ENERGY LAB

ENERGY DESIGN FOR THE FUTURE
INCLUDED GUIDED TOUR

HVL, 14. NOVEMBER 2017
AINA EIDE

Høgskolen i Bergen

HVL has since 1994 wanted to unite the Faculty of Education, Faculty of Engineering and Faculty of Health and Social sciences in one location.

→ Campus Kronstad

- Assigner:
  Ministry of Education and Reseach
- Gross Area:
  Ca. 51.000 m^2
- Start of construction: 2010
- Status: Campus Kronstad opened in august 2014.
- About 6000 students and 600 employees
- Total cost: 2,6 billion NOK

Høgskolen i Bergen- Focus

- Energy consumption: The Main Goal for the new building, was keeping the total energy consumption under 150kWh/m^{2}BTA/year

- Technical installations:
  - All Components have a very high Power efficiency. (Mainly over 80%)
  - The requirements was to keep SFP < 2.0. Focus on running the Pumps effectively. Flow Control.
  - Heat recovery of 80% or more in the ventilastion system.
  - Monitoring, control, regulation. A great deal of local demand controlled ventilation (DCV).
  - Wide range of measuring equipment. – The electrical system accomodate the possibility to registrate all energy measures separately (NS 3031)
  - Ventilation: To optimize the routing and the technical areas, the machine rooms are distributed both on the roof and in the basement. (p_{ducts} between 0,5 and 1,0 Pa)
  - Appropriate distribution of system devices to maintain flexible operation
  - Computer controlled energy monitoring, management and control.
  - Use of heat pump technology. Seasonal storage and reuse of heating- and cooling energy in the ground.
  - Adiabatic cooling

Høgskolen i Bergen

Basic thoughts for this project;

- The energy is supposed to be held within the system boundaries
- To the greatest extent possible =>

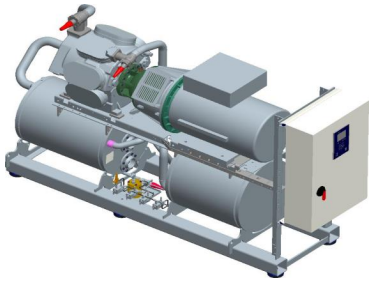
- During winter, surplus heat is used where needed in the zones
- In summer, surplus heat is stored to be used during winter

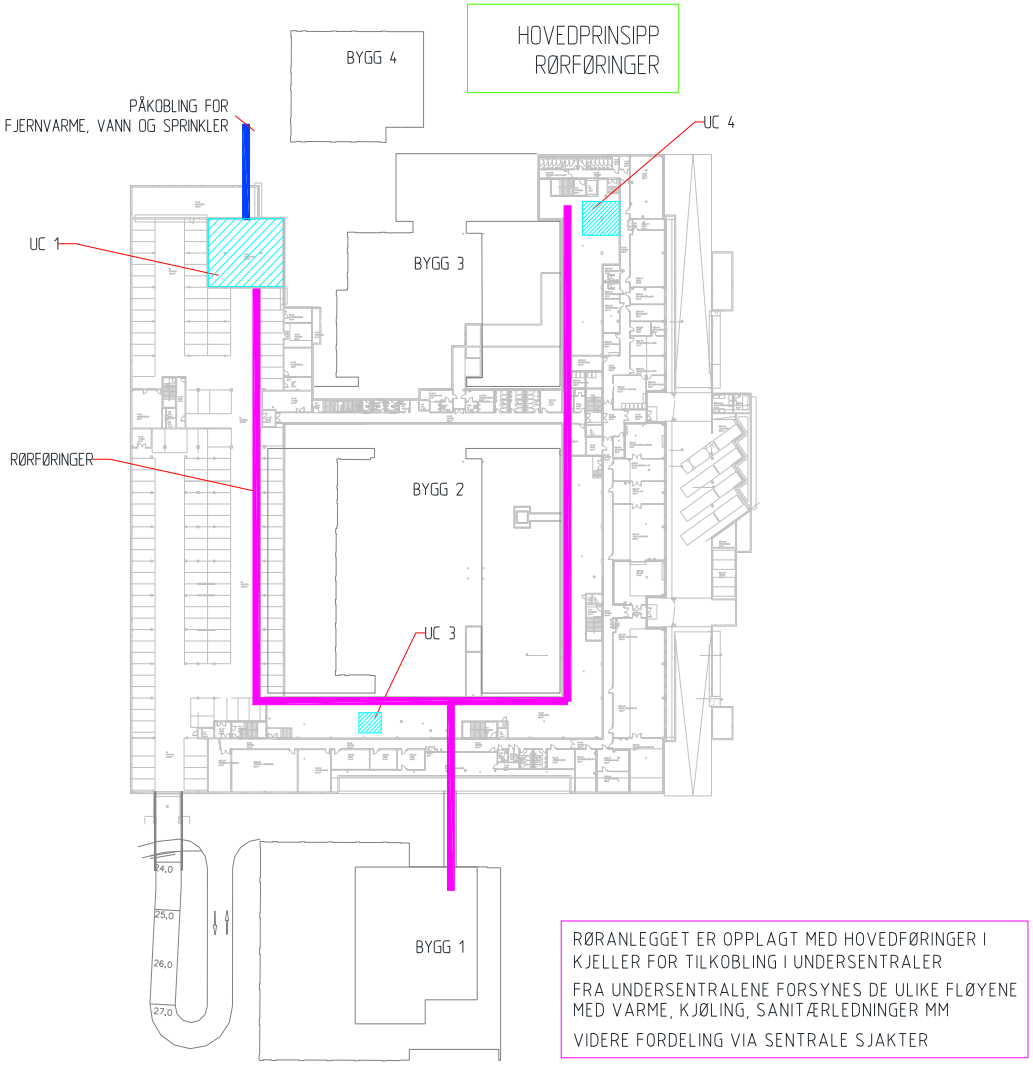
Høgskolen i Bergen

The energysolution is environmentally friendly, with

Interacting between:

- Bore holes
- Thermal energy storage
  Cooling (over night) and Heat (seasonal)
- Heat pumps / refrigerant pumps
- District heating
- Building Management System




HOVEDPRINSIPP
RØRFØRINGER
BYGG 4
PÅKOBLING FOR
FJERNVARME, VANN OG SPRINKLER
UC 4
UC 1
BYGG 3
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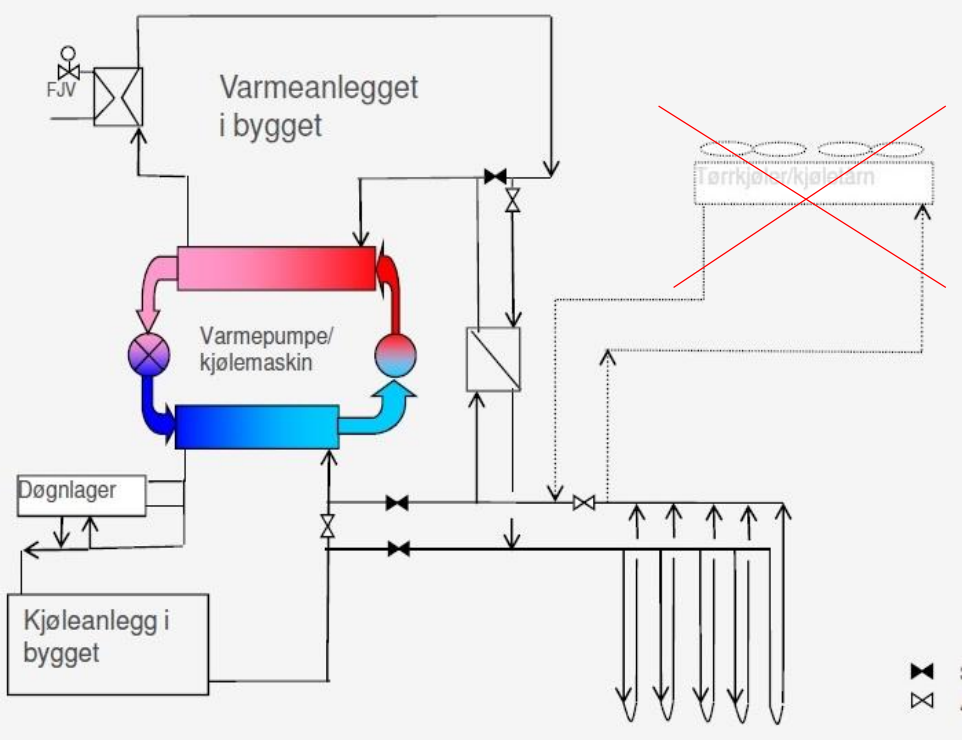
RØRANLEGGET ER OPPLAGT MED HOVEDFØRINGER I KJELLER FOR TILKOBLING I UNDERSENTRALER
FRA UNDERSENTRALENE FORSYNES DE ULIKE FLØYENE MED VARME, KJØLING, SANITÆRLEDNINGER MM
VIDERE FORDELING VIA SENTRALE SJAKTER

The principals of the energy plant



- **Energy System with bore holes and cooling storage.**

- **Heat pumps, 1 400 kW**
- **Cooling Storage / Daily storage 11 200 kWh = 7 hours á 1600 kW**
- **81 Bore holes á 220m depth**
- **Bore holes – heat absorption ca. 1 700 kW**
- **Heat mode – Cooling mode operation**
- **Energy regained to bore holes ca. 700 000 kWh**
- **District heating – peak load**
- **No need for dry cooler or cooling tower.**

Main advantages

The required cooling power is about 3.000 kW. This can not easily be reduced.

By the use of bore holes and storing cooling energy, you obtain many advantages:

- Capacity of the heatpumps are reduced to 1.400 kW (53% reduction)
  Less infrastructure, lower installed effect and smaller installations.

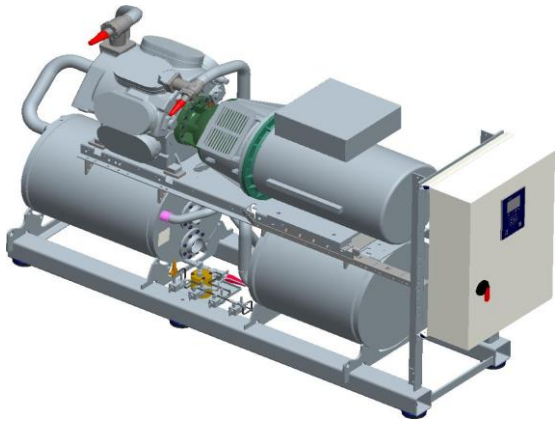
- Excess heat is dumped and stored in the boreholes, which are costumized to heatpump operation.
  No visible components on roof of building. No noise issues.
  All heat is exploited, no heat is let out (like in a drycooler).

- Chillers are customized for optimal operation as heat pump, and obtain a higher COP.
  Great energysavings when energy is fully exploited.

Heating system

•Consisting of 3 heatpumps and wells containing natural coolant, and 81 bore holes, each one 220 m deep.

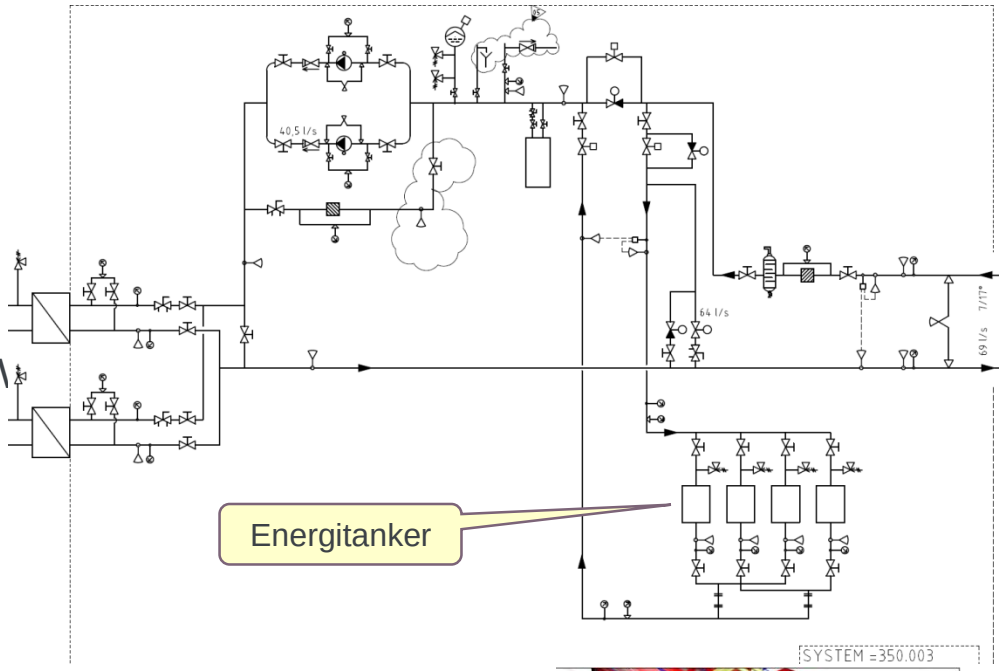
•The reason why we used heat storage in the ground, was to store surplus heat in the summer and use it during winter, when there is a heat demand. (Thermal seasonal storage)

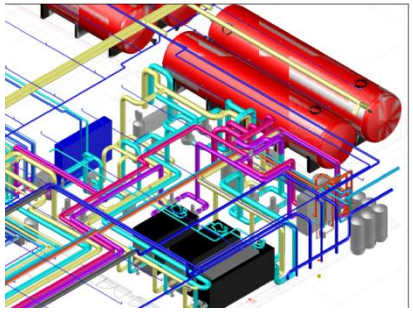


- District heating is used when there is a peak load.

The Structure of the Main Cooling System

- Flow control of the ice water using presure controlled pumps.
- Water tempearure, 7/17 °C
- 3 chiller, 1.400 kW
- Cooling storage, 11.200 kWh
  4 reservoirs of nto 64 m³
- Energy Storage, output ca. 1500 kW
- Flat Ice-elemens, ca 51.000 pcs
- Salt hydrate-decomposition, S10
- Melting point at 10 °C
- Instrumentation





Kjøleanlegg- kuldelagingstanker

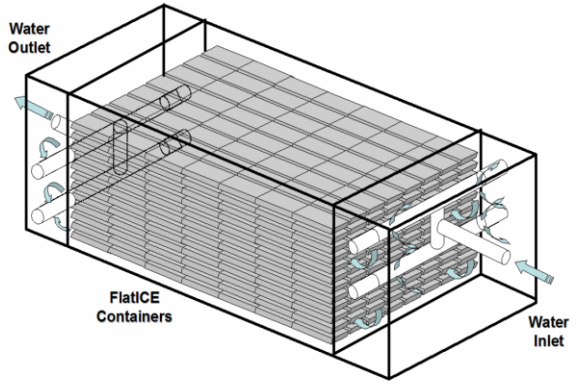
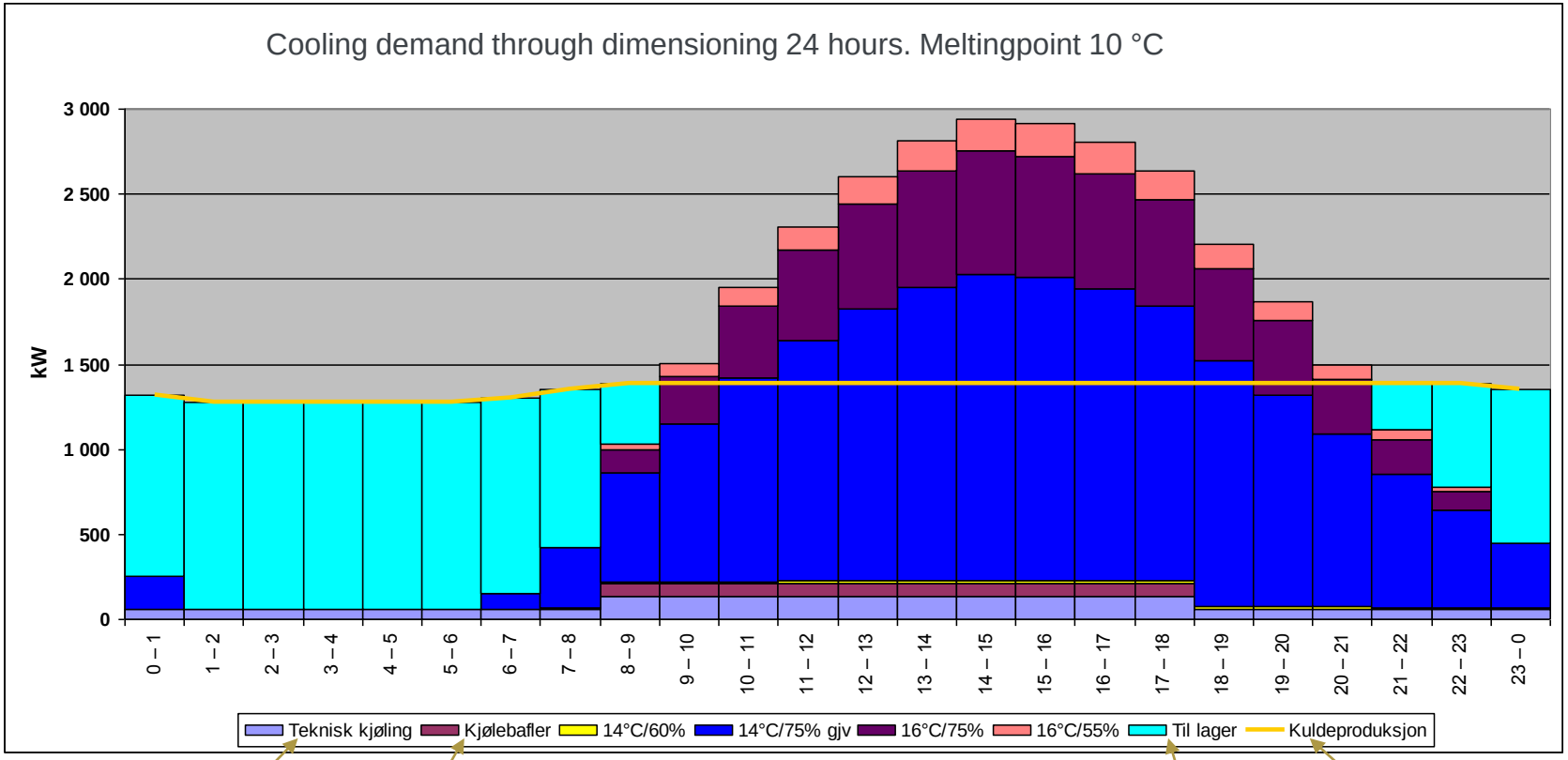


Figure 3.4.3.5 - A typical FlatICE plastic containers Water TES application

4 tanks of 70 m³, contains 12 700 pcs of flat ice elements.

Total gross volume is 280 m³ with 50 800 elements with cooling capasity at 11 200 kWh.

Thermal energy storage - cooling



Technical cooling

Climate cooling

Medium – Salthydrate S10

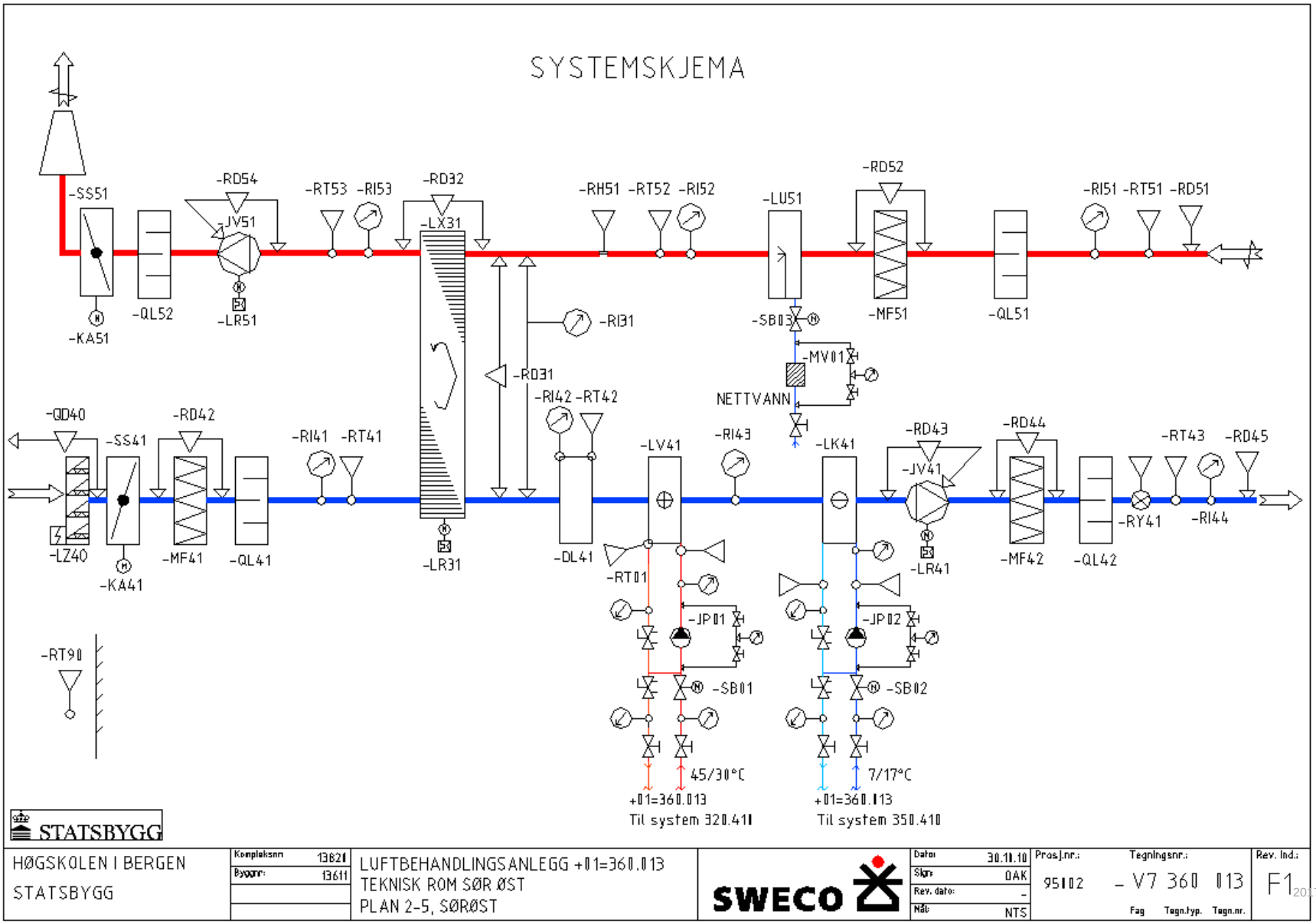
Capacity – 11.200 kWh

Volume – 255 m^3

Storage

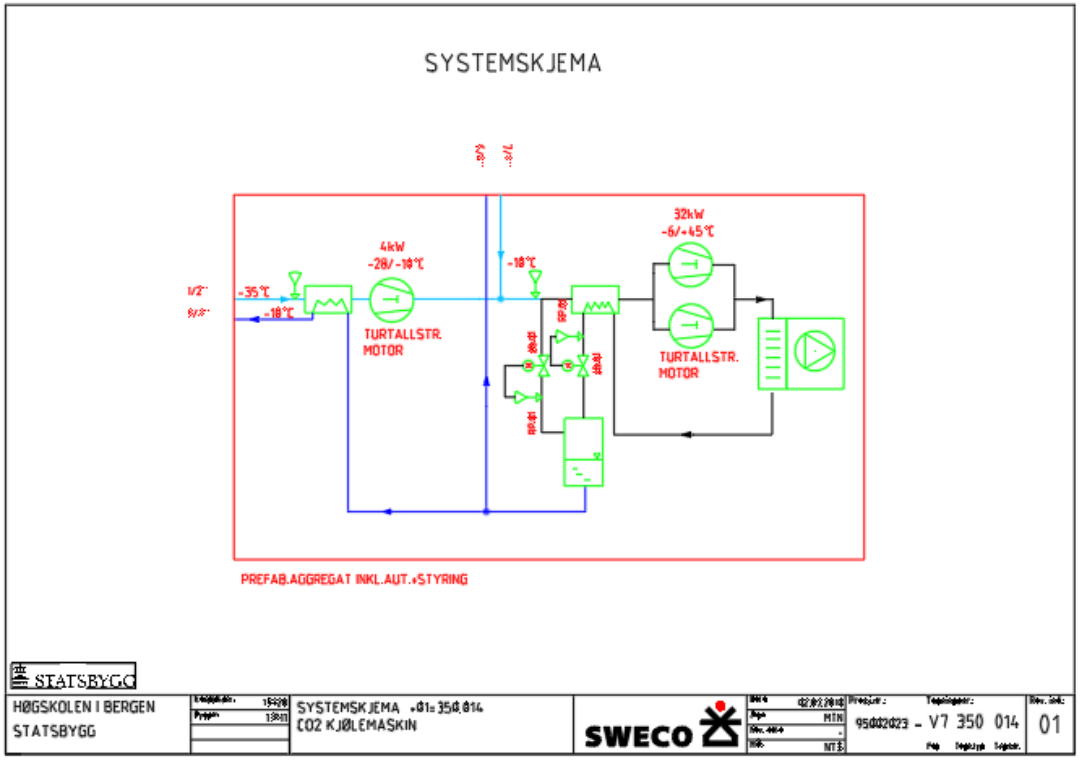
Cooling from chillers

HiB – Indirect evaporative cooling

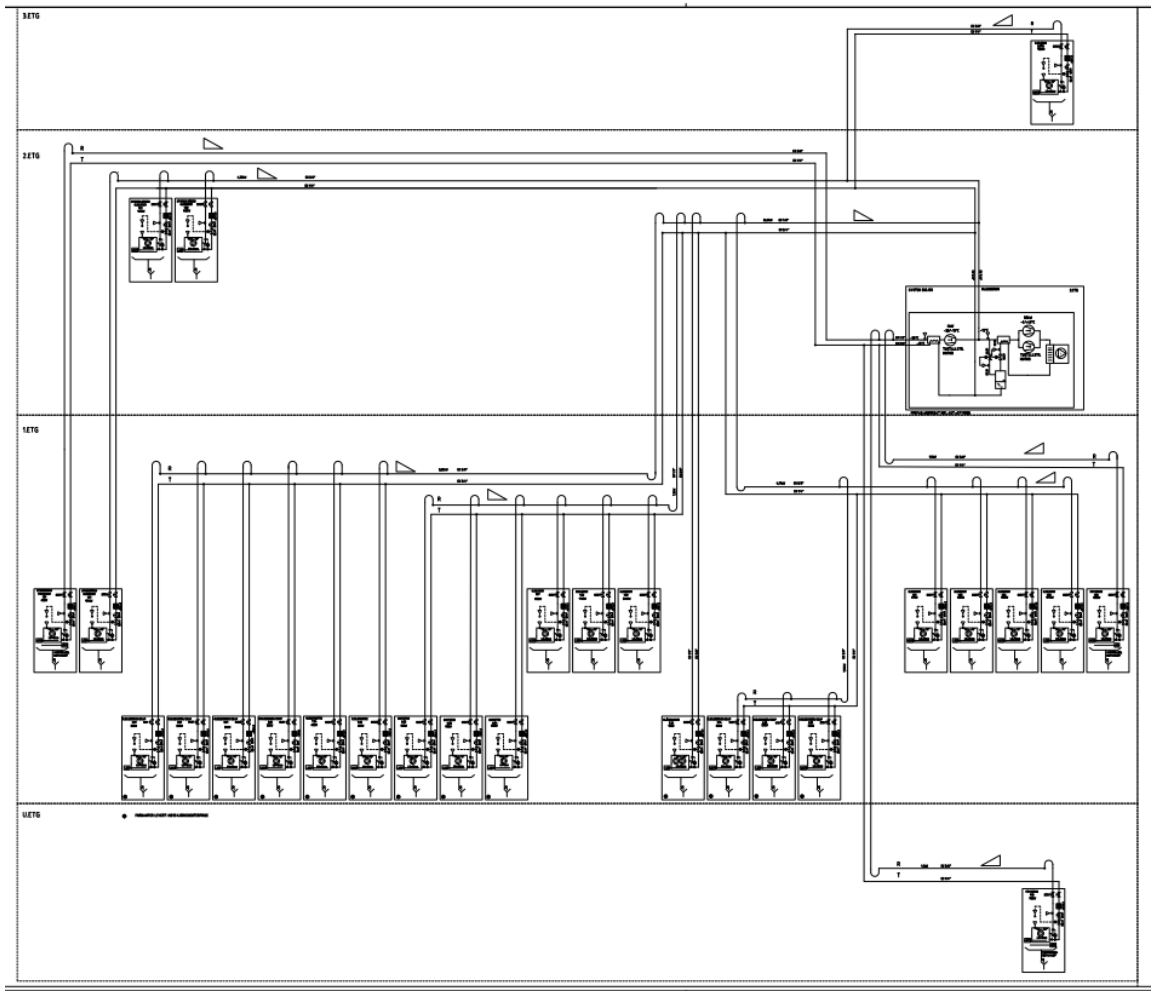


Høgskolen i Bergen

- Not to forget the «stand alone» CO2 heat pump for cooling the fridge and freezer in the cafeteria.

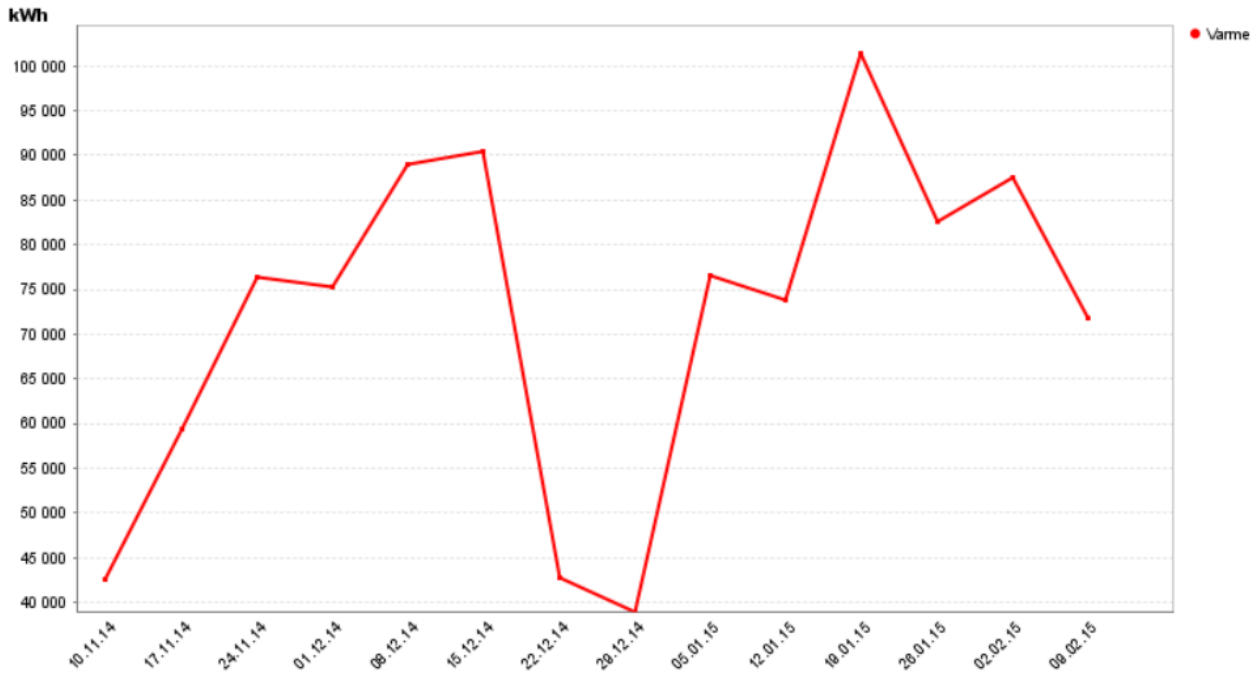


Høgskolen i Bergen



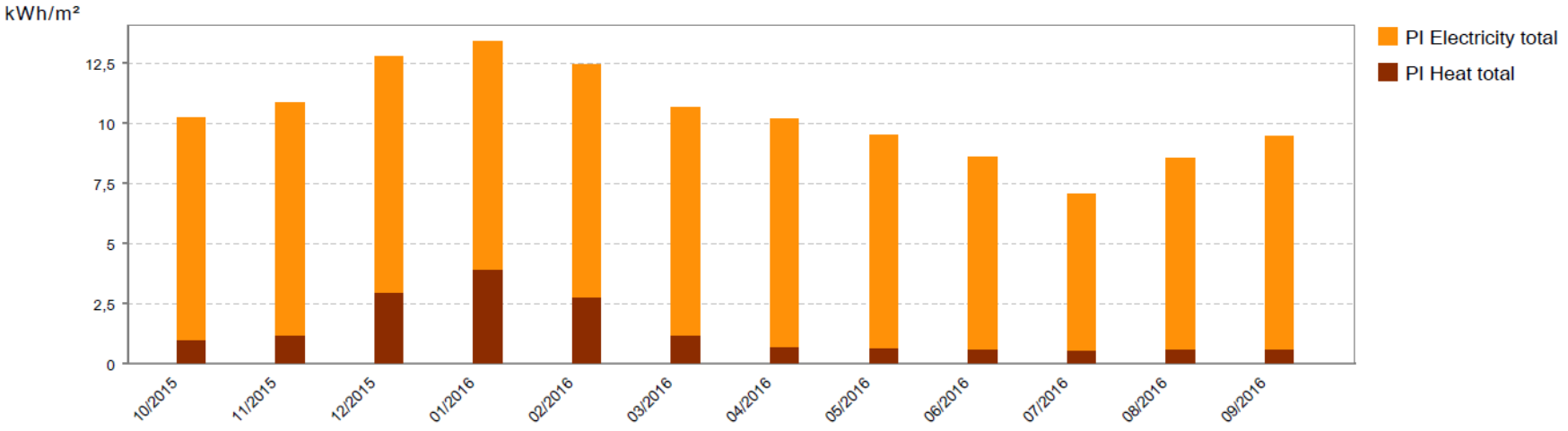
Heat delivered from the heatpumps per week.

	Dato	Varme
		kWh
1	**10.11.14**	42 509,98
2	**17.11.14**	59 306,02
3	**24.11.14**	76 400,00
4	**01.12.14**	75 230,00
5	**08.12.14**	88 978,25
6	**15.12.14**	90 371,75
7	**22.12.14**	42 669,25
8	**29.12.14**	38 894,39
9	**05.01.15**	76 632,36
10	**12.01.15**	73 807,20
11	**19.01.15**	101 365,00
12	**26.01.15**	82 644,00
13	**02.02.15**	87 552,30
14	**09.02.15**	71 731,50
	Sum	**1 008 092,00**
	Snitt	**72 006,57**
	Min	**38 894,39**
	Maks	**101 365,00**

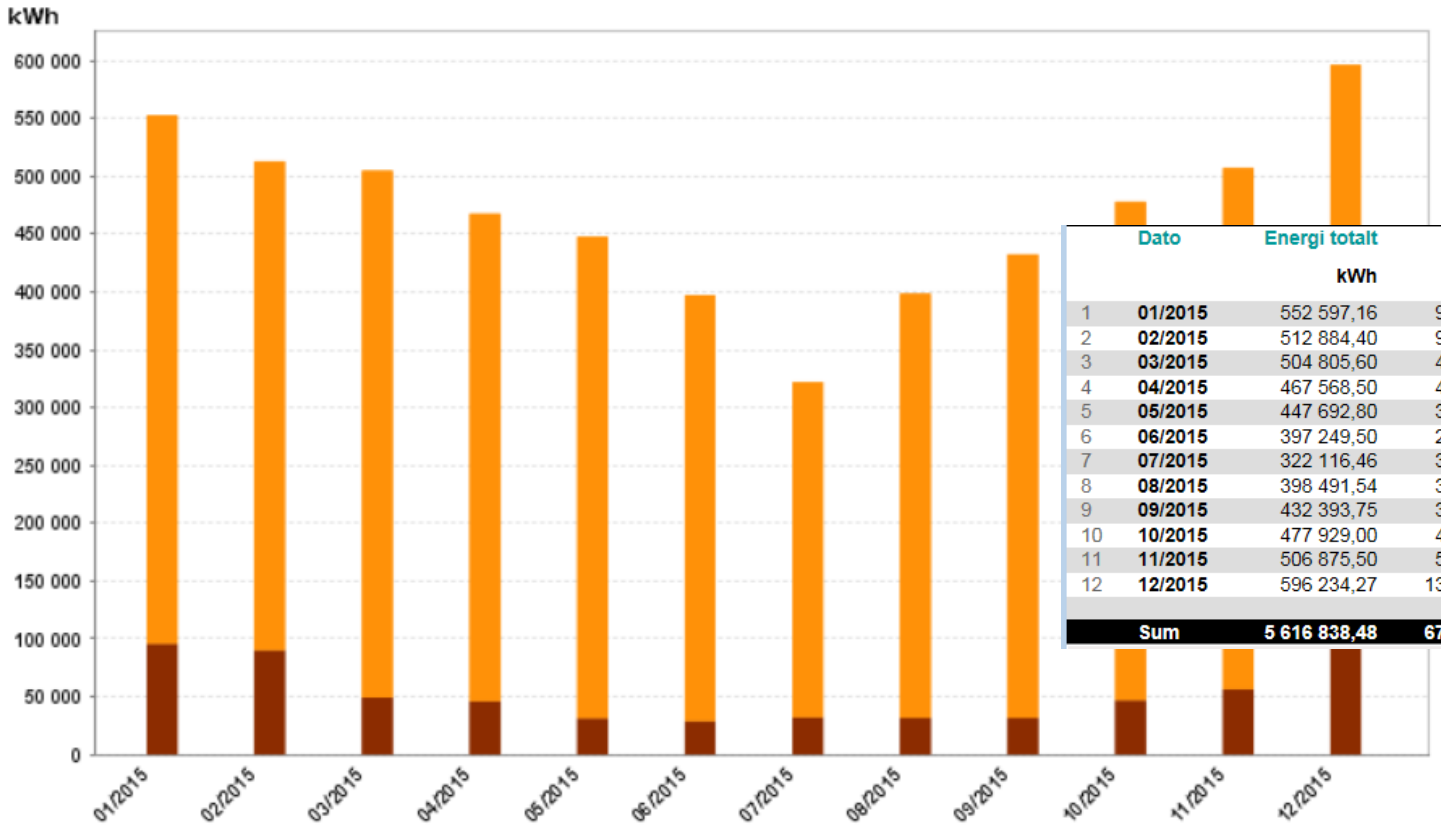


Energy delivered to building [kWh/m² pr. month] (123kWh/m²/year)

Areal (m²) m²	PI Energy total kWh/m²	PI Heat total kWh/m²	PI Electricity total kWh/m²
46 700,00	10,23	1,00	9,23
46 700,00	10,85	1,21	9,64
46 700,00	12,77	2,99	9,78
46 700,00	13,39	3,93	9,46
46 700,00	12,46	2,80	9,66
46 700,00	10,67	1,20	9,47
46 700,00	10,18	0,74	9,44
46 700,00	9,51	0,66	8,85
46 700,00	8,58	0,64	7,95
46 700,00	7,08	0,59	6,48
46 700,00	8,54	0,61	7,93
46 700,00	9,49	0,64	8,84
Sum	123,75	17,01	106,73
Average	10,31	1,42	8,89



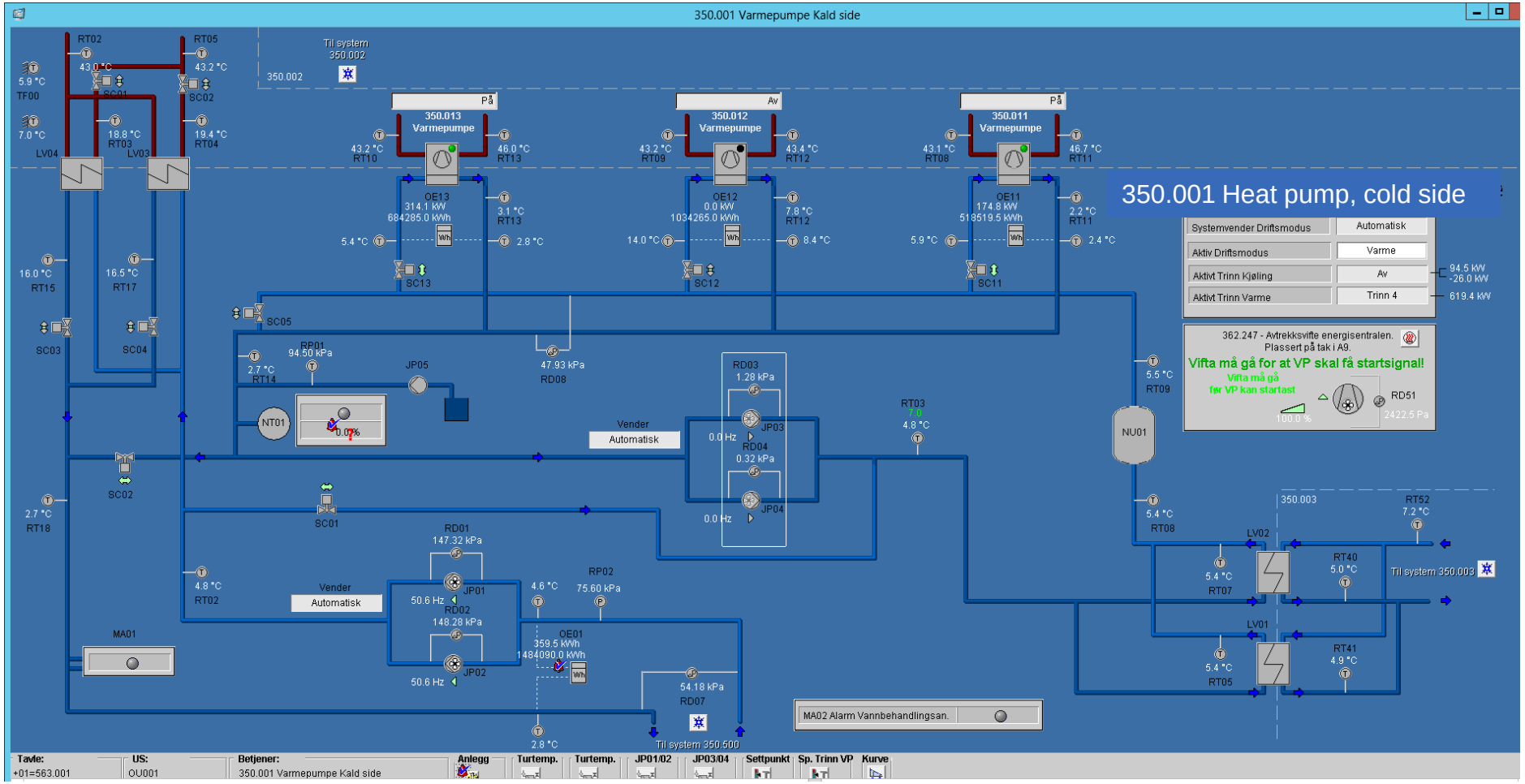
Energy delivered to building [kWh/month]



	Dato	Energi totalt	Heat	El. totalt
		kWh	kWh	kWh
1	01/2015	552 597,16	95 707,60	456 889,56
2	02/2015	512 884,40	90 180,00	422 704,40
3	03/2015	504 805,60	49 320,00	455 485,60
4	04/2015	467 568,50	46 040,00	421 528,50
5	05/2015	447 692,80	31 180,00	416 512,80
6	06/2015	397 249,50	28 880,00	368 369,50
7	07/2015	322 116,46	32 185,71	289 930,75
8	08/2015	398 491,54	31 574,29	366 917,25
9	09/2015	432 393,75	31 540,00	400 853,75
10	10/2015	477 929,00	46 850,00	431 079,00
11	11/2015	506 875,50	56 580,00	450 295,50
12	12/2015	596 234,27	139 557,23	456 677,05
	Sum	5 616 838,48	679 594,83	4 937 243,66

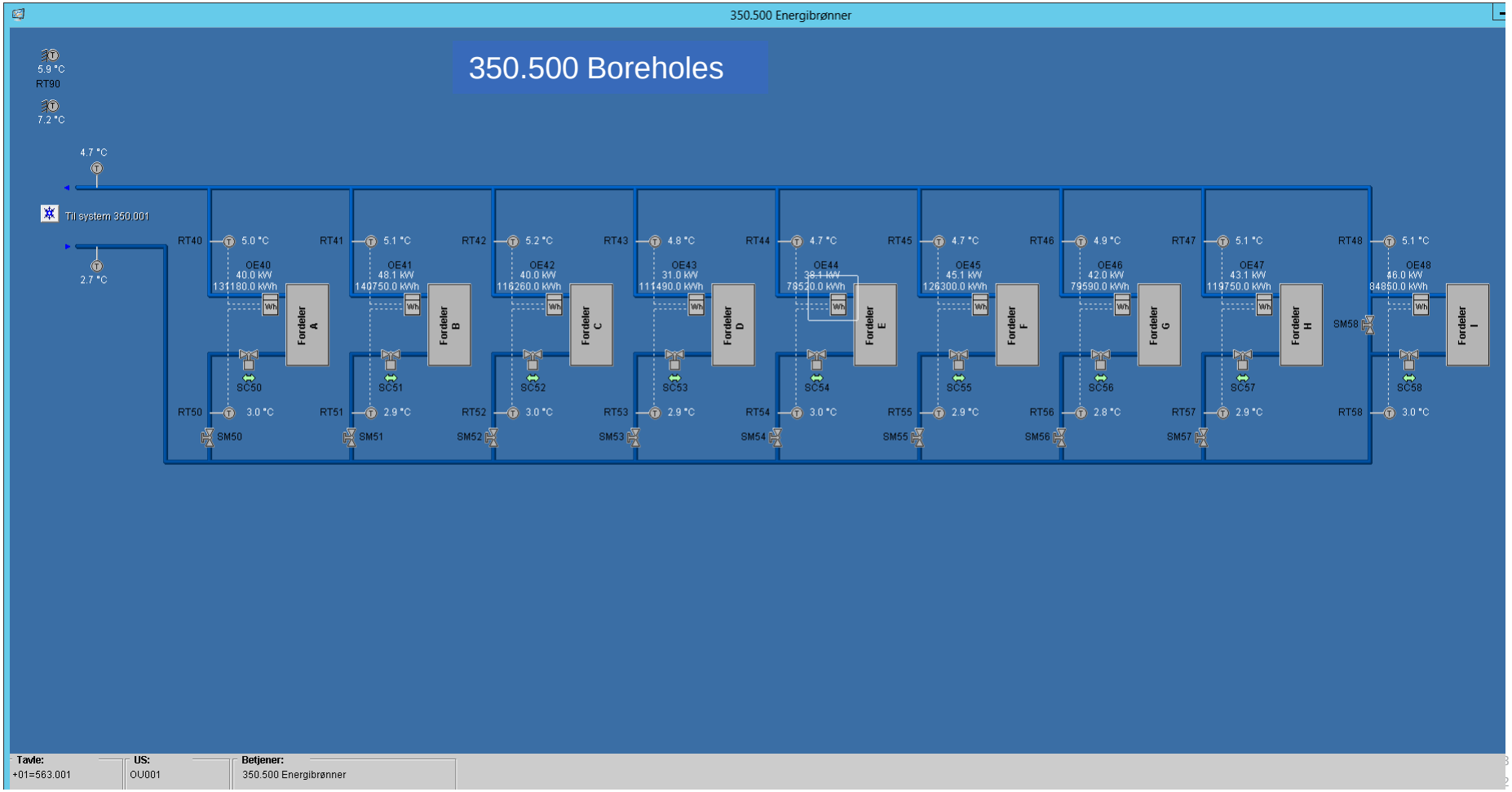
Building Management System

Main cooling system / heat pumps
Evaporator to boreholes and climate cooling



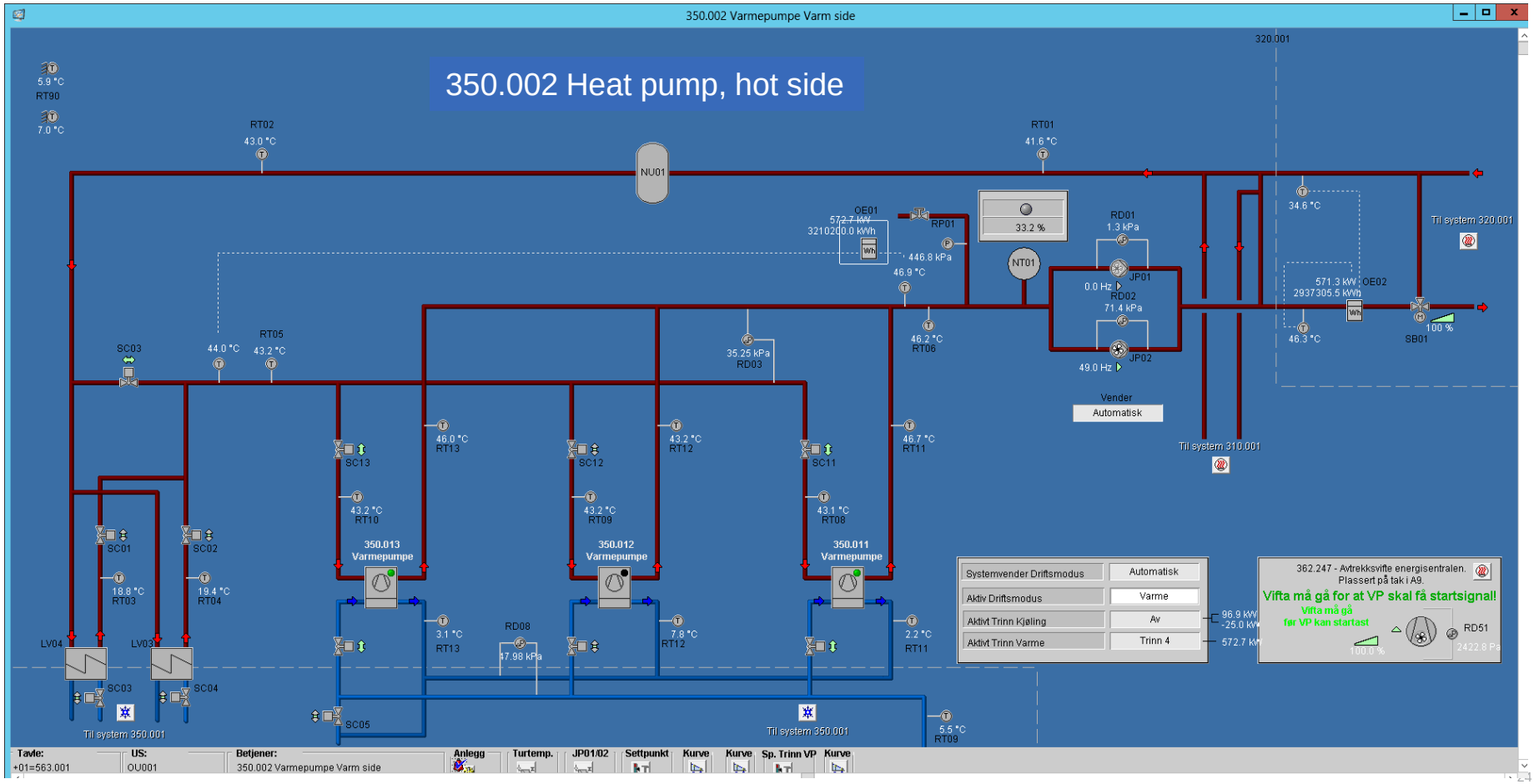
Boreholes – 81 wells at 220 m depth

- Energy flow meters with BUS communication. Power, energy and temperatures are measured.



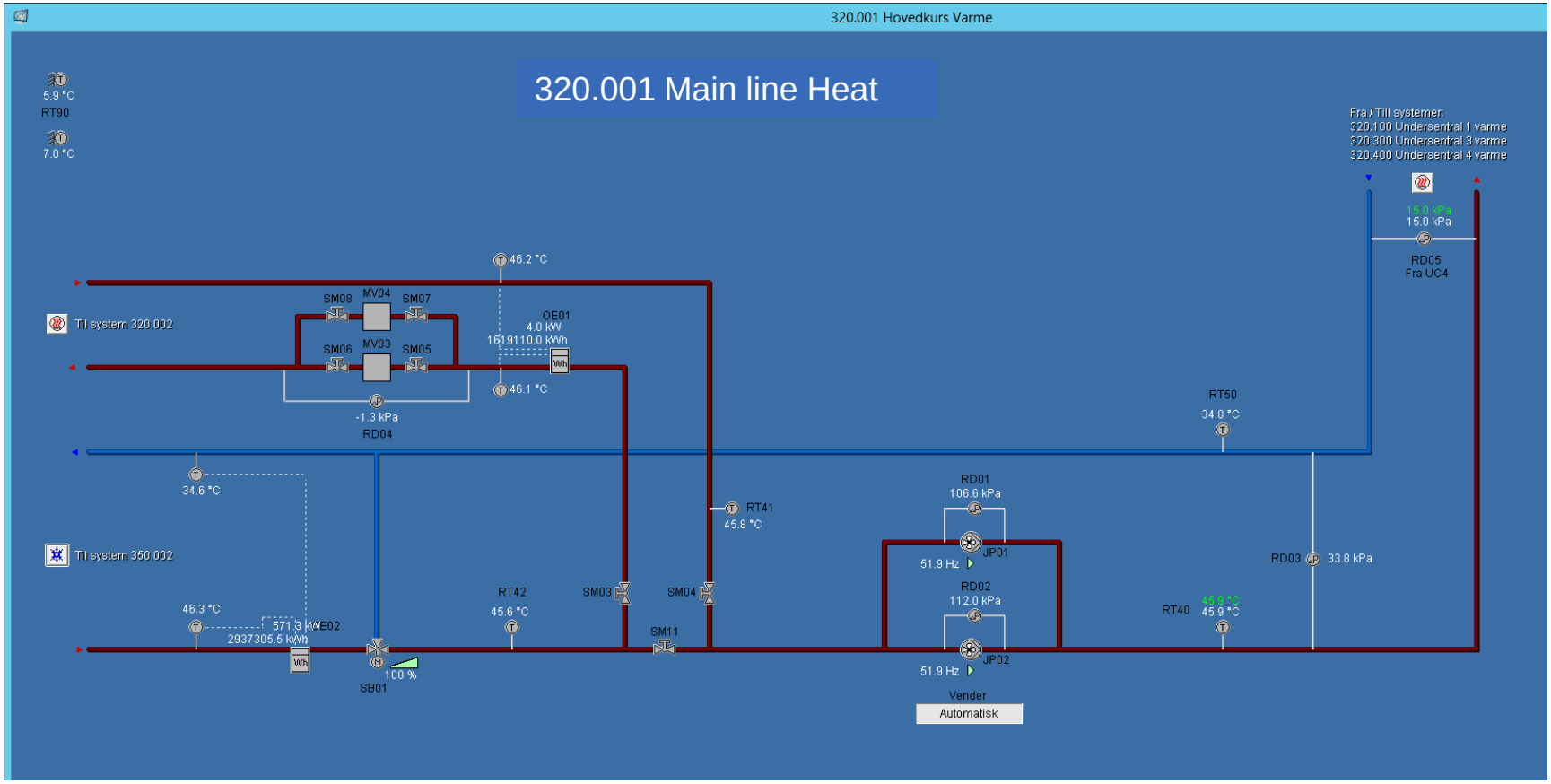
Heat pump, Condenser

- Supply temperature regulated by outside temperature.

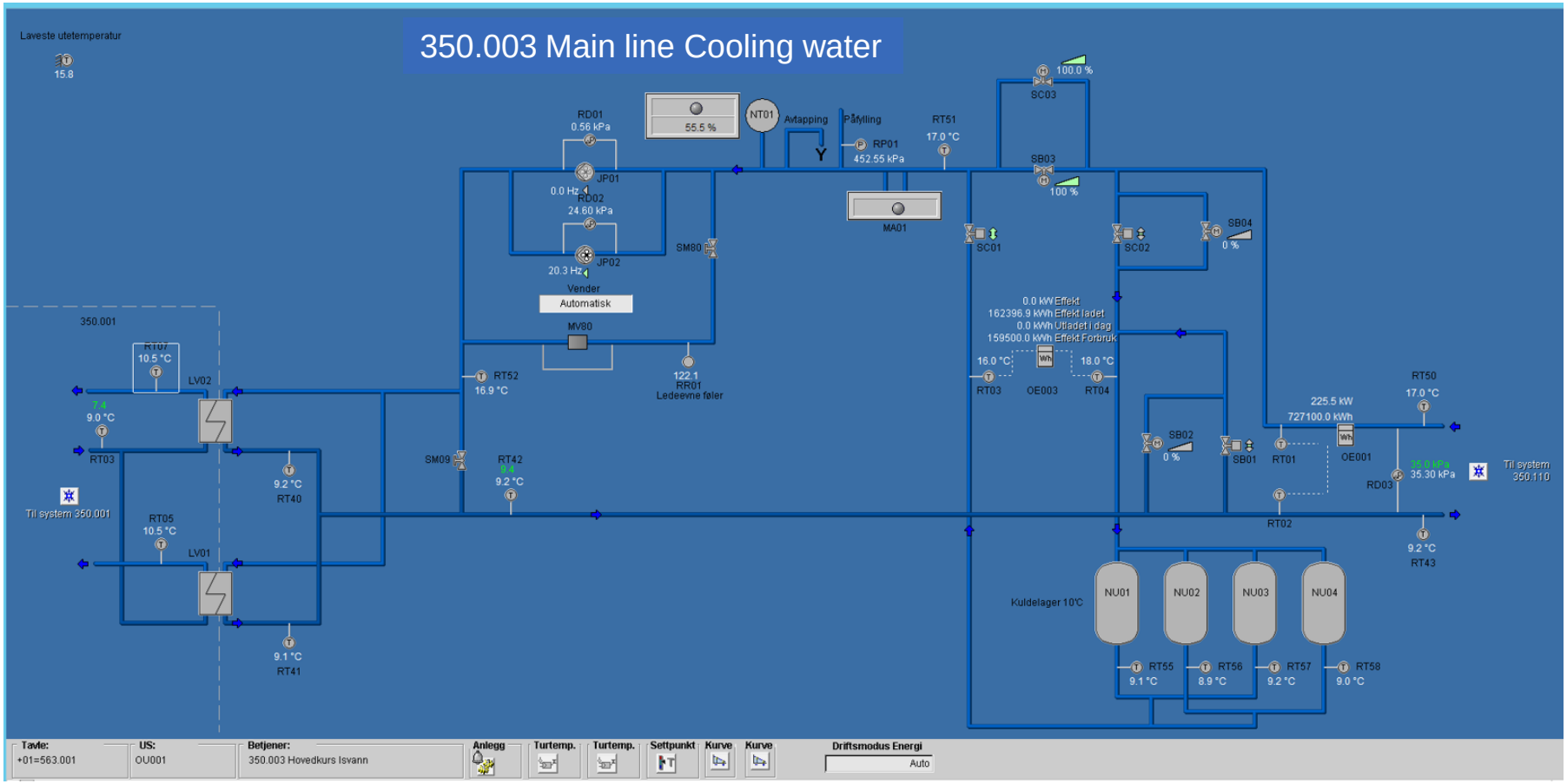


Line for heating of building

- Heat from heatpumps, district heating for peak loads.

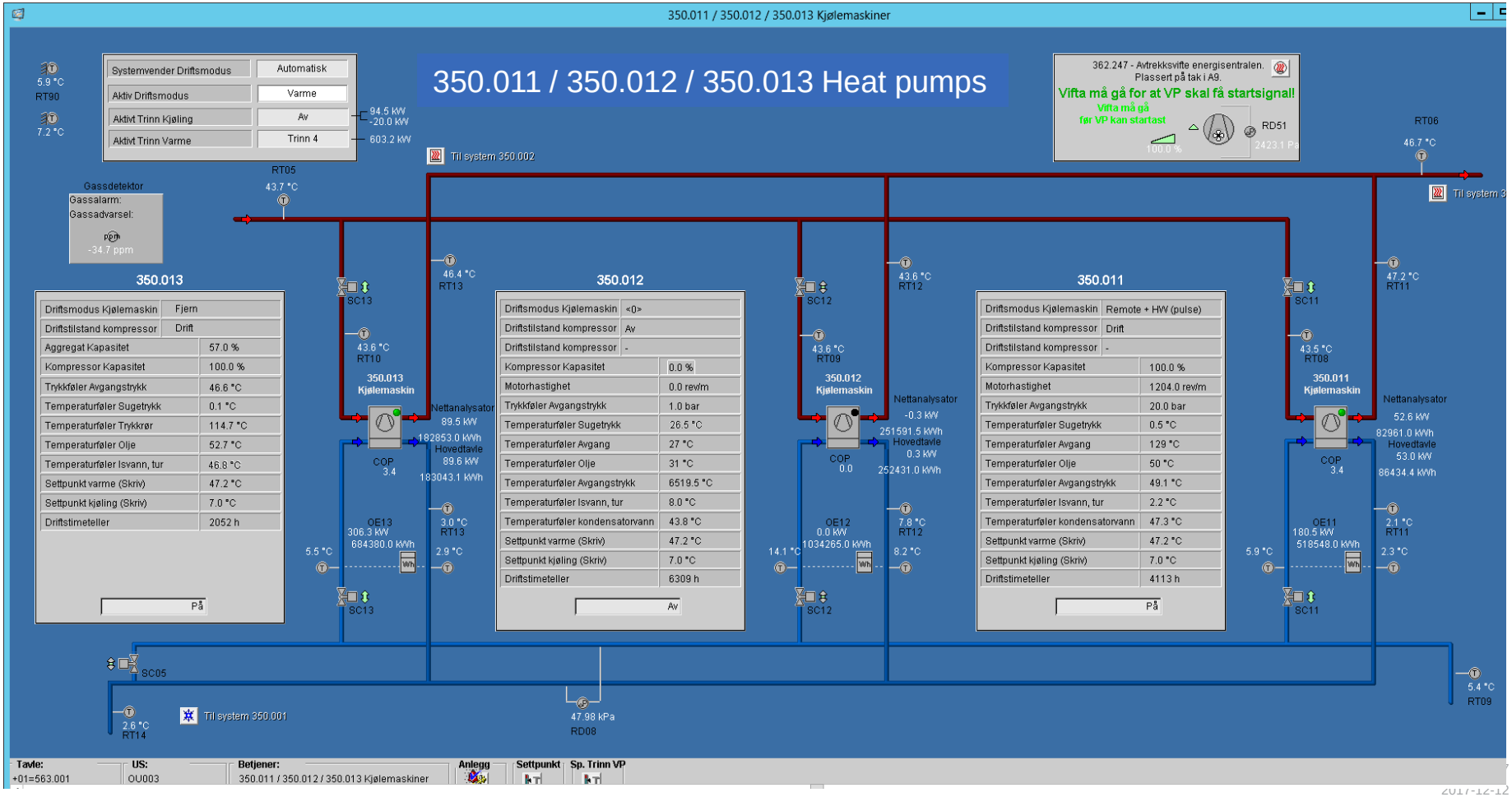


Main cooling system – with energy storage



Heat pumps

- BUS communication. Calculation of COP.



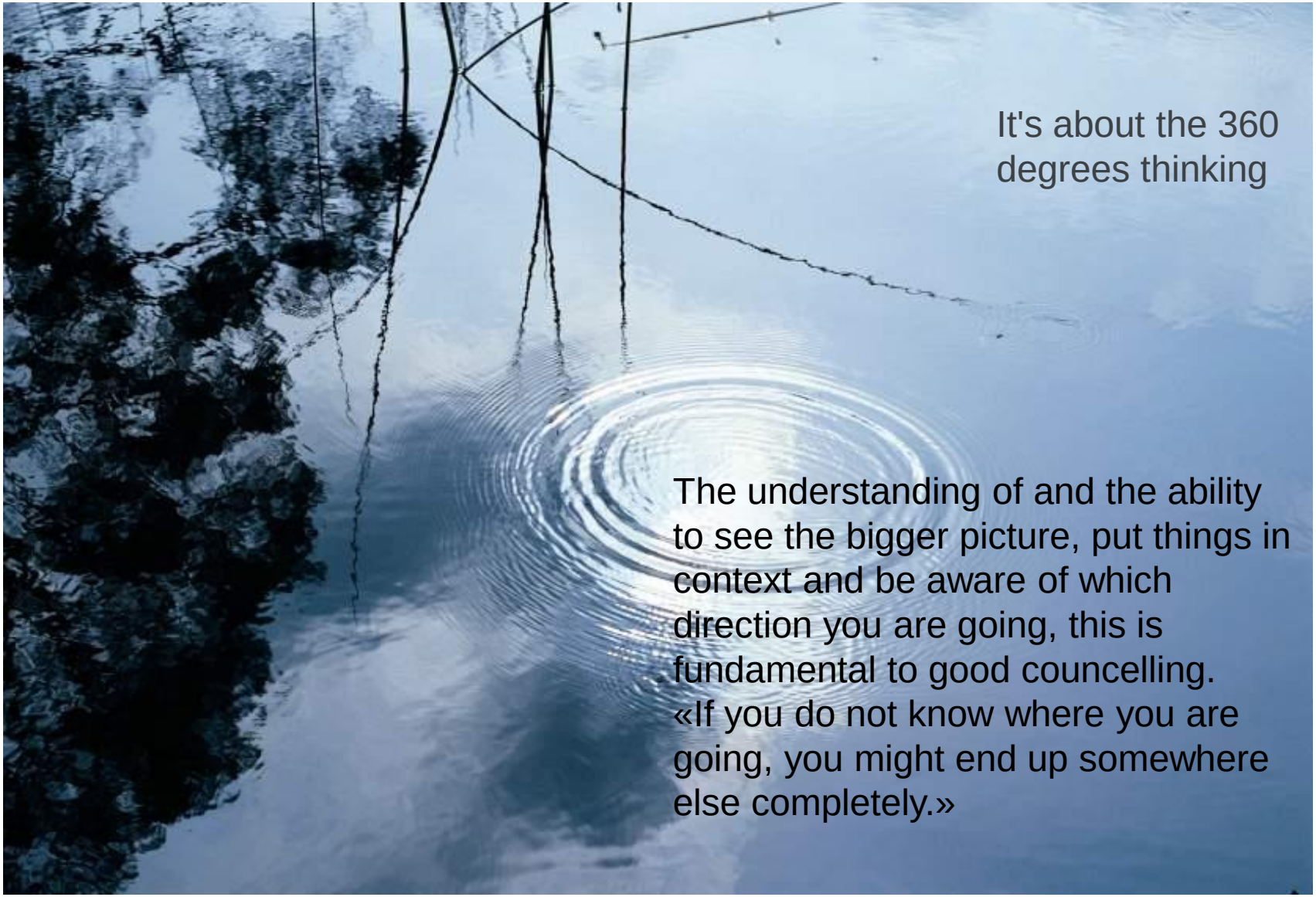
STATSBYGG

Unique in the world context?

The cooling and heating at HiB combines :

- The largest gathering of bore holes (81 holes) in Western Norway
- Among Europe's largest cooling storage (250 m³)
- The largest installation of indirect evaporative cooling (14 plants) in Scandinavia.

- This provides a unique combination in an energy plant and there might be nothing like it in Norway, Europe or the rest of the world?


It's about the 360 degrees thinking
The understanding of and the ability to see the bigger picture, put things in context and be aware of which direction you are going, this is fundamental to good councelling. «If you do not know where you are going, you might end up somewhere else completely.»

Høgskolen på Vestlandet

Høgskolen i Bergen

- Lets go on a tour and look at some of the installations.
- We will walk through the energy sentral the heart of the buildig, You should be aware of the noise there. Ulf from Statsbygg will join us, and he has a couple of hearing protections. Questions can be asked before we enter the room and/or when we are out again.
- I think it will be interesting to look at the dimention of the cooling storage
- We will show you a distribution box for the bore hols
- And at the end we will have a look at an air handling unit.

Thank You so much for Your attention!