SHANGYI SUN
SHABNAM ARBAB
MARCO RIMENSBERGER

ROTVOLL BARN

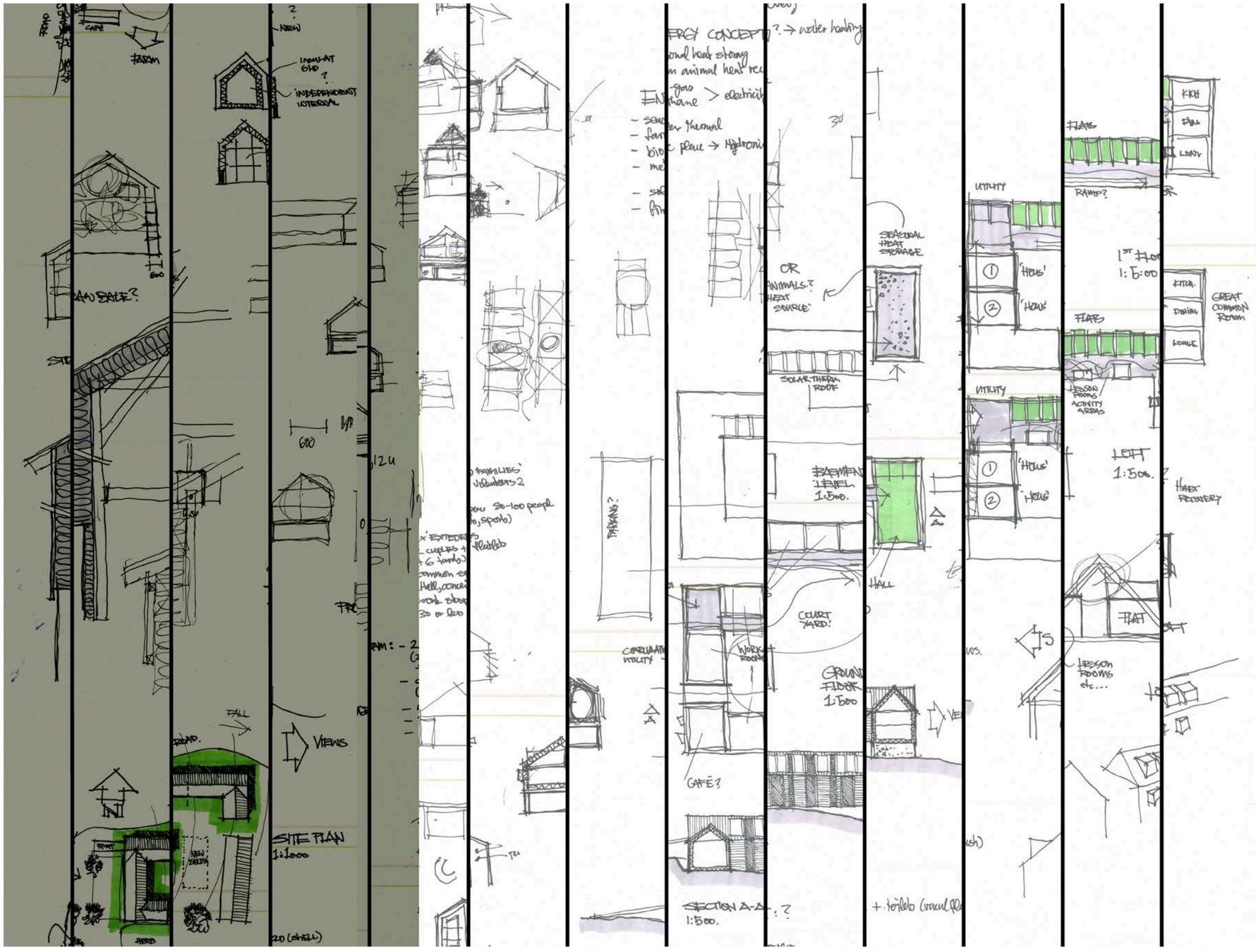
REFURBISHMENT ROTVOLL CAMPHILL

INTEGRATED ENERGY DESIGN

AAR4616

MAY 2010

Architectural Process



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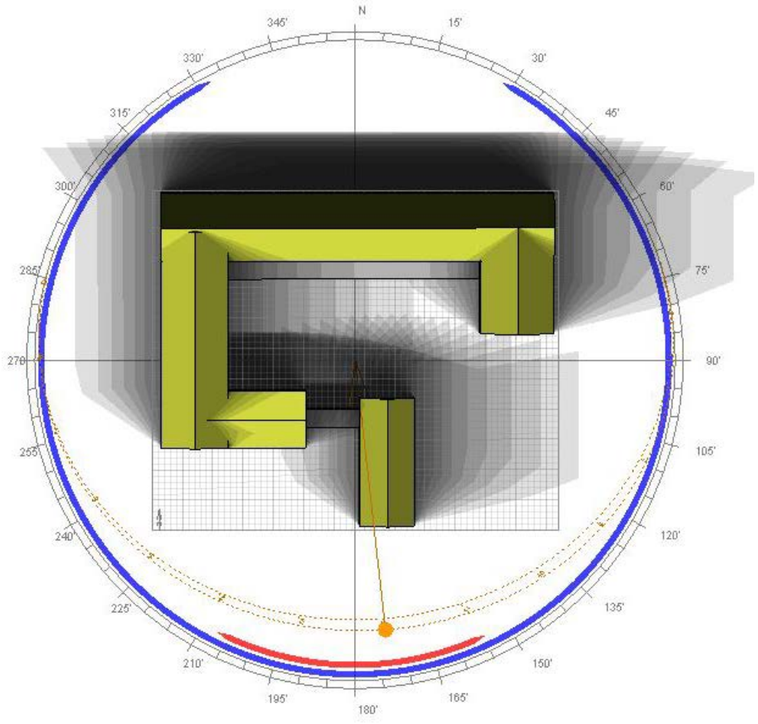
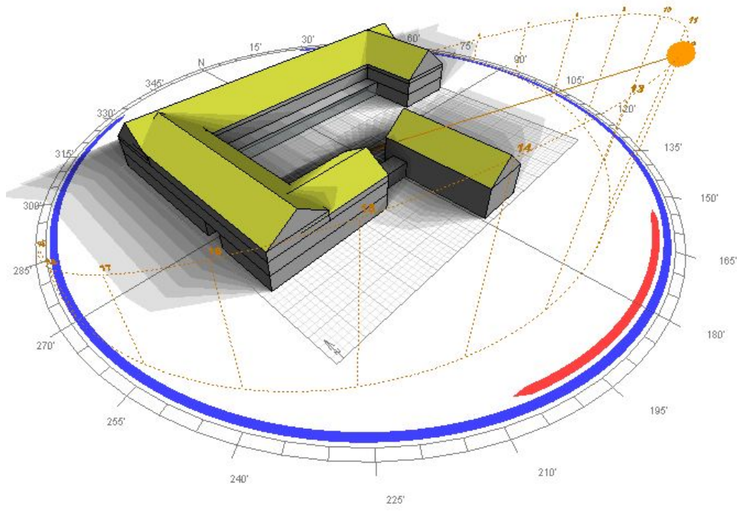
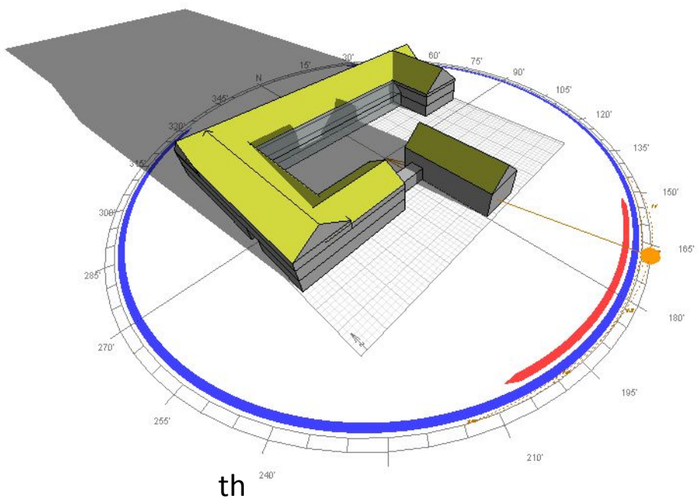
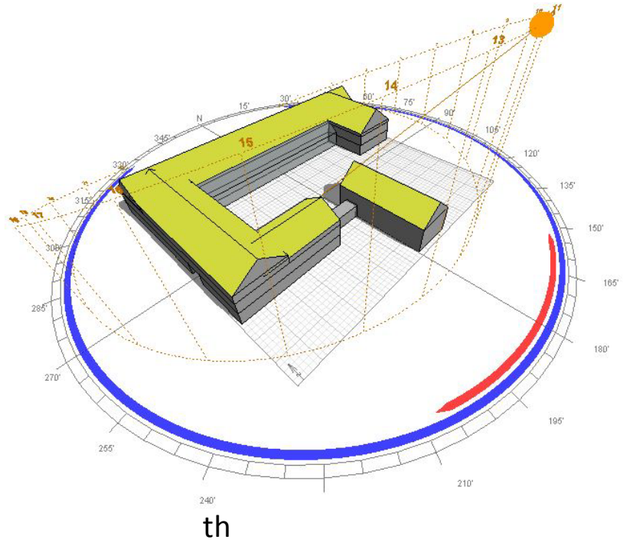




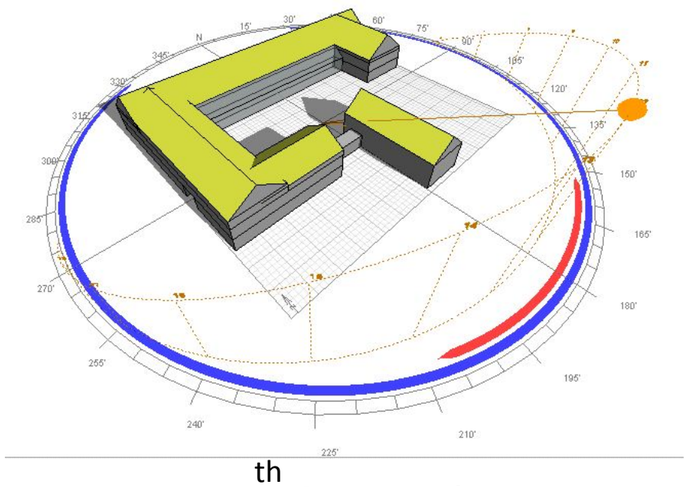
Because we want to maximize solar , we need to analysis how the building interact with the sun



15th January



15th June



15th September

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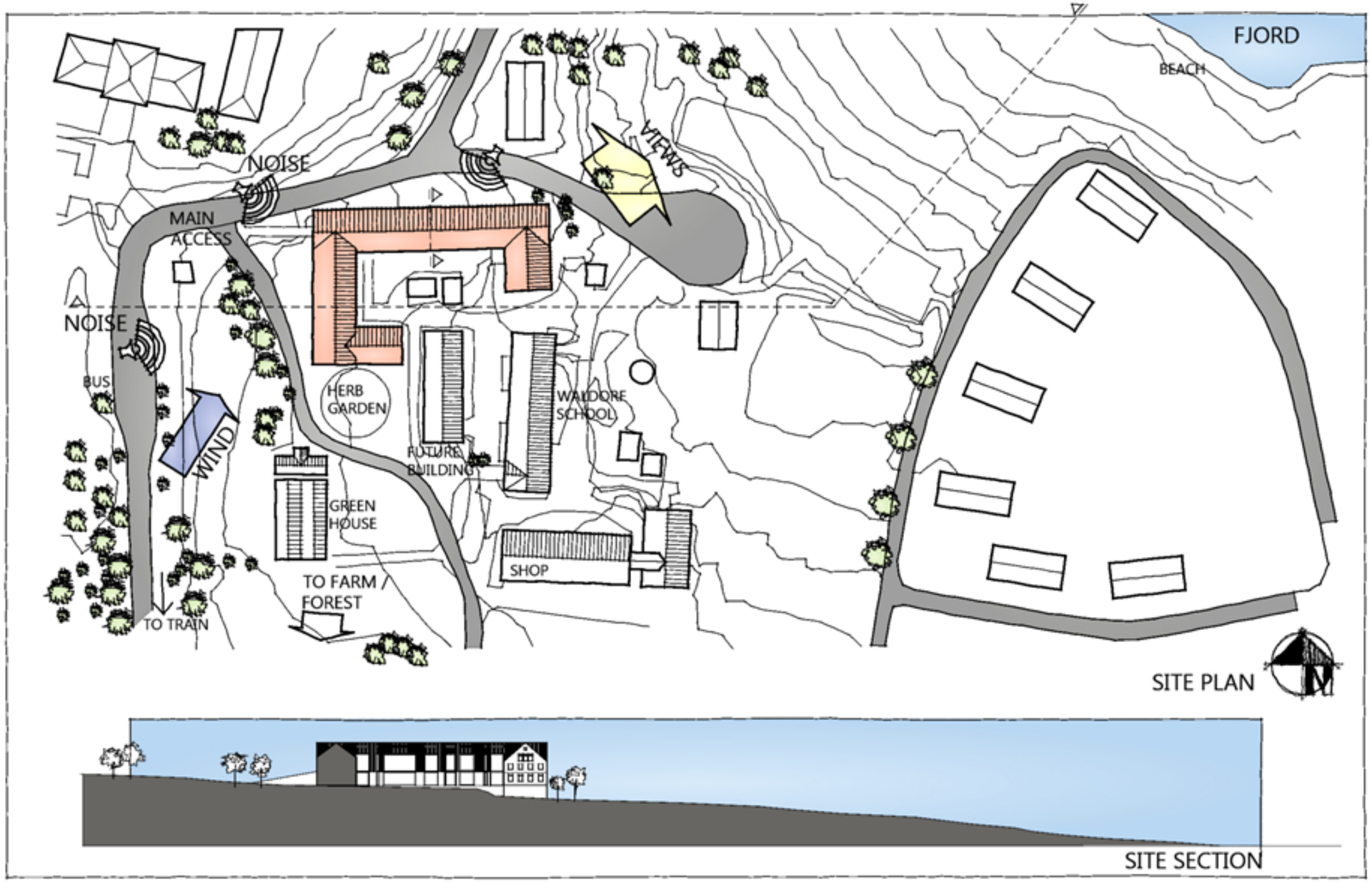

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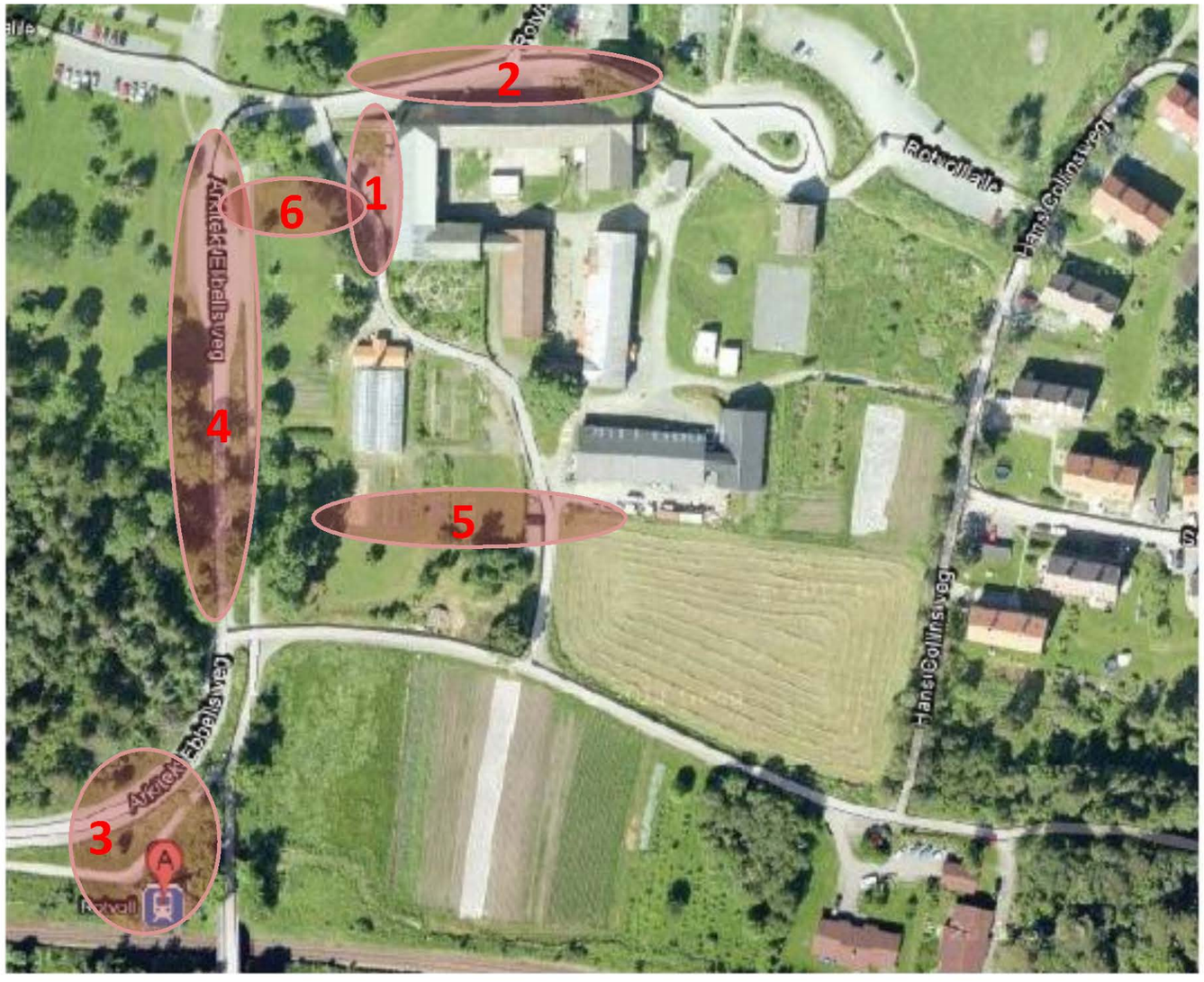

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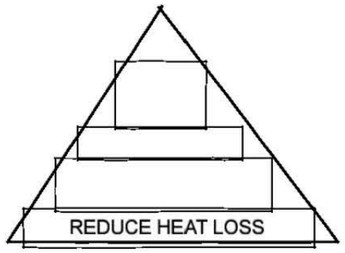
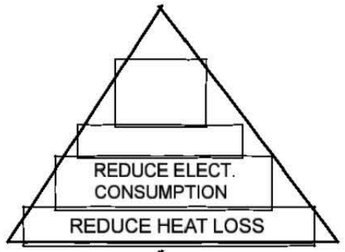
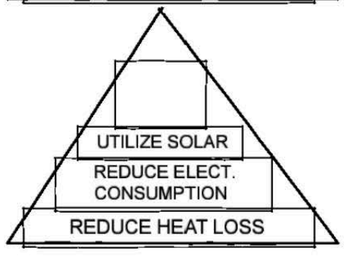
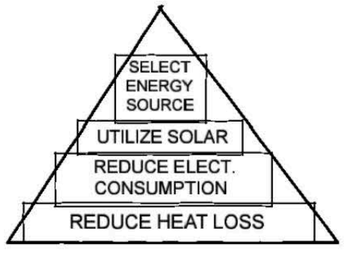
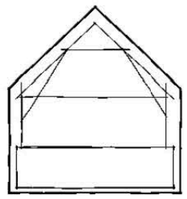
ENERGY CONCEPT RELATED TO KYOTO PYRAMID

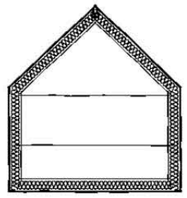


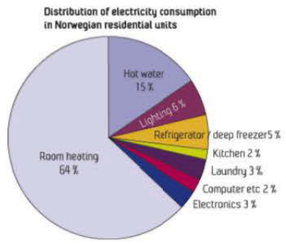


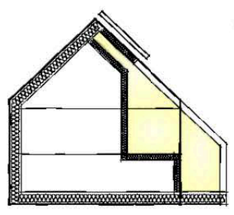


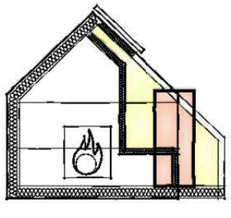




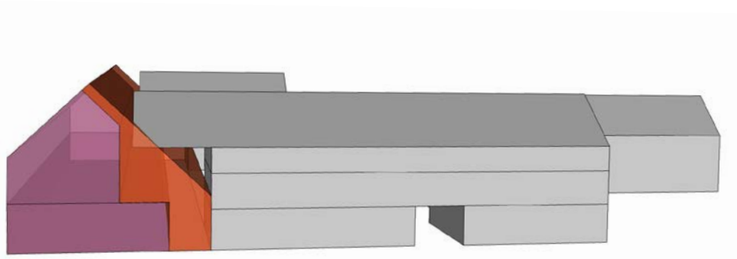








EXIST SECTION



RETROFIT / MAXIMIZE **INSULATION**

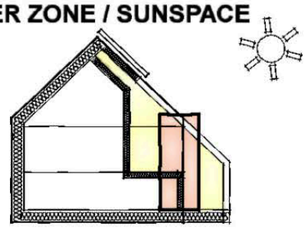
FOCUS ON: **SPACE HEATING , HOT WATER & LIGHTING**

DIVIDE / OPEN SOUTH INSULATION .... CREATE **BUFFER ZONE / SUNSPACE**
DIRECT GAIN, DAYLIGHTING, NATURAL VENT.

USE **SOLAR THERMAL** COLLECTERS &

SEASONAL T**HERMAL STORAGE**

Variable	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Insolation, kWh/m²/day	0.16	0.65	1.74	3.43	5.00	5.19	4.58	3.60	2.32	1.08	0.31	0.07



USE BIO-MASS (WOOD) FOR ADDITIONAL HEAT

BIOGAS?
GRID?
PV?

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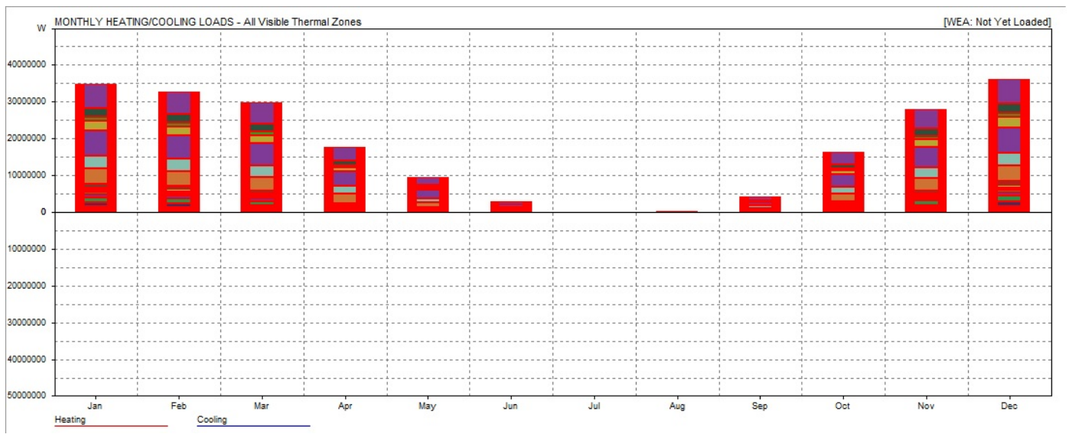
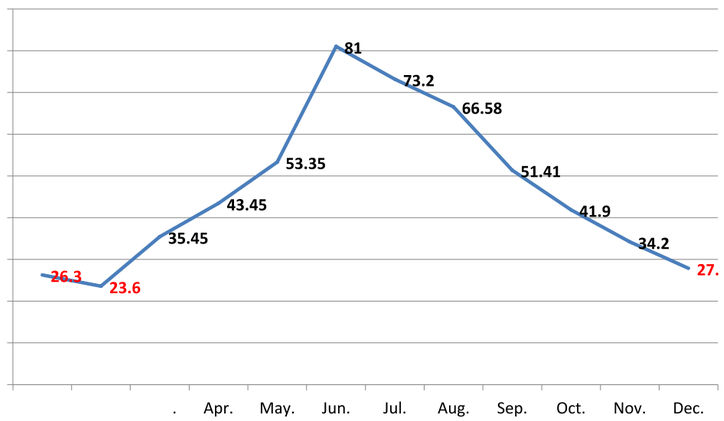


Annual Temperature Variation



HEATING DEMAND:

ALL ZONES: 54kWh/m2/a

CULPRITS:

FLATS 1ST / EAST: 118 kWH/m2/a

FLATS 1ST / WEST: 117 kWH/m2/a

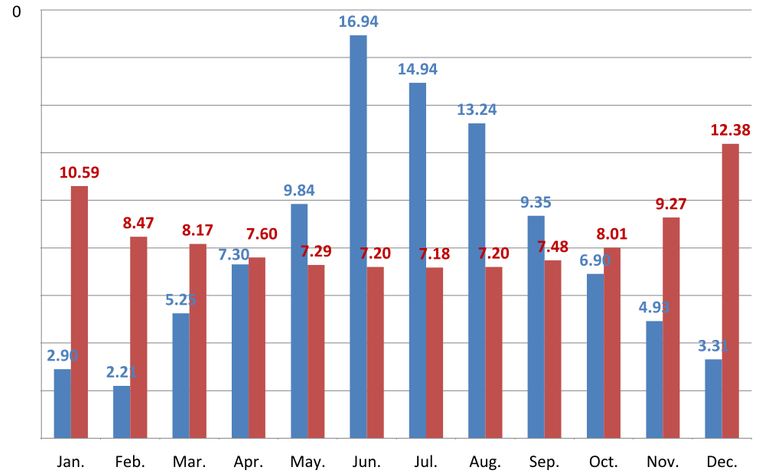
FAMILY SECTION 1ST: 113 kWH/m2/a

FAMILY SECTION LOFT: 112 kWH/m2/a

FLATS LOFT / WEST: 76 kWH/m2/a

COMMON ROOM: 63 kWH/m2/a

Annual solar gain & Heat demand + DHW



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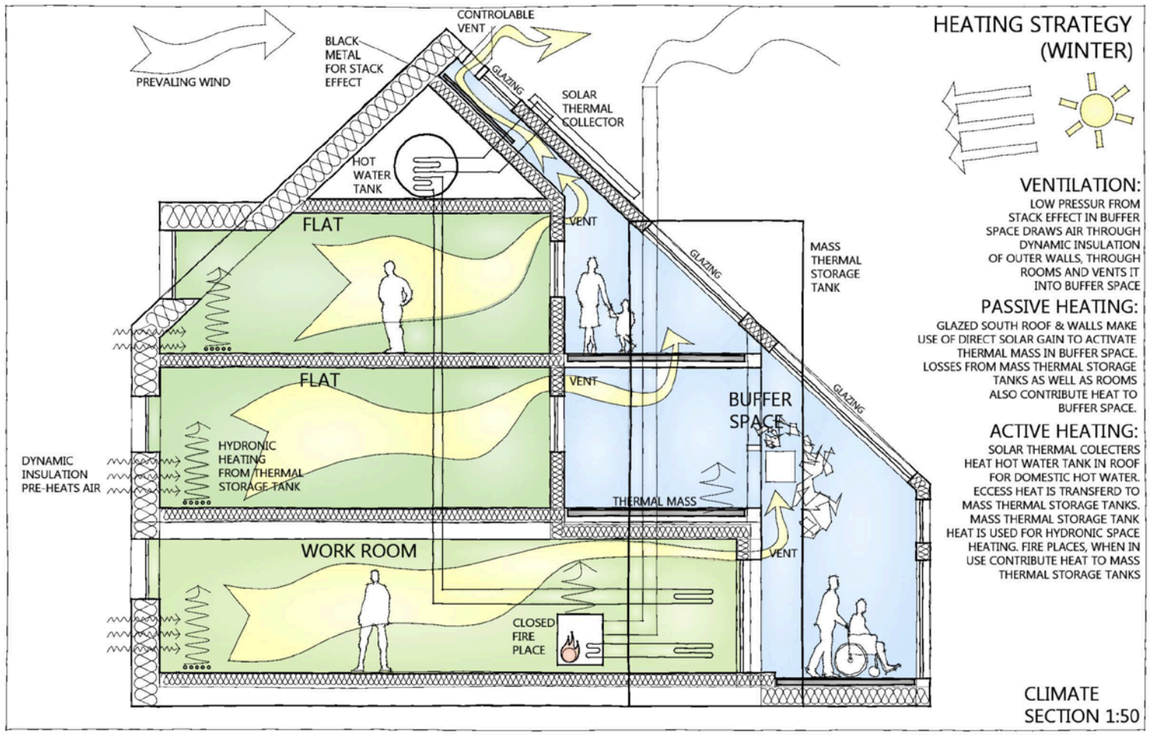


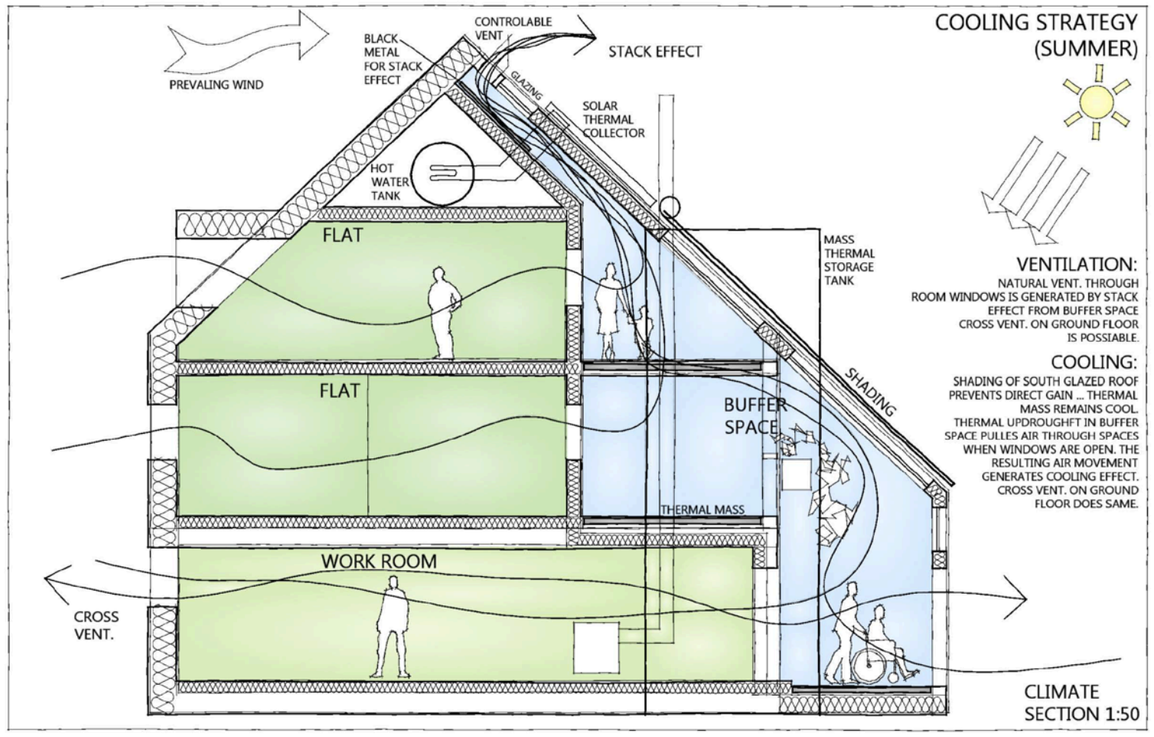
HEATING STRATEGY (WINTER)

VENTILATION:
LOW PRESSUR FROM STACK EFFECT IN BUFFER SPACE DRAWS AIR THROUGH DYNAMIC INSULATION OF OUTER WALLS, THROUGH ROOMS AND VENTS IT INTO BUFFER SPACE

PASSIVE HEATING:
GLAZED SOUTH ROOF & WALLS MAKE USE OF DIRECT SOLAR GAIN TO ACTIVATE THERMAL MASS IN BUFFER SPACE. LOSSES FROM MASS THERMAL STORAGE TANKS AS WELL AS ROOMS ALSO CONTRIBUTE HEAT TO BUFFER SPACE.

ACTIVE HEATING:
SOLAR THERMAL COLECTERS HEAT HOT WATER TANK IN ROOF FOR DOMESTIC HOT WATER. ECCESS HEAT IS TRANSFERD TO MASS THERMAL STORAGE TANKS. MASS THERMAL STORAGE TANK HEAT IS USED FOR HYDRONIC SPACE HEATING. FIRE PLACES, WHEN IN USE CONTRIBUTE HEAT TO MASS THERMAL STORAGE TANKS

CLIMATE SECTION 1:50



COOLING STRATEGY (SUMMER)

VENTILATION:
NATURAL VENT. THROUGH ROOM WINDOWS IS GENERATED BY STACK EFFECT FROM BUFFER SPACE CROSS VENT. ON GROUND FLOOR IS POSSIABLE.

COOLING:
SHADING OF SOUTH GLAZED ROOF PREVENTS DIRECT GAIN ... THERMAL MASS REMAINS COOL. THERMAL UPDROUGHFT IN BUFFER SPACE PULLES AIR THROUGH SPACES WHEN WINDOWS ARE OPEN. THE RESULTING AIR MOVEMENT GENERATES COOLING EFFECT. CROSS VENT. ON GROUND FLOOR DOES SAME.

CLIMATE SECTION 1:50

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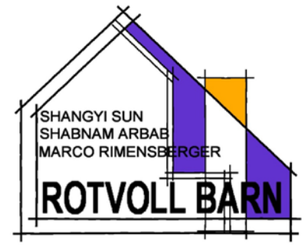
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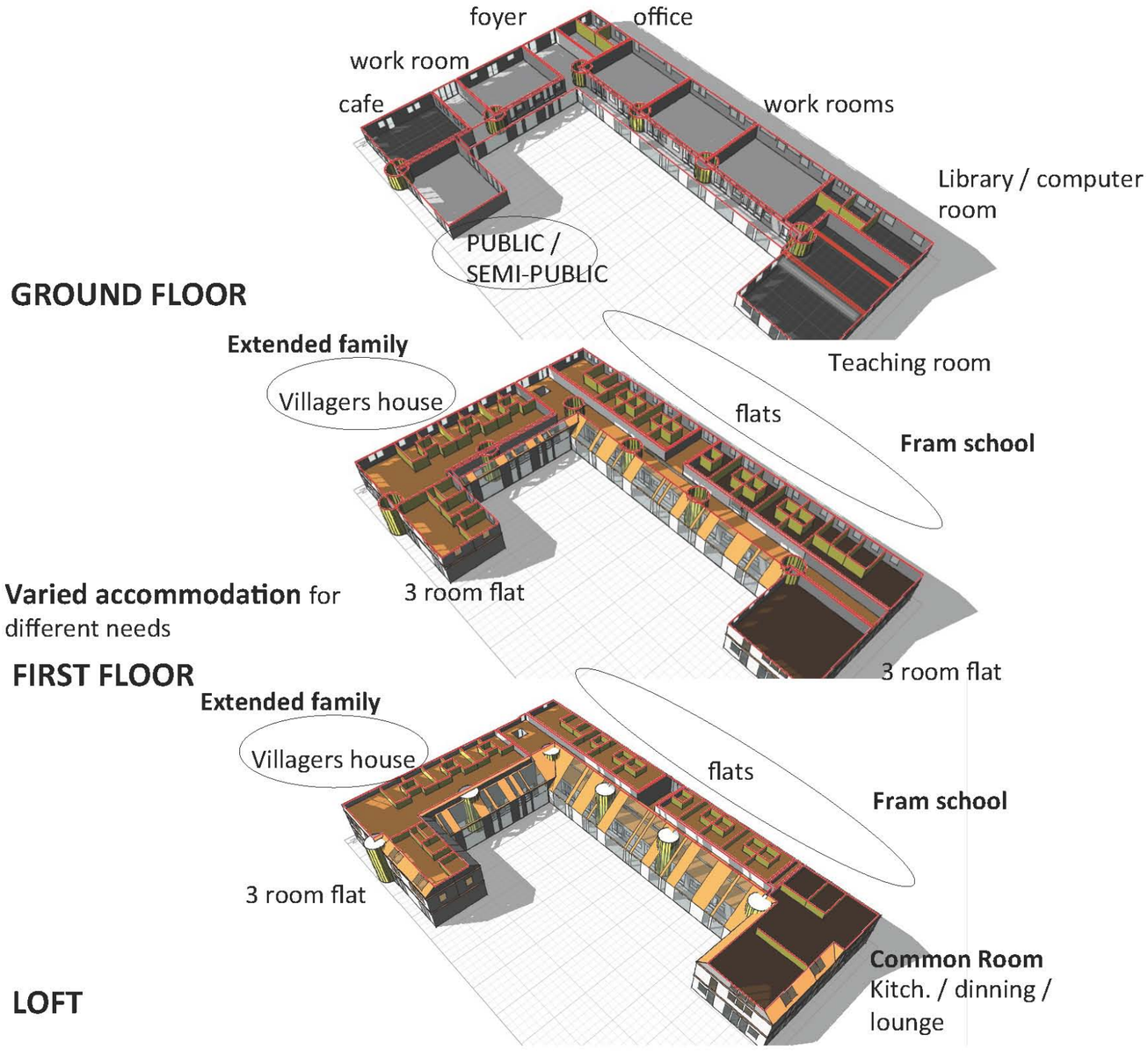
SPACE ARRANGMENT



Spaces	Area(m2)
public area(tanks included)	980.1
work room	476.43
apartments	803.22
family houses	747.68
common rooms	244.9
offices&admin.	57.28
library&computer room	110.6
teaching room	90.3
cafe	106.1
tech. room	64.5
public bathrooms	20

The building can provide accomidation for 51 people in all, and 148 people in working room at the same time.

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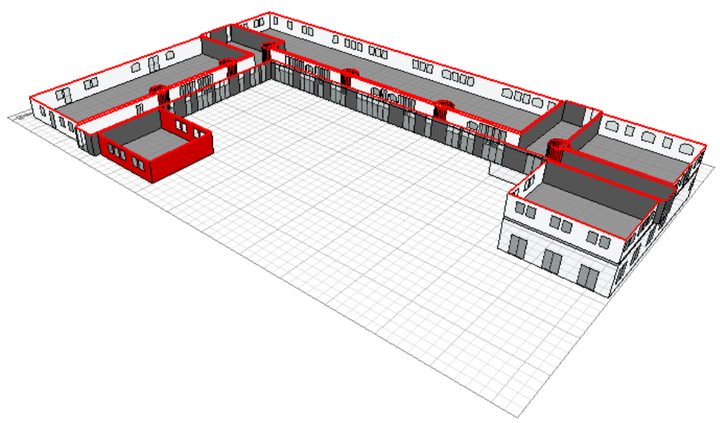
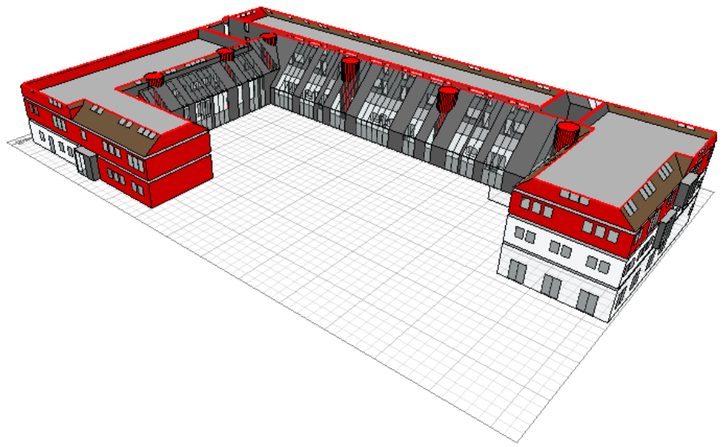
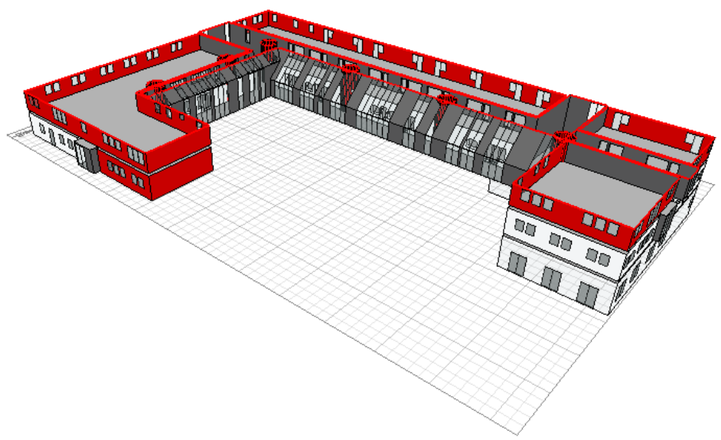
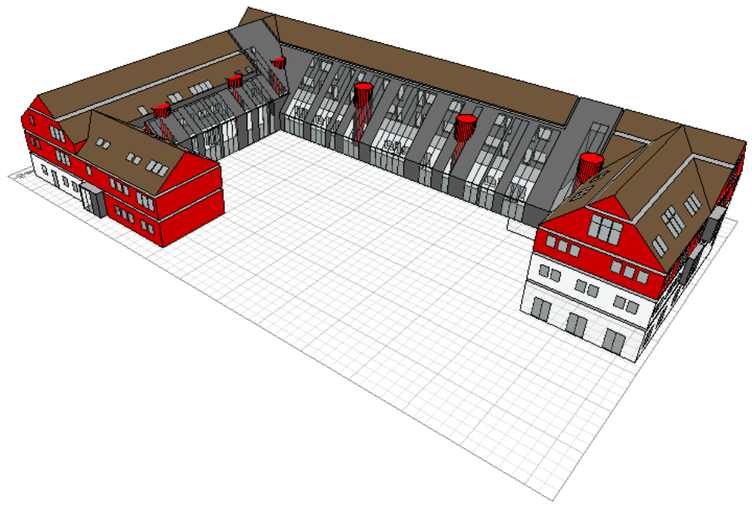
ECOTECH MODELING AND ANALYSIS









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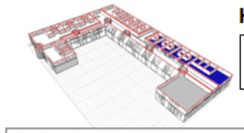
FLATS 1ST EAST: DAYLIGHT & HEATING DEMAND



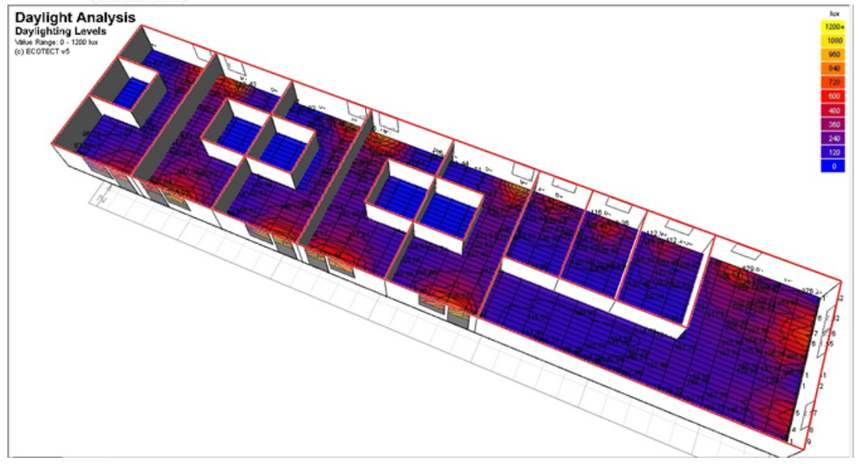
GLAZING REDUCED BY APROX 40%

DAY LIGHTING

DAYLIGHT FACTOR:
AVR: 2.48%
LIGHTING LEVELS
AVR: 210 LUX

HEATING DEMAND

HEATING DEMAND:
155.1 kWh/m2/a



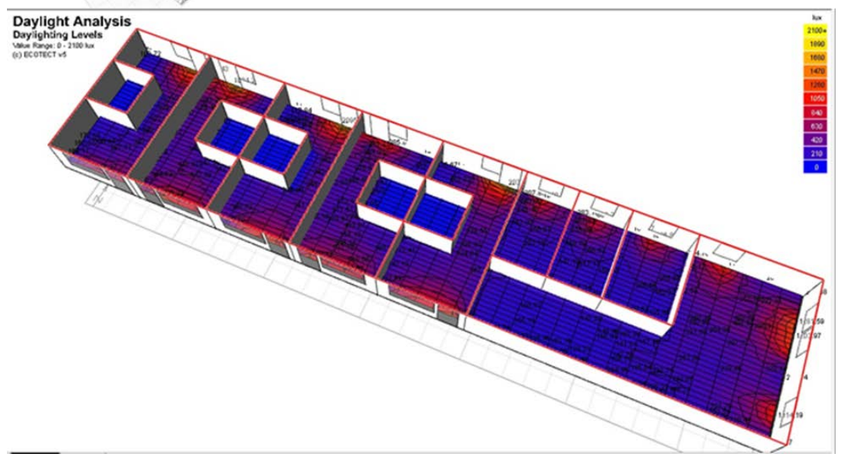
FLATS 1ST EAST: DAYLIGHT & HEATING DEMAND

DAY LIGHTING

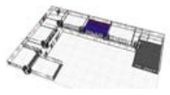
DAYLIGHT FACTOR:
AVR: 3.91%
LIGHTING LEVELS
AVR: 332 LUX

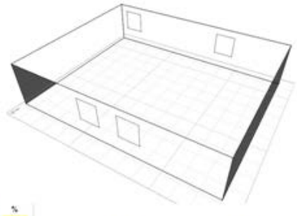
HEATING DEMAND

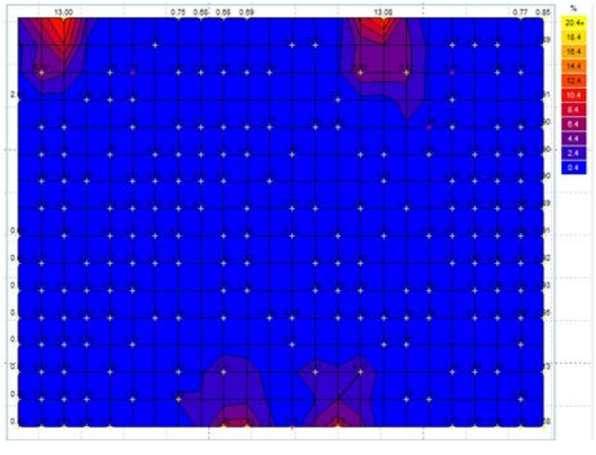
HEATING DEMAND:
169.5 kWh/m2/a



WORK ROOM 2: DAYLIGHT & HEATING DEMAND







ORIGINAL WINDOWS

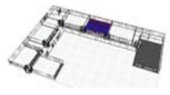
DAY LIGHTING

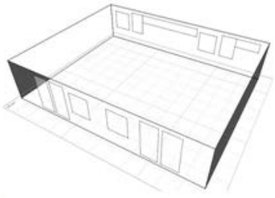
DAYLIGHT FACTOR:
AVR: 1.51%
LIGHTING LEVELS
AVR: 127 LUX

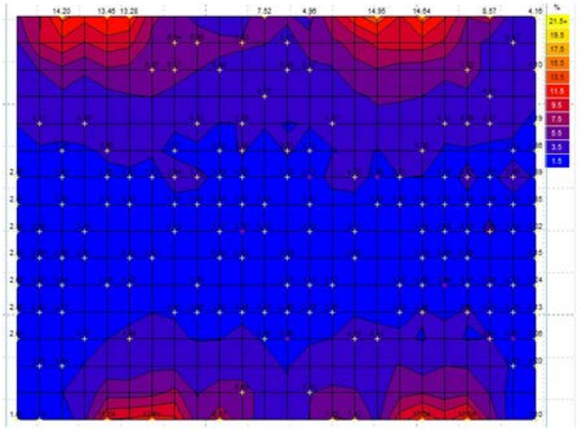
HEATING DEMAND

HEATING DEMAND:
20,8 kWh/m2/a

WORK ROOM 2: DAYLIGHT & HEATING DEMAND







ORIGINAL WINDOWS + NEW WINDOWS

DAY LIGHTING

DAYLIGHT FACTOR:
AVR: 4,6%
LIGHTING LEVELS
AVR: 391 LUX

HEATING DEMAND

HEATING DEMAND:
21,3 kWh/m2/a

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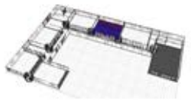
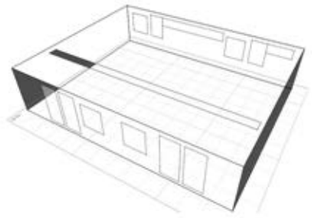
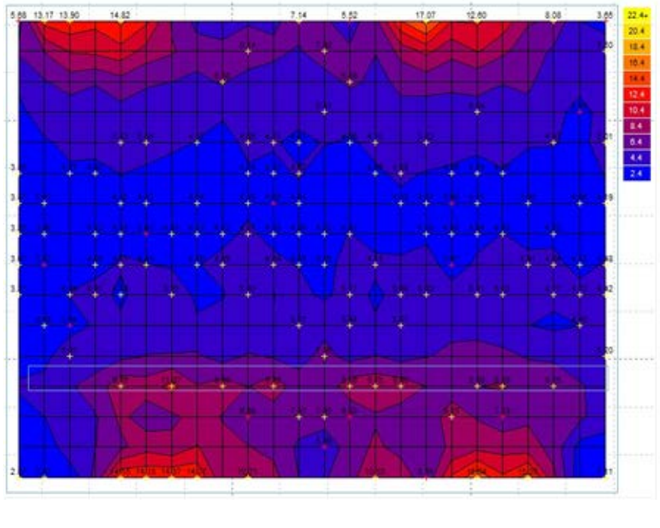
WORK ROOM 2: DAYLIGHT & HEATING DEMAND







ORIGINAL WINDOWS
+ NEW WINDOWS
+ SKYLIGHT

DAY LIGHTING

DAYLIGHT FACTOR:
AVR: 6%
LIGHTING LEVELS
AVR: 514 LUX

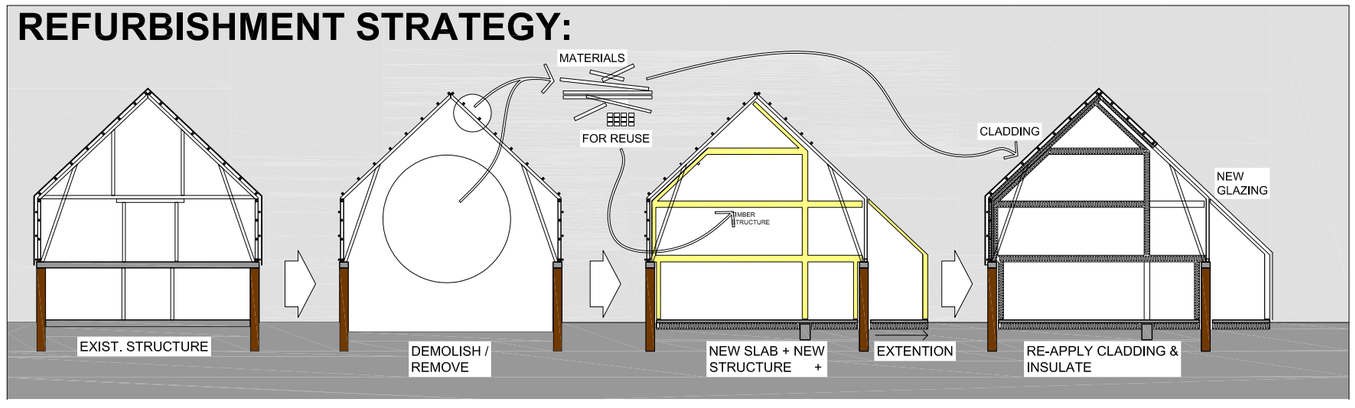
HEATING DEMAND

HEATING DEMAND:
22,9 kWh/m2/a

HEATING DEMAND:

ALL ZONES: 39kWh/m2/a

Structural Concept



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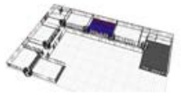
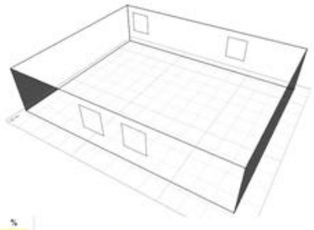
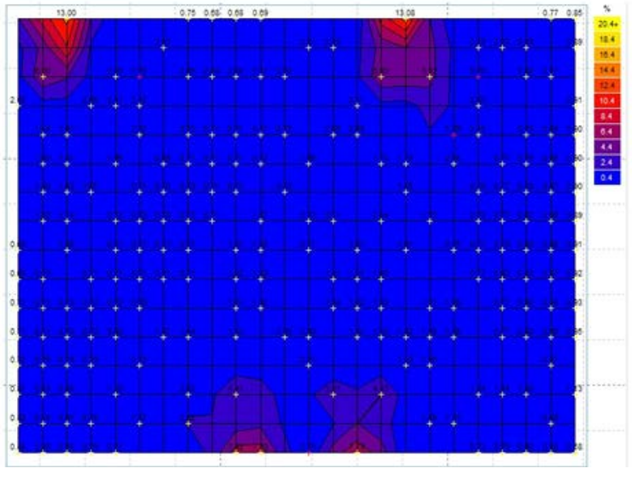
WORK ROOM 2: DAYLIGHT & HEATING DEMAND







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HEATING DEMAND

HEATING DEMAND:
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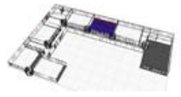
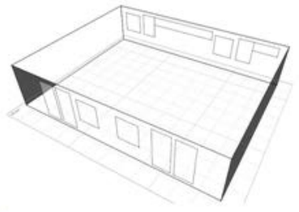
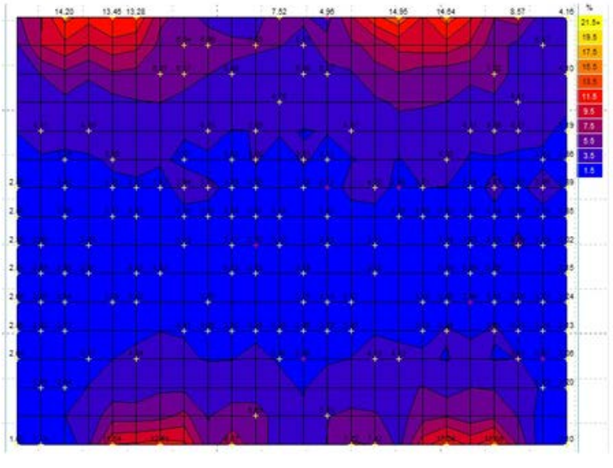
WORK ROOM 2: DAYLIGHT & HEATING DEMAND







ORIGINAL WINDOWS
+ NEW WINDOWS

DAY LIGHTING

DAYLIGHT FACTOR:
AVR: 4,6%
LIGHTING LEVELS
AVR: 391 LUX

HEATING DEMAND

HEATING DEMAND:
21,3 kWh/m2/a

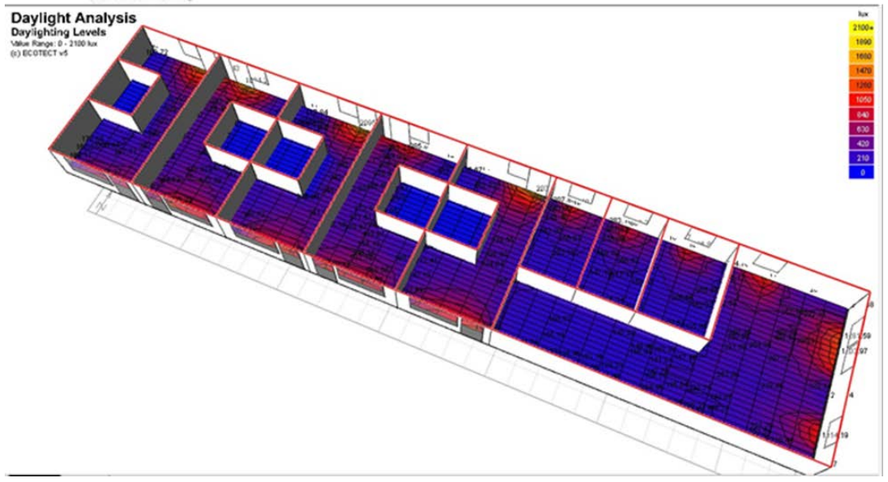
FLATS 1ST EAST: DAYLIGHT & HEATING DEMAND

DAY LIGHTING

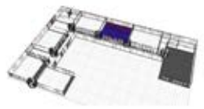
DAYLIGHT FACTOR:
AVR: 3.91%
LIGHTING LEVELS
AVR: 332 LUX

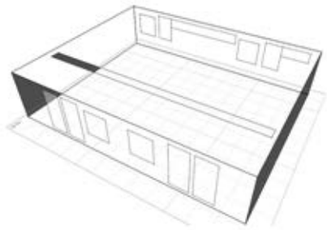
HEATING DEMAND

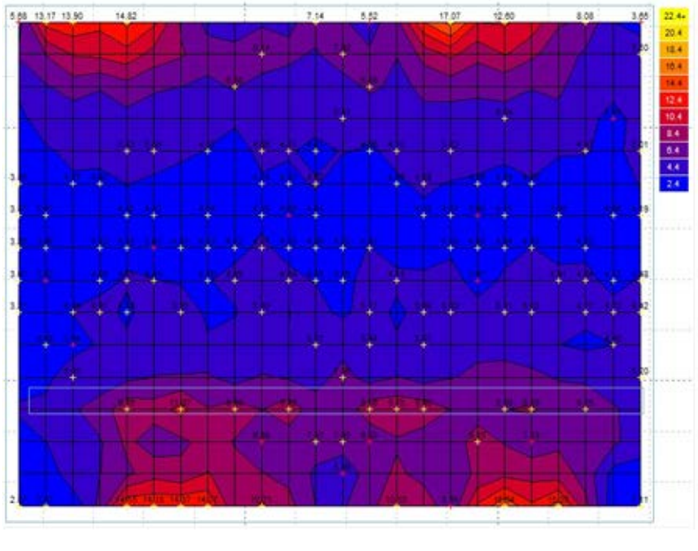
HEATING DEMAND:
169.5 kWh/m2/a



WORK ROOM 2: DAYLIGHT & HEATING DEMAND







ORIGINAL WINDOWS
+ NEW WINDOWS
+ SKYLIGHT

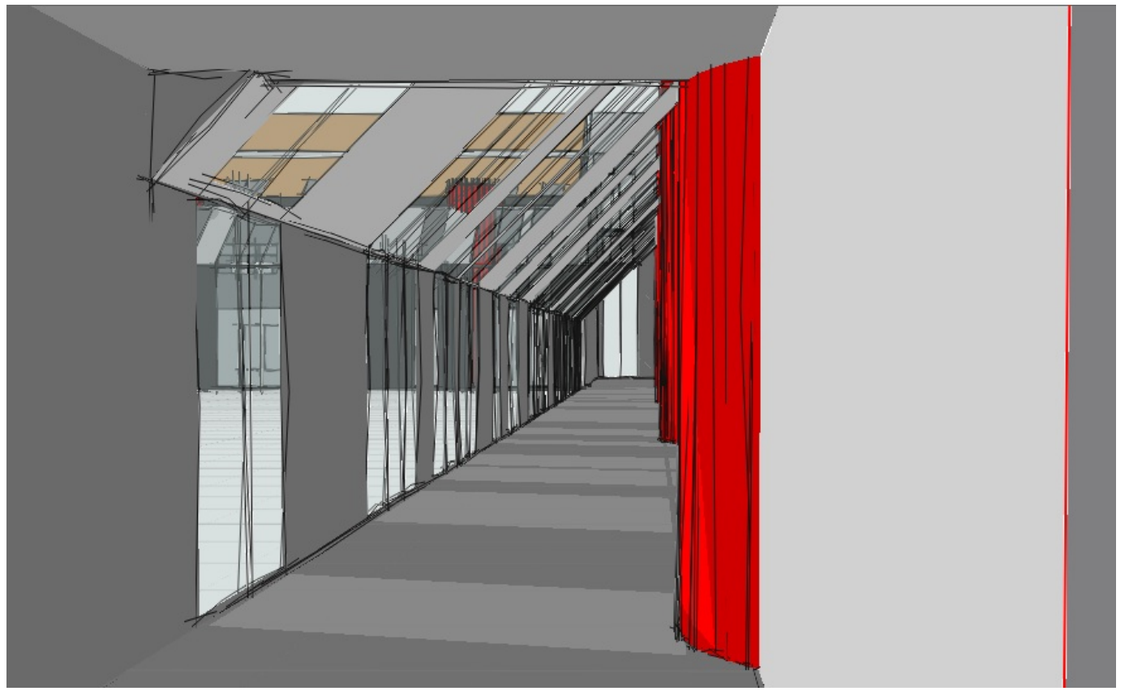
DAY LIGHTING

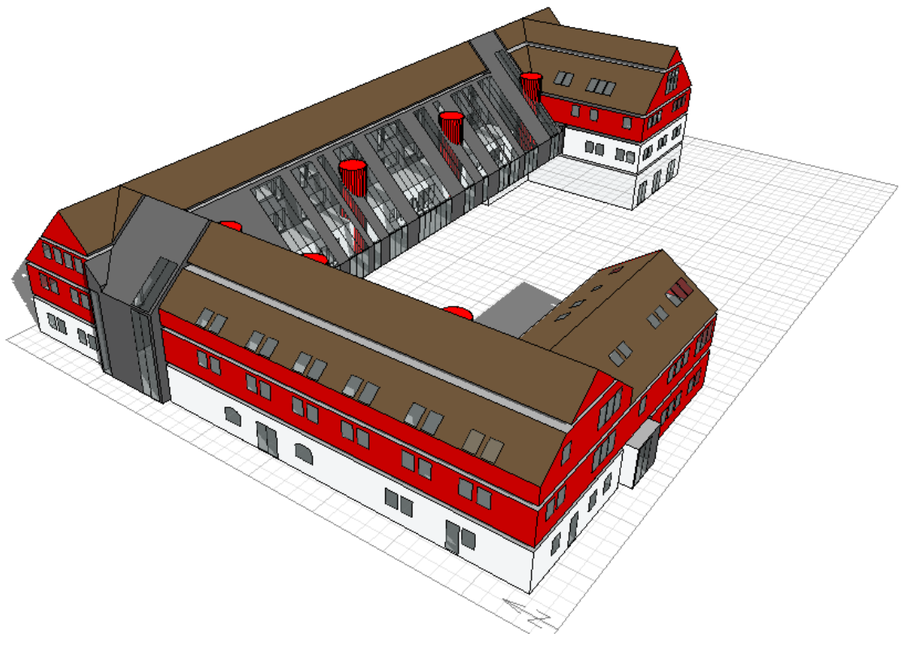
DAYLIGHT FACTOR:
AVR: 6%
LIGHTING LEVELS
AVR: 514 LUX

HEATING DEMAND

HEATING DEMAND:
22,9 kWh/m2/a

Structural Concept





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Interior of Dorm

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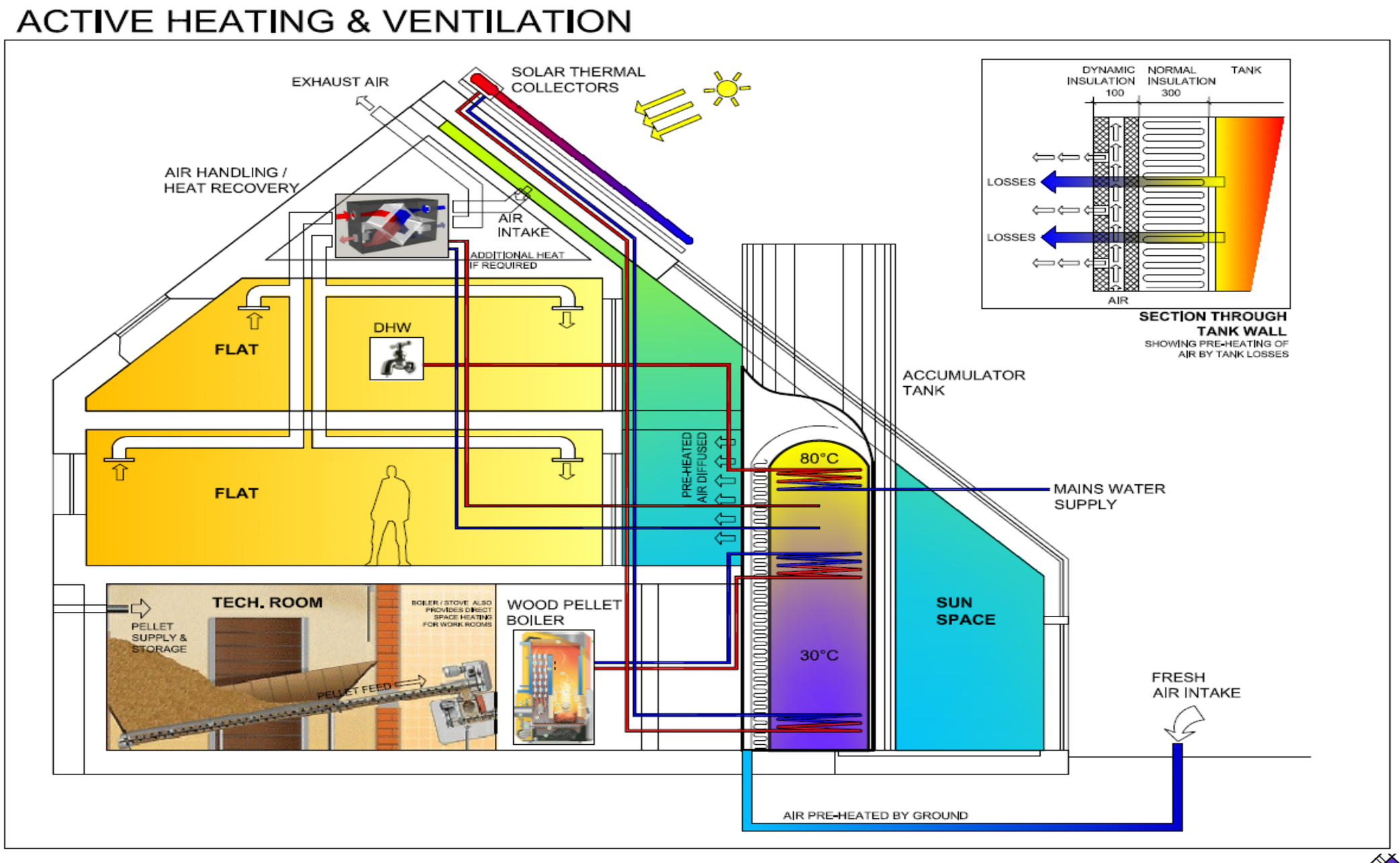
Energy Strategies



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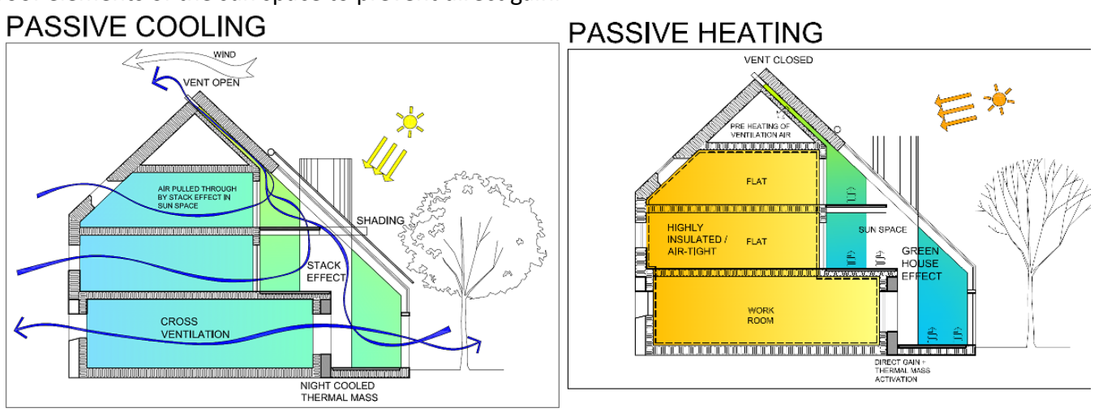
Passive strategies

Passive cooling

Shading, natural ventilation and thermal mass are employed in the passive cooling strategy of the design.
The retractable shading device (Conservatory awning W8 from Warema) is extended over the glazed roof elements of the sun space to prevent direct gain.



Opening the fenestration of the sun space on ground level allows for cross ventilation when other ground level windows / doors are opened. Cooling breezes result.

Fig 1. Passive strategies cooling & heating

Opening external as well as sun space facing openings on the upper levels promotes the stack effect for natural cooling and hot air exhaust ventilation: As the hot air rises in the sun space and wind over the roof creates a negative pressure the open rotary vent in the roof apex allows for a natural stack effect, drawing cooling air through the living and working spaces.
Clear story windows of sun space on ground floor level are meant to stay open at night to allow adequate night flush ventilation of the thermal mass which can then absorb the heat of the following day.

Passive heating

Strategies concerning this emphasise heat retention and direct gain combined with thermal mass and greenhouse effect.
Preventing heat loss of living / working spaces through high levels of insulation and air-tight construction are important heat conserving measures.
Large glazing of south facing sun space maximizes direct solar gain. Thermal mass in sun space absorbs, stores, and releases radiation from direct gain. This results in a ‘greenhouse’ effect in the sun space with long wave radiation being trapped in the glazed area. Heated thermal mass also provides thermal inertia to the space.
The sun space thus acts as a buffer between inside and outside, an intermediate space. It provides pre-heated air which is then intended for the ventilation system. And this is where the passive strategy meets the active system.

Active strategies

A prominent feature of the design is the thermal water storage tanks located at regular intervals within the sun space. Each tank corresponds to a technical room located on ground level or basement level as in module 4. Each tech. room also contains a vertical services shaft for distribution.
The result is: ‘service modules’ consisting of the spaces adjacent and above. This system allows for a decentralized approach allowing for more demand governed service provision as well as reducing piping / ducting distances. These all result in energy reduction. With regard to heating and ventilation services each module has: large thermal accumulator or buffer tank, wood pellet boiler, air handling unit, and an allocation of solar thermal collectors on roof. All equipment can thus be sized according to its ‘service module’ demand.

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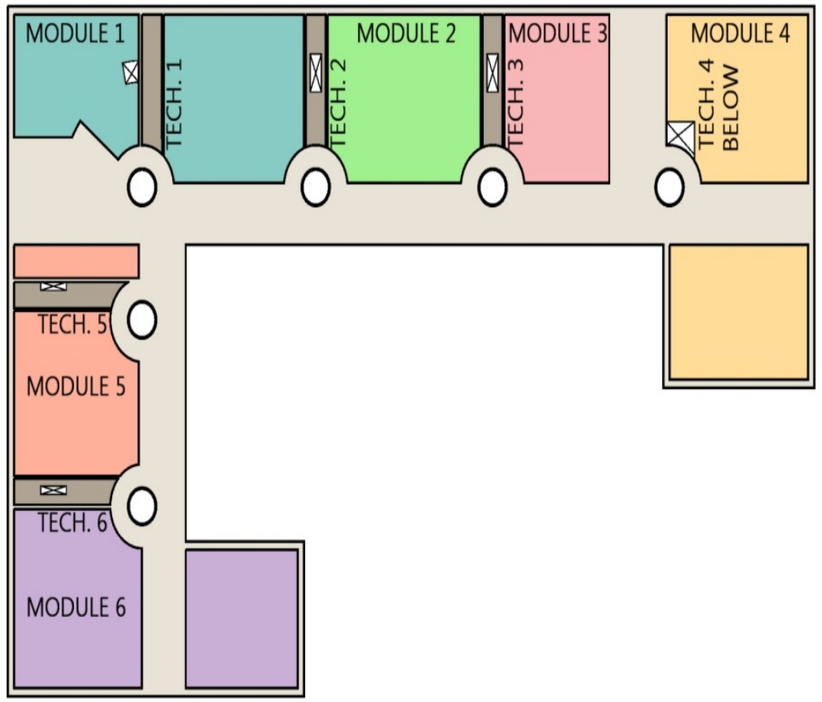

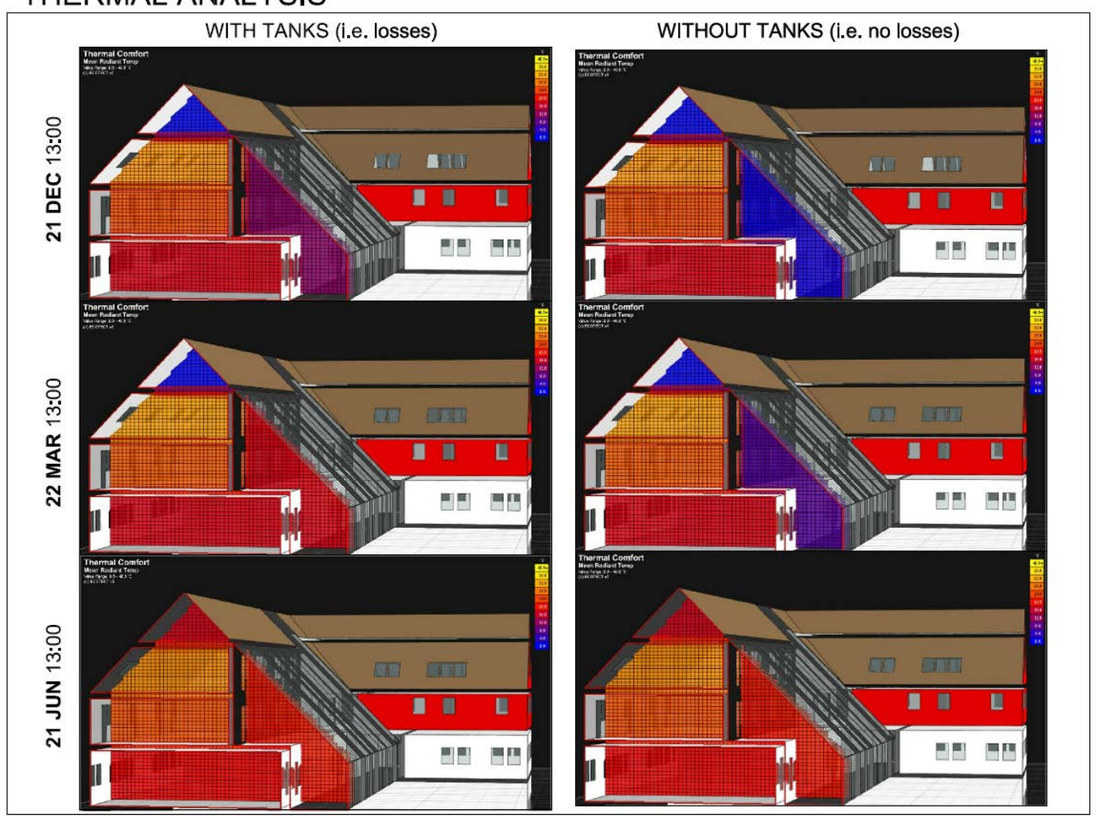

Fig 2. showing 'service modules' (heated zones(colour)). The grey sunspace is a non-heated zone.

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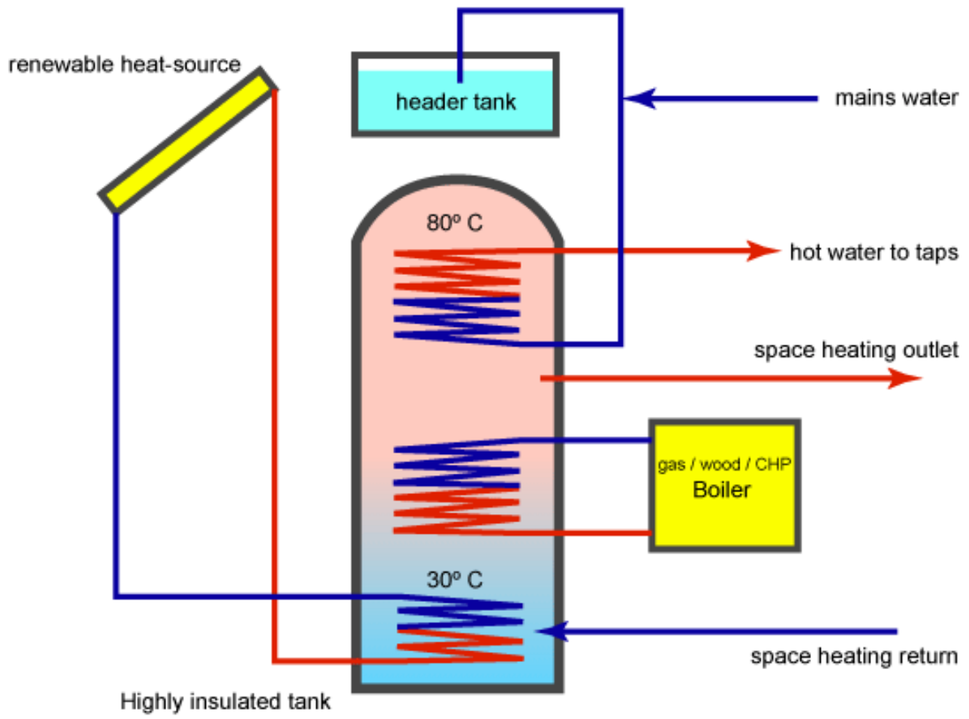
Thermal Storage

It addresses the particular problem of the temporal dislocation associated with heat sources that provide heat during certain times but when the need for heat is at other times. An example is that of solar heating, where heat is generated during the day, but often needed in the evening or during other periods of low solar gain. By storing heat for future use, the problem is overcome. This technique is often known as ‘buffering’.



The principles of thermal storage

A thermal store provides both space heating (radiators or under floor) and mains pressure hot water.

A thermal storage water cylinder reverses the normal process whereby the boiler heats the water that is to be sent to the taps, this water being stored until required. By contrast, in a thermal storage system, domestic hot water (DHW) is provided via a heat exchanger. Cold water from the mains enters the coil at the top of the tank and is heated by the surrounding hot water before outputting to the taps. Hot water is therefore effectively provided on demand and at mains pressure.

The water that passes through the central heating system also passes through the cylinder.

This water never changes, it simply flows around the vented or un-vented heating circuits before being re-heated through the thermal store.

A boiler, whether supplied by gas, biomass or CHP, is usually the prime generator of heat to a thermal store. Water heated by the boiler passes into the tank and through a heat-exchanging coil and heats the water in the tank.

Additional renewable heating technologies (eg solar collector or heat pump) can be

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included by adding a further coil to the bottom of the tank-where relatively low-grade heat can be most efficiently employed in heating the coldest part of the tank.

Thermal storage - pros & cons

Pros:

- ✓ Provides effective buffering
- ✓ Reduces boiler cycling
- ✓ Allows for integration with low temp heating systems
- ✓ Adds mains pressure to hot showers
- ✓ Provides potable hot water
- ✓ Use of a heat exchanger means that in most cases, thermal stores can be integrated with existing pressurised boiler circuits
- ✓ Requires much smaller cold water tank then standard vented systems
- ✓ Thermal storage is recognised by NHER software

Cons:

- ➢ Heat can be lost through inefficient heat exchangers
- ➢ Storage temperature will usually have to be 10 deg C higher than required DHW temperature
- ➢ Cannot be used with existing DHW power showers and pumps
- ➢ Expensive and unvented storage, very expensive
- ➢ Vented stores require a header tank to be located above the heating systems

Points to consider when specifying a Thermal Store

- The design of the heating system should be matched to the calculated peak heat load.
- When including solar heating, ensure that there is extra capacity within the store to accommodate fluctuations.
- Where a biomass boiler is being used, consider sizing the store to provide for the heat capacity generated in a load / firing
- Consider designing not only for short-term anticipated capacity but possible future extensions to the system.
- Consider stratification of water temperatures within the store, particularly where low-grade heating is provided. Effective separation between the hot water at the top of the tank and the cooler water at the bottom, can increase the time between charges.
- Ensure that there is adequate insulation to the store (100mm + PU foam)
- Ensure that there is adequate pipework insulation

ABOUT THE BOILER:

Advantages of Wood Pellets Boiler:

- ***Wood pellet boilers provide owners with more control over spiraling heating costs, and save homeowners as much as 40-60%.***
- Families enjoy the same level of comfort from a retrofitted pellet central heating system as they do from their traditional fossil-fueled heat source.

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- By some conservative estimates, an investment in a pellet boiler can provide a return on investment (ROI) as high as 49% per year over 15 years.[2]
- Wood pellets are readily available throughout North America, and can be delivered to your home.
- Pellet boiler technology is proven, with one million successful installations in Europe.
- Wood pellet fuel is not as bulky, burns cleaner, and is much more convenient than firewood.
- Wood pellets support and help sustain the regional economy where you live.
- Wood pellets improve the energy security of the region where you live.
- Wood pellet prices are not impacted by world markets, and the inflationary effects of a weakening dollar and growing demand abroad.
- Fuel cost savings can amount to tens of thousands of dollars, which can be saved, or spent in better ways.

Ecological Impact:

Heating with a carbon-neutral fuel such as wood pellets is a sustainable solution that's better for our ecosystem than is non-renewable fuels such as propane, natural gas, oil, and most electricity.

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Product Information:

PRODUCER NAME: Nordjysk Bioenergi ApS DK 9750 Oester Vraa Denmark

DESCRIPTION: High efficiency boiler, 91 - 93 % With vertical smoke plates and a big ash tray Special designed for wood pellet heating. Easy access for cleaning and maintenance. Hole for mounting of the burner, on both sides of the boiler.

Power: 230 volt 50 Hz

Maximum consumption: 20 - 300 watt

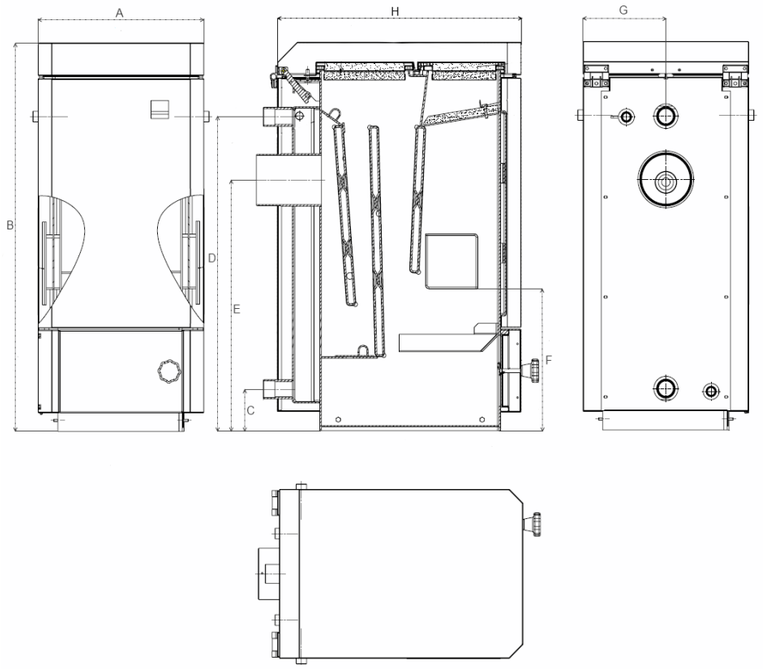
Standard auger length: 2000 mm. (can be ordered up to 3000mm)

Weight: 15 - 40 Kg.

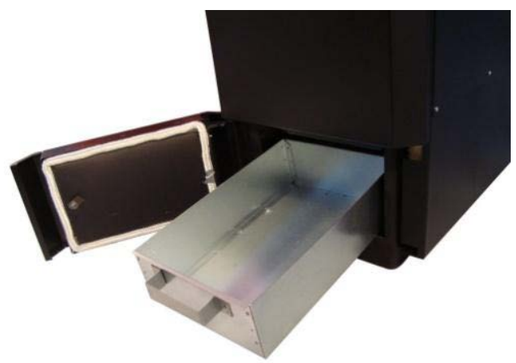
Info: Modulating wood pellets burner with graphic digital controller.

Functions supported: Circulations pump control. Hot water priority. Kwh calculating. Outside temperature compensation. Compressor cleaning. Interface to PC, multi-language.

Art Output Min / max Burner head size H x W x D : 100020 3-20kw/ 120x120x200mm.



GREEN ENERGY TECHNOLOGY



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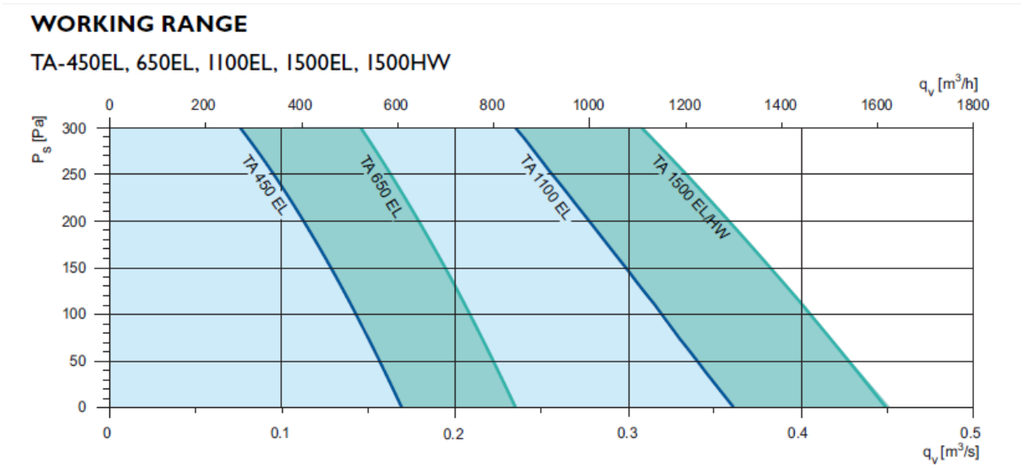
ABOUT THE AIR HANDLING UNIT:

Basic information:

- Handles airflows of 0.07-1.25 m3/s
- Low overall height
- Complete with control system
- Adjustable speed
- Parallel connection of extract air fan
- Wide range of accessories

TECHNICAL DATA :

- Voltage/Frequency V/50Hz 230/400
- Phase 3
- Power rating, motor W 220
- Power rating, heating coil kW 5/8.3
- Fuse A 10/16
- Weight kg 63
- Filter, supply air – F5



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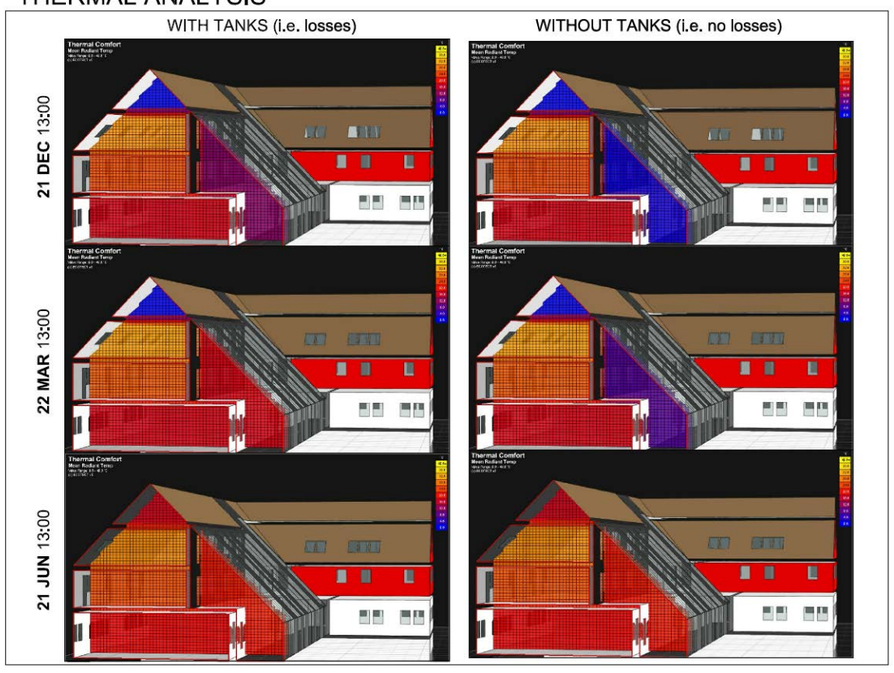
Summary of U-values of the components

Envelop	Exterior Wall	Roof	Ground	Partition wall
U-value(w/m2 k)	0.109	0.124	0.287	0.375

Windows

G-value	U-value
0.5	0.8

Thermal analysis from Ecotect



PHPP Calculation

Air Change Rate=0.6,

Specific Demands with Reference to the Treated Floor Area

Treated Floor Area: 2523.0 m^2

	Applied:	Monthly Method
Specific Space Heat Demand:	18	kWh/(m^2a)
Pressurization Test Result:	0.6	h^{-1}
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	48	kWh/(m^2a)
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	26	kWh/(m^2a)
Specific Primary Energy Demand Energy Conservation by Solar Electricity:		kWh/(m^2a)
Heating Load:		W/m^2
Frequency of Overheating:	3	%
Specific Useful Cooling Energy Demand:		kWh/(m^2a)
Cooling Load:		W/m^2

Air Change Rate=0.2,

Specific Demands with Reference to the Treated Floor Area

Treated Floor Area: 2523.0 m^2

	Applied:	Monthly Method
Specific Space Heat Demand:	16	kWh/(m^2a)
Pressurization Test Result:	0.2	h^{-1}
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	46	kWh/(m^2a)
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	24	kWh/(m^2a)
Specific Primary Energy Demand Energy Conservation by Solar Electricity:		kWh/(m^2a)
Heating Load:		W/m^2
Frequency of Overheating:	3	%
Specific Useful Cooling Energy Demand:		kWh/(m^2a)
Cooling Load:		W/m^2

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Solar Tank Detail

400mm Polystyrene Foam insulation, U-value 0.1 w/(m2·k)

Dimensions (insulation not included):

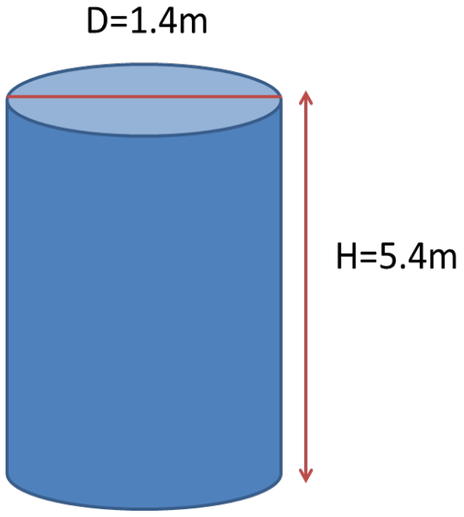
Six tanks: volume in all-50m3;

Surface area in all-223.9m2

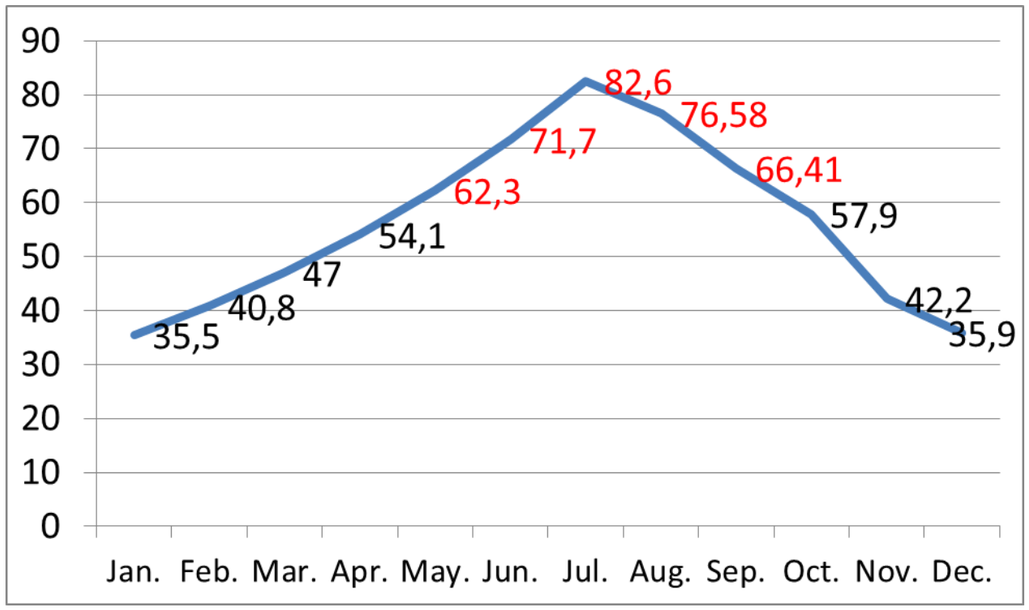
Assuming the water comes in with temp. Of 80 ℃, environment temp. is 18℃.

Q=λ*ΔT*A

λ= 0.1 w/(m2·k); ΔT=temp. inside-temp. Outside; A=223.9m2.



Annual Temperature Simulation (Solar Collector ONLY)



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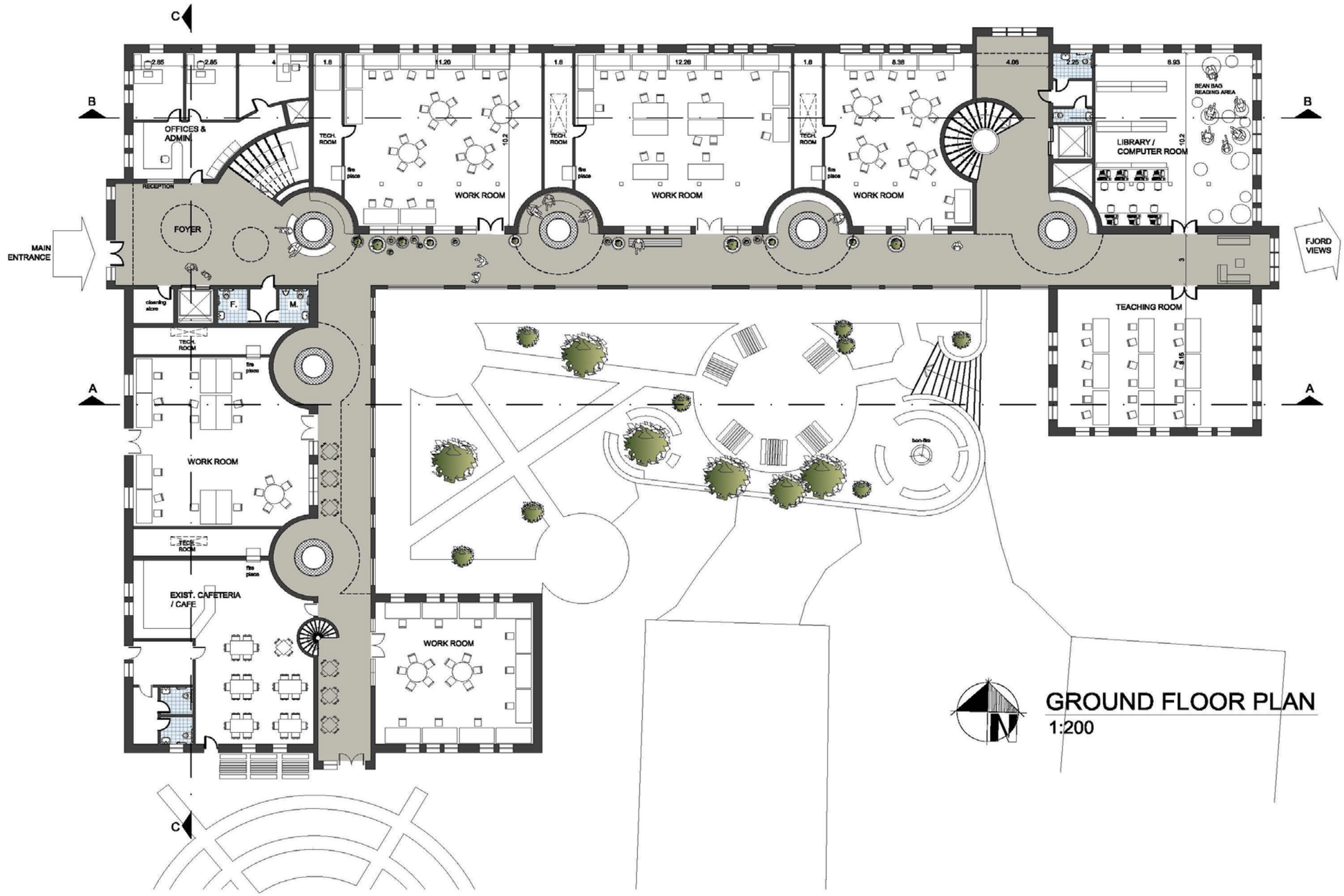

GROUND FLOOR PLAN
1:200

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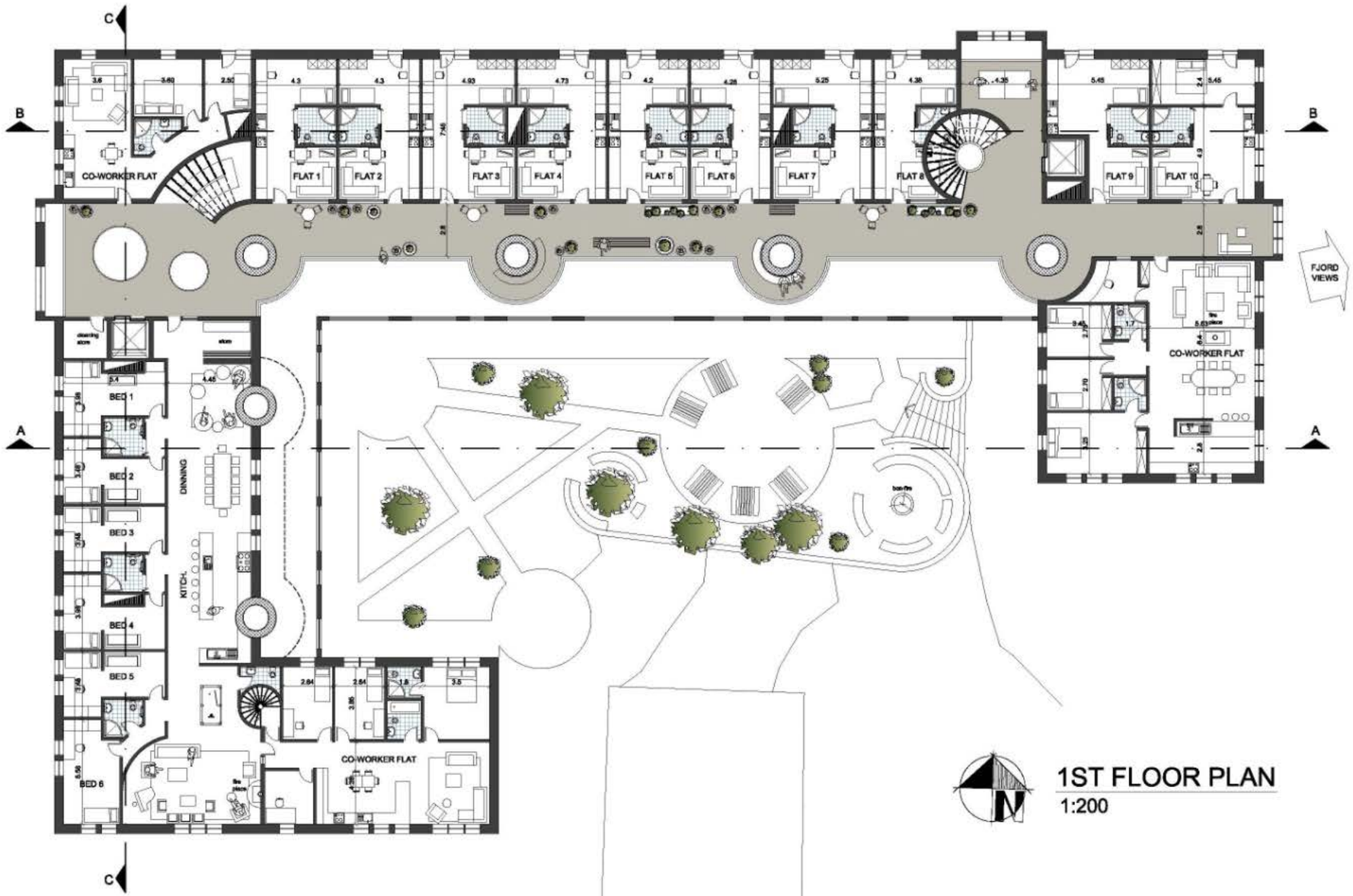

1ST FLOOR PLAN
1:200

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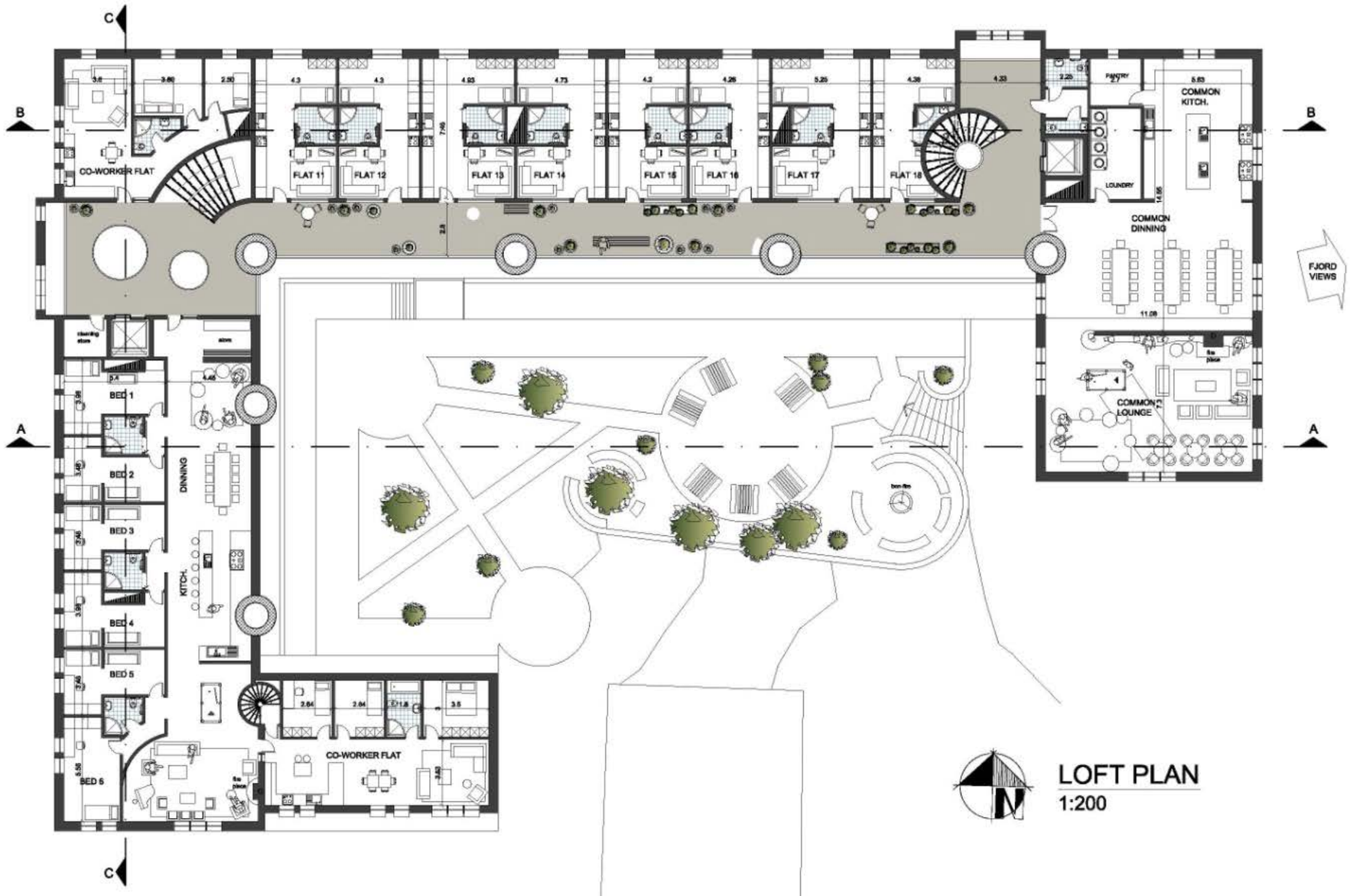

LOFT PLAN
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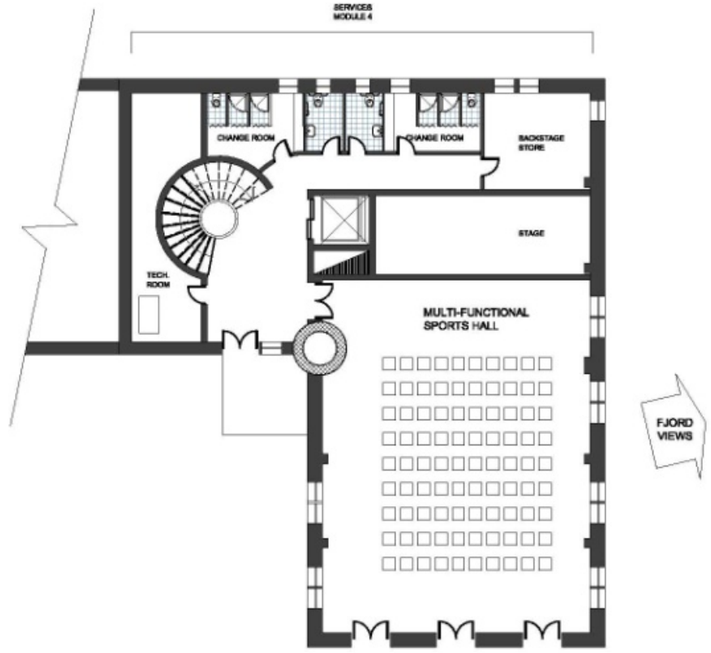

BASEMENT PLAN
1:200

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NORTH ELEVATION
1:200

WEST ELEVATION
1:200

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EAST ELEVATION
1:200

SOUTH ELEVATION
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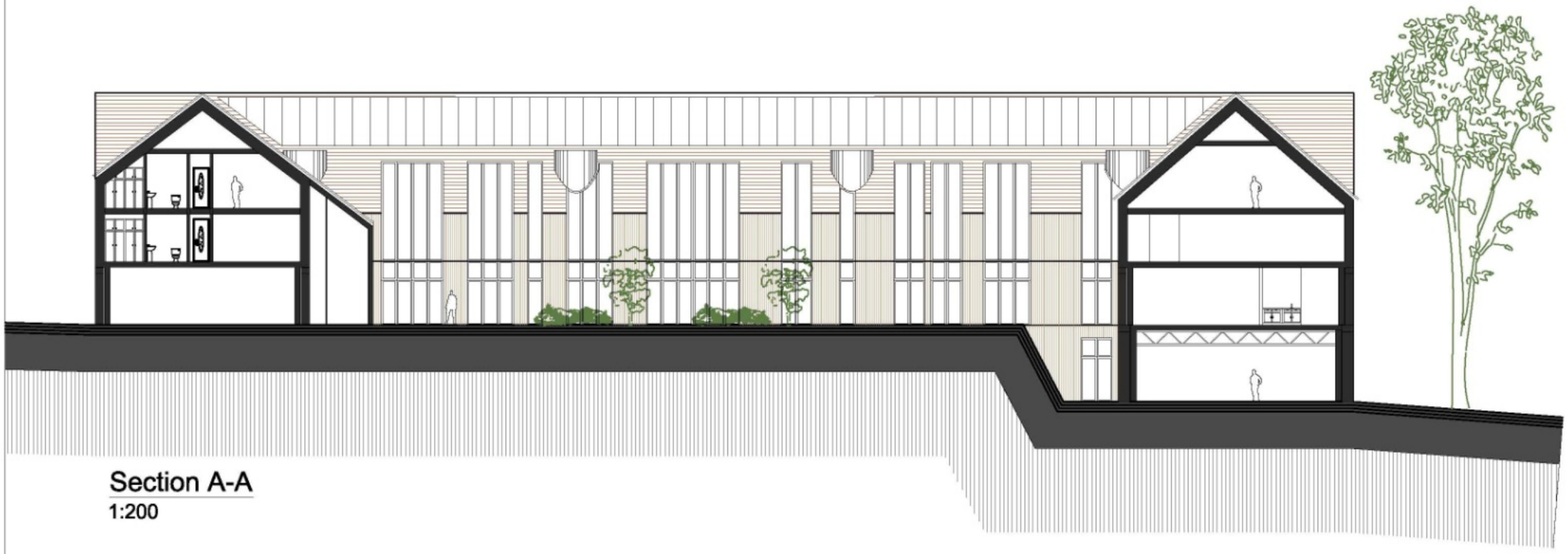

Section A-A
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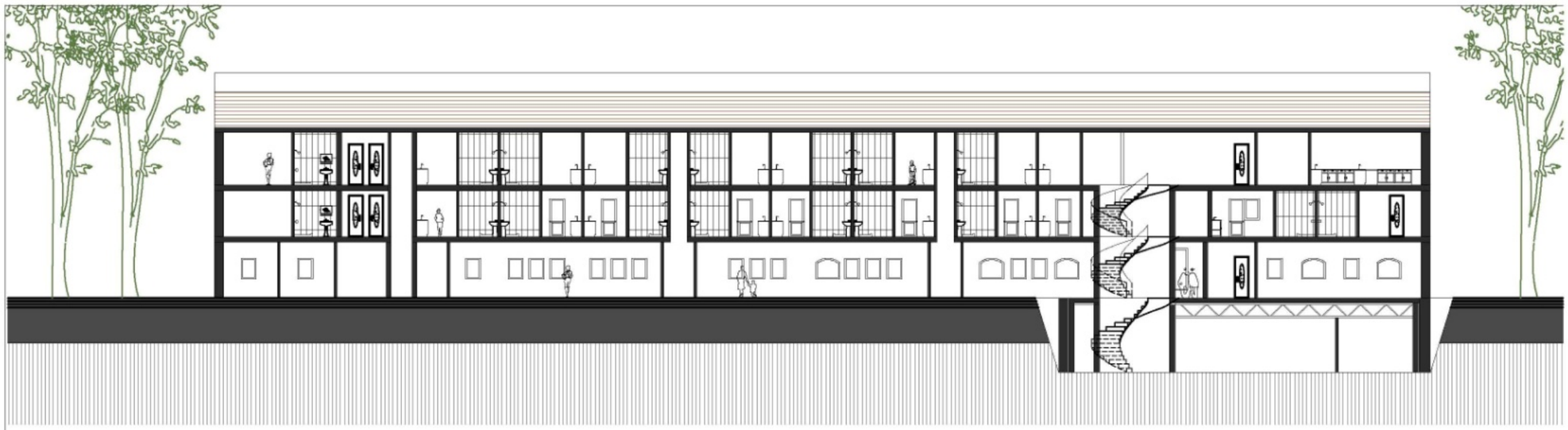

Section B-B
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Section C-C
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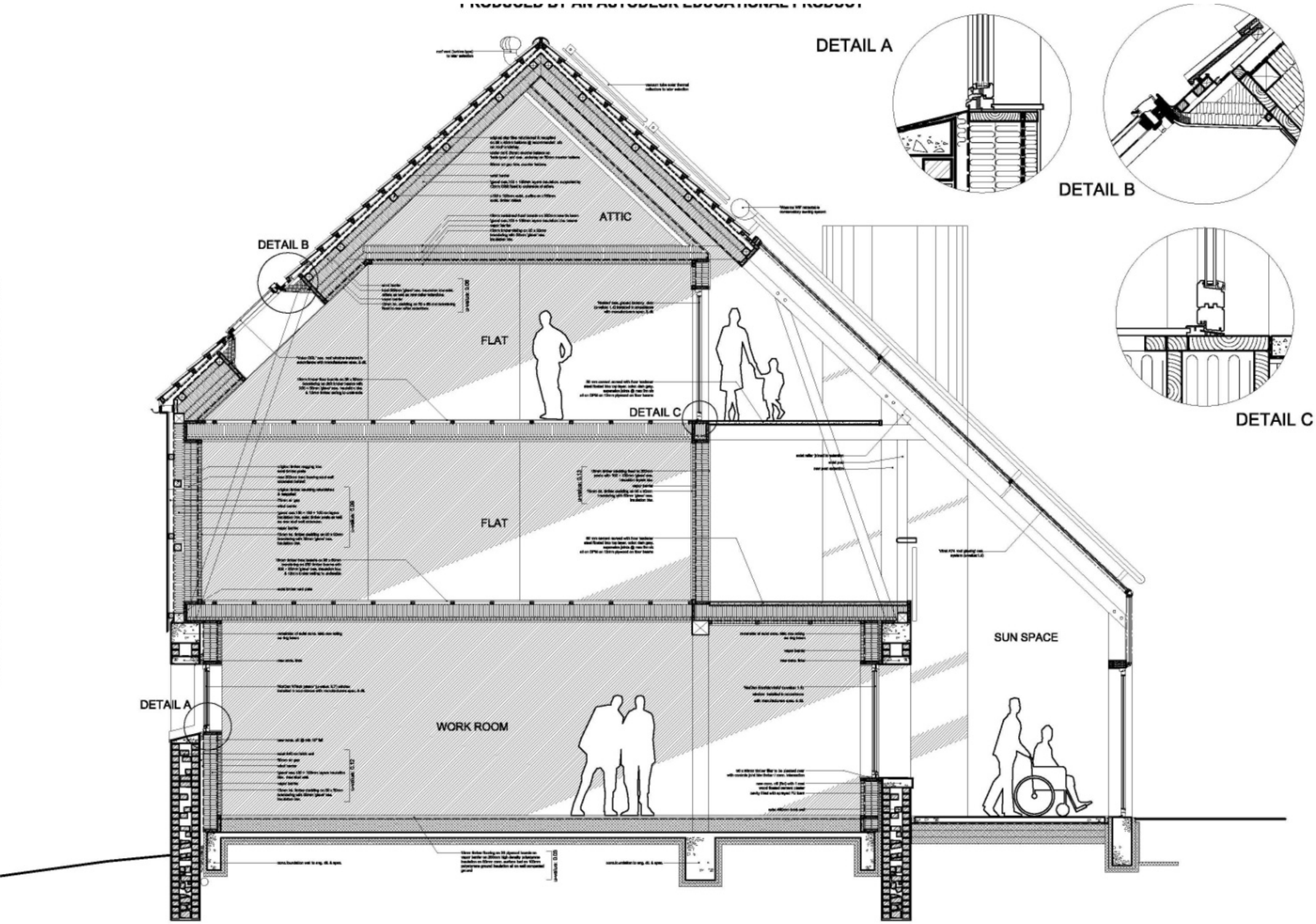

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