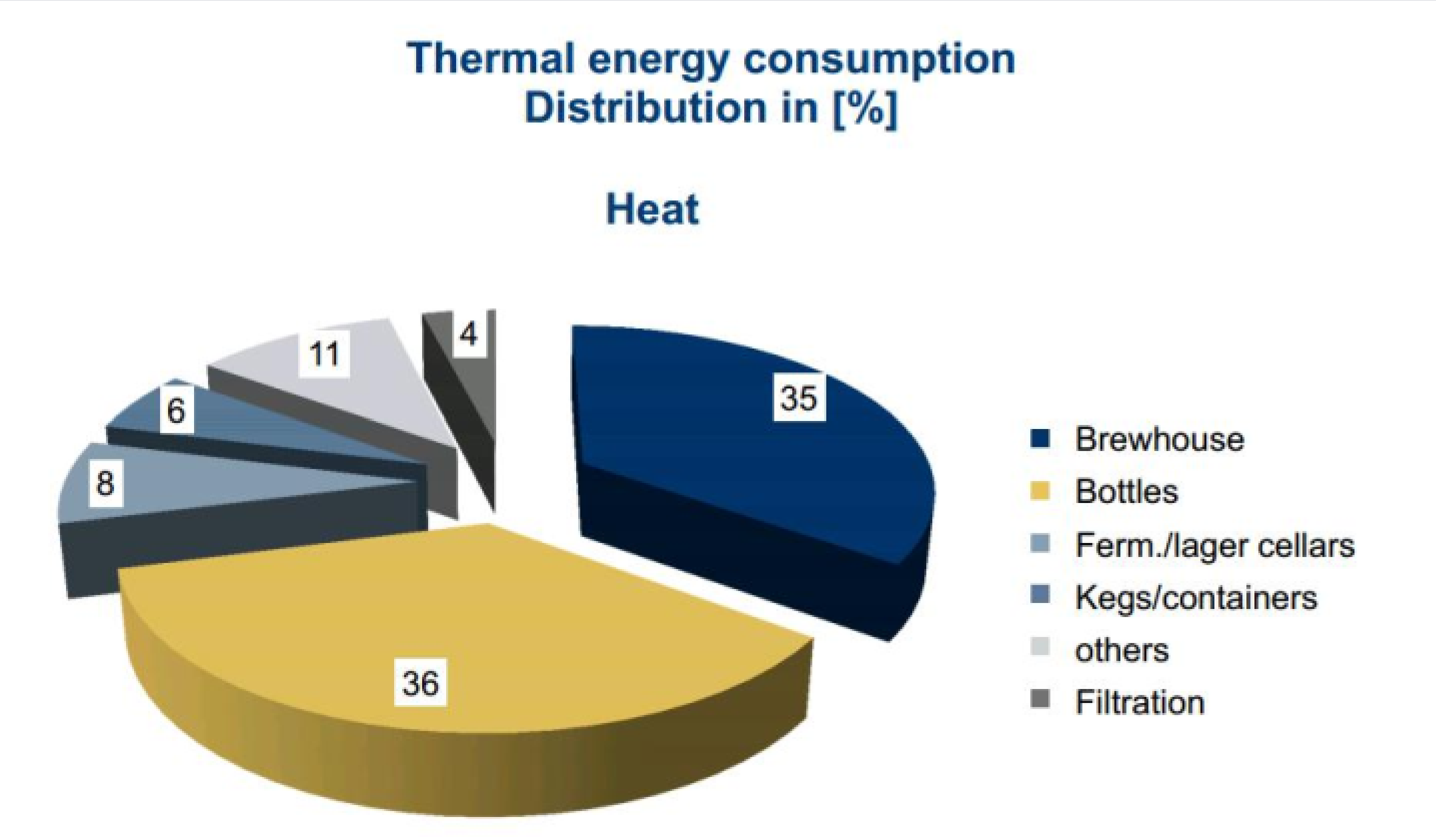
Cooling consumption



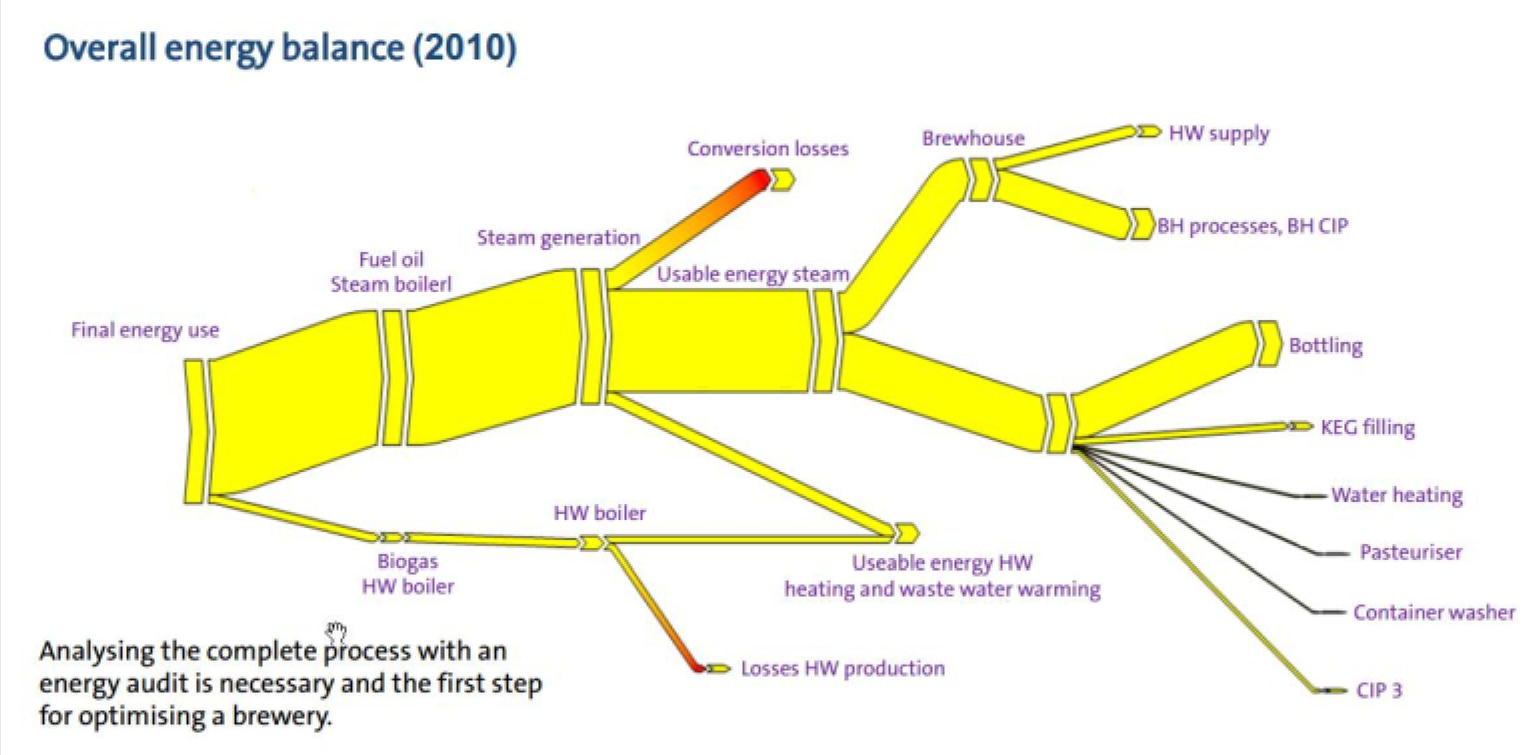
Electrical consumption



Thermal energy consumption



Overall energy balance



Measuring the consumption (at Kulmbach)

- **Measuring the consumption:**

  220 installed consumption meters
  - 90 Water meters
  - 90 Electricity meters
  - 25 Gas meters
  - 15 Heat meters

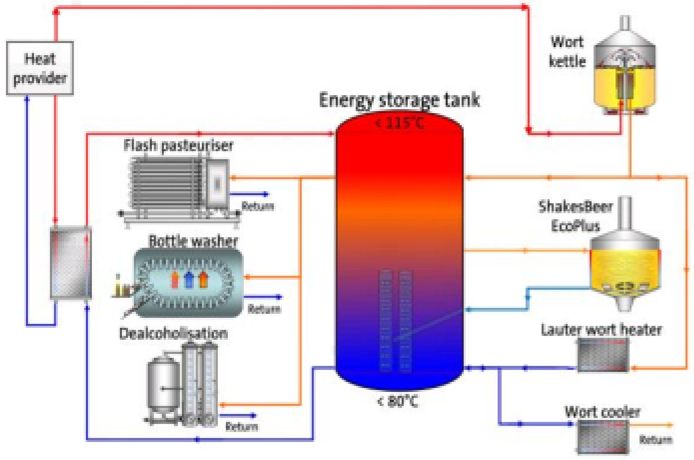
- **Determining the consumption data:**
  - Individual metering, no bus system or network
  - All meters are bar coded for identification
  - Monthly, manual determination via PDA
  - Data transfer to Qualifax -> exported as Excel-file
  - Analysis and visualization using MS-Excel

Central storage heater

A central storage heater as interface for all processes

- One energy storage tank for all consumers
- Energy storage tank reduces peak loads
- Allows constant loading
- Integration of alternative energy sources (CHP)

➔ Multifunctional buffer – energy storage tank



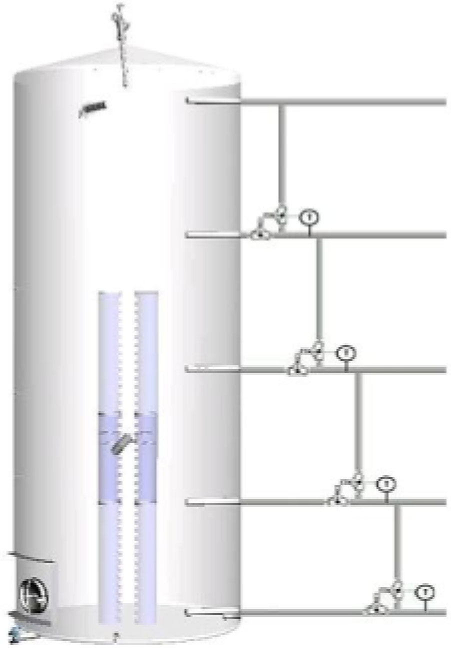
Energy storage system of the Murau eGen brewery

Optimum use of heat capacity by cascade circuit

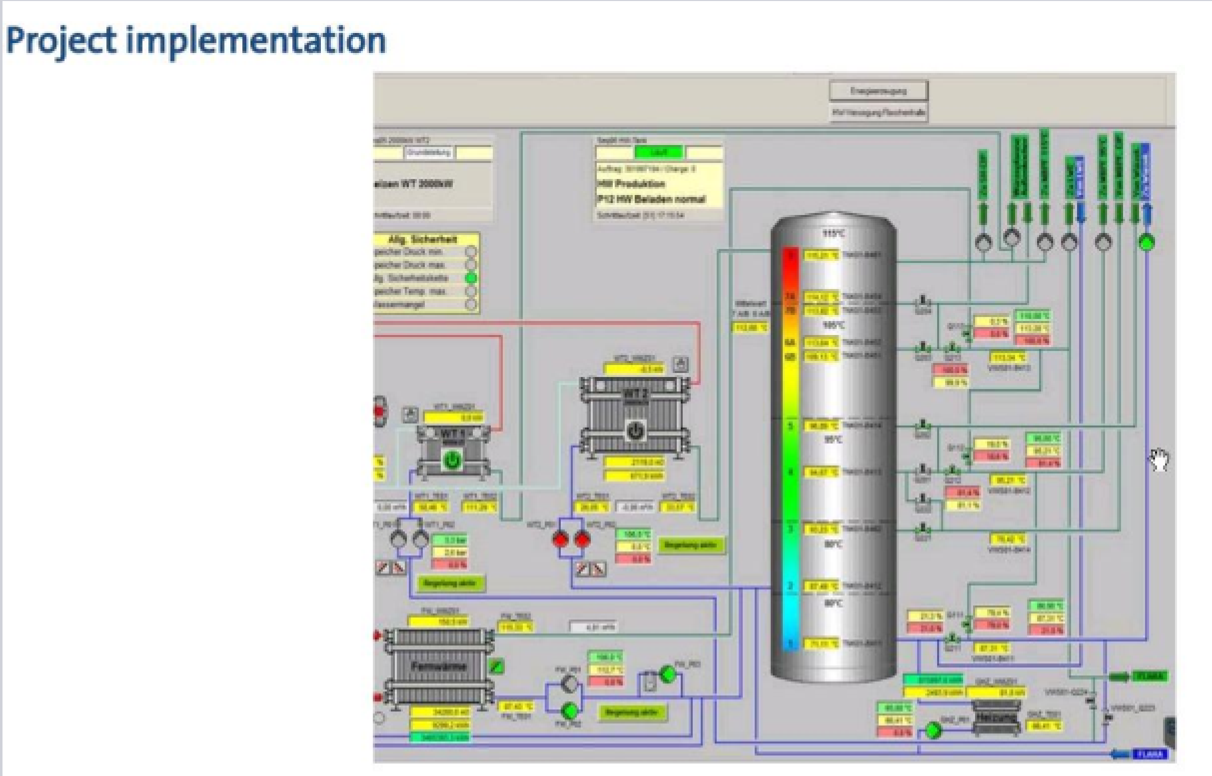
Optimum use of heat capacity by cascade circuit

- There are four process-based temperature levels for supplying all consumers in a brewery
- The preflow temperatures to consumers can be individually and variably adjusted with the cascade circuit
- Optimised placement and removal of energy by means of layer charging lance
- Stepwise multiple use of the heating medium

➔ **Efficient use of heat, adjusted to the needs of consumers**



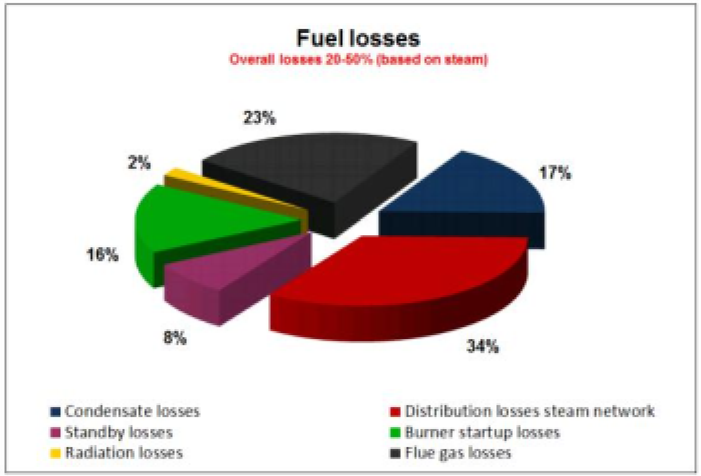
Project implementation



Why low temperature using hot water and one enery storage tank?

Why low – temperature using hot water and one energy storage tank?

- Steam systems cause high distribution, condensate and flash steam losses
- Most processes in a brewery run at under 100 °C
- Lower heat transfer medium temperatures reduce delivery, radiation and system losses
- Special stratified energy storage tanks avoid consumption peaks due to overlap of heat consumers



Brauwelt Nr.6, 2012, page 175

Low temperature brewery

How we define a low temperature brewery

- Maximum process temperature up to 115 °C
- Hot water as heat transfer medium in a closed system
- Energy provision via a central storage tank
- Multiple use of thermal energy
- Simple integration of recuperative energies
- One energy center also for renewable energies

Example

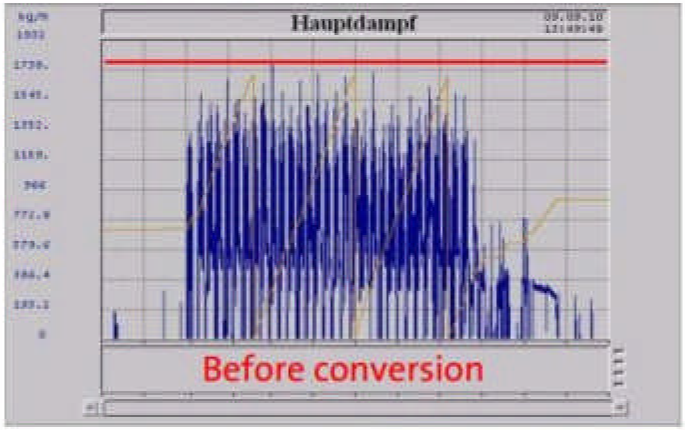
2.880.000 kWh_{th}/year → 835 t CO_2 /year → 144. 000,- €/year

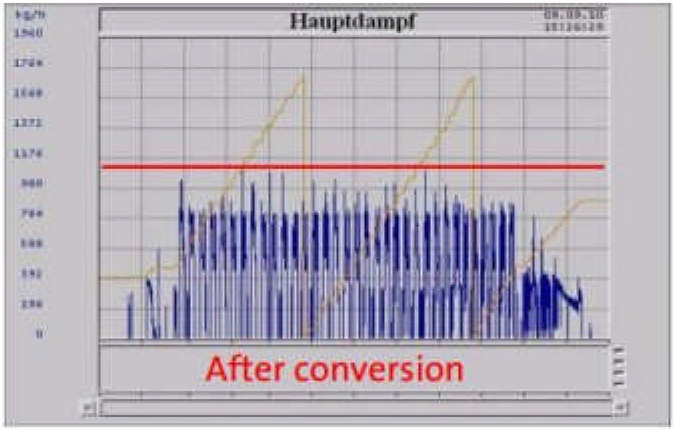
300 T hl beer (unblended) / year, conversion to a low-temperature concept 115°C, 5,0 ct € / kWh_{th}

Energy saving: Main-Steam modification

Energy savings of 20 per cent and more

Hauptdampf = steam





	Before	After	Savings
Performance peak	1,750 kg/h	1,150 kg/h	reduced by 34 %
Electrical energy, ice water preparation *	22.0 kWh/brew	16.9 kWh/brew	23 %
Wort cooler, hot water preparation	18.9 m³/brew	14.5 m³/brew	23 %
Thermal energy (average)	827 kwh/brew	561 kWh/brew	32 %

Saving with little investment

Savings with little Investments

- Installation of small modules by members of staff in order to e.g. reduce the water flows during down times or half loads of machinery.
- Application of movement detectors for staircase lighting.
- Energy saving lamps (up to 50 % savings)

Measures: Changing the tubes

Measures

Kulmbacher Gruppe

- 2007: Dimmable T5 tubes with presence detector and brightness control
- 2012: Insertion of T8 LED-tubes (26 W)

Thermal measures 1

- **Measures (1):**
  - **Heat supply:** 90 % natural gas, 10 % biogas
  - **Steam boiler** with economizer and utilization of condensing technology
    - Boiler pressure < 4.0 bar_o, steam pressure in system: 2.8 bar_o
    - Dimensioning of consumers: steam pressure 2.5 bar_o
    - Heat exchanger for blow-down and feed water
    - Shutting down the boiler during work stoppages > 12 h
  - **Bottle washing machines**
    - Direct heating with natural gas and utilization of condensing technology
    - Exhaust gas temperature < 52 °C
  - **Brewhouse:** Internal boiler with vapor condenser

Thermal measure 2

- **Measures (2):**
  - **Heating of buildings** (not connected to the boiler plant):
    - Offices: natural gas condensing boiler, programmable thermostats, seven day time switch
    - Filling plant: only using waste water from washing machine
    - Logistics halls: no heating (frost protection), high-speed doors
  - **Insulation**
    - All pipelines > 50 °C
    - Insulation thickness (pipes and tanks): EnEV 2007/2009 plus 50%
    - Insulation of fittings (also retroactively)
    - Inspection/control using infra-red cameras

(EnEV = German energy saving ordinance)

Measures: Cooling

Cooling

Kulmbacher Gruppe

- **Measures (Ammonia refrigeration plant):**
  - **Compressor regulation in 14 steps**
    - Load dependent compressor changes
    - Suction temperature – 2,5 °C
  - **Condenser regulation in 15 steps**
    - optional air/water, set value 10 bar, 27 °C
  - **NH_3-Direct evaporation** primarily
    - Tank farm: 56 CCVs with NH_3, 25 CCVs with Glycol
  - **Dimensioning the heat exchanger**: ($\Delta T < 2K$)
  - **Recovery of the cooling energy** by the CO_2-evaporation

Measures: Lighting

Lighting

Kulmbacher Gruppe

- **Measures:**
  - **Primarily daylight:** windows or skylights
  - Technical and logistics areas:
    - **Presence detector**
    - **Daylight dependent brightness control**
  - **Changeover to LED illumination**:
    - Fluorescent tubes (80 W) by LED-“tubes“ (26W)
    - from HQI lamps (300W) to LED floodlights (125W)

Measures: Water consumption

5. Water consumption

Kulmbacher Gruppe

- **Measures:**
  - **Savings :**
    - Optimization of the CIP and flash pasteurization systems
    - Air-cooled compressed air generator
    - Cooling the pasteurizer using a cooling tower
  - **Recycling:**
    - Central batch water tank in filling plant
    - Reuse of rinsing water and intermediate CIP rinses
    - No fresh water in the dry areas

Measures: electrical energy

4. Electrical energy

Kulmbacher Gruppe

- **Measures:**
  - **Load management** for power peaks
    - Freeing capacity for the peak loads of the refrigeration plant
    - CO_2-recovery, ventilation systems
  - **Frequency inverter** for pumps and gear motors
  - **IE 3 or IE 4 energy efficiency class of the motors** (IE 2 is prescribed)
  - **Centrifuge:** synchronous motor (50 kW -> 35 kW)
  - **KZE (flash pasteurizer):** base load pump and FI-controlled pumps
  - **Product pumps matched for their particular application**
  - **Bottle and container conveyors**: switched off during stoppages

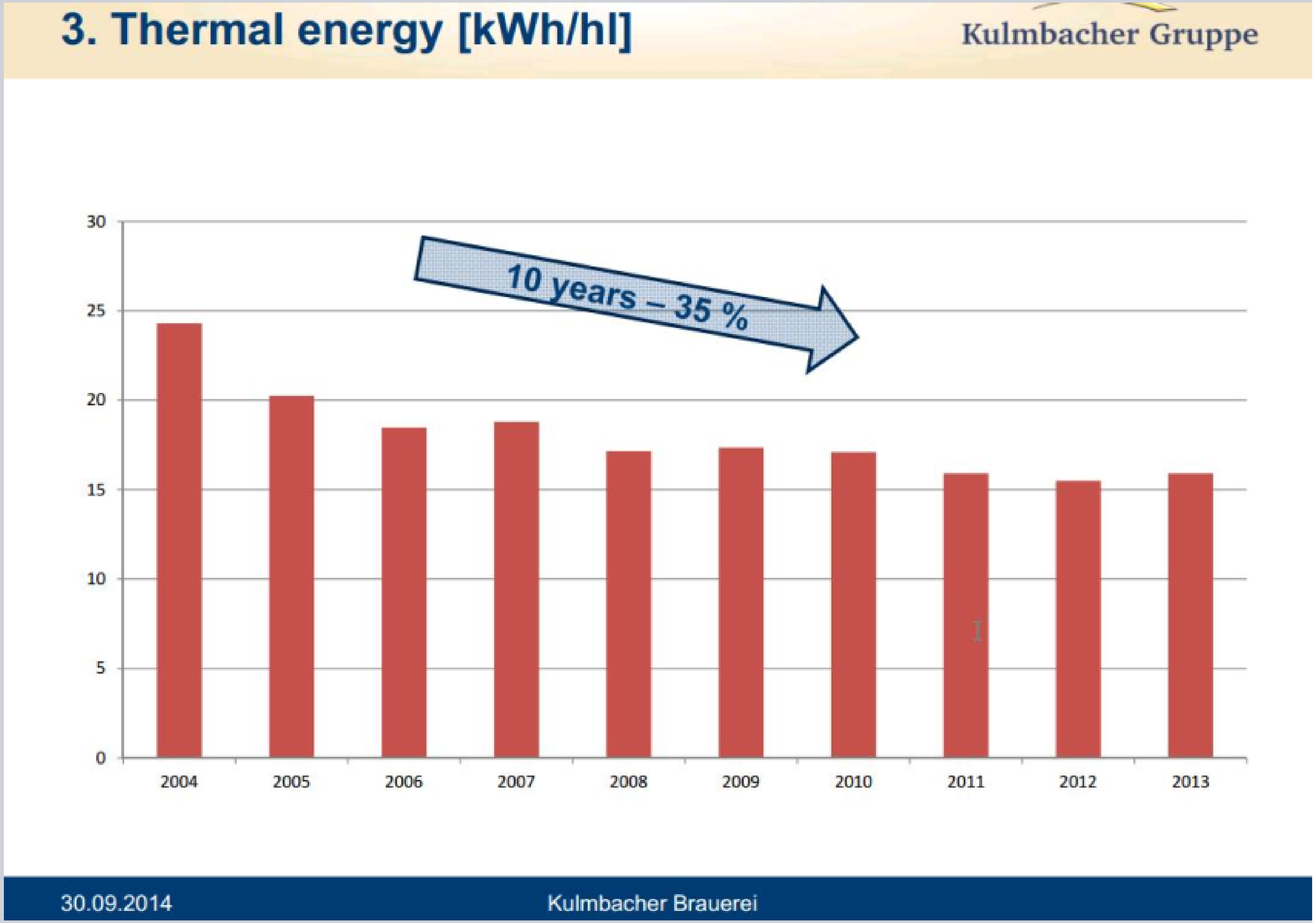
Measures: secondary Raw Material Management

Secondary Raw Material - Management

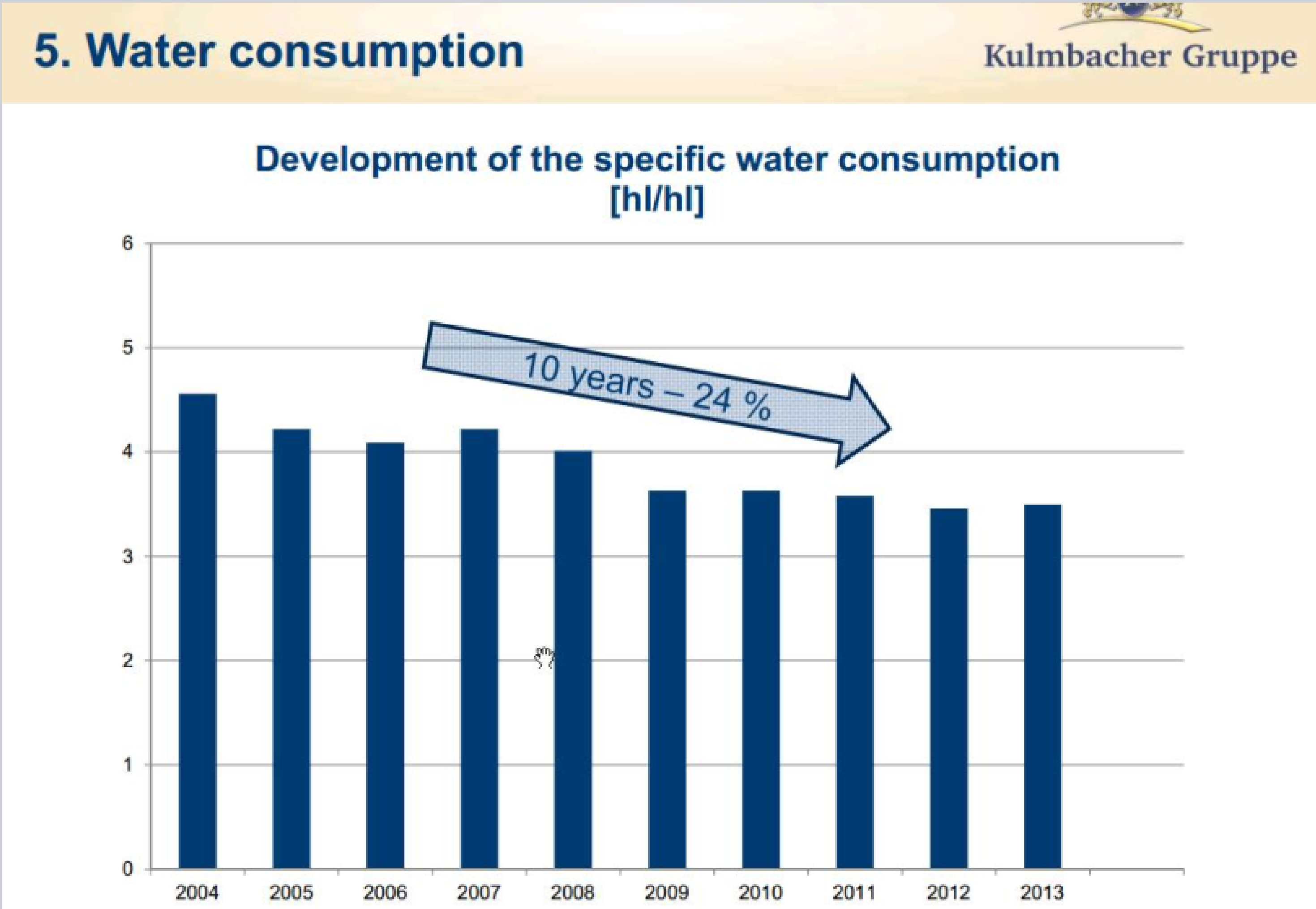
Spent Grains

- Weak wort for energy production
- Spent grain filtrate for energy production
- Combustion of spent grains
- Dewatered spent grains as animal feed

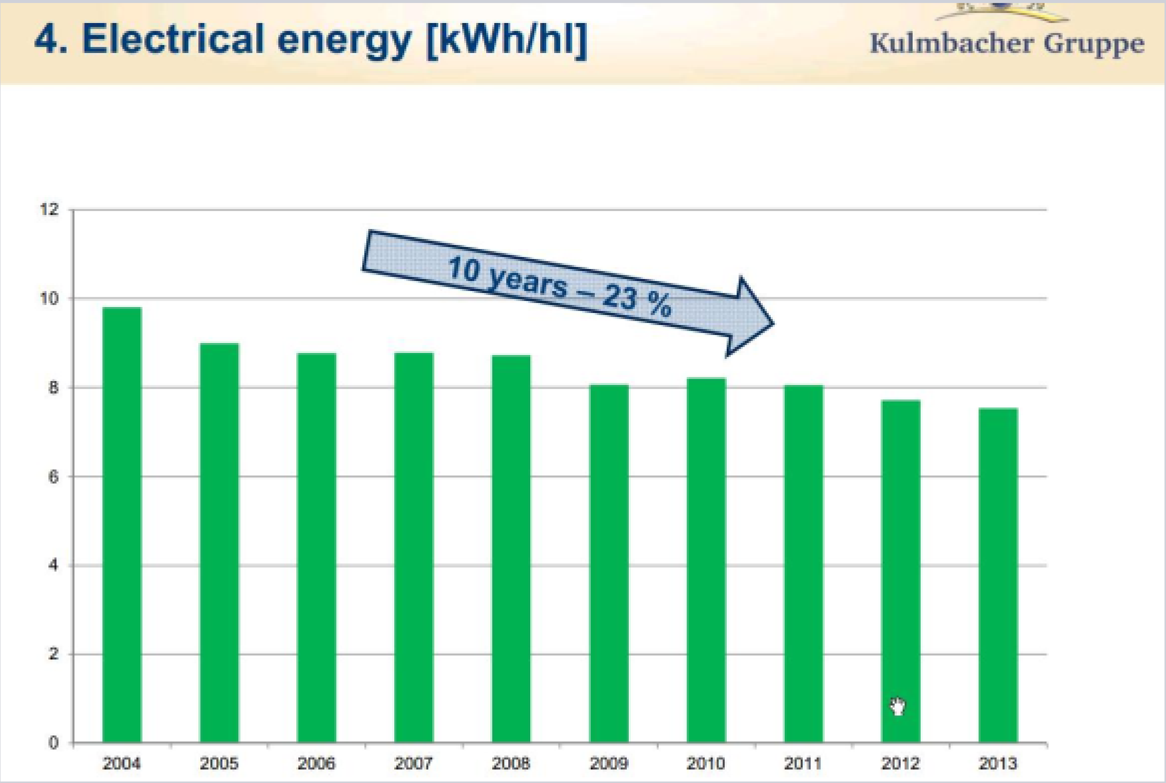
Result: Thermal Energy



Result: Water consumption



Result: Savings electrical energy



Status quo in Germany

Wind Energy

Wind Energy

Testing of usability of wind energy for brewing applications:

- pressure air
- electricity

- not yet ready for maturity phase

Solar thermic collectors v/s Photovolatic modules

Solar thermic collectors – Photovoltaic modules

Comparison at 1000 W/m² solar radiation:

Solar thermic collectors	Photovoltaic modules
Module efficiency of solar thermic collectors → ca. 65%	Module efficiency of photovoltaic modules → ca. 14%
System efficiency → ca. 500 – 650 W/m²	System efficiency → ca. 100 - 140 W/m²
Advantage: easy storage, available when required (night)	Disadvantage: Storage problems only available when generated

Result: Area reduction by factor 4

An approximate 4 times higher energy amount is available based on the same area. Compared to photovoltaic the savings potential is significant.

Solar energy for process water

Solar energy for process water

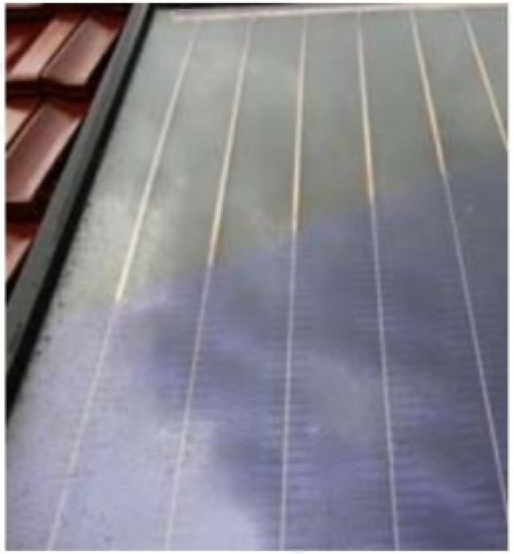
Flat-plate collector

Pro:

- ✓ more days of production (snow!)
- ✓ simple technology
- ✓ low maintenance
- ✓ robust
- ✓ favorable pricing

Con:

- ✗ low process temperatures ca. 100 C



Solar energy for process water

Solar energy for process water

Evacuated tube collector

Pro:

✓ high process temperatures up to 130 °C

✓ quick response

Con:

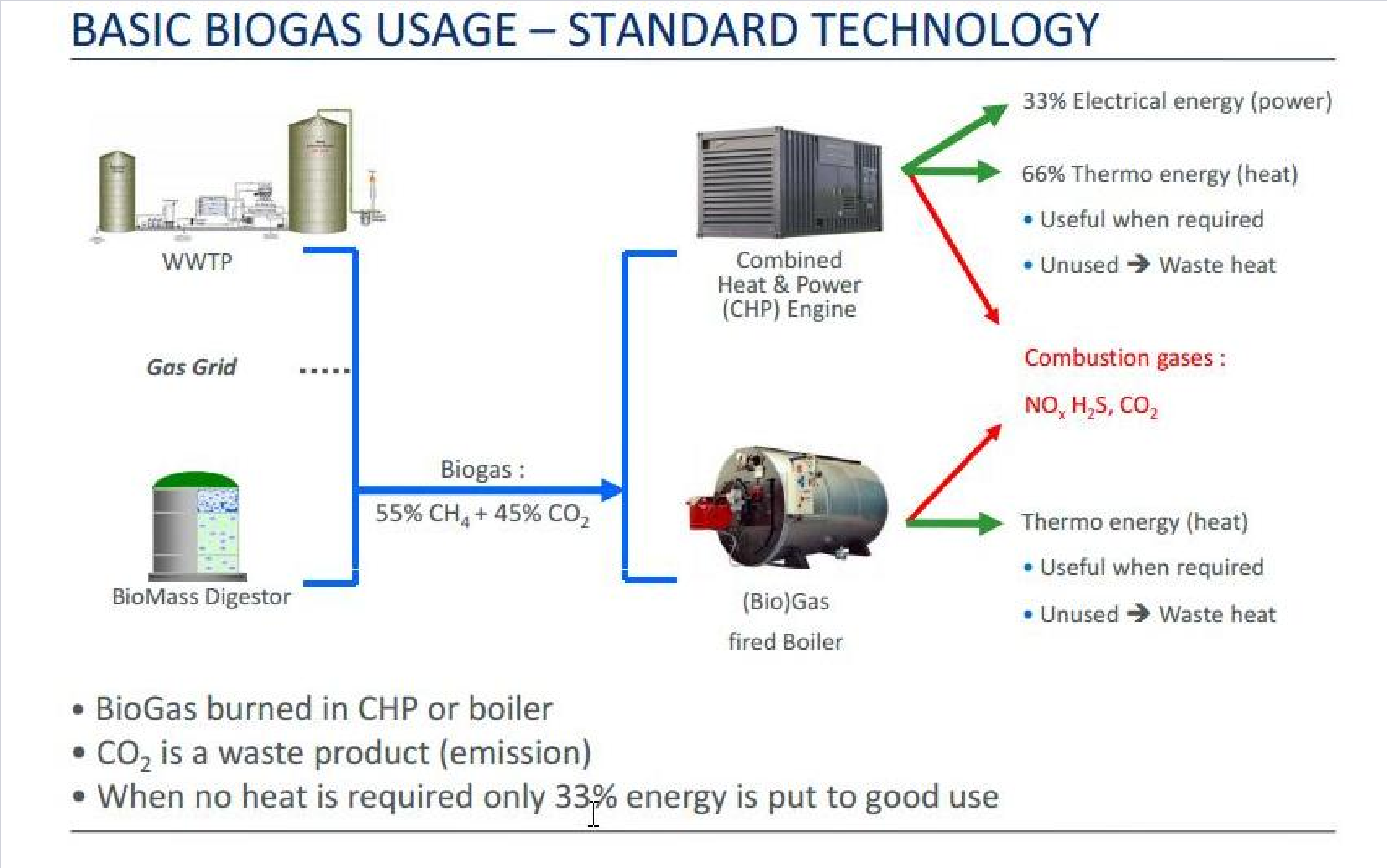
✗ high acquisition costs

✗ high-maintenance

✗ vulnerability of collector tubes (vacuum)

✗ sensitivity for dust, dirt, leaves, snow

Biogas Usage



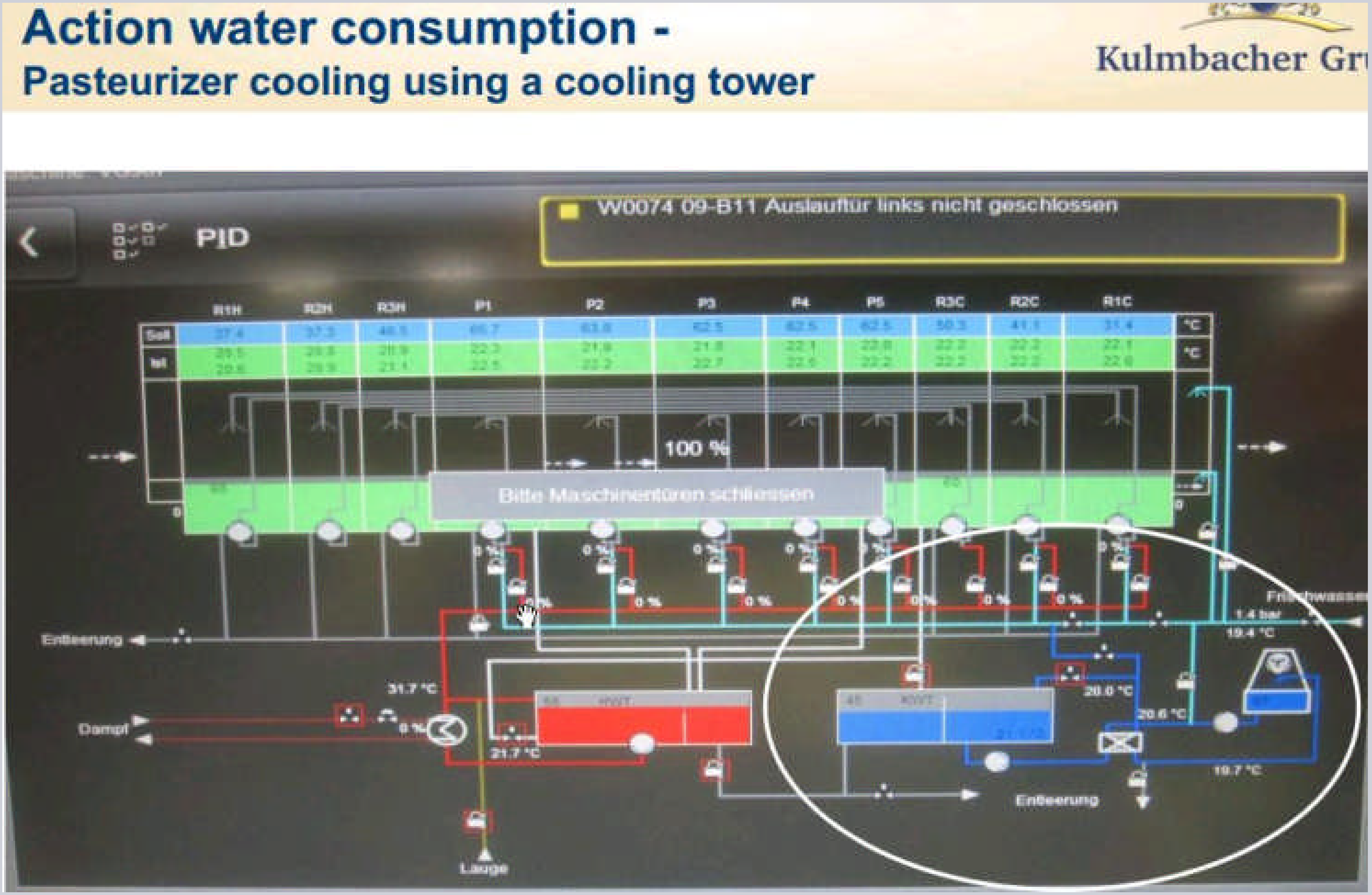
Heat and Power Example

Technology

Equipment: combined heat and power plant

Electric power:	2 x 1.1 MW
Thermal output:	2 x 1.1 MW
Overall efficiency:	85 %
Fuel:	natural gas H
Operating hours:	min. 6,500 h

Pasteurizer using a cooling tower



Measures in a Brewery: Some Impulses 1

Energy saving and cost saving measures

- At current energy-peaks switch loads off of plant parts (refrigerant compressors, pressure air compressors), as long as sufficient buffer is there.
- For low-power tariff times (eg at night) turn of plant parts (refrigerant compressors, pressure air compressors), to fill the buffer. If the current is low, go down with the glycol temperature;
- Hot water tank production in low-power tariff times.
- Drive cleaning programs in low-power tariff times
- Optimal use of heat exchangers; Keep K-value high. Fouling problem!
- consider the simultaneity factor for motors.

More Impulses 2: General Actions

Energy saving and cost saving measures

- switch Air conditioning on only in the presence of personal (moving-detector).
- switch Lighting on only if it is dark (Sensor) and in the presence of human.
- Warm-water-boiler on only in time relevant times (Timer)
- Vacuum solar collectors for hot water.
- If the window is open turn heater / cooling devices off (switch)
- Switch not active PC in standby and restart by network (Power-on LAN).

Measures in a Brewery: Ressouce conversation

Ressource conservation and cost savings

- Line cleaning: for media separation use only about 6 hl of water between different agents. With that a good media separation this is possible.
- Optimization of switching-points for the medium-separation (caustic, water, acid etc).
- Flush vessels only if no next Brew is coming.
- Mash-Tun-Kettle: Heat with 1 °C per minute. Cleaning is required if it takes too long.Related software on request!
- Wort boiling with enthalpy. These requires additional measurements-devices such as vapor pressure and Flow, steam temperature, condensation temperature. A good energy savings is possible with it. Related software on request!

Measures in a Brewery: Ressouce conversation 2

Resource conservation and cost savings

- Cooling energy is extremely expensive, and the compressors can save a lot of energy when they are used optimally.
- adjust the temperature and pressure for Glycol dynamically by the demand. This should be calculated from the cooling equipment such as tanks (which amount is included and which Delta-T is the aim), word cooler etc. Also, the set point for the pressure can be optimized.
- The refrigeration compressors have an optimal speed range, depending on how they are currently in use. Comply with these operating rules by according Software.

More Measures

Energy Management

- Light / Device delayed off after activation by push-button or motion-detector.
- Light / Device delayed off after activation by switch
- Devices (air conditioning etc) turn on only during the day
- Refrigeration compressors turn on only when there is low power consumption
- Refrigeration compressors turn on if temperature < x ° C.
- Interlock big energy consumer against each other
- Load shedding; shutdown cooling compressors during peak load in the factory

Solutions with Braumat: Load Shedding

Almost all small and medium-sized enterprises, when their connection power exceeds 30 kW (depending from the power supplier), have to pay a higher price in addition to the working price. An energy peak within a measuring period beyond the agreed power supply limit can increase the electricity cost for the entire year drastically.

With this function, it is possible to deactivate different units independently, depending on the energy consumption. This allows the customer to easily implement a load shedding system and to save energy and reduce costs.

2 digital inputs for power and for the synchronization impulse.

32 outputs can be freely defined for 32 units.

Additional logic is possible by parameterization or programming.

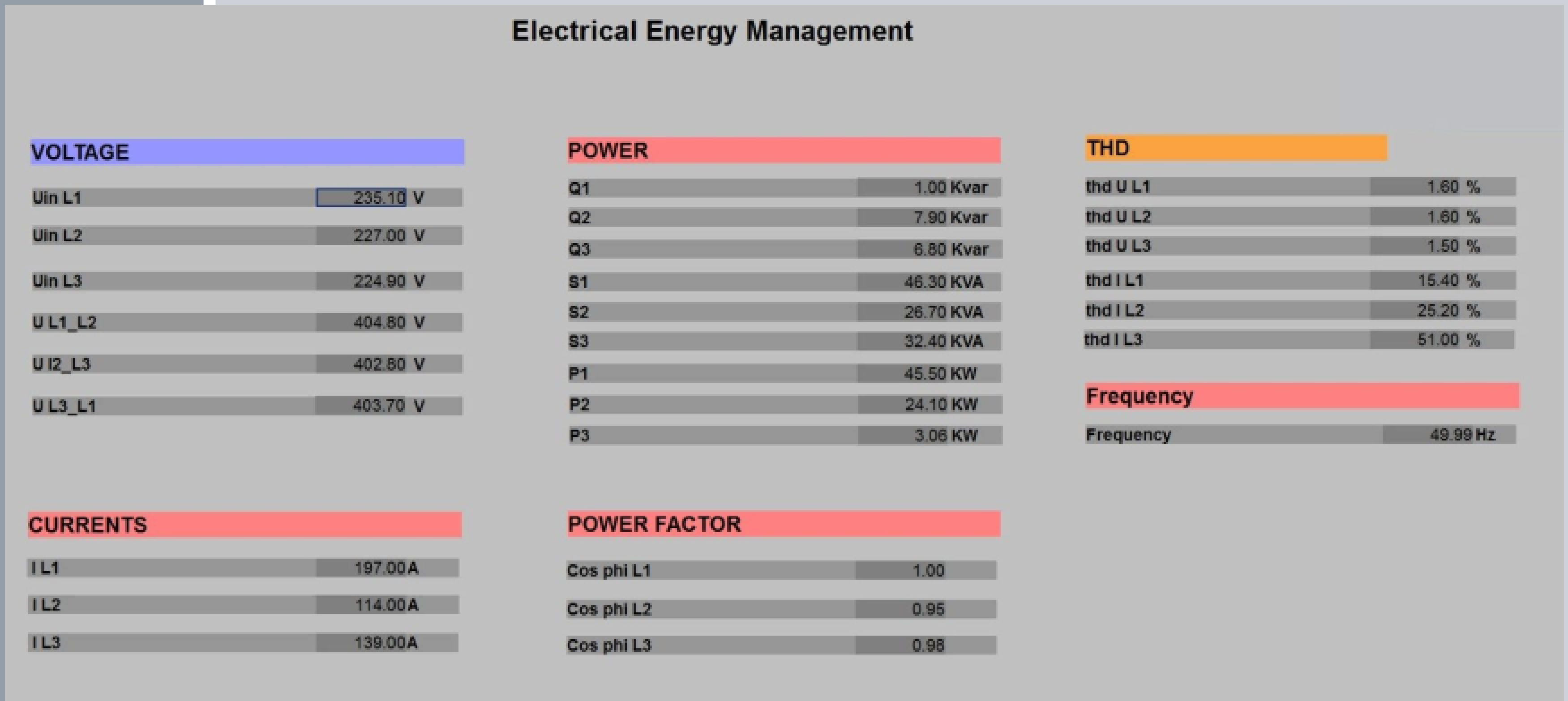
Freely programmable priorities for the devices applicable for load shedding

Minimum switching-on time as well as minimum and maximum switch-off times for each output.

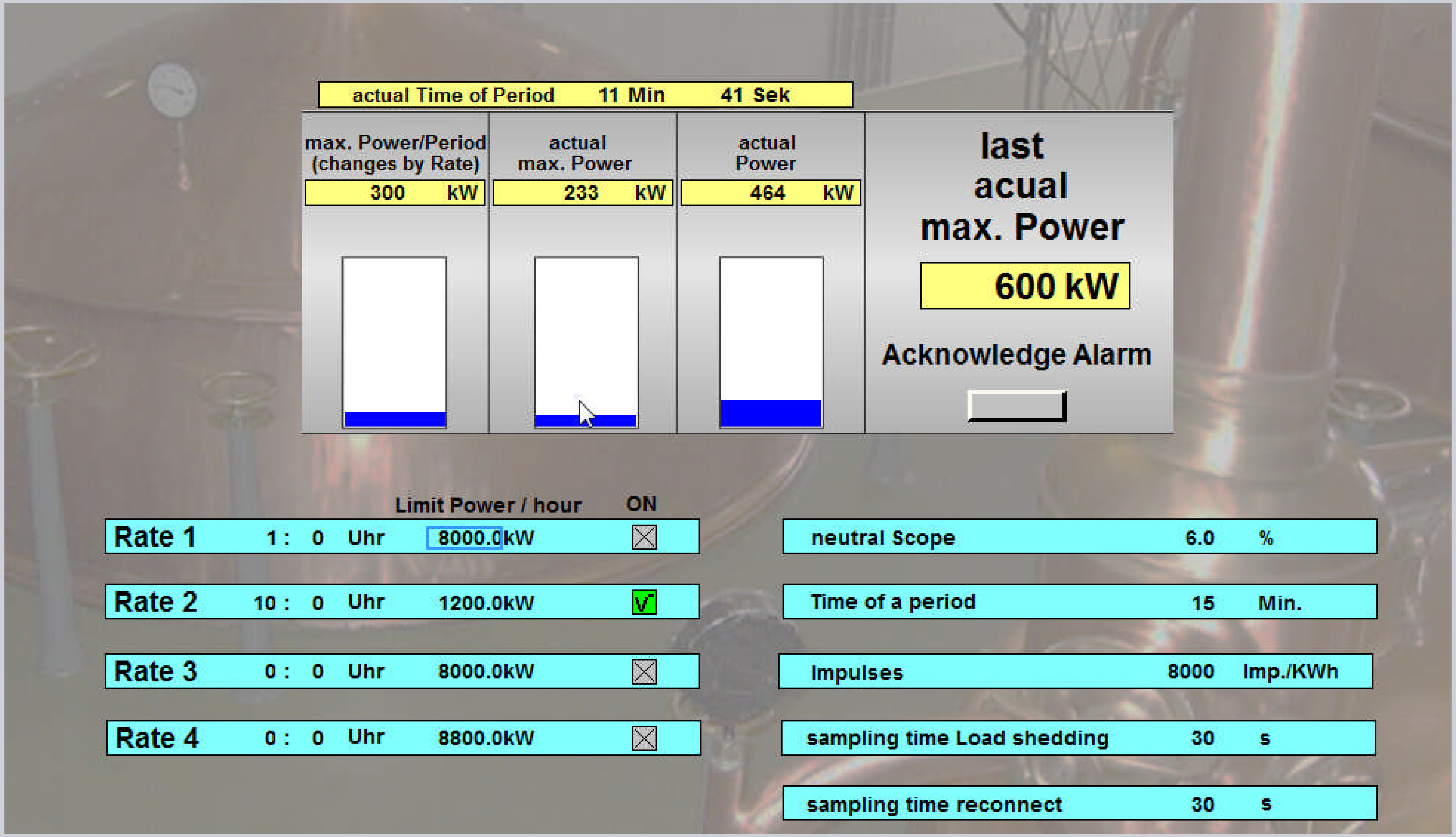
The measuring pulses have a variable ratio (for example, 1000 pulses / kWh)

The measuring period or synchronous pulse is variable, usually every 15 min.

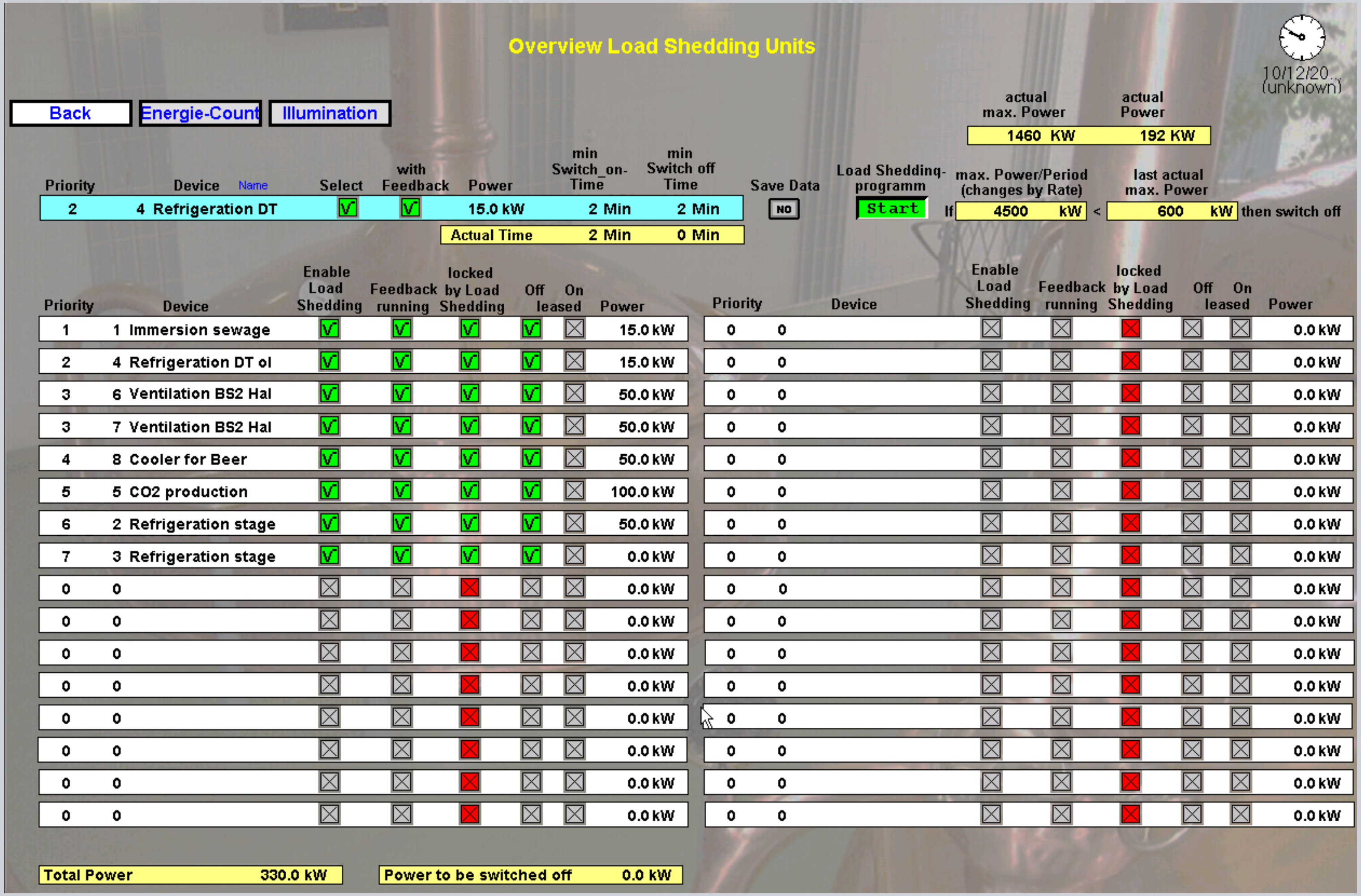
Integration of external Products in Braumat
UMS96, PAC3200



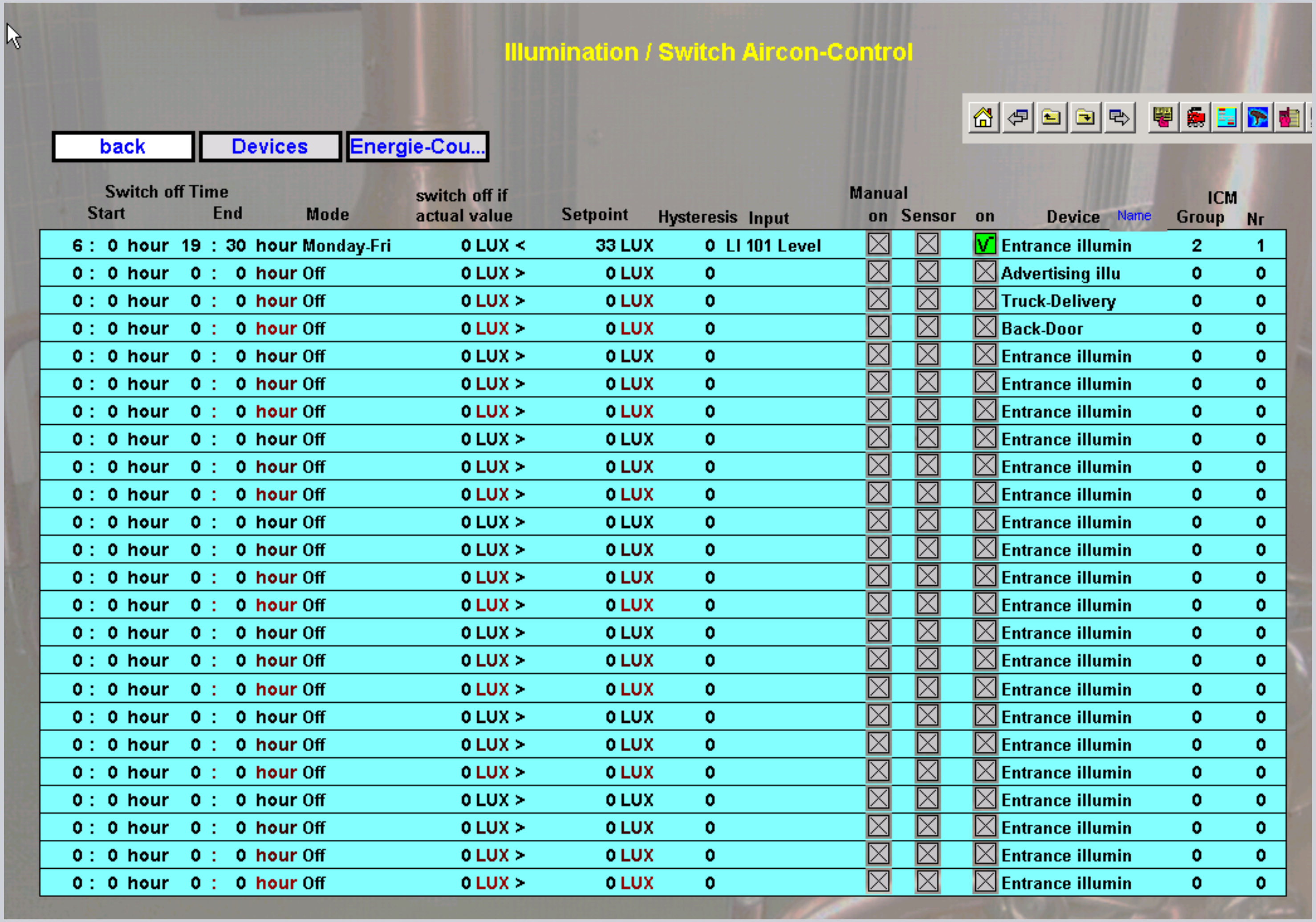
Load Shedding: Setup of Impulses



Load Shedding: List of Units for Load Shedding



Load Shedding by Time and Analog-Values



Switch off Time Start	End	Mode	switch off if actual value	Setpoint	Hysteresis	Input	Manual on	Sensor	on	Device Name	ICM Group	Nr
6 : 0 hour	19 : 30 hour	Monday-Fri	0 LUX <	33 LUX	0	LI 101 Level	☒	☒	☑	Entrance illumin	2	1
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Advertising illu	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Truck-Delivery	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Back-Door	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0
0 : 0 hour	0 : 0 hour	Off	0 LUX >	0 LUX	0		☒	☒	☒	Entrance illumin	0	0

Cooking by Enthalpie-calculation

Boiling Energy Management
(by Enthalpie-calculation)

INPUTS

Steam Flow	1807.20	m3/h
Steam Temp	133.70	°C
Steam Pressure	2.00	bar
Condensate Temperature	132.00	°C
Wort Kettle Full Vol Nominal	382.00	hl
WortKettle Actual Temp.	100.50	°C
Wortkettle Actual Density	12.00	°P

INTERMEDIATE VALUES

Steam Density	0.00	kg/m3
Steam Enthalpy	0.00	kJ/kg
Condensate Enthalpy	0.00	kJ/kg
Enthalpy	0.00	kJ/kg
Density Wort Nominal	0.00	kg/hl
Heat Transmission coef.I	0.00	W/m2K

OUTPUTS

Steam Mass Flow	0.00	kg/h
Steam Mass	0.00	kg
Steam Mass for Heating Up	0.00	kg
Steam Mass for Boiling	0.00	kg
Enthalpy Flow	0.00	kJ/s,kW
Thermal Energy	0.00	kWh
Thermal Energy for Heating Up	0.00	kWh
Thermal Energy for Boiling	0.00	kWh
Heat Up Rate of Wort - Heating	0.00	°C/min
Evapor. Rate of Wort % WKfull/h	0.00	%WK/h
Evapor. Rate of Wort - Boiling	0.00	hl/h
Evaporation of Wort % WKfull/h	0.00	%WK
Evaporation of Wort	0.00	hl
Actual Density by Evap Calc	0.00	°P
Temperature Steam Saturated	0.00	°C
Thickness of Fouling Material	0.00	min

PARAMETERS

Steam Press. offset to abs.Press	1.01325	bar
Enthalpy of Evaporation of Wort	2256.54	kJ/kg
Heat Capacity of Wort	4.20	kJ/kg/K
Wort Kettle Full Density	11.00	°P
Area for Heat Exch.of.Int.Boiler	32.89	m2
Outer Diameter Tubes in Int.Boiler	60.30	mm
Thickness of Tubes in Int.Boiler	2.00	mm
Lambda of Cr-Ni Steel	52.00	W/m*K
Lambda of Fouling Material	1.20	W/m*K
Alpha inside pipe Wort Bulk Boiling	10000.00	W/m2*K
Alpha outside pipe Steam Film.Cond	8500.00	W/m2*K

Braumat-Interface to B-Data and Power-Raid

B-Data and Power-Raid

- **B-Data** can be combined with Braumat as well. A interface is defined.
- **Power-Raid** can be combined with Braumat as well. A interface is defined.
- Braumat has a driver for Sentron PAC3200 (Profibus)
- Braumat has a driver for Schneider UMG96 (Profibus)

Standards

Standards and Guidelines for Energy Management Systems

- At the moment the implementation of an energy management system is not yet required.
- An EnMS could be applied on the base of
  - DIN EN 16001
  - ISO 50001 (so far preliminary draft)
- The latter serve companies at the moment implementing energy management systems.

Summary

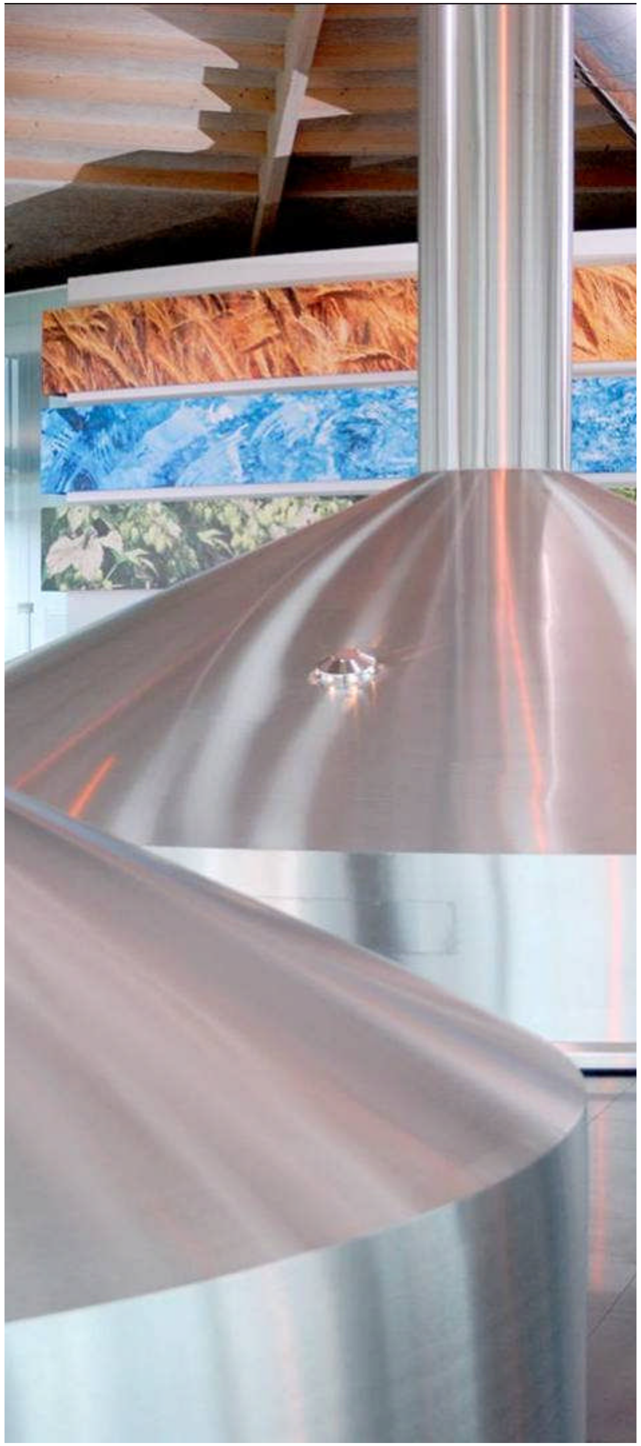
Summary

- Savings potential in the industrial sector: 25 %
- EnMS leads to the systematic tapping into this potential. The standard DIN EN ISO 50001 provides a formal framework.
- Holistic approaches deliver optimal results
- Success depends on individual implementation
- Frequent initial situation: ignorance about savings potential and psychological barriers
- Objective: energy management with an optimal effort/benefit ratio

Perspectives

The four main advantages

- Saving of 750.000 liter heating oil per year
- Reducing CO_2 emissions by 1900 tons per year
- Reduction of 36 % primary energy demand for production (incl. filling & packaging)
- Revival of regional economic cycles



Thank you very much!

Stefan Schranner

Mobil: +49 152 54690448

E-Mail: StefanSchranner@yahoo.de
StefanSchranner@siemens.com

”