EC CONCERTOII project REMINING-Lowex

Minewater based energy and exergy concepts

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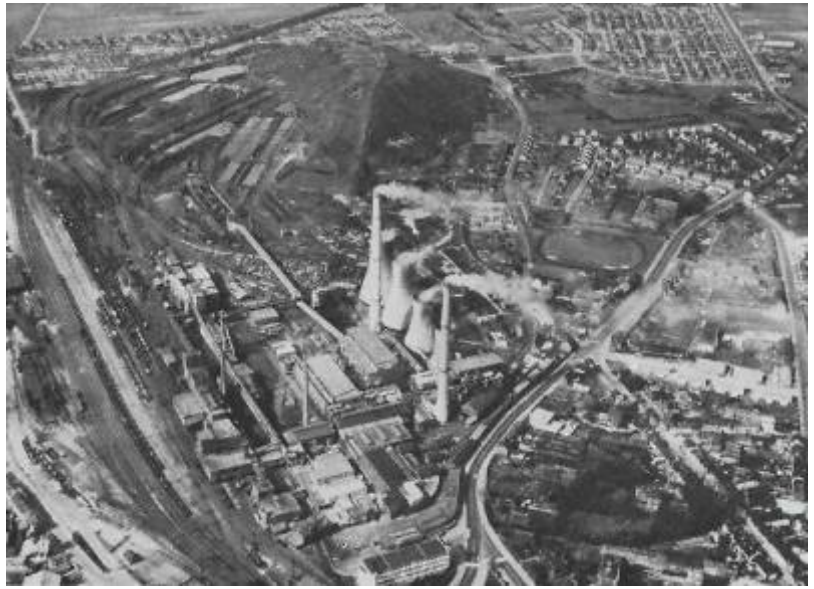
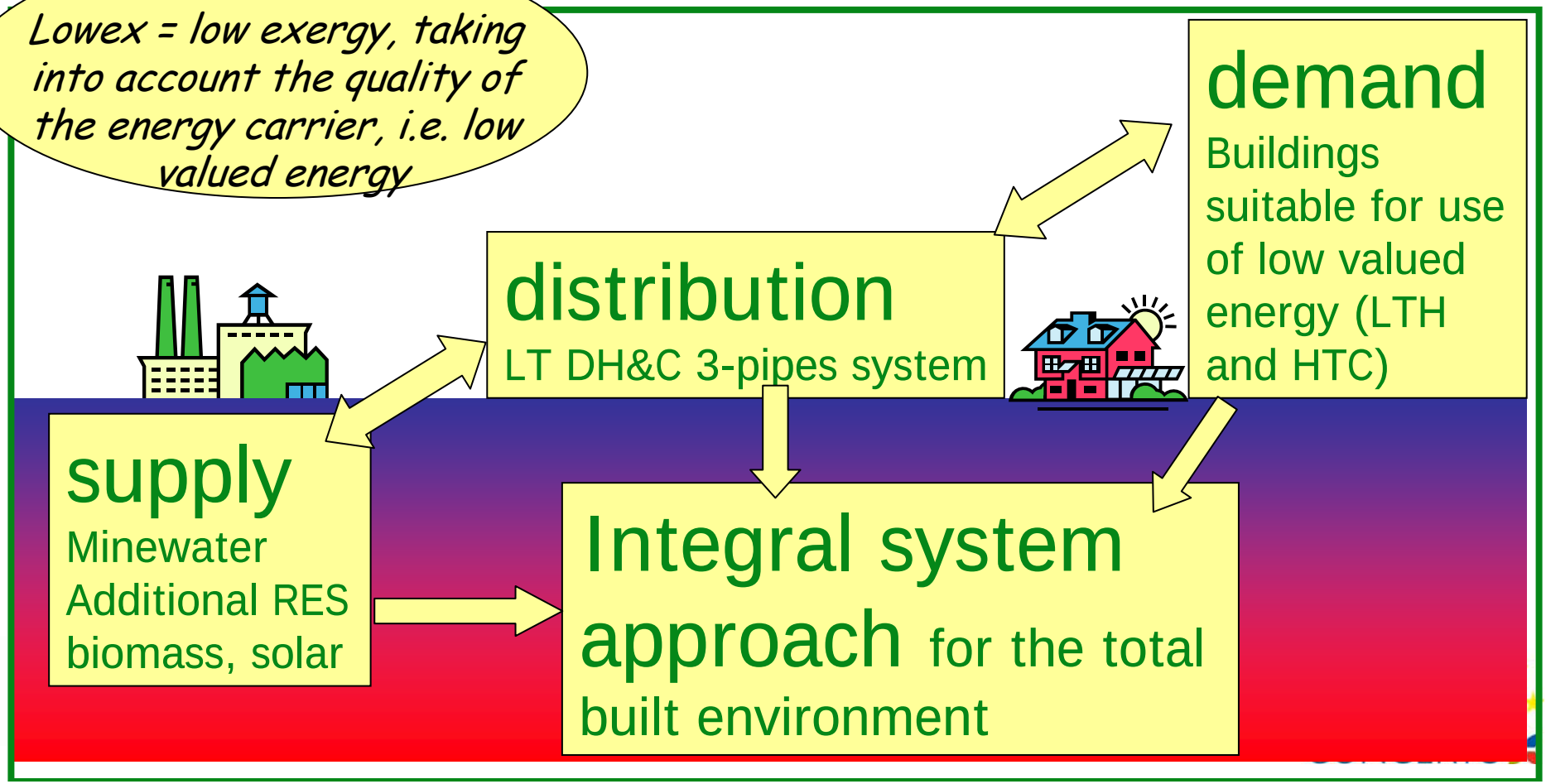
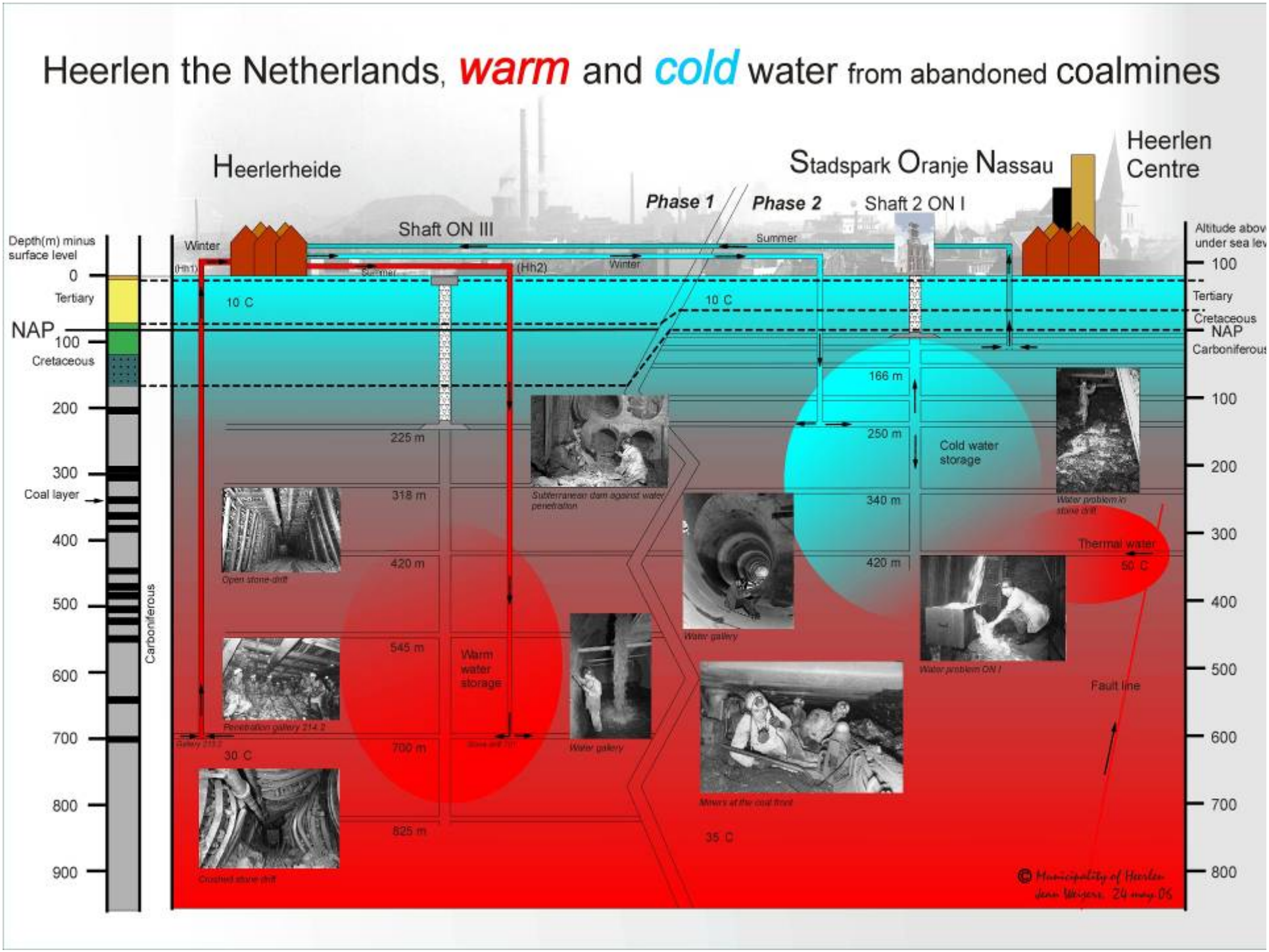


Lowex approach for the Mine Water Project Heerlen:

balancing supply side (RES) with demand side (RUE) on basis of low exergy principles

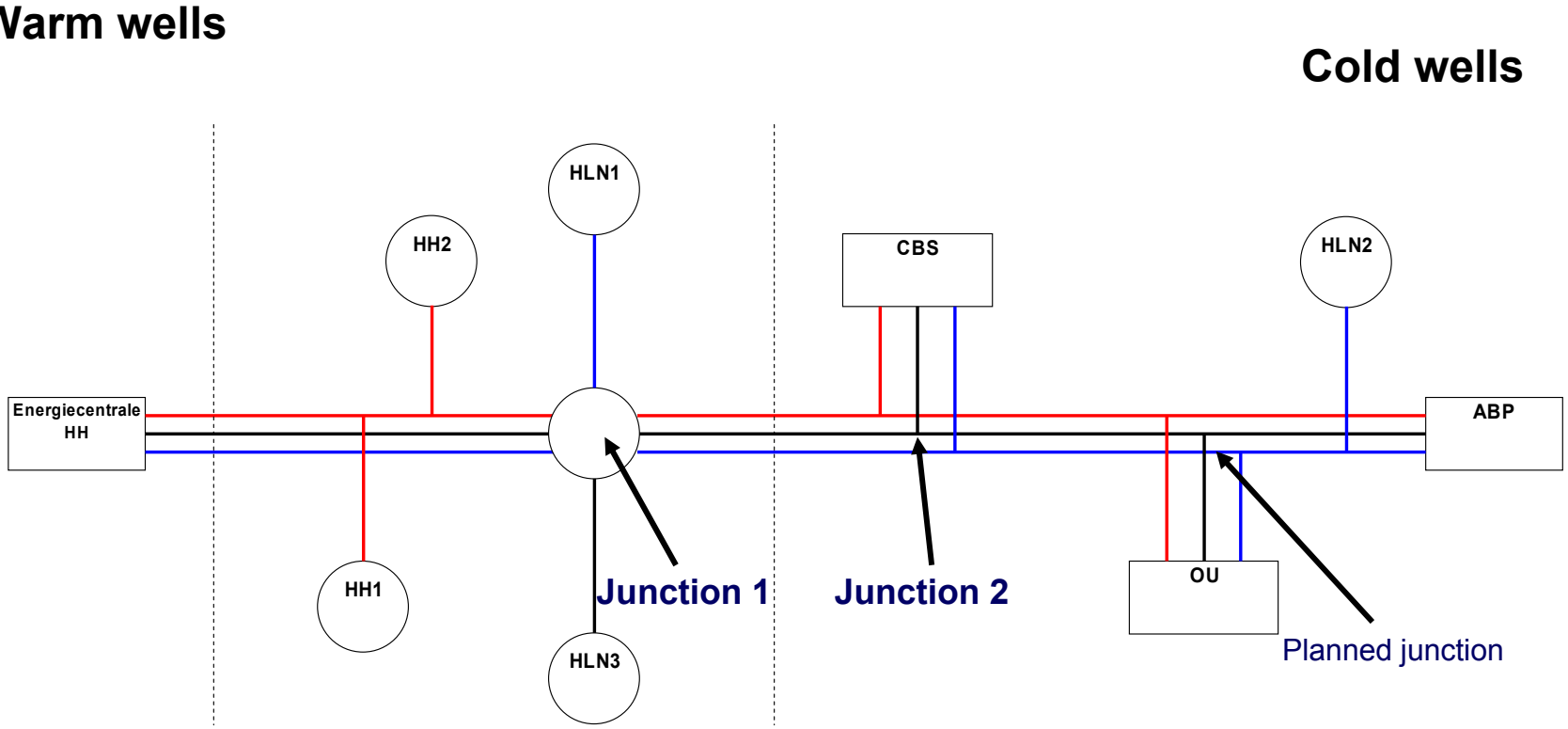


Heerlen the Netherlands, *warm* and *cold* water from abandoned coalmines



Distribution:
Low temperature (‘lowex’) H&C distribution system
the primary grid

Functional scheme primary grid



From a schematic approach to a LT H&C grid in practice

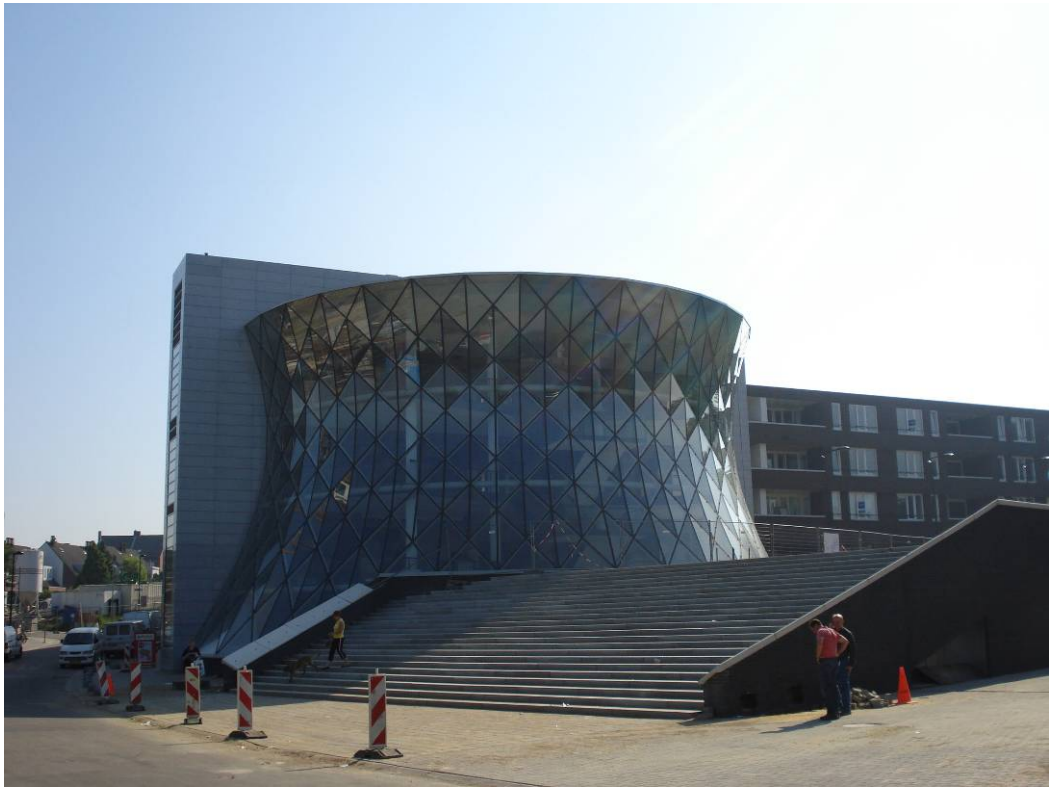
(Some!) decision parameters:

- Length op the grid
- (Type of) paving
- Drillings (road crossings)
- Existing infrastructures

From a schematic approach to a LT H&C grid in practice (Some!) design constraints:

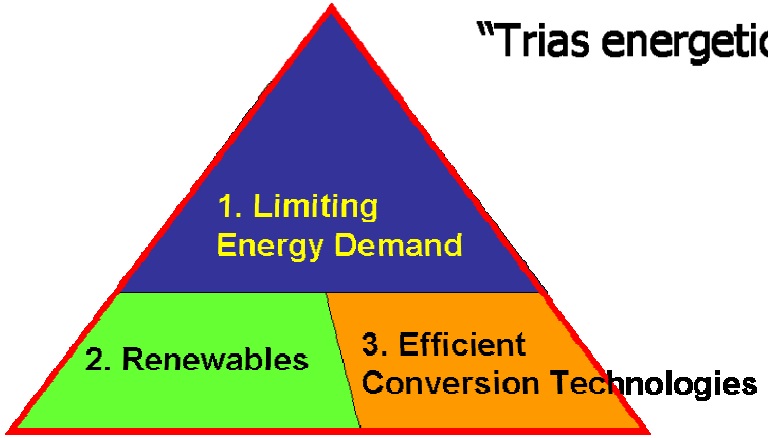
- Chemical quality of the mine water
  - sediments and sludge's
  - scaling
  - corrosion
  - bacterial corrosion
  - gas (CH_4 and CO_2)
- *Pressure ~ 1 bar = enough*
- *Velocity: ~ 1,5 m/s*
- Leakage detection
- Cleaning *(foam pigs)*
- Transport energy (pumps)

Demand side:
The buildings

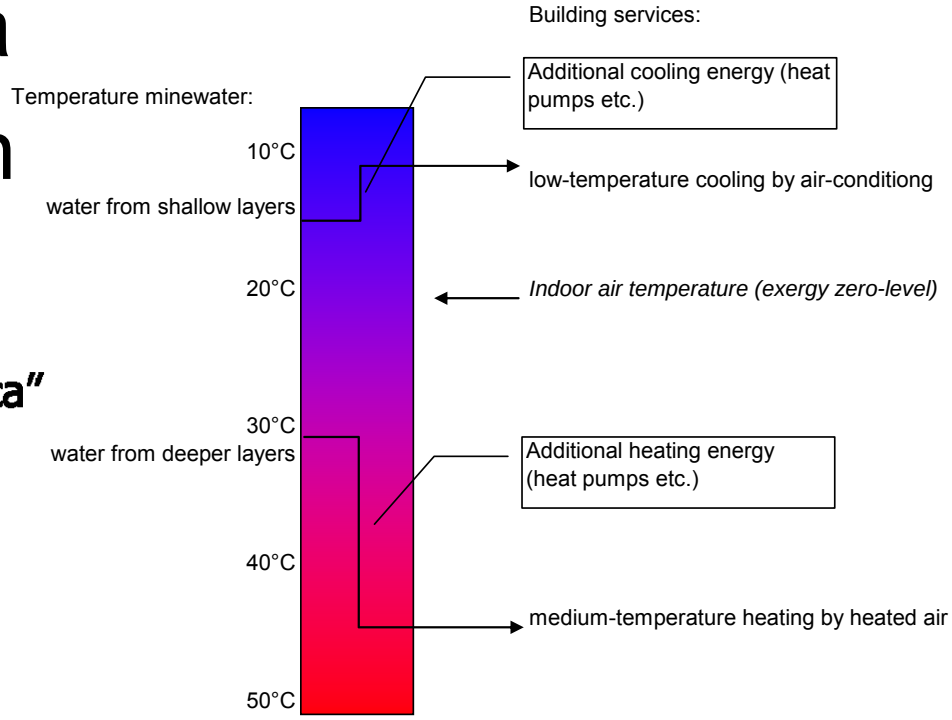


Basic principles

- the Trias Energetica
- the low-ex approach
- load duration curve

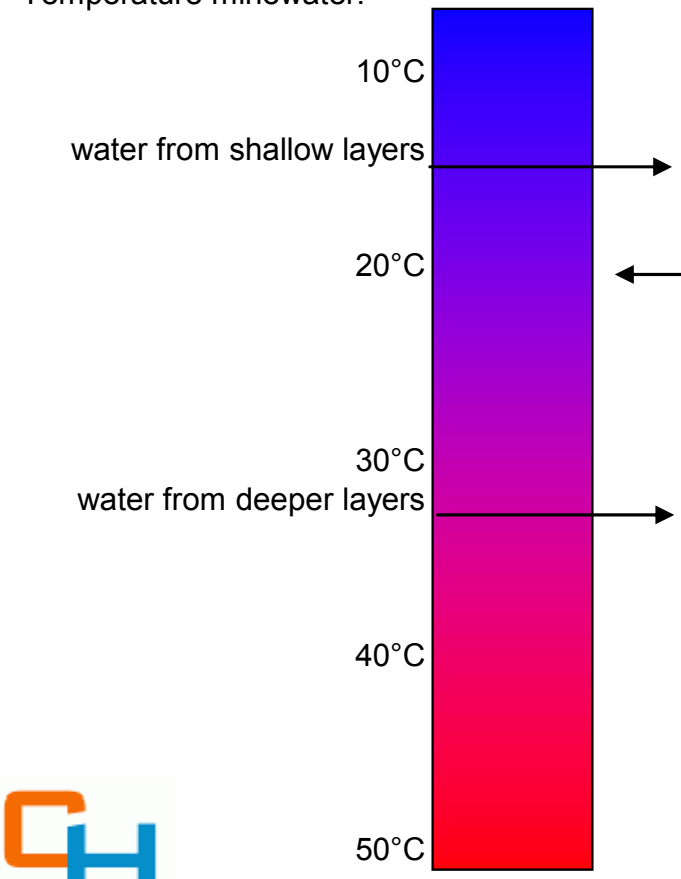


With as overall prerequisite:
Limitation of temperature levels of heat and cold supply:
Low temperature heating (LTH)
High temperature cooling (HTC)

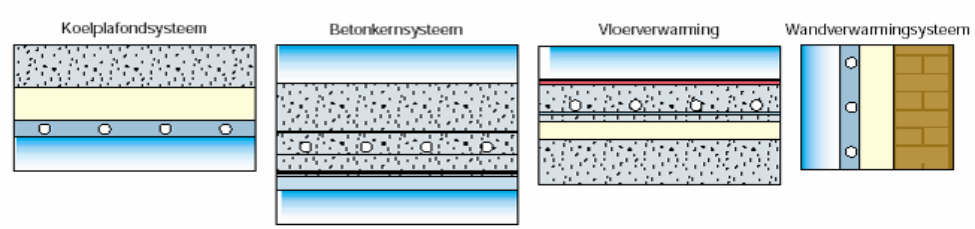


Low-ex (direct) heating and cooling

Temperature minewater:

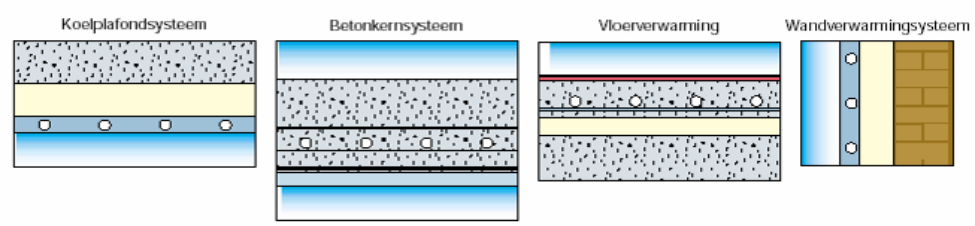


Building services:



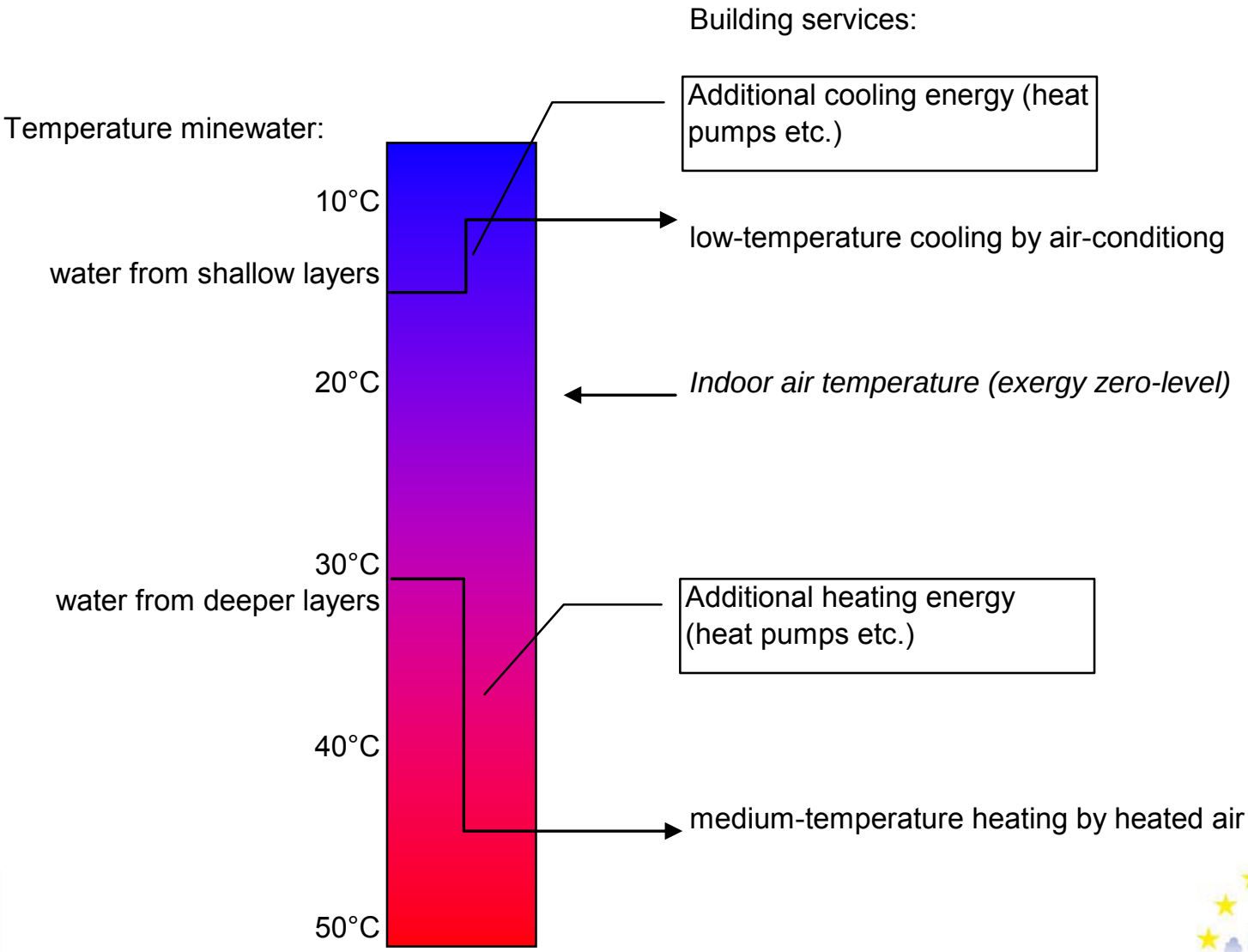
high-temperature cooling by thermally activated building parts

Indoor air temperature (exergy zero-level)



low-temperature heating by thermally activated building parts

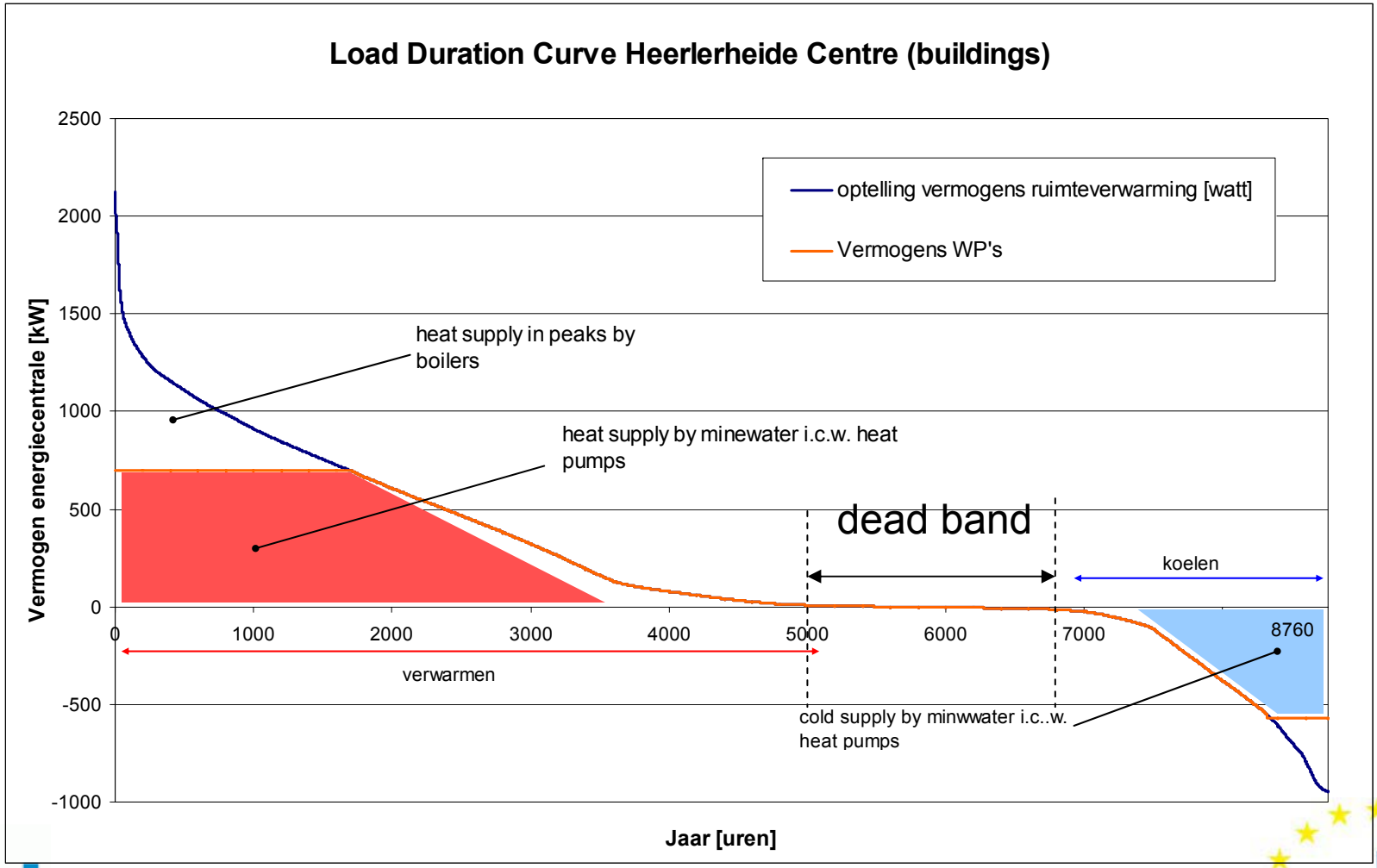
Indirect heating and cooling



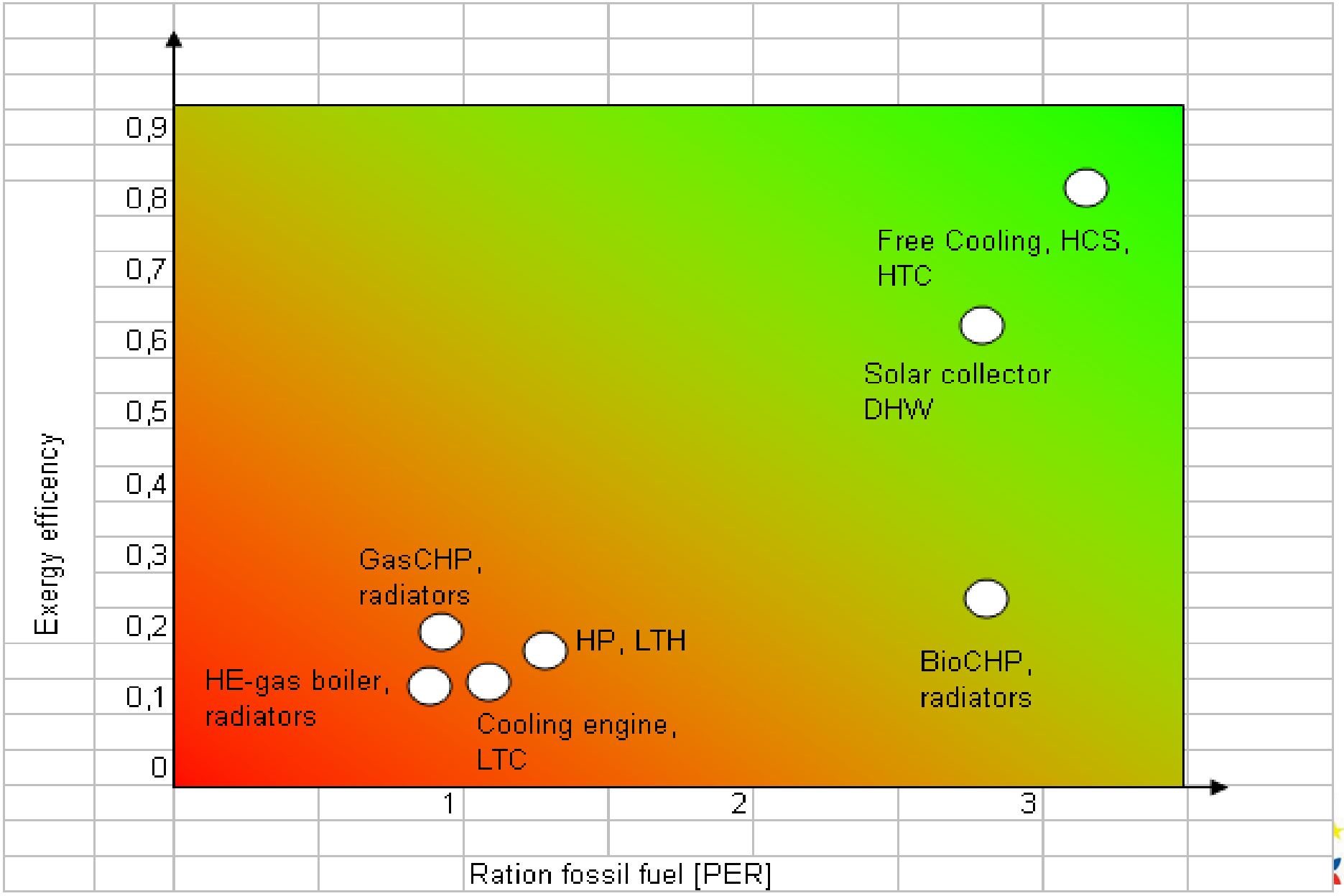
Optimization by using Load Duration Curves

- Dynamical buildings simulations by TRNSYS
- Temperature levels for heating, cooling and DHW
- Ratio RES (and HP) and conventional
- Balancing H and C storage
- Optimization transmission and ventilation losses and seasonal operation
- Enlarging the ‘dead-zone’ = period without H or C demand > *conflict with energy exploitation and economical feasibility! (decrease of energy demand = decrease of profits)*

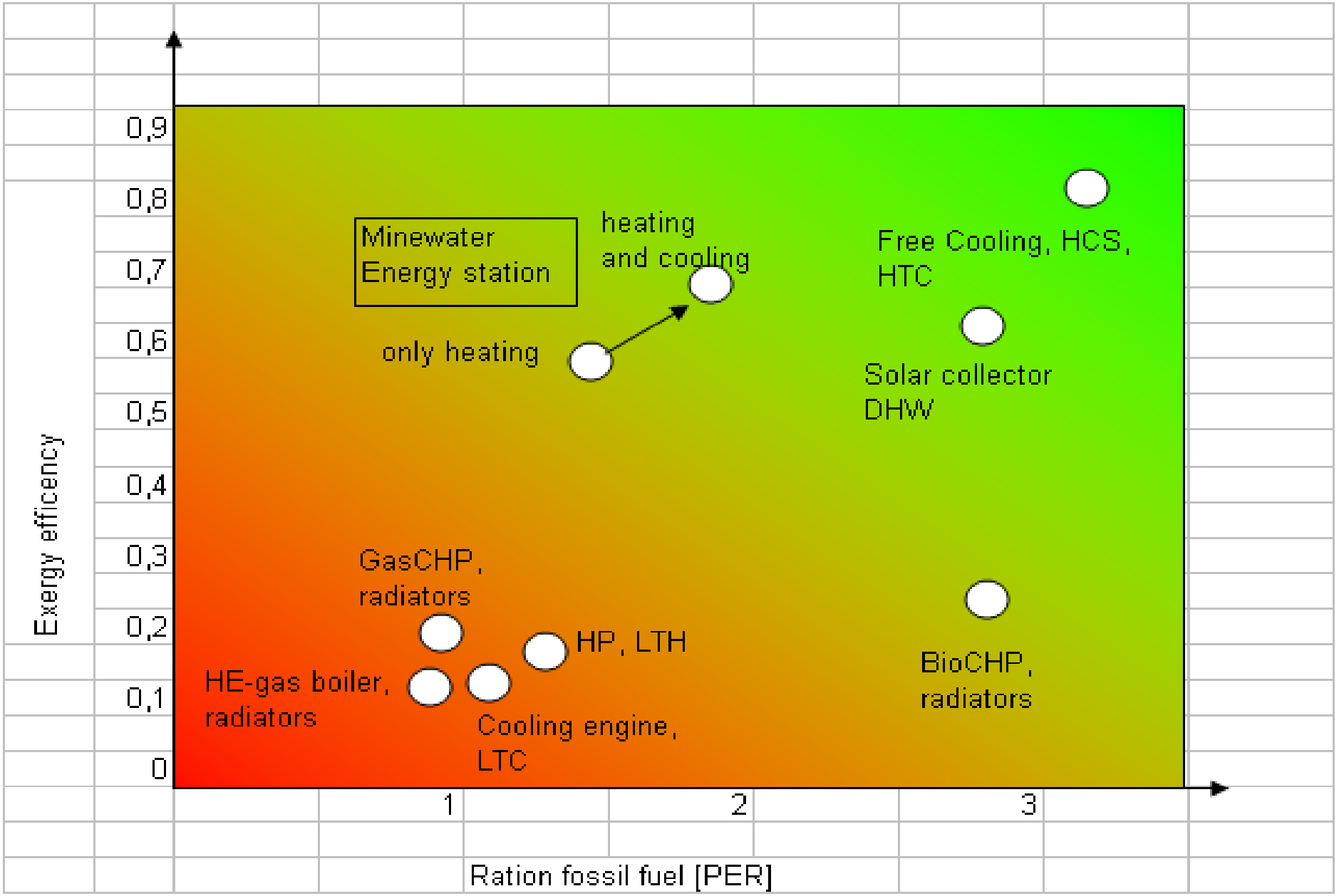
Optimizing ratio RES/conventional by using a LD curve Heerlerheide



Positioning of concepts in qualities of exergy and PER (Primary Energy Ratio)



Positioning in Exergy/PER diagram

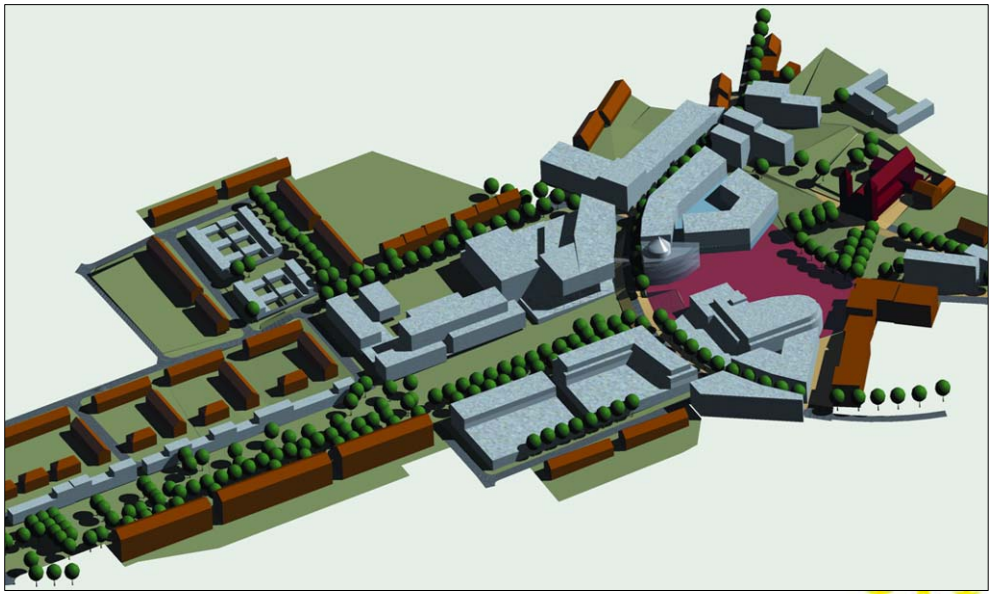


Boundary conditions

- Hydraulic separation between the mine-water system and the building services
- The heating and cooling capacity of thermally activated building parts is limited. The system is sensitive to excessive transmission and ventilation losses.

The Minewater project in Heerlen, the Netherlands

- The minewater concept
- Realised infrastructure and buildings
- First experiences



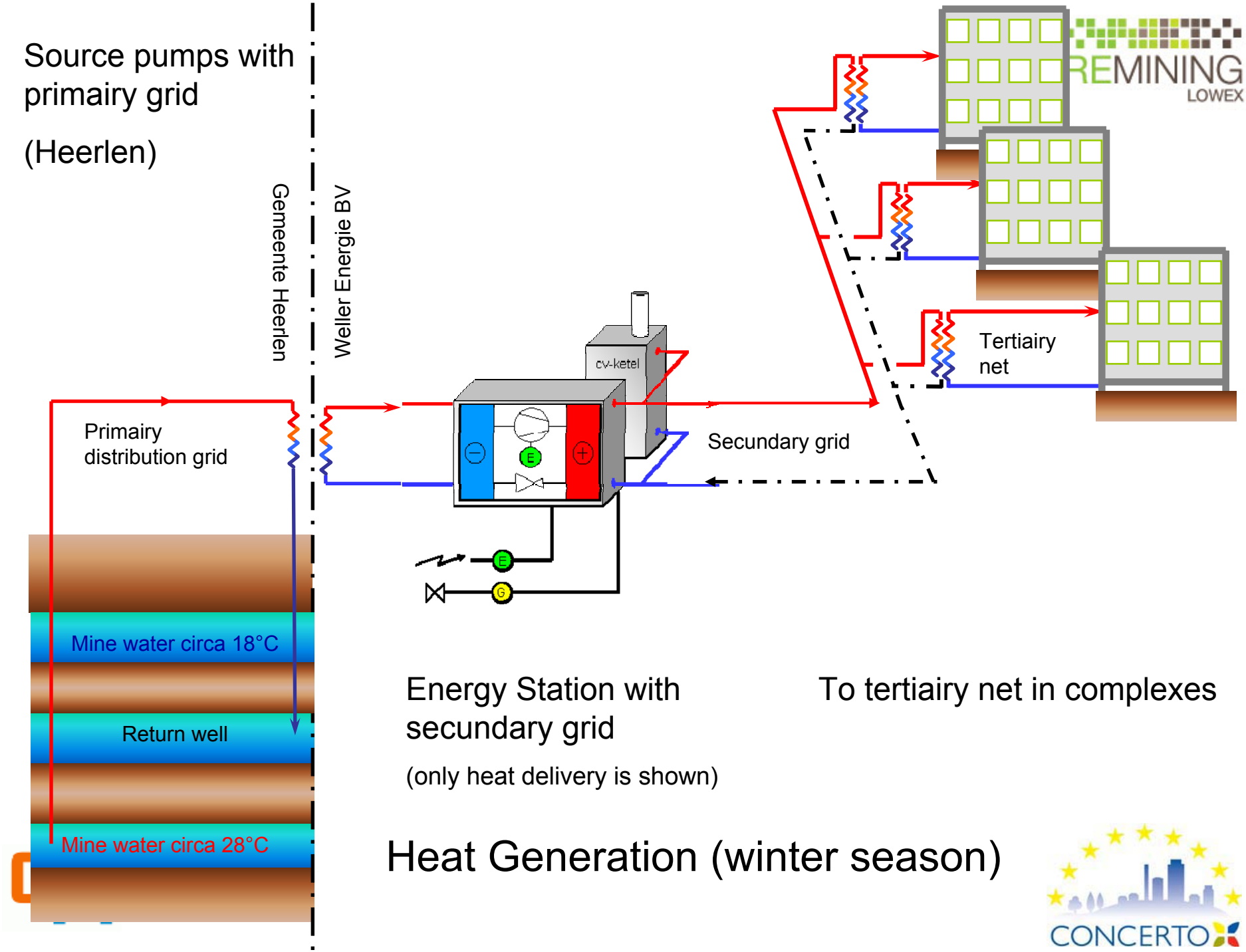

PLUS

CBS building (new office)

ABP building (retrofitting)

Source pumps with primairy grid

(Heerlen)



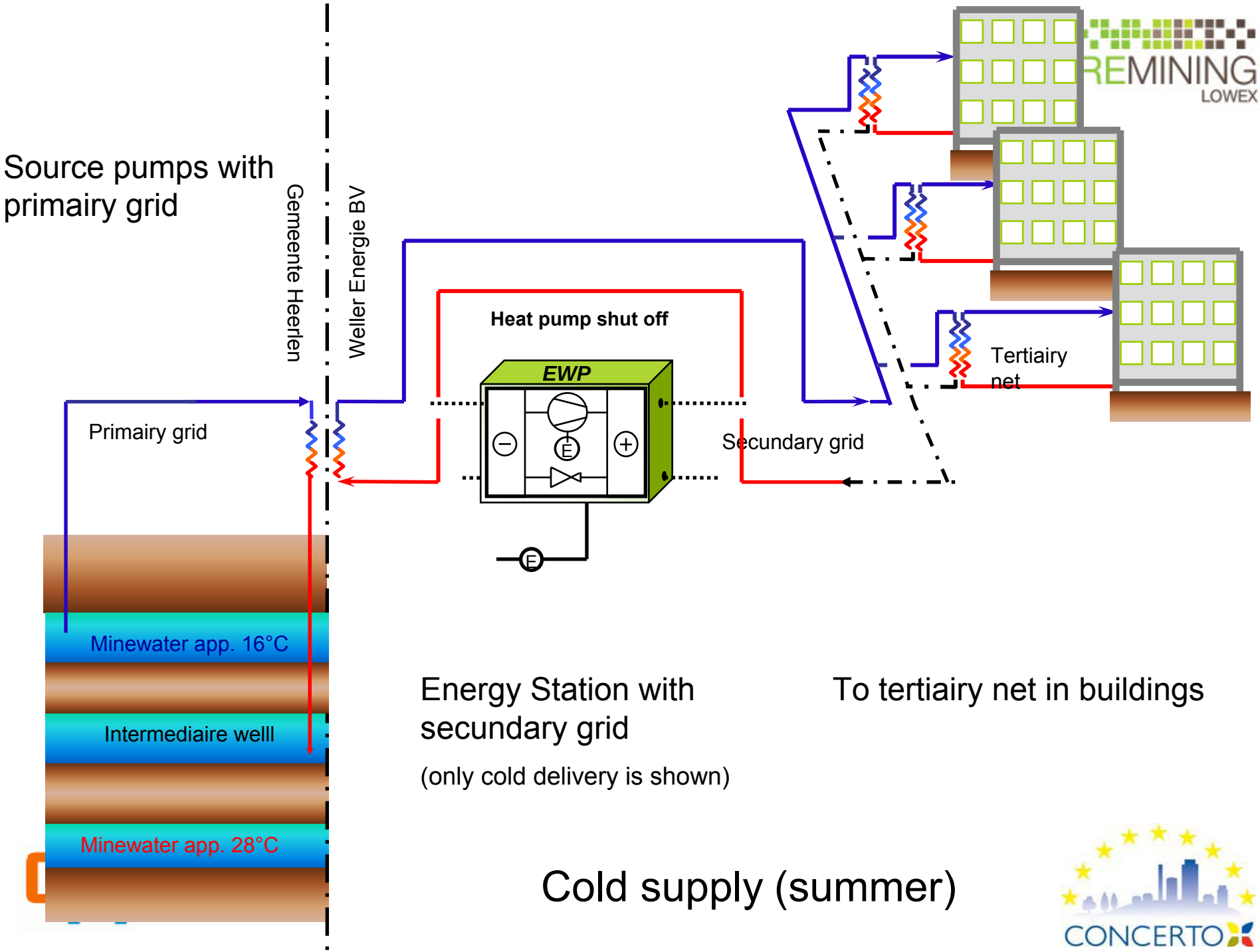
Energy Station with secundary grid

(only heat delivery is shown)

To tertiairy net in complexes

Heat Generation (winter season)

CONCERTO


Source pumps with primairy grid
Gemeente Heerlen
Weller Energie BV
Heat pump shut off
EWP
Primairy grid
Secundary grid
Tertiairy net
Minewater app. 16°C
Intermediaire welll
Minewater app. 28°C
Energy Station with secundary grid
(only cold delivery is shown)
To tertiairy net in buildings
Cold supply (summer)
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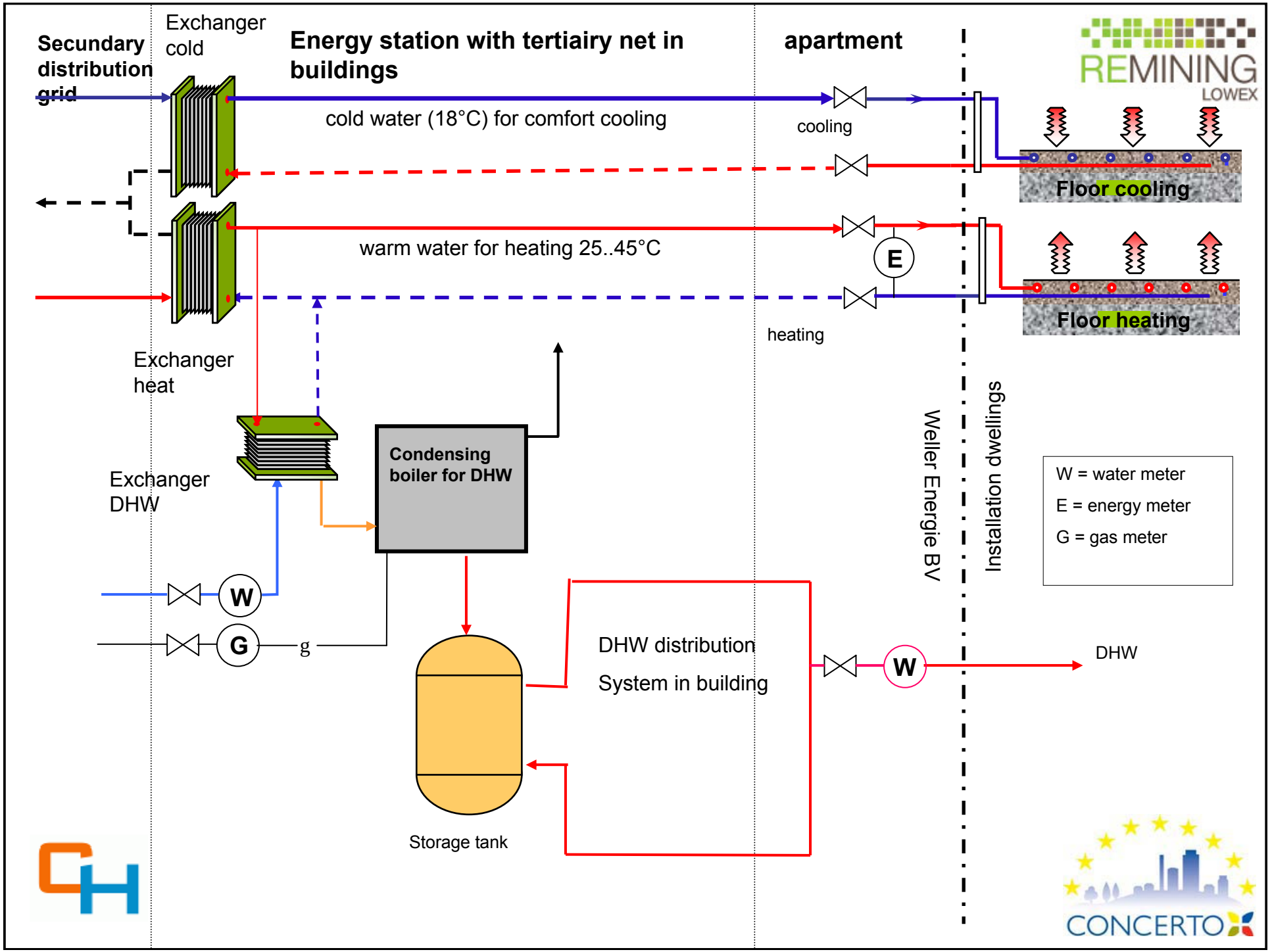
Secundary distribution grid
Exchanger cold
Energy station with tertiairy net in buildings
apartment
cold water (18°C) for comfort cooling
cooling
Floor cooling
warm water for heating 25..45°C
E
heating
Floor heating
Exchanger heat
Exchanger DHW
Condensing boiler for DHW
Weller Energie BV
Installation dwellings
W = water meter
E = energy meter
G = gas meter
W
G
g
DHW distribution
System in building
W
DHW
Storage tank
REMINING
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Thermal insulation
Envelope U < 0.25 W/m^2.K
Glazing U < 1.2 W/m^2.K

Ventilation
MVHR η = 95%

Air tightness
n_{50} <1

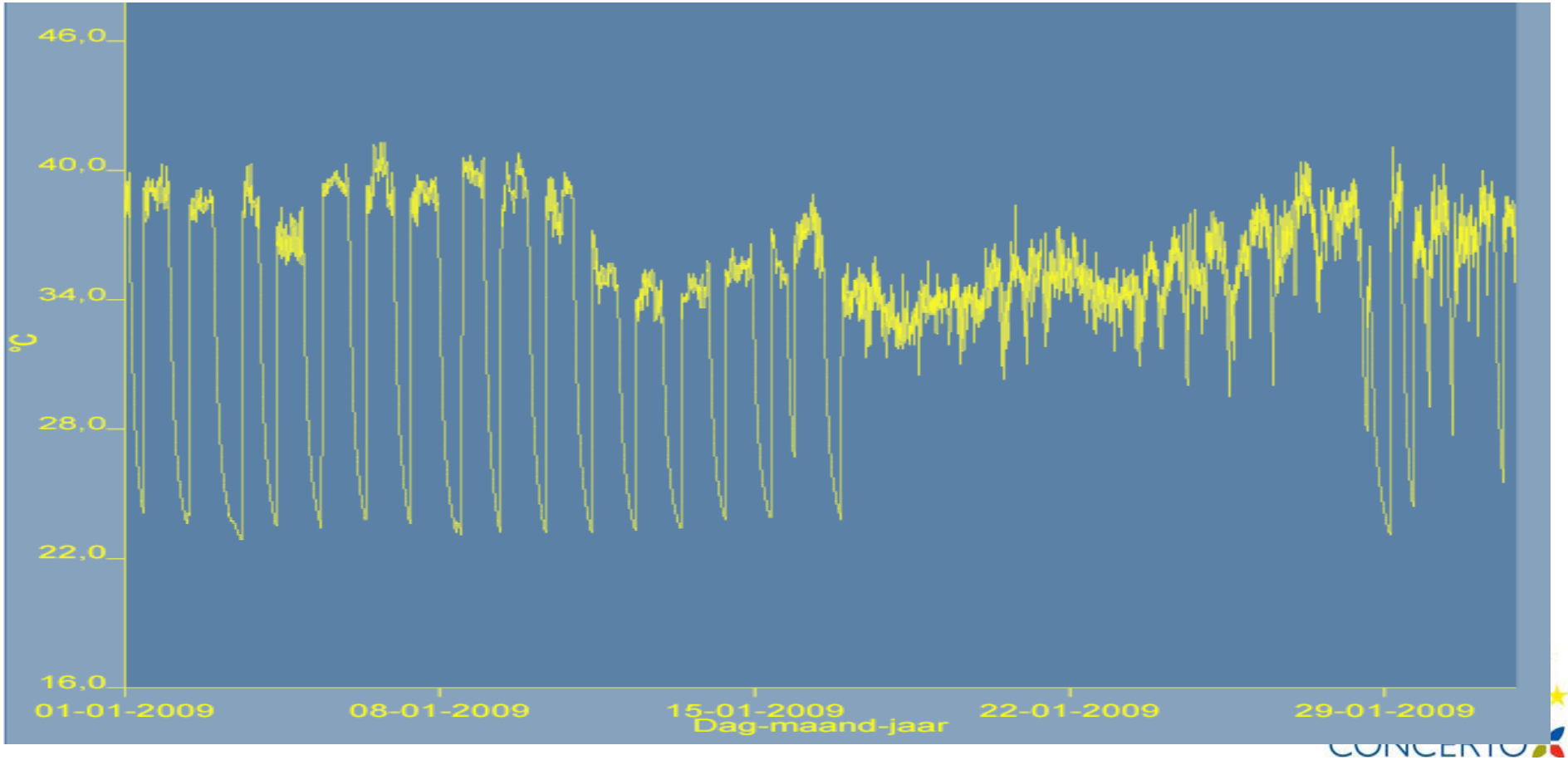
Emission system
Floor heating and cooling

HVAC system/efficiency
Mine water with heat pumps (boiler back up)
Sustainable cooling

PRIVA Top Control 6.1 monitoring

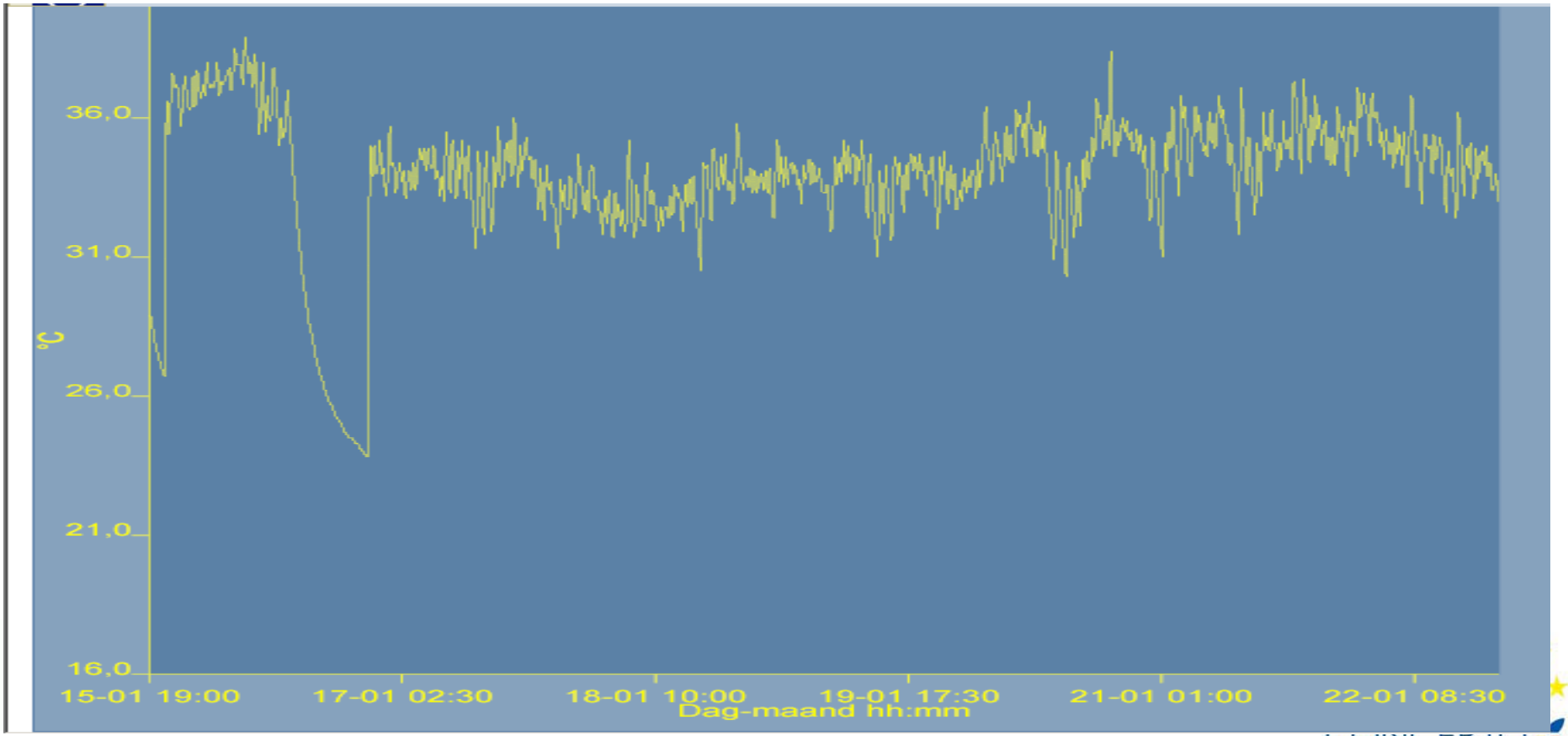
Supply temperature winter

(january 2009, average outdoortemp. 1°C)

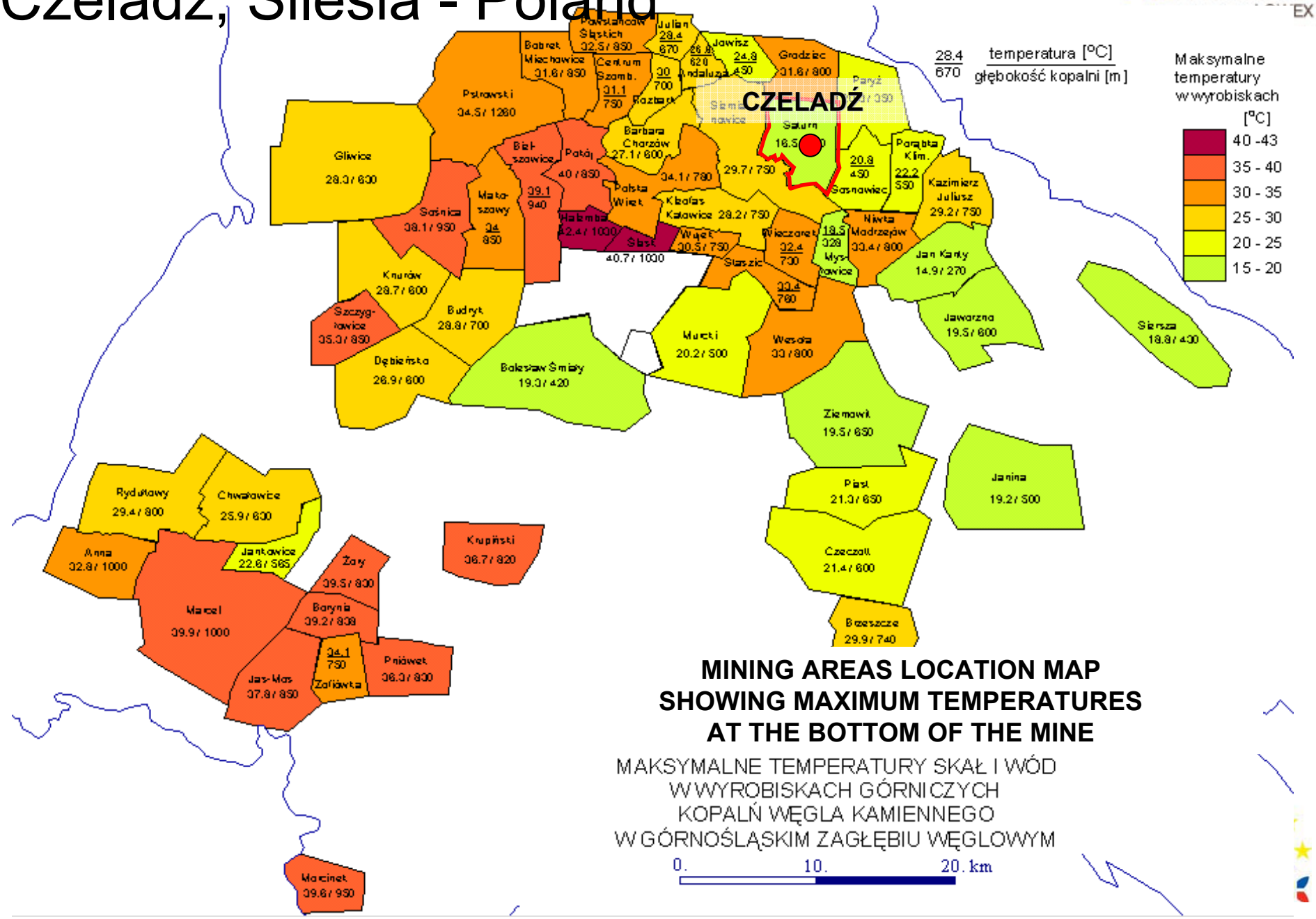


Supply temperature winter

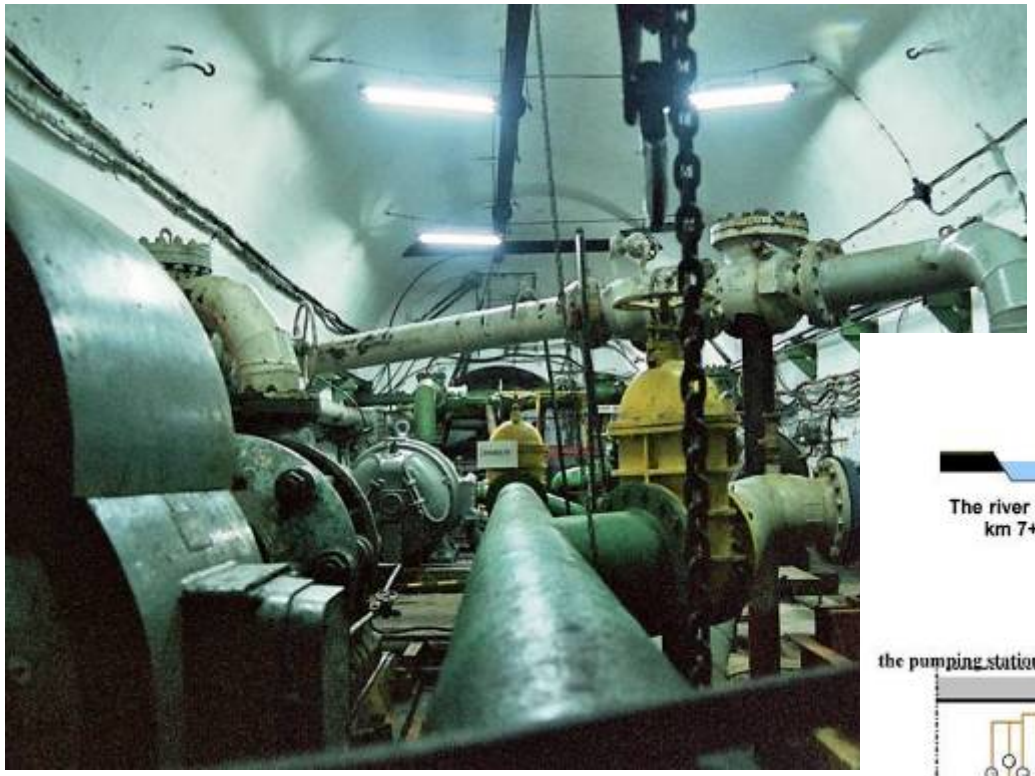
One week in detail

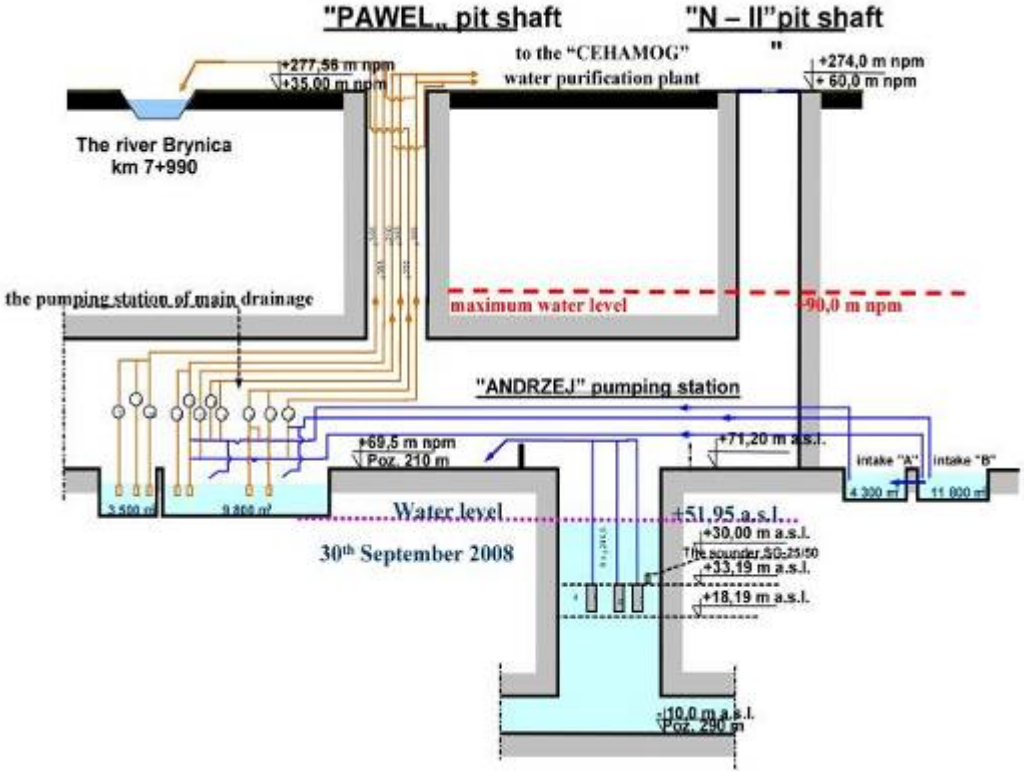


Czeladz, Silesia - Poland



Czeladz - Poland
no wells - but water available from pumping stations





Differences between the Dutch and the Polish situation – the sources/supply

- The Netherlands: the ‘difficult’ way
  - Wells and drillings necessary
  - High investments for drillings and infrastructure
  - Extra pumping costs

- Poland – Silesia: the ‘easy’ way
  - No drillings
  - Limited investments in infrastructure
  - Pumping takes place allready, limited extra pumping costs for transport
  - Some projects on mine areas, very close to source

Quick Scan

- General: favourable conditions (no drilling, mine water available near building locations)
- Temperature 12,2 -14,4°C: suitable for indirect heating (heat pumps) and free cooling
- Building density for district heating: 75 apartments / ha
- 11 mln m^3 minewater / year:
  - 400.000 GJ heat (≈ 28.000 apartments)
  - OR 250.000 GJ cold (≈ 50.000 apartments)
- Domestic hot water?
- Pumping 24/7?

Idea's for energy distribution systems

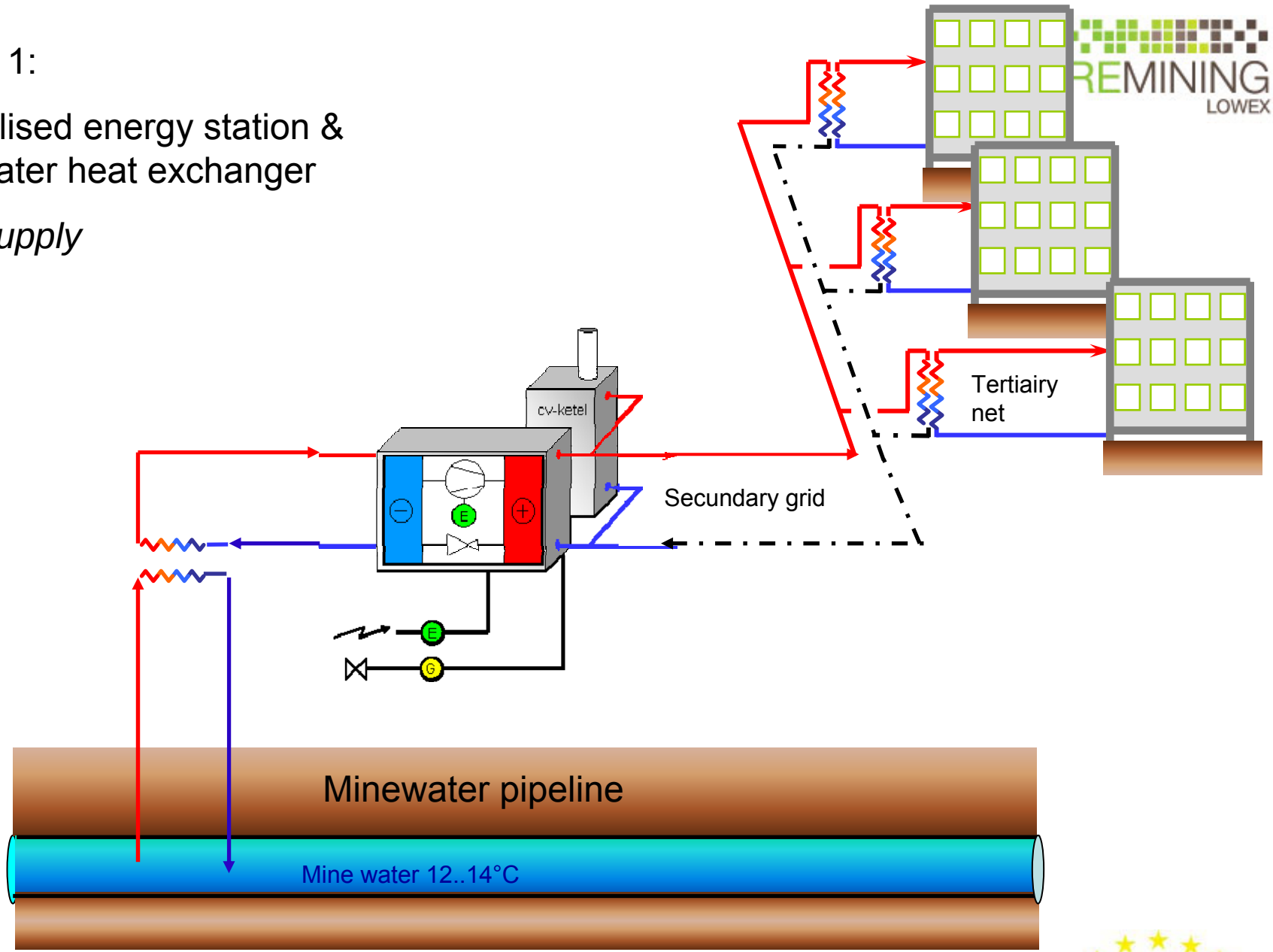
Three main options for the heat and cold distribution are available:

- a central energy station, which serves the complete area (like in the Heerlen case);
- a grid for the minewater distribution through the area, from which each building complex extracts heat and cold for local post processing

Option 1:

Centralised energy station &
minewater heat exchanger

Heat supply



Heat Generation (winter season)

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Centralised energy station&
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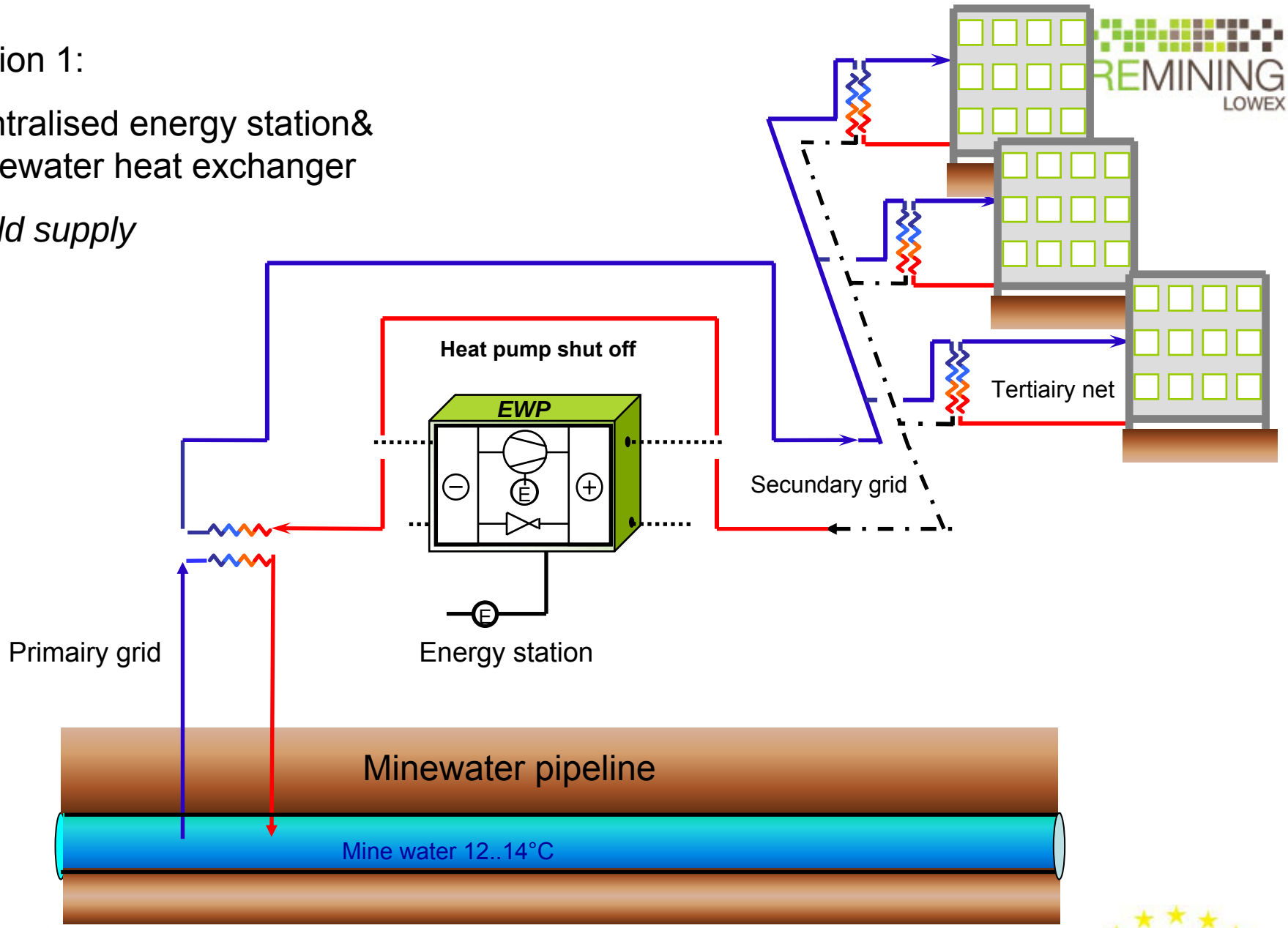
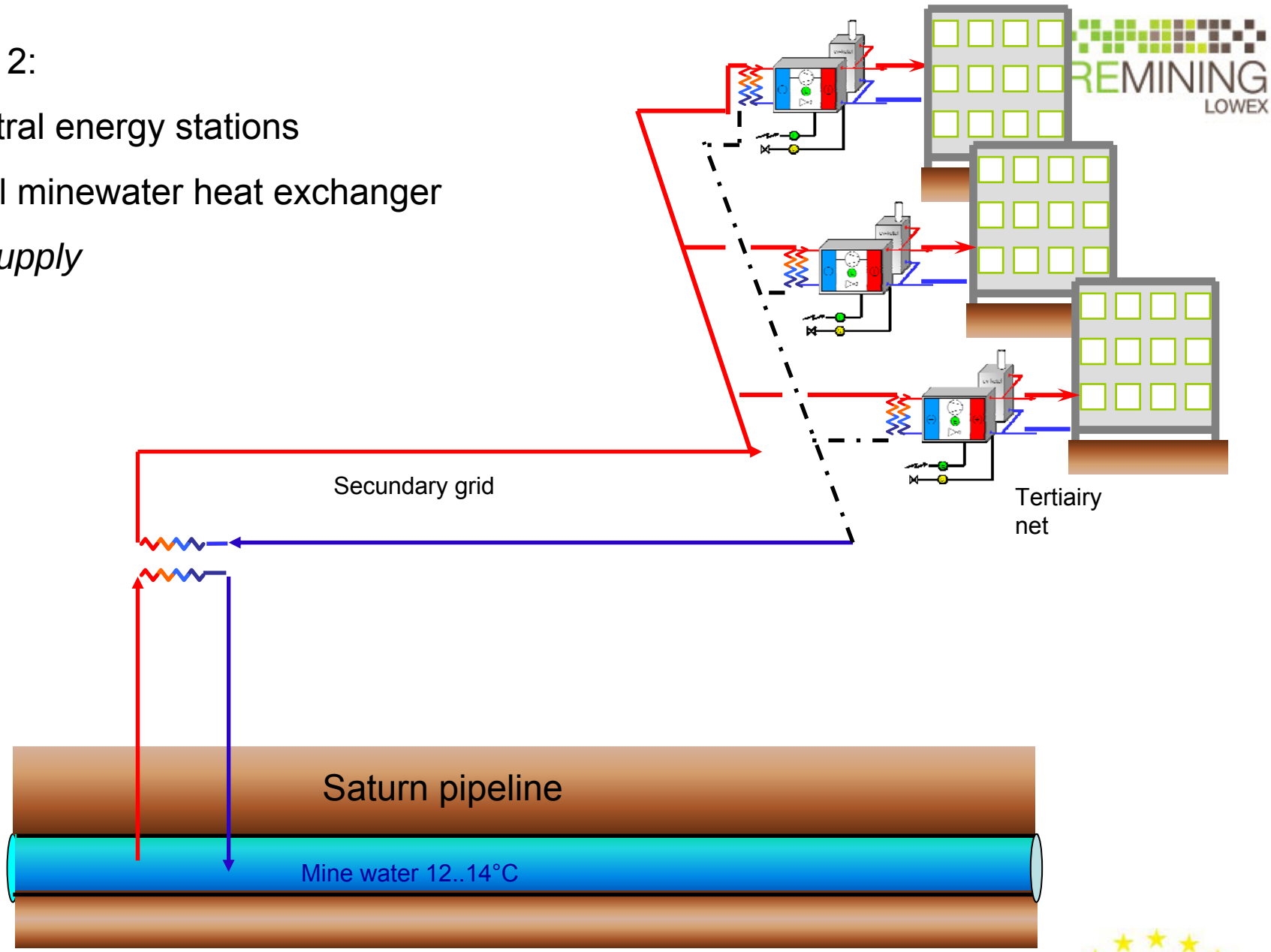


Option 2:

Decentral energy stations

Central minewater heat exchanger

Heat supply



Heat Generation (winter season)

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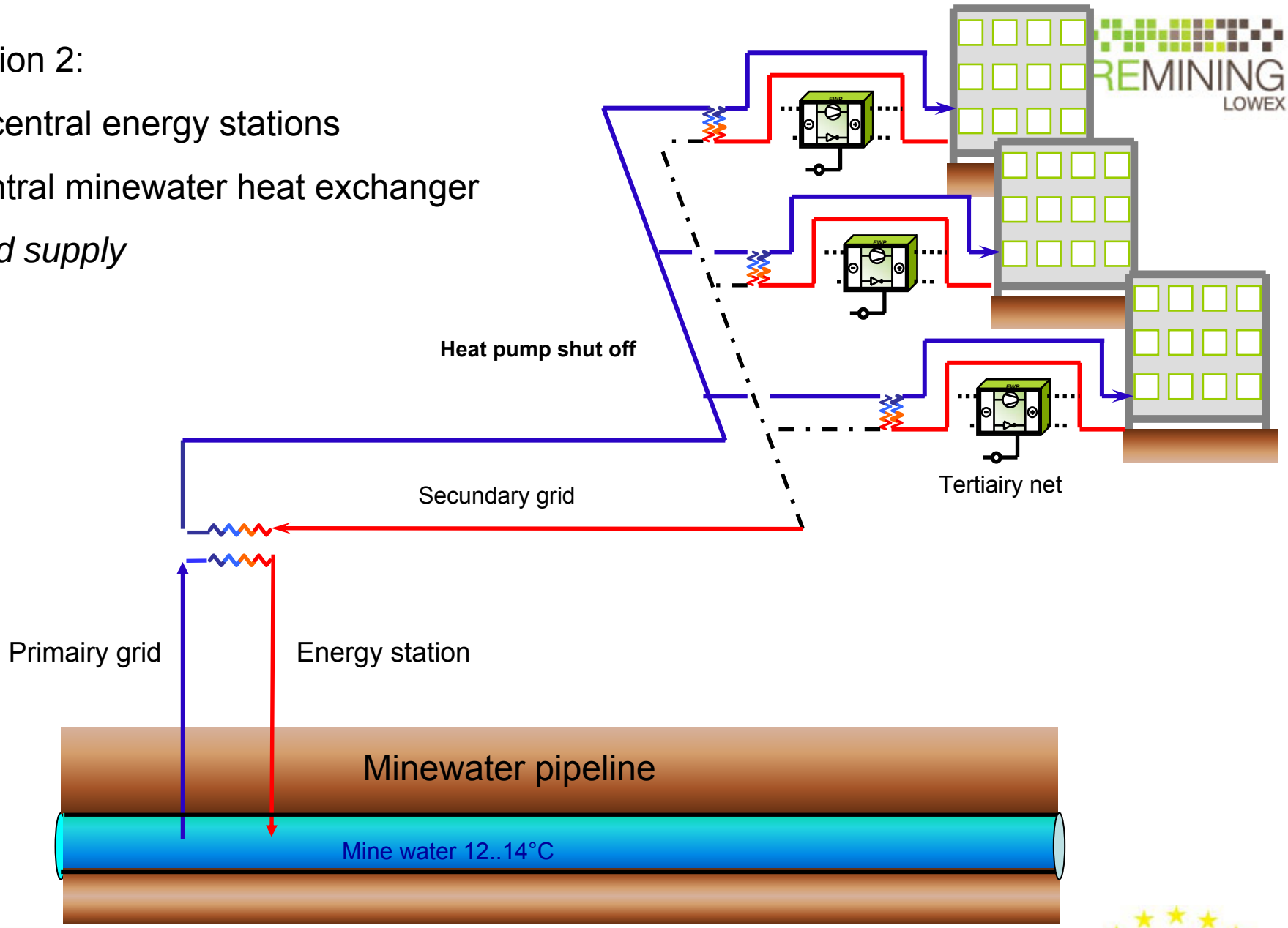
Cold supply

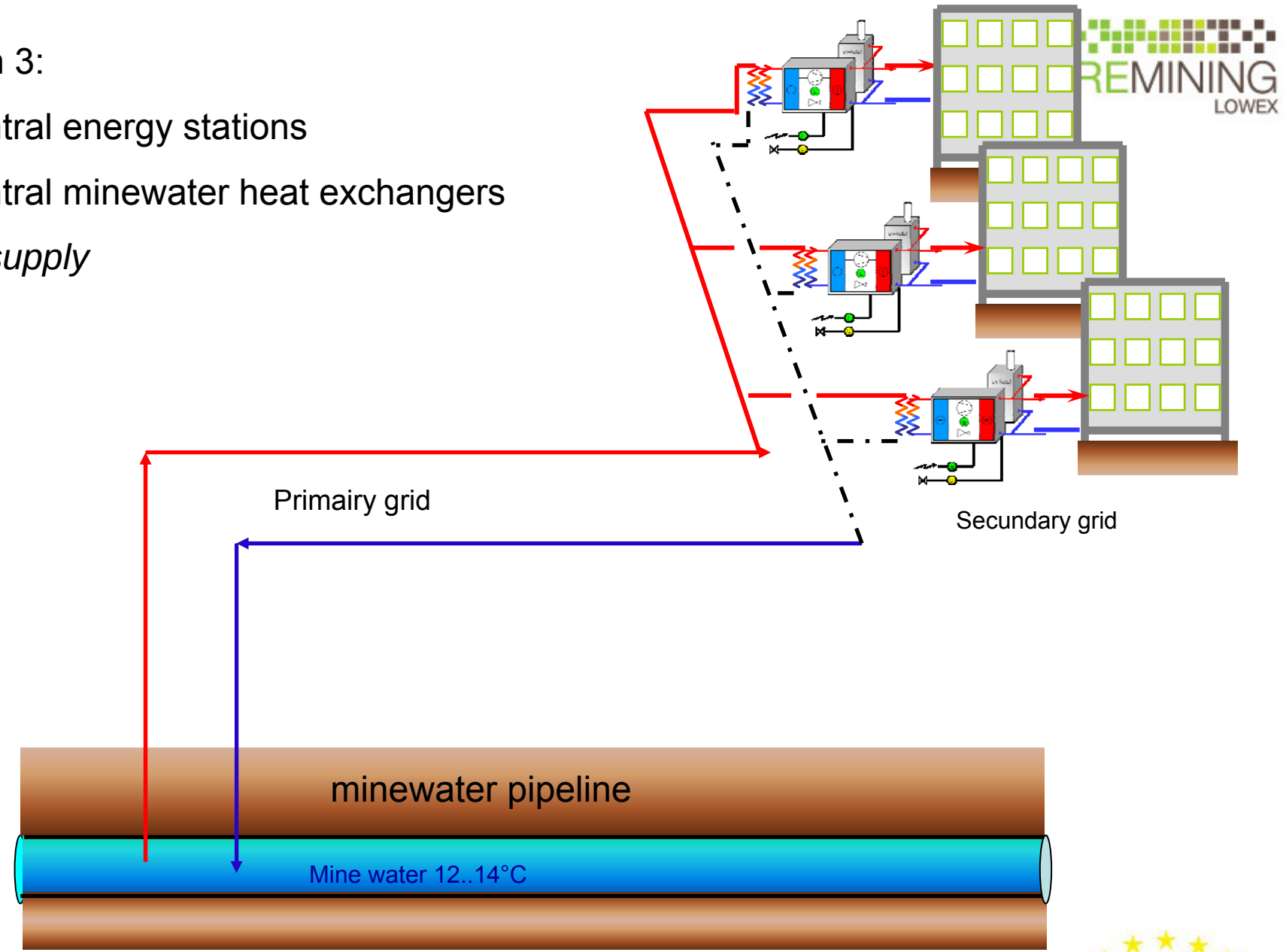


Option 3:

Decentral energy stations

Decentral minewater heat exchangers

Heat supply



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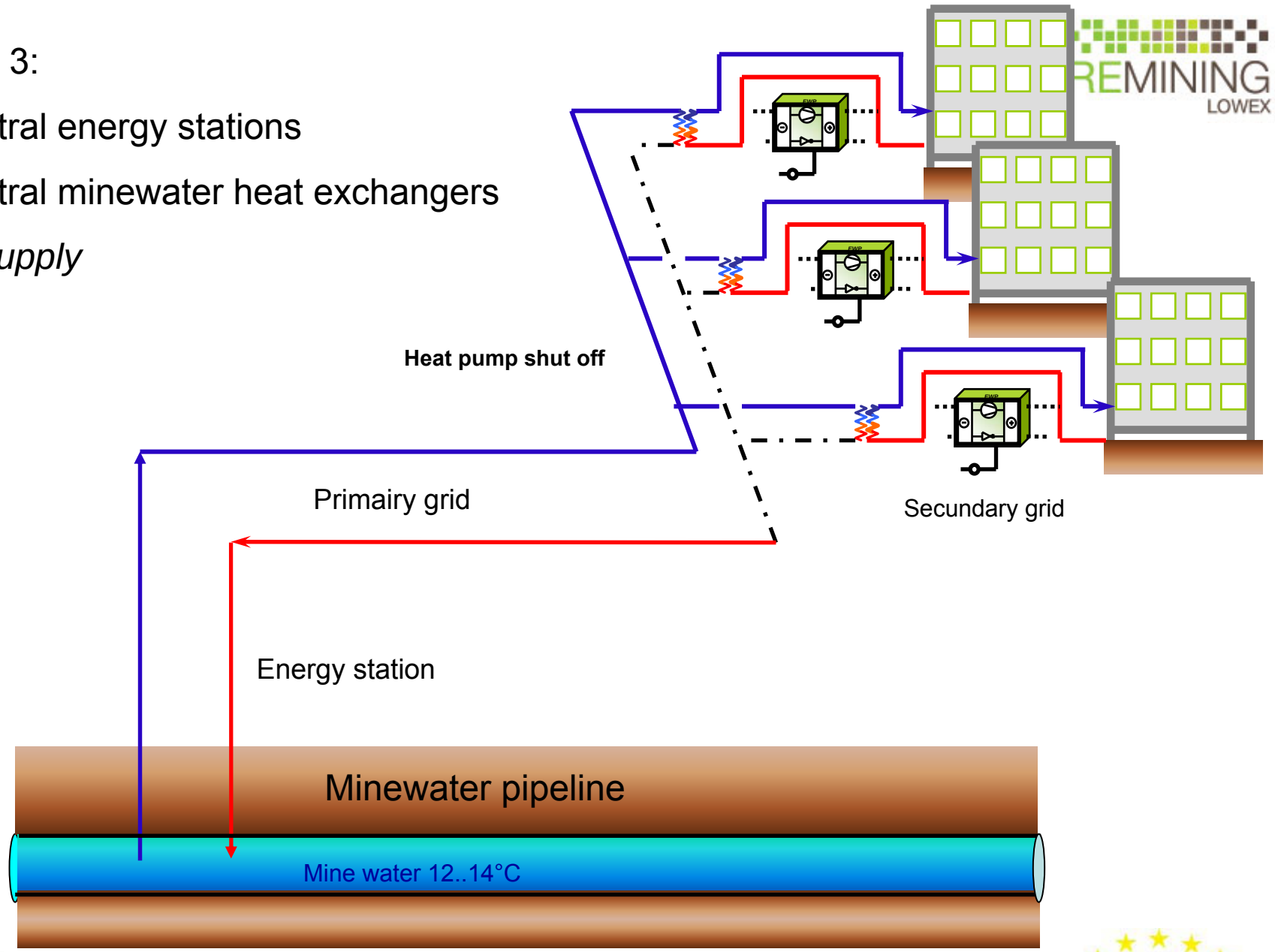

Summary (1)

- Integrated design of a low temperature energy supply structure (based on use of mine water) is possible if supply and demand side are balanced on the basis of exergy principles
- Supply side: geological research is crucial, reservoir modelling and technologies for (controlled and steered) drilling
- Demand: how to make buildings mine water/lowex proof
  - ✓ Extra thermal insulation
  - ✓ Airtight building, energy efficient ventilation systems
  - ✓ LT heating, HT cooling systems
  - ✓ Limitation of internal and solar heat gains in summer

Summary (2)

- The mine water as an energy source is an concept which needs close collaboration of specialist in the field of geology/mining, hydraulics, building physics and building services. They must be supported by financial and legal experts.
- The energetic and financial performance of minewater as an energy source depends on a variety of parameters. Therefore, a field of expertises is needed to come up with a solid overall view.
- Problems with domestic hot water in LT grids; solutions are still necessary

FP6 CONCERTO II

REMINING LOWEX

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