

Energy saving potential with combining heating, cooling and thermal storage

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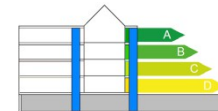
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IFHE 2014
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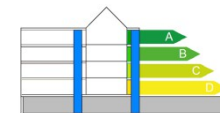
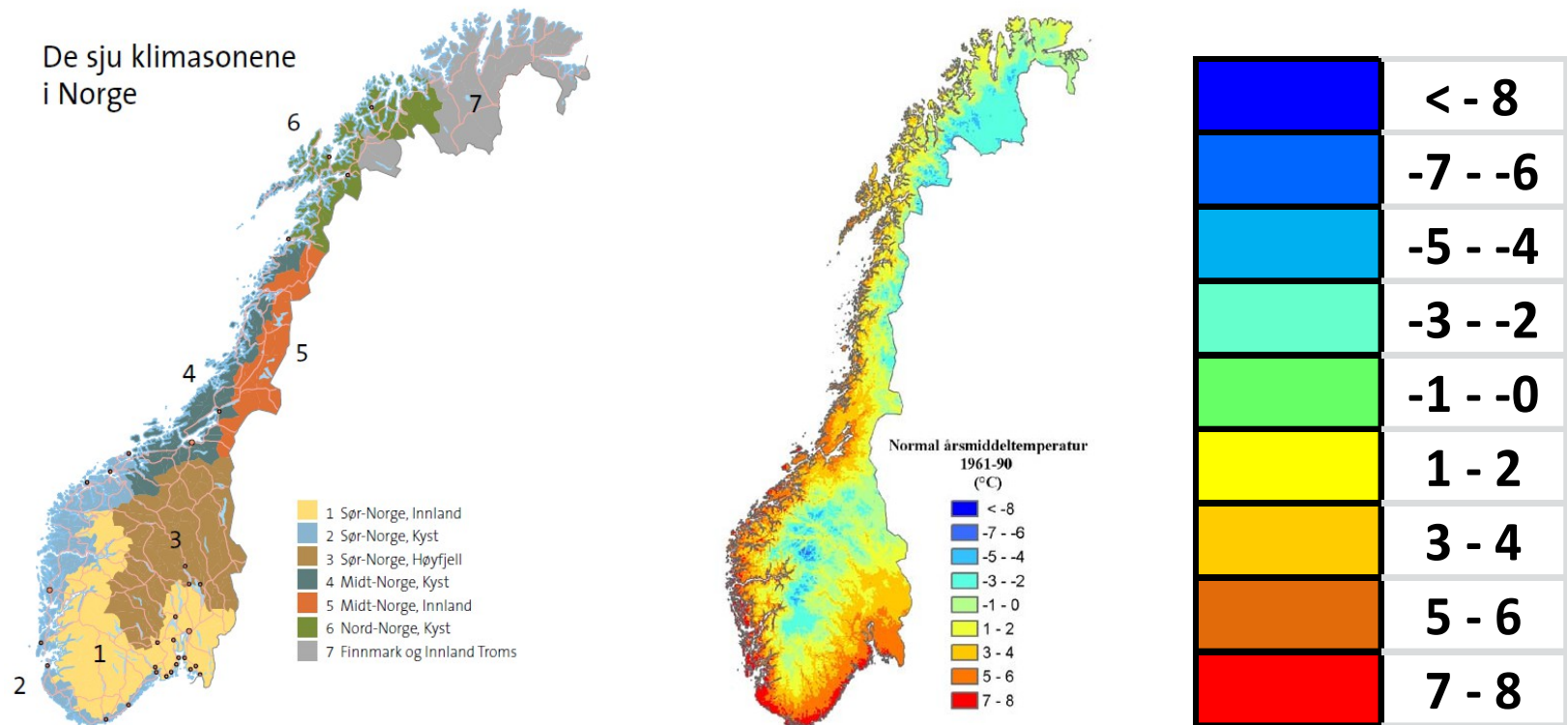
23rd Congress of the
International Federation of Hospital Engineering (IFHE)





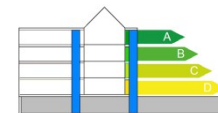
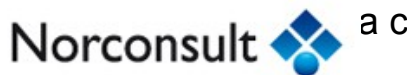
Climate zones in Norway

Normal annual mean temperature



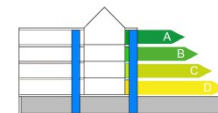
Low Energy Hospitals

- **Low Energy Hospitals** is an innovation project whose goal is to find and promote feasible design measures which can halve the energy consumption in new hospitals built in Norway
- Led by **Norconsult AS**, Norway's largest multi-disciplinary consulting engineering company, supported by the Norwegian Research Council and matching funds from private sector partners:
 - **Helse Sør-Øst** - Norway's largest regional health authority
 - **Nordic Office of Architecture** - a leading architecture company in Norway
 - **GK-Norway** - a large supplier of HVAC equipment and services in Scandinavia
 - **SAAS** - designs and delivers complete building automation systems
 - **Siemens Healthcare** - global supplier of medical equipment
 - **Norconsult Information Systems** - IT solutions for hospitals or in Scandinavia



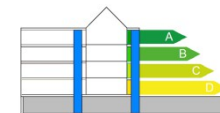
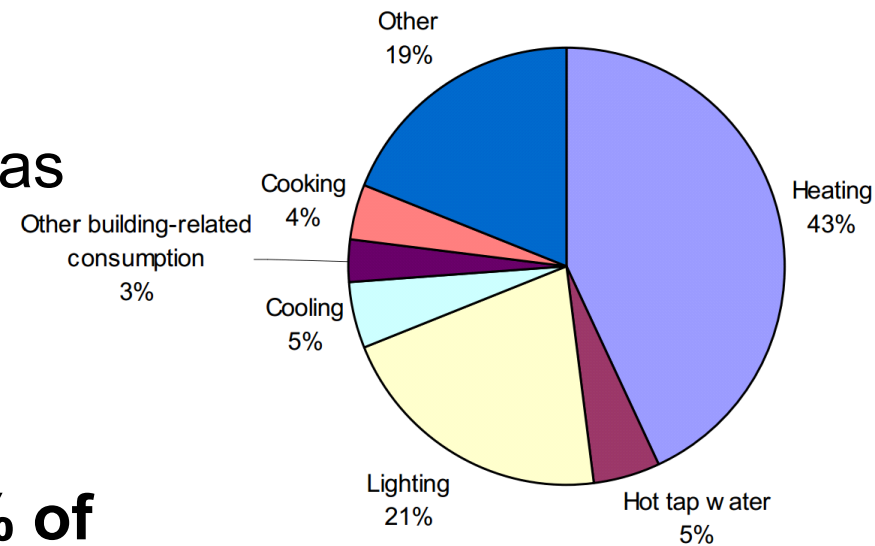
Objectives

- Energy consumption in hospitals in focus
 - Reducing energy consumption with 50% (in total) without compromising health, comfort and staff efficiency
- Energy-efficient system for heating system
 - Examples from simulation from different temperature levels
- Combining heating, cooling and ground storage system
 - Examples from simulation from different tempe



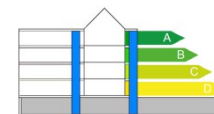
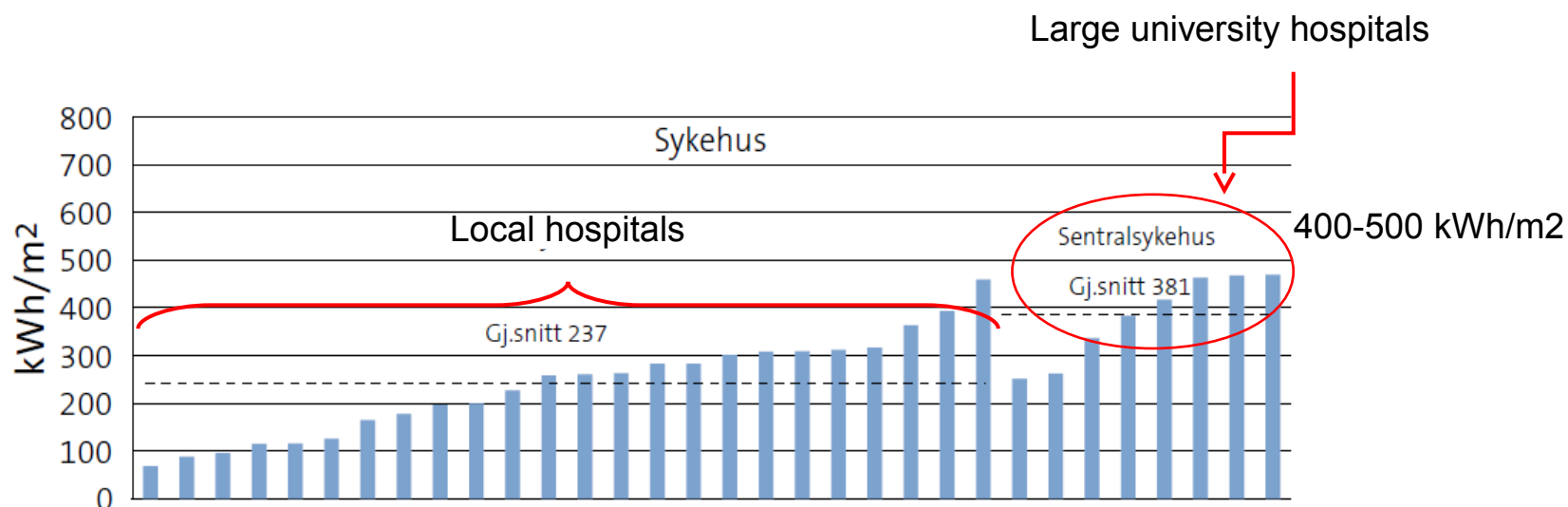
Focus on Hospital Energy Consumption

- Healthcare buildings represents 10% of the total heated area of commercial buildings in Norway
- Healthcare building use twice as much energy than other commercial buildings
- **Healthcare building use 20% of the energy consumption in commercial building in Norway**



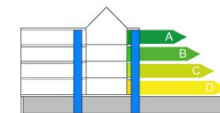
Focus on Hospital Energy Consumption

- Specific energy consumption for hospitals pr. year



Requirement of technical regulations and energy label

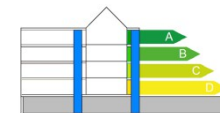
Building Category	Total net energy - maximum values (kWh/m2 heated BRA per year)					
	TEK-10	TEK-07	Diff Tek10- Tek07	Energy label A	Energy label B	Energy label C
Small Houses, holiday homes of 150 m ²	120+1600m ² oppv.BRA	125+1600m ² oppv.BRA	-5	79	118	158
Apartment building	115	120	-5	67	100	134
Children's garden	140	150	-10	90	135	180
Office building	150	165	-15	84	126	168
school building	120	135	-15	79	118	158
University / College	160	180	-20	95	143	191
Hospital	300(335)	325	-25	179	268	358
Nursing homes	215(250)	235	-20	136	203	271
Hotels	220	240	-20	135	202	269
Sports building	170	185	-15	109	164	218
Business Buildings	210	235	-25	129	194	258
Culture Building	165	180	-15	105	158	210
Light industrial / garage	175(190)	185	-10	106	159	212
						tilsv. TEK07?



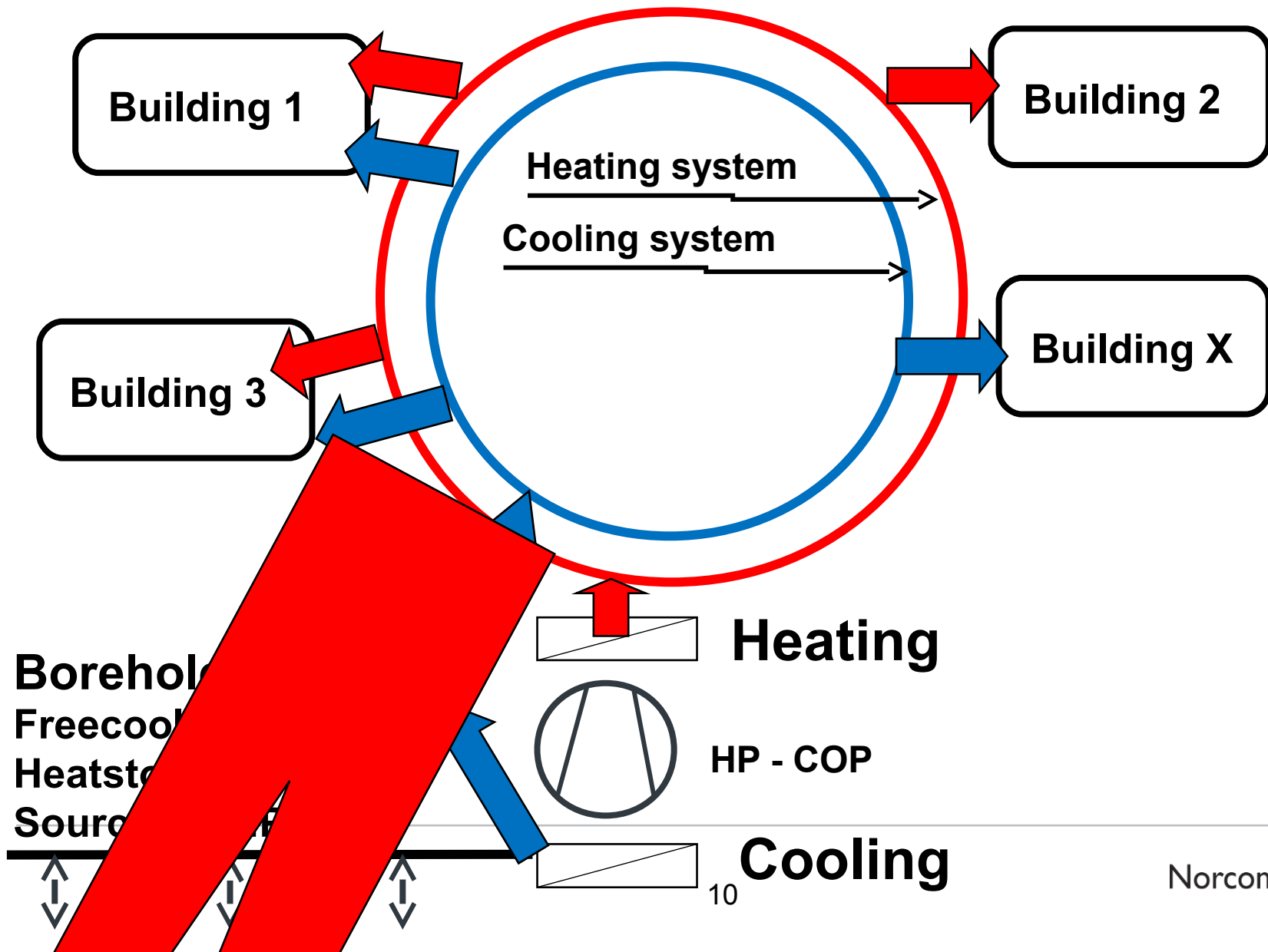
Healthcare - energy consumption

- Hospital building category with the largest specific energy consumption
- The energy consumption is spread on the following categories

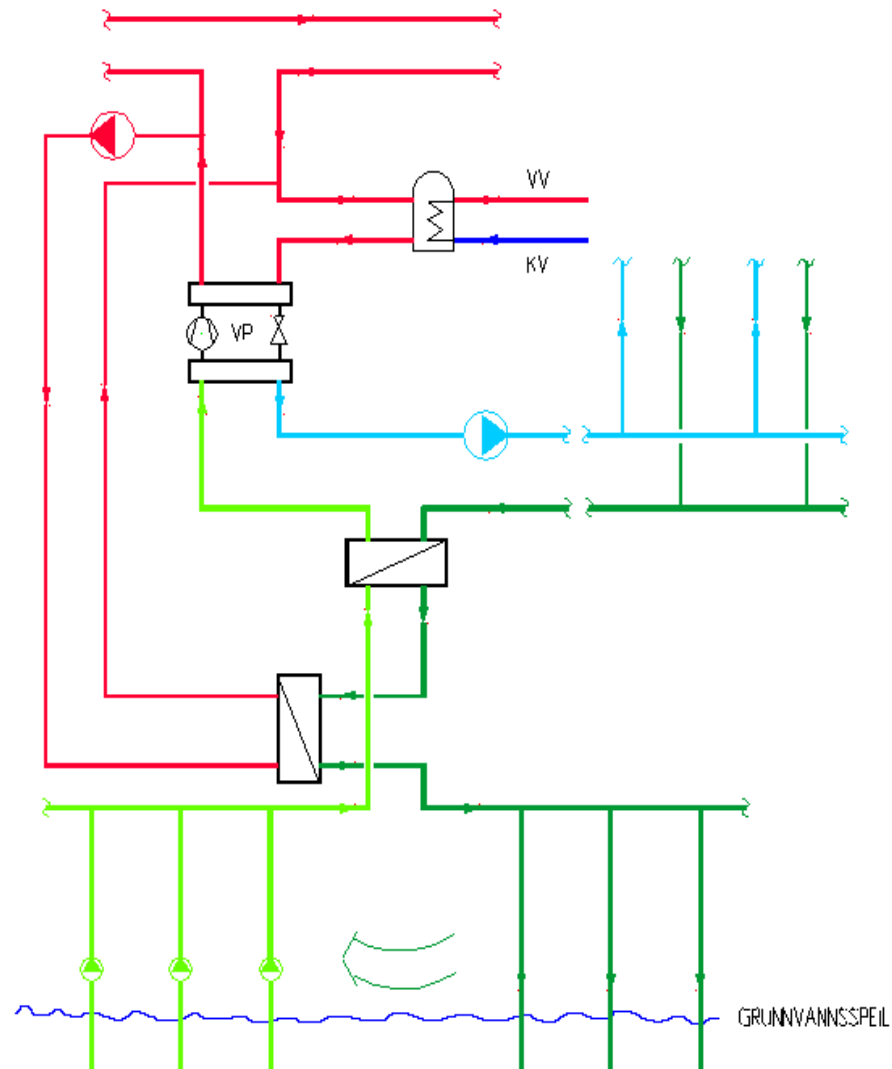
		kWh/year	kWh/m2	%
Electrical power	Ventilation Fans	632 667	40	9,6 %
	Light	1 470 095	92	22,3 %
	Equipment	1 483 725	93	22,5 %
Thermal cooling	Ventilation cooling	167 453	10	2,5 %
	Room cooling	566 822	35	8,6 %
Thermal heating	Ventilation heating	1 828 830	114	27,7 %
	Room heating	443 297	28	6,7 %
	Sum	6 592 889	412	100,0 %

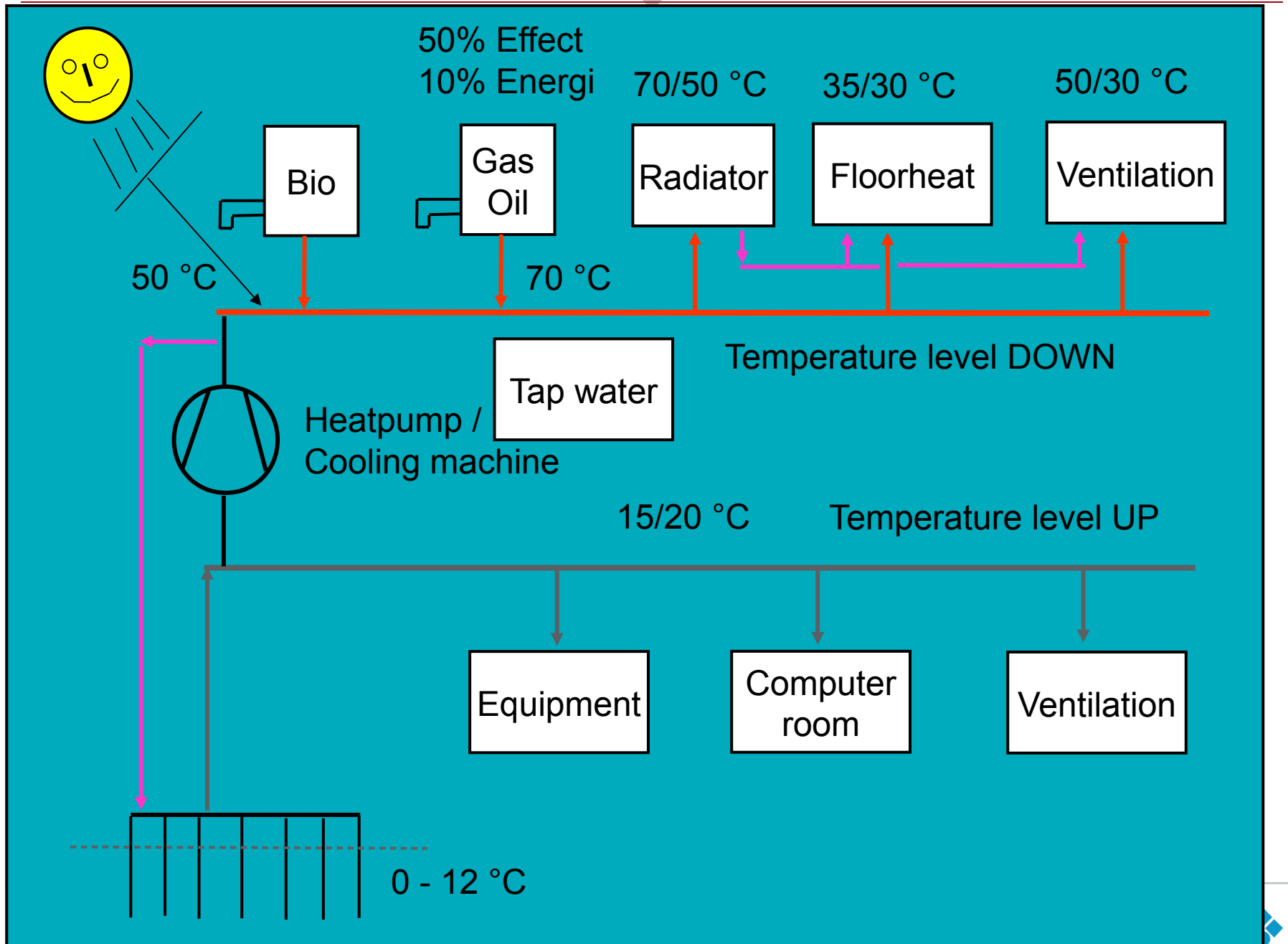


Interacting heating and cooling

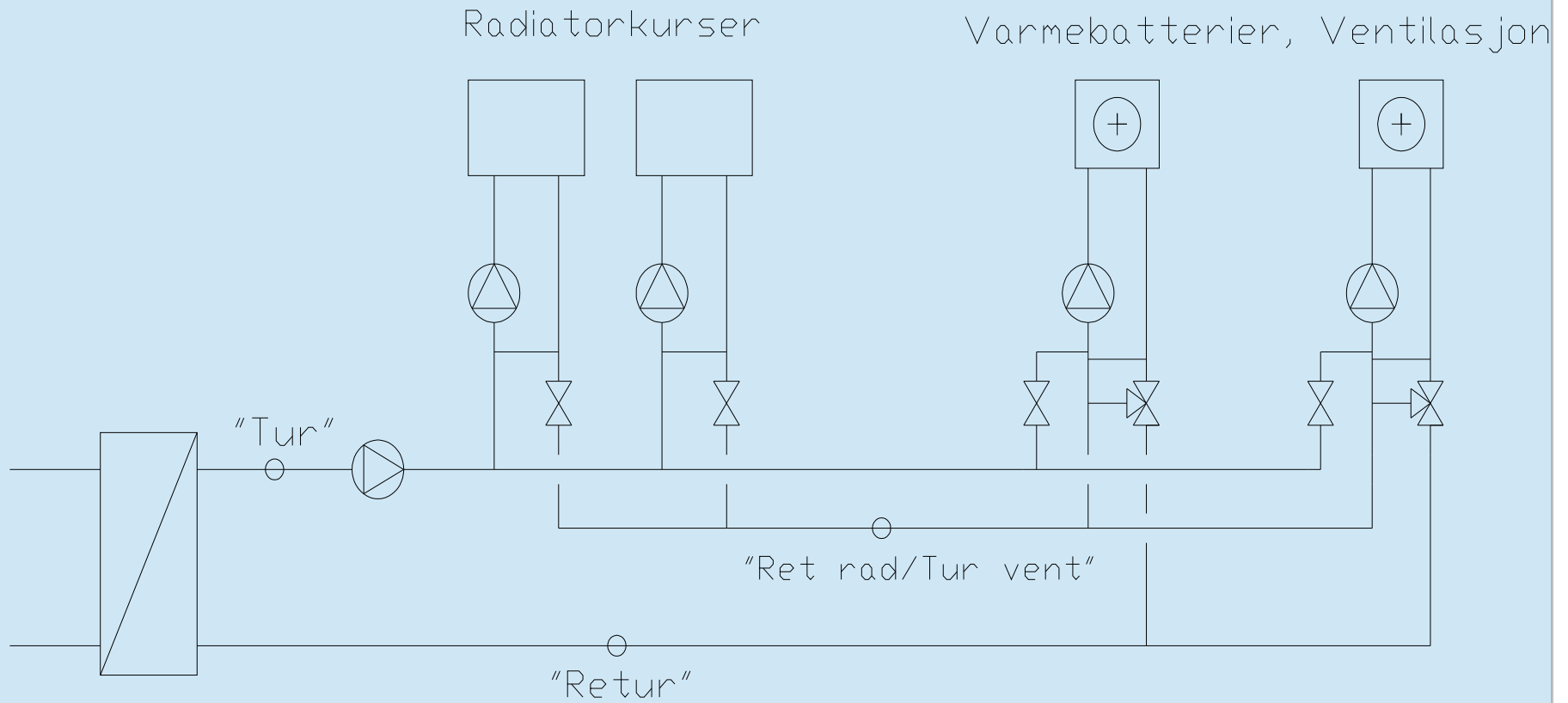


Overview interacting heating and cooling system

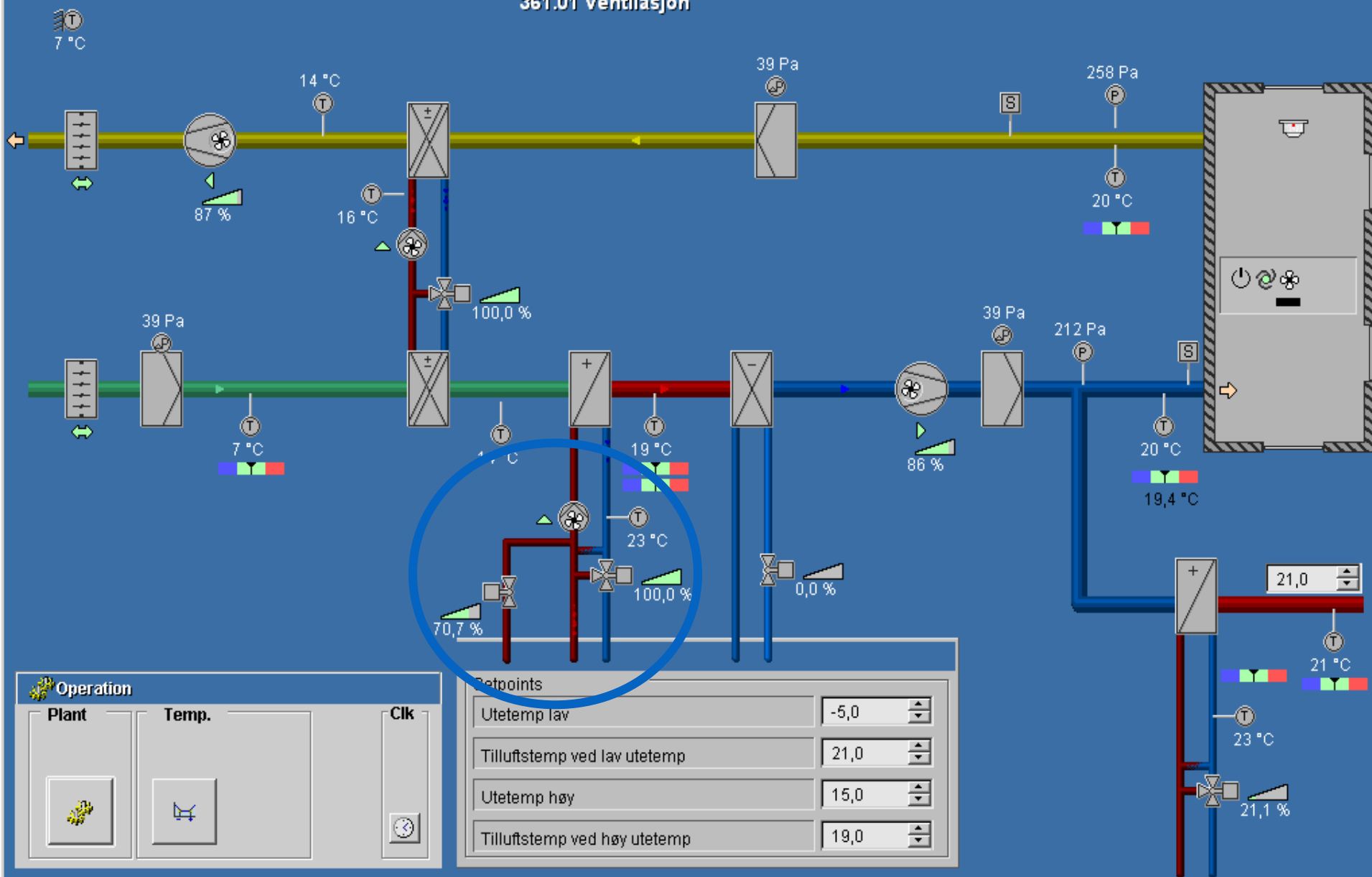




System outline 70/30 °C



361.01 Ventilasjon



324.01 Varmeanlegg

Utekomp.kurve

28 °C

26 °C

Utekomp.kurve

41 °C

26 °C

28,8 %

46 °C

0,8 bar

22 °C

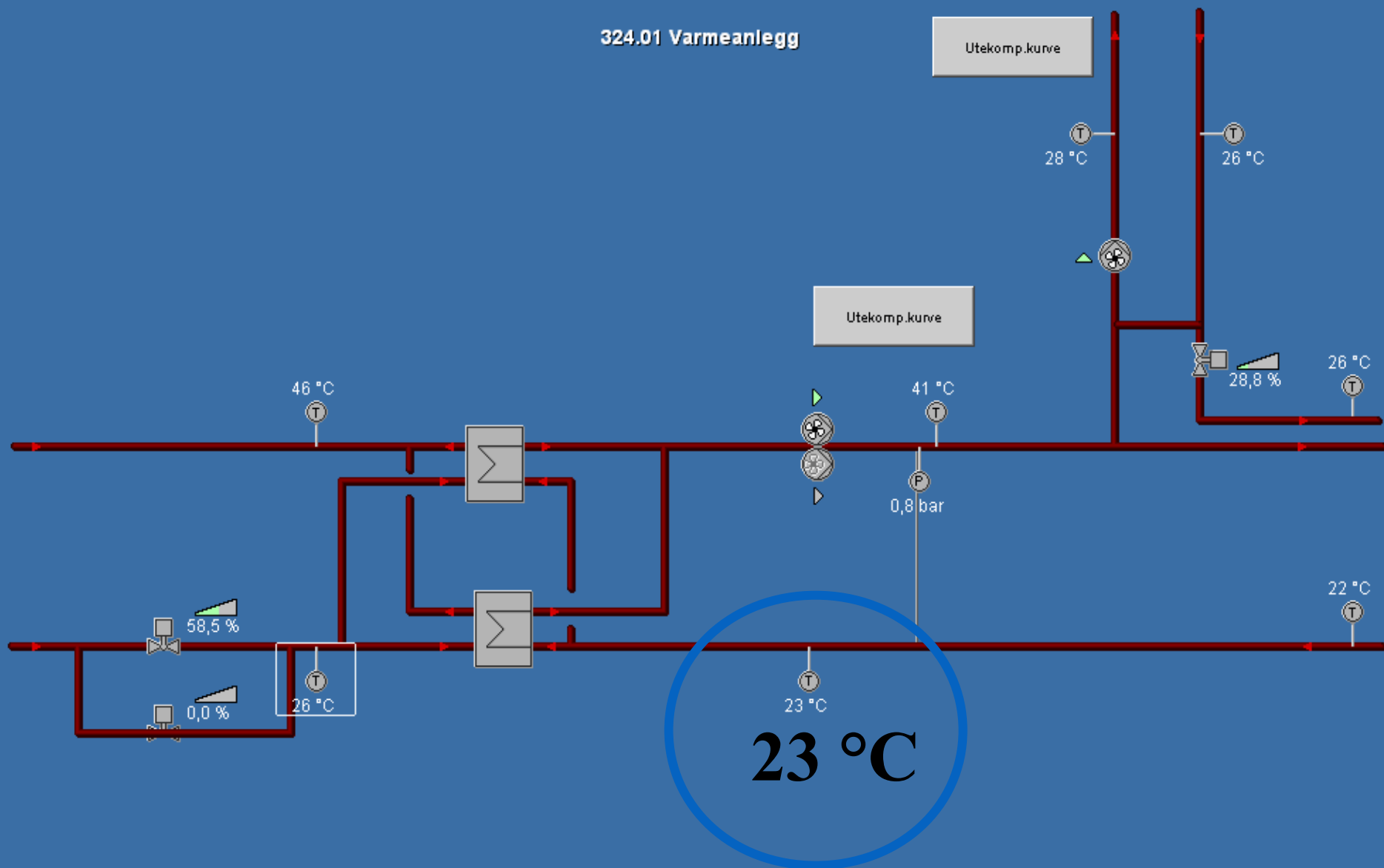
23 °C

23 °C

58,5 %

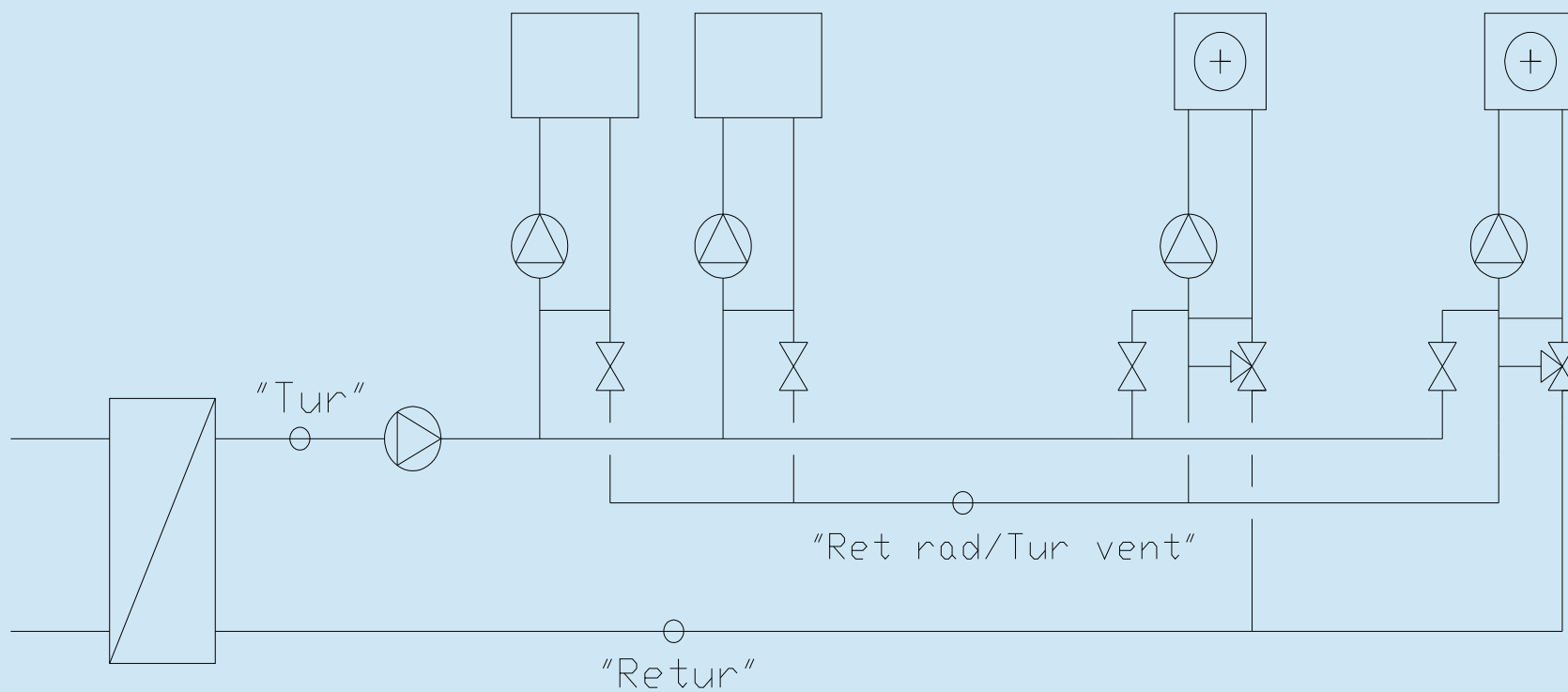
0,0 %

26 °C

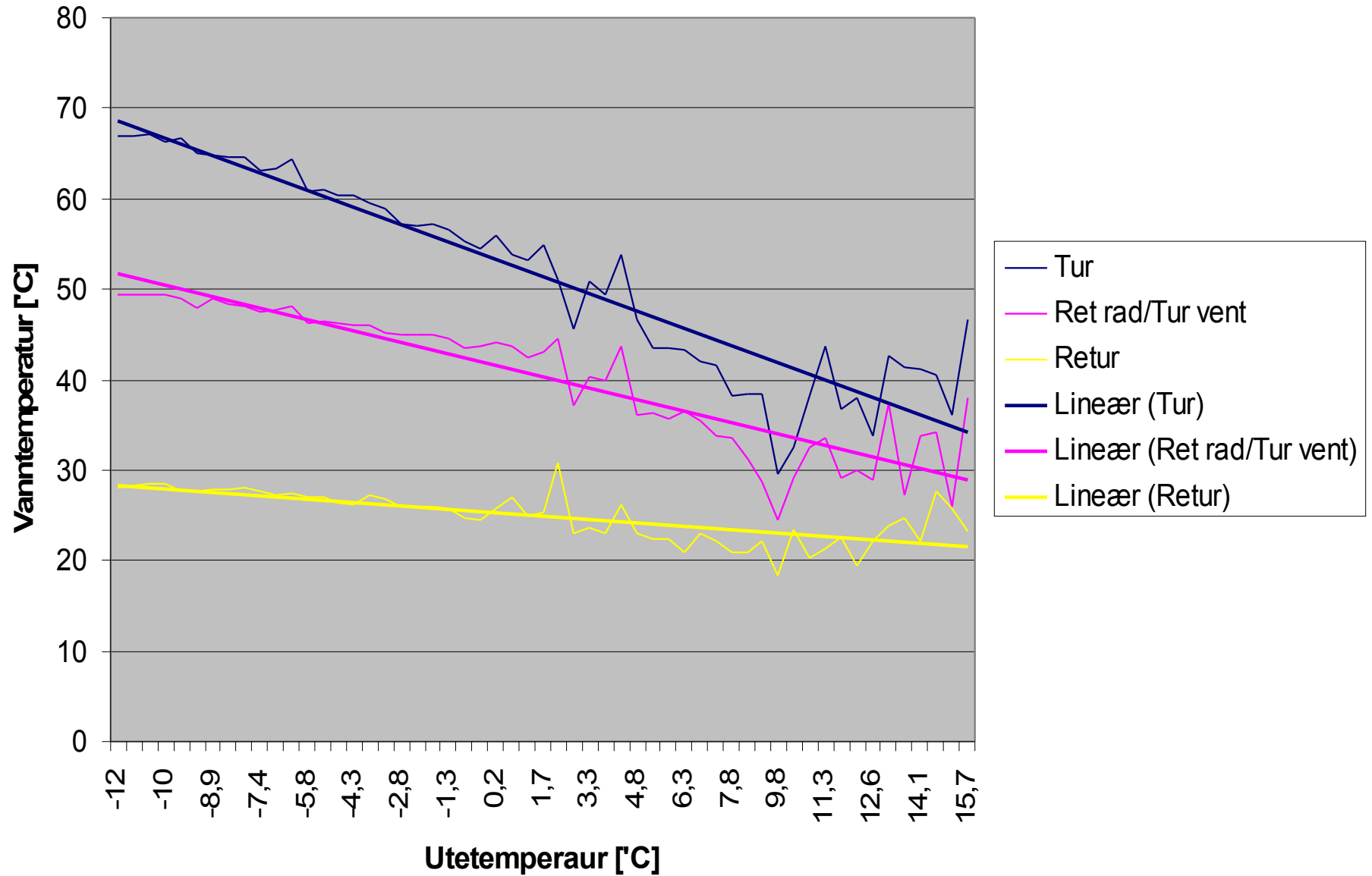


Radiator kurser

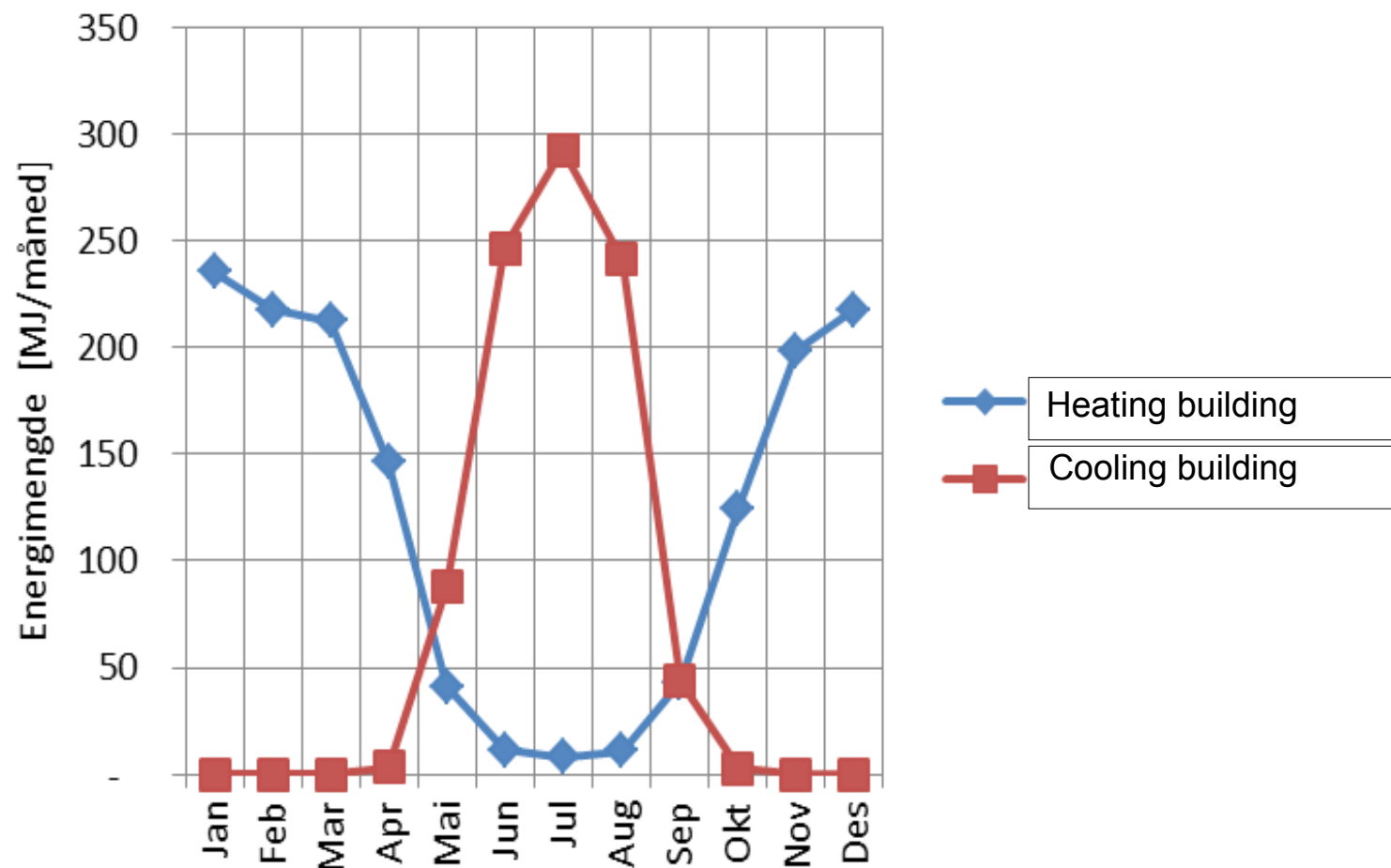
Varmebatterier, Ventilasjon



Supply and Return flow secondary side



Heating- and cooling energy simulation



Simulation in different hospital area

Hospital area

Bed ward

Public area

Day treatment area

Surgical Operation area

Office and administration area

Polyclinic area

Imaging area

Lab area

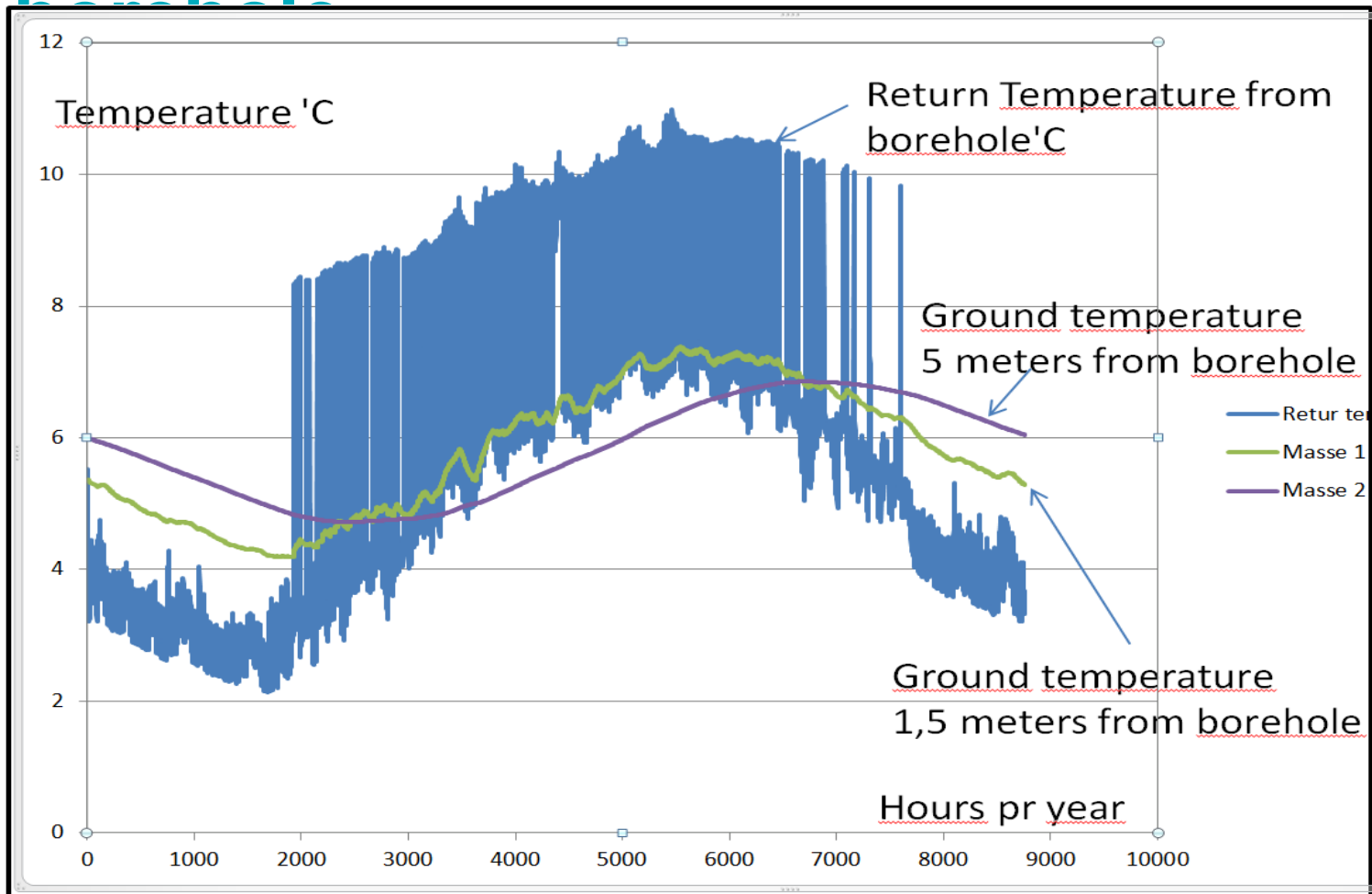
Patient hotel

Acute area

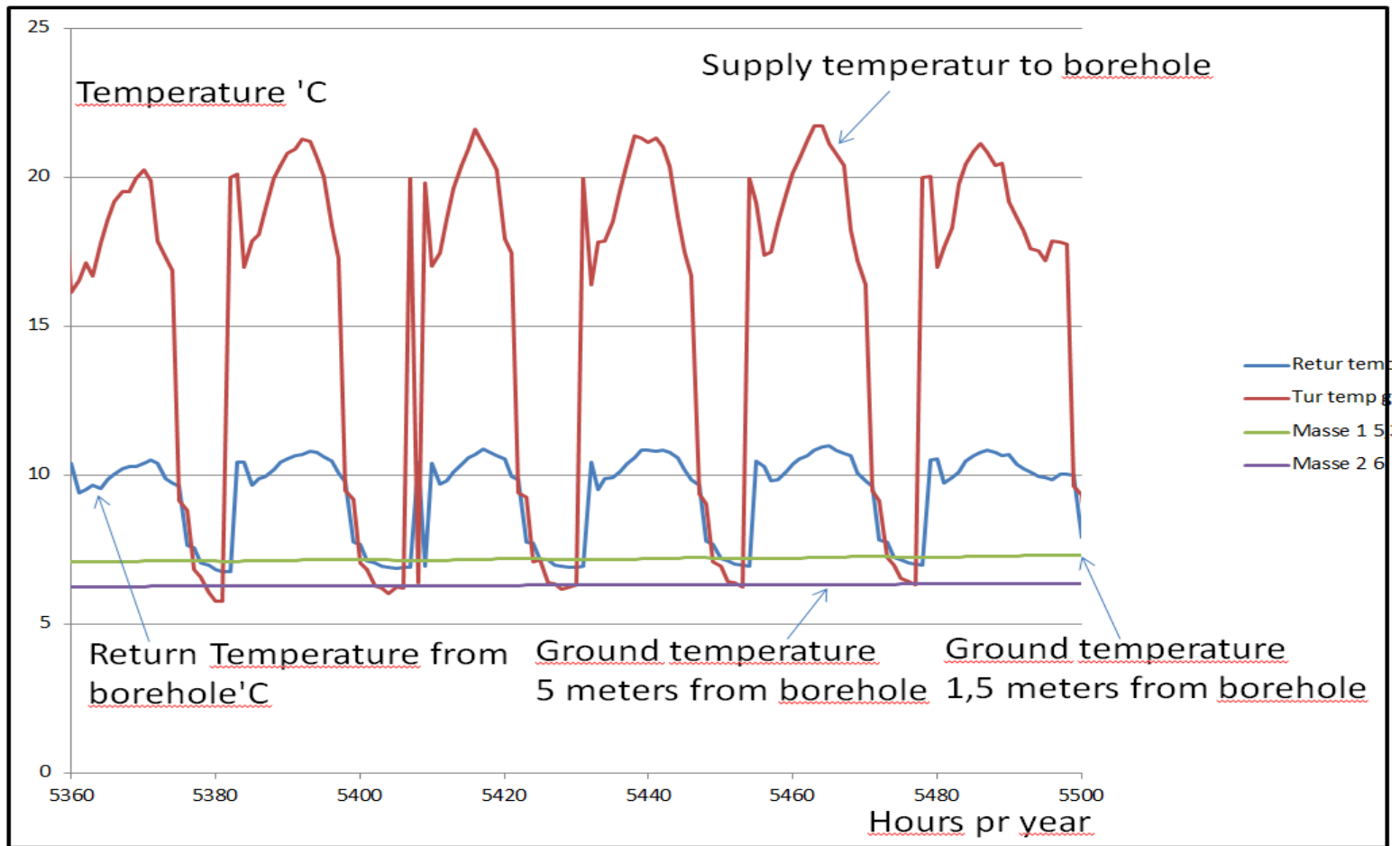
Results from simulations

No	Alternative system input	System COP	Savings (%)
1	Reference 80/60 oC – heat pump	2,31	0
2	Reduced return temperature ventilation coil 40 oC	2,44	5
3	Reduced return temperature ventilation coil 30 oC	2,48	7
4	Reduced return temperature ventilation coil 25 oC	2,50	8
5	Dimension temperature ventilation coil 45/25 oC	2,54	9
6	Return temperature radiator 50 oC	2,78	17
7	Return temperature radiator 45 oC	2,86	19
8	Return temperature radiator 65/45 oC	2,82	18
9	Dimension system temperature 70/50 oC	3,68	37
10	Reduced condensation temperature heat pump from 53 to 50 oC	3,20	28
11	Dimension system temperature: 60/40 oC	4,17	45
12	Return temperature radiator 55/35 oC	4,17	45
13	Improved heat pump A++	4,81	52
14	Change the evaporation temperature from 8 to 10 oC	5,13	56

Temperature fluctuation through a year 1,5 and 5 meters from the borehole



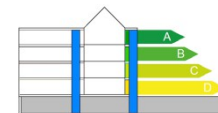
Temperature fluctuation through a specific period of a year



Conclusion

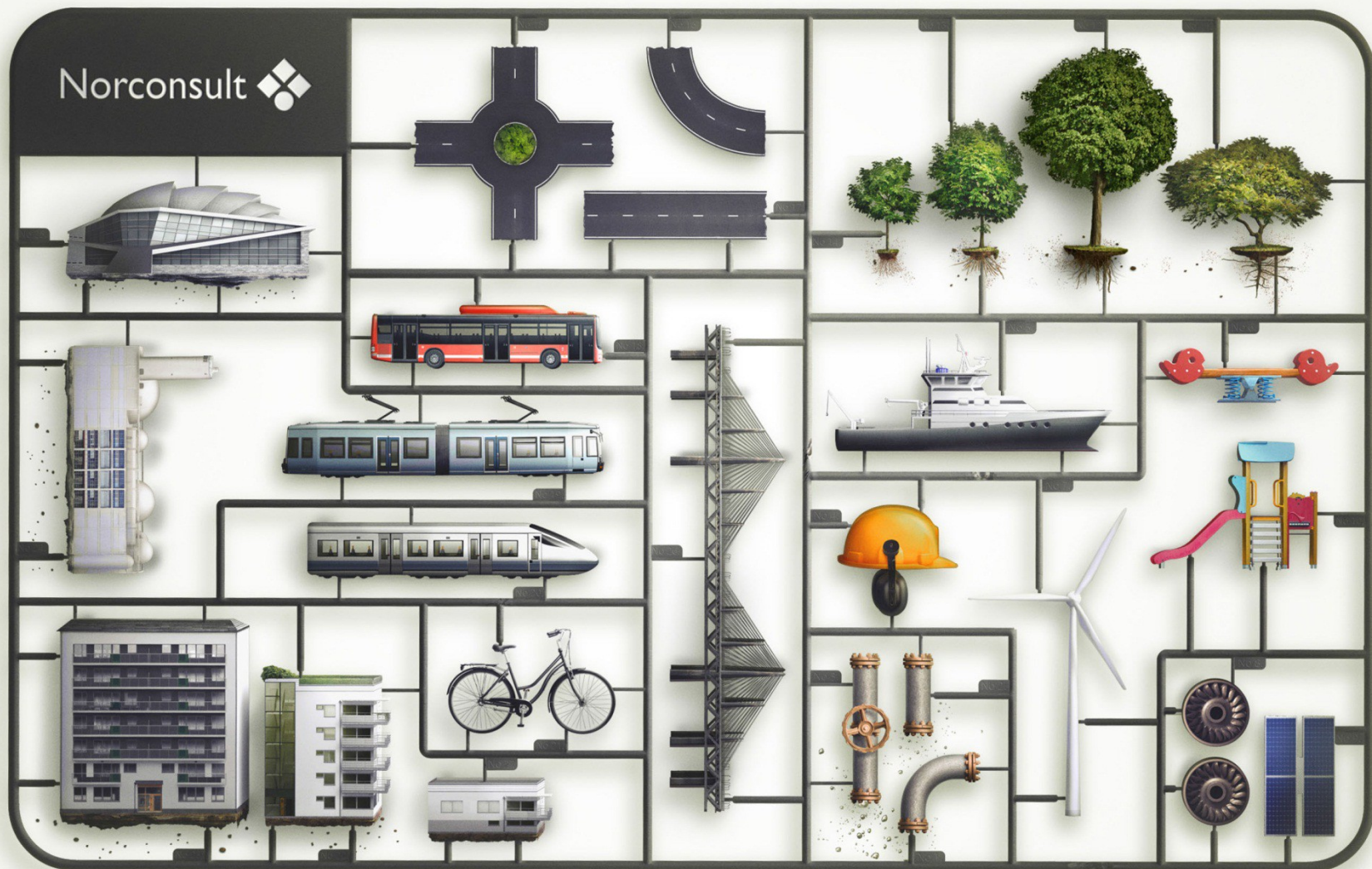
Energy efficient hydraulic heating and cooling system

This paper has given an example for optimisation for low energy consumption by changing the hydronic systems and temperature level in combination with ground storage. We find that using the water twice, or serial connection for heating solution, can optimize the use of heatpump and reduce the energy consumption significantly. High design temperature for ventilation cooling coil and local fan coils can optimize the borehole specification.









Thank you for your attention

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