

A schematic diagram of a hydronic heating system. On the left, a red boiler with a flame icon is connected to a black pump. The pump circulates water through a network of red (supply) and blue (return) pipes. The system branches out to six radiators arranged in two rows of three. The pipes then merge back into a single return line that loops back to the boiler.

[illegible]

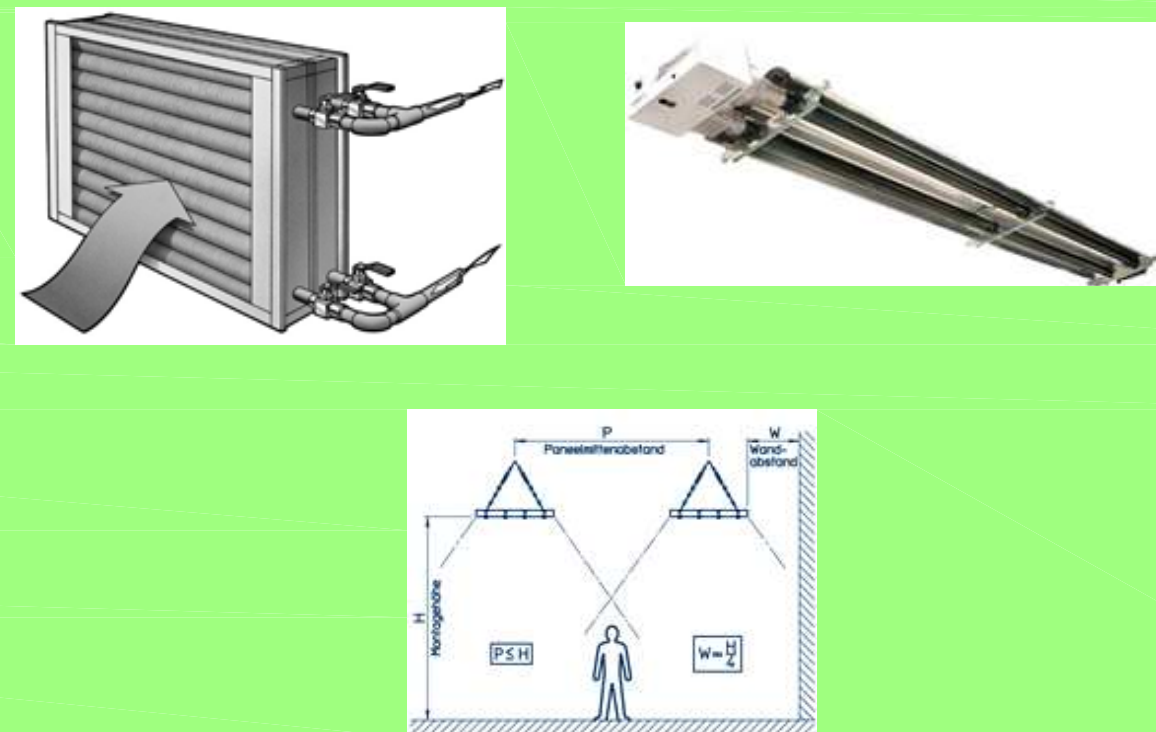
The system consists of 3 circles with one pump each. We chose the Danish company Grundfos which produces high efficiency pumps which are worldwide in use.

Two Grundfos ALPHA2 15-40 130 supply the office area.

2x1795DKK

The storage area is supplied with a Grundfos ALPHA2 15-60 130.

1x2107DKK



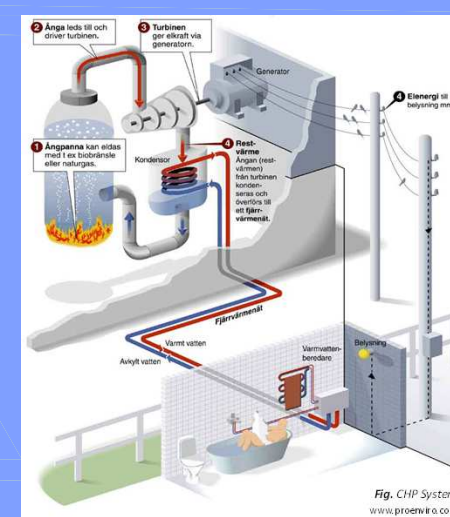
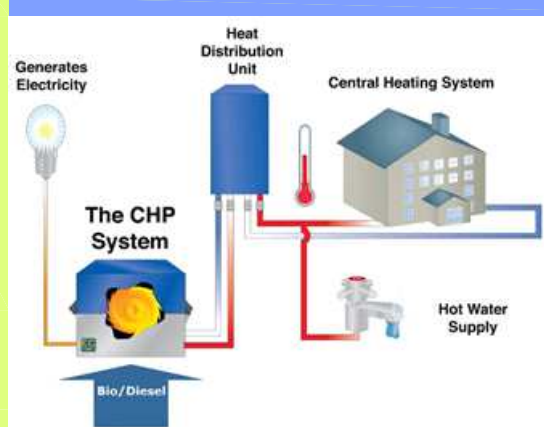
After had taken in count at the light requirement and put a suitable system of lightening in each rooms, the total requirement in electricity use for lightening is value at 22700 kW per year in the office. So, 28,2 kWh/m² per year. And after do the same in the storage the total requirement is value at 8900 kW per year. So, 11,7 kWh/m² per year. The total annual consumption is 31600Kwh per year.

The office part has an additional electric consumption because of the electric staff like 35 computers for the employer, 12 printers, 11 screens, all of the tools for using in a canteen etc... The calculation for this consumption is done by the average time of the tools utilization. Example one computer is used around 8 hours by day at a power about $P=144W$ only the fridge is used all time including the night with an average power of $P=175W$. Finally after add all of the electronic tools consumption the annual electric demand for this is 94823kWh. So, 117,8kWh/m² per year. The additional electricity in the storage part is negligible.

So the global specific electric demand is about 126243 kWh per year for all of the building. The picture on the right come from the BE10 program and represents the energetic requirement in the office part in kWh/m². As it's possible to see on it this demand can increase depending about the energetic system which will find.

Selected electricity requirements	
Lighting	28,2
Heating of rooms	0,0
Heating of DHW	0,0
Heat pump	0,0
Ventilators	0,0
Pumps	0,0
Cooling	0,0
Total el. consumption	146,0

DISTRICT HEATING

[illegible]

DOMESTIC HOT WATER PRODUCTION

First all I decided to produce the domestic hot water independent of the heating boiler. The reason for this decision is that in offices the consumption of domestic hot water is not very high.

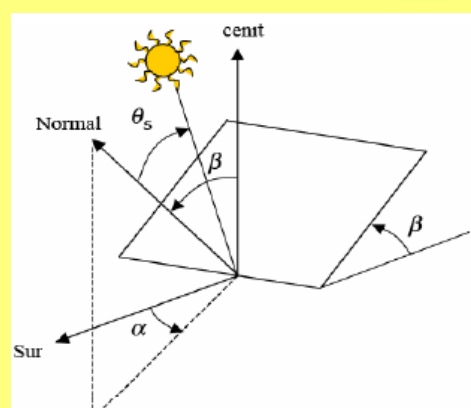
This could cause hygienic problems with legionella. A way to avoid hygienic problems would be to have a long circle with a circulation pump to provide the hot water quickly and keeps the water flowing. The chosen solution includes a continuous hot water heater for the canteen and a continuous hot water heater with 30 liter storage for the showers and toilets. The heater – storage combination can be mounted outside of the office area in the storage wall and supply ground and first floor with short ways.

The chosen models are:

Vaillant minVED H 3/2N	3,5kW	
Vaillant VENTH 3/2N	20,0/min	956/712,50DKK
Vaillant YENH 3/2N	30 liter	453,50K/204,25DKK
	2kW	



The diagram illustrates a smart grid architecture. It starts with an 'energy source' (represented by a sun icon) which feeds into 'energy conversion (photovoltaic modules)' (represented by a grid of solar panels). The output then goes through 'energy inversion and conditioning (inverter)' (represented by a box with a battery icon) and a 'controller' (represented by a box with a battery icon). This is followed by 'energy storage (batteries)' (represented by a box with a battery icon). The energy then flows through 'energy distribution (utility meter)' (represented by a box with a battery icon) to 'energy use' (represented by a light bulb icon). The entire system is connected to an 'electric utility' (represented by a power line icon).



To provide the office area and storage with the necessary energy we could also use a gas condensing boiler. Condensing boilers have an increased efficiency in comparison with non-condensing boilers because they also extract the heat which is stored in the water which is gaseous after the burning process and condense it. For this process low system temperatures are necessary which we have with 55/45.

The head loss of the building is 38.993W. The chosen boiler would be by the manufacturer BUDERUS.

The chosen model would be the **Logamax plus GB162 45kW**.

Boiler size	GB162-45
Power (kW)	9,6-44,9
Hot water temperature (°C)	Up to 85
Efficiency with 40/30°C (%) Hs/Ht	Up to 99,5 / up to 110,5
Efficiency with 75/60°C (%) Hs/Ht	Up to 96,4 / up to 107
Height (mm)	695
Width (mm)	520
Depth (mm)	465+6
Electrical consumption max/ average (W)/63/53	45
Mass (kg)	
Price	

4025€ / 30 187,50DKK



The diagram illustrates the heat pump cycle, showing the flow of refrigerant and the transfer of heat. The cycle consists of four main components connected in a loop:

- Compressor:** Located at the top, it increases the pressure of the refrigerant, pushing heat into the heating water. A label states: "increasing the pressure raises the temperature. Heat is transferred to the heating water."
- Condenser:** Located on the right, it releases heat to the room. A label states: "Heat is transferred to the room by radiators or underfloor heating."
- Expansion Valve:** Located at the bottom, it allows the refrigerant to expand and cool. A label states: "The refrigerant expands (cooling it to cold)".
- Separator:** Located on the left, it separates the refrigerant from the heating water. A label states: "Heat is transferred from the heating water to the refrigerant in the heat pump."

The refrigerant flows clockwise through the cycle, while the heating water flows counter-clockwise. The ground loop is shown as a U-shaped pipe in the ground, with a pump circulating water. The heat pump is connected to the ground loop via a separator and a pump.

Contribution to energy requirement		Net requirement	
Heat	6,5	Room heating	6,5
El. for operation of building	29,6	Domestic hot water	5,4
Excessive in rooms	17,8	Cooling	0,0
Selected electricity requirements		Heat loss from installations	
Lighting	28,2	Room heating	0,0
Heating of rooms	0,0	Domestic hot water	0,8
Heating of DHW	0,0		
Heat pump	1,4	Output from special sources	
Ventilators	0,0	Solar heat	0,0
Pumps	0,0	Heat pump	5,4
Cooling	0,0	Solar cells	0,0
Total el. consumption	43,7	Wind mills	0,0

Description		Heat pump for hot water system	Hot-water tank
Heat pump	Share of floor area, -		
Type	0		Volume 204litres
	0kW		
Room heating	0kW		
0	0,4		Normal effect, kW
0	0,3		Normal COP, - Incl. of pumps, ventilators and automatics
0	0		Rel. COP at 50% load, -
Test temperatures, °C			
0	7		Cold side
0	55		Warm side
Earth hose	Venting		Cold side: Earth/hose, Vent, Outdoor air or Other source
Room air			Warm side: Room air, Air supply or heating plant
0	0		Special auxiliary tool, kW, not included in nominal COP
0	0		Automatic, stand-by, W, (constant service)

Description		Heat pump for heating by ventilation	
Heat pump Type	Share of floor area, -	Hot-water tank	
Room heating	0	Volume 200 litres	
Room heating	DHW		
5,8	0	Nominal effect, kW	
3,4	0	Nominal COP, -, Ind. of pumps, ventilators and automatic	
1,2	0	Ref. COP at 50% load, -	
Test temperatures, °C			
20	0	Cold side	
20	0	Warm side	
Venting	Earth hole	Cold side: Earth house, Vent, Outdoor air or Other source	
Air supply		Warm side: Room air, W, supply or Heating plant	
0	0	Special auxiliary tool, W, not included in nominal COP	
50	0	Auxiliary, stand-by, W, (constant service)	
Heat pumps connected with ventilation			
0,82	0	Temp. Efficiency for HW before heat pump, -	
20	0	Den. air supply temperature, °C	
0,14	0	Air flow, m/s	

<div> <div>CALCULATION</div> </div>				
<div> <div>Description</div> <div>Builer for hot water production</div> </div>				
<div> <div>Fuel</div> <div> <div>Biomass</div> <div>Oil, Gas or Biomass fuel</div> </div> </div>				
<div> <div>Heat performance</div> <div>No. of boilers</div> <div>Normal effect, kW</div> <div>Share from norm. eff. to DHW production, -</div> </div>				
1	3,2			
<div> <div>Normal efficiencies Load</div> <div>Efficiency, -</div> <div>Boler Temp., °C</div> <div>Correction, °C</div> </div>				
1	0,95	70	0,001	Full load
0,3	0,81	35	0,003	Partial load
<div> <div>Side loss Load</div> <div>Loss factor, -</div> <div>Share for room, -</div> <div>Temp. diff., °C</div> </div>				
0	0,01	0,5	30	
<div> <div>Operating</div> <div>Boler Temp., min/°C</div> <div>Temp. factor, b for setup room</div> </div>				
60		0		
<div> <div>100 Fan etc., W</div> <div>Ef for automatics, W</div> </div>				
		5		

Description	Boiler for heating only										
Fuel	Biomass	Oil, Gas or Biomass fuel									
Heat performance No. of boilers	Nominal effect, kW / Share of nom. eff. to DHW production; -										
1	42										
Nominal efficiencies Load, %	Efficiency, %	Boiler temp., °C		Correction, °C							
1	0,90	70		-0,01							
0,3	0,82	60		0,003							
Idle loss, Load, %	Loss factor, %	Share for room, °		Temp. diff, °C							
0	0,01	0,5		30							
Operating											
60	Boiler temp., min, °C			Temp. factor, B for setup room							
100	Fan etc., W			Bf for automatics, W							

Now we are going to see the prices of a Spanish company, Biomasal during season prices 2011/2012	
- Olive pit, heating 1º, bulk driven, silo more transport	0.15 €/kg
- Olive pit, heating 1º paper bag of 15 kg	0.13 €/kg
- Pine pellets 100% without bark, bulk driven, silo more transport	0.19 €/kg
- Pine pellets 100% without bark, paper bag of 15 kg	0.17 €/kg

- Adaptation mouths to the impulsion of the tank to work silos	15 C/unit
- Metallic silos with storage bag and filling openings since 1 to 5 Tn	variable cost

The fuel price list includes:

- Transport until 50 km of beginning, to 0.7 km just compute outward
- Pneumatics impulsion service to silo
- Weighbridge during downloading
- To transport of bag in pallet of 750 kg consult the prices (are variable)

This prices are going to be the same during the next 5 years and they are not include the

	PCI		MOISTURE
Materials	(KJ/KG)	KWh/Kg	b.h. (%)
Pellets	17.000 - 19.000	4,7 - 5,3	<15
Chips	10.000 - 16.000	2,8 - 4,4	<40
Olive nut	18.000 - 19.000	5,0 - 5,3	7-12
Nut shell	16.000 - 19.000	4,4 - 5,3	1-8
Wood	14.400 - 16.200	4,0 - 4,5	<20
Briquettes	17.000 - 19.000	4,7 - 5,3	<20

Description				
Biomass combined				
Fuel	Biomass	OK, Gas or Biomass fuel		
Heat performance kW / boiler		OK, Gas or Biomass fuel	Share of nom. eff. to DHW production,	
1	48.7	0.15		
Nominal efficiencies Load				
1	Efficiency	70	°C	Correction, - / °C
Load	0.88	70	°C	0.001
0.3	0.80	60	°C	0.003
				Partial loss
Idle loss Load				
0	Loss factor, -	Share for nom.	Temp. of, °C	
0	0.01	0.5	30	
Operating				
50	Boiler temp., min, °C	0	Temp. factor, % for setup room	
100	Fan etc., W	5	Eff for automatics, W	

Net requirement	
Room heating	9,9
Domestic hot water	5,4
Cooling	0,0

Heat loss from installations	
Room heating	0,0
Domestic hot water	0,8

Description		
Use solar panels for all of the hot water consumption		
Type	DHW	Domestic hot water, Room heating or Combined
Solar collector	23.5	Total collector area, m ²
	0.85	Tank volume, litres
	3, start eff. -	(From domestic hot water)
	0	1. order coefficient of heat loss a1, W/(m ² K)
	2	2. order coefficient of heat loss a2, W/(m ² K)
	0.98	Angle factor, -
Solar collector pipe		
	16	Length, m
	0.2	Heat loss, W/(m K)
	0.8	Heat exchanger efficiency, -
El-consumption, pump and regulation		
	50	Pump in solar collector circuit, W
	5	Automatics, stand-by, W

Description			Use solar panels in domestic hot water, Room heating or Combined		
Type	Combined =	Domestic hot water, Room heating or Combined			
Solar collector					
71.3	Total collector area, m ²		1000		Tank volume, litres
1.80	Solar collector efficiency, %				1000 Domestic hot water
3.5	1. order coefficient of heat loss a ₁ , 1/(W/m ² K)				
0	2. order coefficient of heat loss a ₂ , 1/(W/m ² K)				
0.00	Angle factor, -				
Solar collector pipe					
0	Length, m				
0.8	Heat loss, W/(m ² K)				
6.2	Heat exchanger efficiency, -				
El-consumption pump and regulation					
500	Pump in solar collector circuit, W				
5	Automation, standby by, W				
Orientation and shading					
5	Orientation, S, SE, E, ..., or deg., S=180				
47	Slope, °, vertical=90				
10	Horizon offset, °				
			0		Shadowed = 0.04

There are three different possibilities to use electric heating:

One would be to have a heater spiral in a water containing radiator. The water can store the thermal energy for some time. Possible as well is the possibility to heat over heating by electrical heating plates. These heating plates are made of a material that can store thermal energy for a long time. This offers the possibility to heat up the material during night when the electricity prices are lowest and give the heat to the room during the day. Depending on the heating demand it can blow more air through the heat emitting material.

Advantages:

- No storage room for fuels
- Low investment costs
- Low or even no maintenance costs

Disadvantages:

- High operation costs
- Not everywhere allowed
- Cool storage in the evening (especially problematic for under floor heating)
- The electricity depends in the end on the way www.aeg-heat-tech.de

The electricity was produced (which is often not very efficient)

For the reason that we wanted to choose an environmentally friendly and efficient system that offers a good indoor climate we don't choose a form of electrical heating. Main reasons are the high operation costs and the fact that to get a good certification for a building with electric heating, it was also not possible to find a system based on electrical heating which is suitable for the storage

Times News Record (2006). Another interesting solution for the building would be a seasonal storage system. The German company Incovent invented a system in collaboration with the company Viesmann. The system is not spread so far but has from my point of view a lot of potential in the future. The system bases on the phase change of water to ice, a heat pump and a solar absorber. Function: During the heating phase the heat pump extracts energy from the water in the lake and is located outside of the building underground. By the time the ice starts to freeze (this process gives extra 332kJ/Kg). The extracted heat can then be used to heat the building. During the summer/cooling phase the created ice can be used to cool the building. In the chosen case scenario the solar collector can be used to heat the building. In addition to that a solar collector or air collector can be used to heat up the storage again. The solar collector can also fulfill the demand of hot domestic