

Property name:	Kaarstadbygningen	Total Concept method Step 1. Creating the action package
Property owner:	Statsbygg	
Consultants:	SINTEF Byggforsk	

Building and its use

Year built: 1922
Area: 2 800 m² Heated area
Type of building: Universitet/Høgskolebygning

Volda University College consists of eight buildings. The current building, Kaarstad building, was built in 1922 and has an extension from 1982. The main building and its park are protected with protection class 2, which means that reconstruction, replacement of building components or change of color is no permitted without clarification with cultural heritage expertise in Statsbygg. The building is mainly used for teaching. There are a few offices in the north, but most of these have been moved to the extension due to poor indoor air quality. The lower ground floor is used as a canteen and classrooms including a kitchen for teaching. 1-3. floor includes seminar rooms for teaching, a larger auditorium and the old banquet hall and some group rooms and offices to the north. The building has a cold loft with numerous small rooms, which mainly stands empty, but is something used for storage.



Indoor climate

It is natural ventilation in most parts of the building and problems with over temperatures due to heat gain from the solar radiation. Most offices have been moved to the extension because of the poor indoor air quality. For solar shading, there are only interior blinds and solar films on the inner glass on the windows facing south.

The status of the building and its technical systems before measures

Building envelope

The building has a protected exterior but the interior is refurbished in combination with the extension in 1982. The loft has much of the original interior preserved. The building's exterior is well preserved walls are assumed to be approximately 400 mm unreinforced, concrete with smooth painted plaster facades.

The building has a window and door area of 17% of the heated area (BRA). Part of the building's windows are original windows. The building also has some newer windows from the 80s and 90s, where especially the windows from the 80s is in poor condition. The south facade windows has solar film on the inner glass to reduce the solar transmission. Some windows were also repaired during rehabilitation in 2010. The building has

a cold attic where the floor has been added blow-in loose insulation, estimated to 150mm.

Heating and cooling

The building is supplied with domestic hot water and space heating from the local heating plant in the neighboring building (sports center with swimming pool). The local heating plant is an electric boiler with an oil boiler as backup. The heating plant also supplies the heating coil for the ventilation. Kaarstad building has radiators as distribution system, with manual control. The facility is quantity regulated and the flow temperature to the radiators is controlled by the outside temperature. The circulation pump is pressurized and stops when there is no heat demand. There is no cooling in the building and there are problems with the temperatures during much of the year.

Ventilation

Det er opprinnelig naturlig ventilasjon i bygningen. Ved tilbygningen i 1982, ble det installert balansert ventilasjon i store deler av underetasjen med kantinen og matkultur. Samt de store salene som auditoriumet og den gamle festsalen. Ellers er det noen ventilert i veggene, men fremst ventileres det med vinduslufting mellom leksjonene. Ventilasjonen er på mellom 7.00-16.00, 5 dager i uken, 49 uker i året. Utenfor driftstid er ventilasjonen av.

It is originally natural ventilation in the building. When the extension was built in 1982, balanced ventilation was installed in large parts of the lower floor with the canteen and kitchen, and the auditorium and the old banquet hall. In all the other rooms there are vents in the walls, but foremost it is ventilated with window ventilation between lessons. The ventilation is between 7.00 to 16.00, 5 days a week, 49 weeks a year. Outside operating the ventilation off.

Lighting

Large parts of the building has old lighting fixtures, T8 type. Estimated value for lighting is 12 W / m²

Energy and resource use before measures

Since there are only old Kaarstad building that is considered for the measures, and not the extension, this is separated in the energy calculations, which yields an estimated delivered energy 295 kWh / m² for the Kaarstad building.

The baseline used for the profitability considerations, is assumed a measure of ventilation up to building code requirements. Energy measurements with simulated energy use with upgraded ventilation up to regulatory level, constitute our baseline for profitability considerations of additional energy measures. This provides an energy consumption of 248 kWh / m².

Specific energy use before measures	248 kWh/m ² ,år
Whereas	
Heat energy	190 kWh/m ² ,år
Electricity for building operation	58 kWh/m ² ,år

Identified energy saving measures

Due to the poor indoor air quality, the ventilation in the building will be upgraded. This means that a portion of the costs associated with moving users, rigging and operation mm, is not included in the further profitability calculations of the energy saving measures.

SINTEF has defined further energy saving measures that can be performed simultaneously when users have already moved out of the building. Calculations are performed for existing buildings and energy efficiency

measures up to TEK10 level and further up where it may be possible, in terms of conservation and building physical conditions. Table 1 shows the energy savings and the investment cost for the individual measures. The alternatives a or b are two options for the same building component, to compare whether it pays off to invest a little more. The cost of measures on the windows it is not included the added cost for replacement of newer windows with a replica of the original windows, which may be a requirement due to the cultural heritage.

Tabell 1. Cost and energy savings for the various measures

TC-rank	Measure	Life time [year]	Investment cost [kNOK]	Energy saving [MWh/år]	Cost saving [kNOK/år]	IRR [%]
1	3 Heating system- replace radiators (50%) and new thermostatic valves	20	420	52,6	47,3	11,4
2	7 Added insulation wall internally 50mm	40	2357	145,0	130,5	4,6
3	4b Added insulation in roof floor 200 mm	40	568,8	34,7	31,2	4,6
4	4a Added insulation in roof floor 100 mm	40	504	29,1	26,2	4,2
5	Ground heat pump	15	3007,2	283,9	255,5	3,2
6	1 Demand controlled ventilation	15	672	59,4	53,4	2,3
7	2b Replace old windows to PH	30	2773	80,1	72,1	-1,5
8	2a Replace old windows to TEK10	30	2540	63,6	57,2	-2,4
9	5 Lighting	15	182	1,7	5,5	-6,5

Summary of the measures in the action package

With the help of the Total Concept method an action package with 5 energy efficiency measures defined as profitable.

- 1 Heating system- replace radiators (50%) and new thermostatic valves
- 2 Added insulation wall internally 50mm (requires building physical assessment)
- 3 Added insulation in roof floor 200 mm (requires state of cultural heritage professional)
- 4 Demand controlled ventilation
- 5 Lighting

The action package reduces the delivered energy by 277 200 kWh/year, 100 kWh/m²year.
The action package investment cost is 4.2 million NOK and provides a summed IRR of 5.95%.

In a listed building as the Kaarstad building there are still possibilities to perform an ambitious renovation. By performing this action package the Kaarstad building would reduce its delivered energy by 40%, from 248 to 148 kWh/ m² year.

Table 2. Cost and energy savings for all of the measures

Measure	Investment cost kNOK	Cost saving kNOK/år	Energy saving MWh/år
1	420	47	52
2	2357	115	128
3	568	27	30
4	672	49	55
5	182	13	10
6	2773	58	65
7	3007	115	128
-	Sum	427	470

Figure 1. Internal rate of return graph for the action package

