

**Property name:** Vegkontoret Steinkjer  
**Property owner:** Statsbygg  
**Consultants:** SINTEF Byggforsk

## Total Concept method

Step 1. Creating the action package

### Building and its use

**Year built:** 1967, 1976, 1984  
**Area:** 4 330 m<sup>2</sup> heated area  
**Type of building:** Office Building

The buildings consist of three wings built in different building phases; 1967, 1976 and 1984. The original part is a one-floor building including a control hall and the northeastern wing with 3 floors. The southwest wing was built in 1967 originally with 3 floors, but was expanded with 2 floors in 1984.

The building consists mainly of offices for the Public Roads Administration and canteen in the first floor. The company is expanding and require more office space, thus a new wing is needed. One part of the building is a control hall, but this will not be included in further evaluations.



### Indoor climate

The requirement for indoor climate is based on the Working Environment Act and Class 2 in EN 15251. The staff complains of poor indoor air quality, especially in those parts of the building with the oldest HVAC-systems. Change of layout in the office area has also worsened the indoor climate.

### The status of the building and its technical systems before measures

#### Building envelope

The building is of concrete with covers, beams, columns and walls as primary building components. The facades are of 150mm thick concrete internally insulated with 100mm and have a U-value of 0.41 W/m<sup>2</sup>K. Some concrete pillars are located in the facade and create large thermal bridges. The air tightness is not measured but estimated to 3.5 h<sup>-1</sup>. There are large horizontal window bands between the concrete walls. The windows are original coupled windows with average U-value of 2.4 W/m<sup>2</sup>K.

All wings have a flat roof with 150mm insulation of 150 mm concrete. The roofs have a U-value of 0.23 W/m<sup>2</sup>K, except over technical rooms with an U-value of 0.33 W/m<sup>2</sup>K.

The floor is a concrete slab on ground floor and has an estimated insulation of 100 mm with an equivalent U value of 0.15 W/m<sup>2</sup>K.

## Heating

The building has two oil boilers á 350 kW and one electric boiler of 225 kW. The boilers cover space heating, heating coil for ventilation and domestic hot water. The electric boiler is prioritized and constitutes 99% of the heating. The space heating is distributed through a conventional radiatorsystem and hydronic heating coil to ventilation (80/60 ° C). The extension of the west wing (4th-5th. Floor) has electric heaters.

## Ventilation

The building has six ventilation units in total, whereas two of them are from 1976 and in poor condition. These two also have a low heat recovery rate of 42 and 62%. The units have an average SFP of 3.7 kW / (m<sup>3</sup> / s).

## Cooling

The buildings are air-conditioned and have a cooling system consisting of a chilled water plant from 1975. The latter covers comfort cooling via chilled beams in the 2nd floor, as well as comfort cooling via ventilation, for the entire building. The eastern wing is air-conditioned via the ventilation system and locally placed DX-units.

Process cooling of server rooms, telecommunication center, waste areas and UPS room is provided by smaller local DX units at the room / installations, respectively. There are altogether 15 cooling units in the building. The DX-units have a total capacity of 119 kW and the chilled water plant at 100 kW.

## Lighting

The building has mainly office space, with T5 and T8 lighting fixtures in the offices and corridors. The required power used in energy simulation is 8 W/m<sup>2</sup> and for equipment 11 W/m<sup>2</sup>. Passenger load is estimated to 4 W/m<sup>2</sup>.

## Energy and resource use before measures

Statsbygg has documented measured energy use for the entire building for the last 10 years. The energy report for 2013 shows the total measured delivered energy, degree days corrected and corrected operating hours. for the entire building including the control hall. Total heating is 79 kWh / m<sup>2</sup> for the whole building, whereas 99% is electricity and only 1% oil. Total delivered energy from electricity, excluding heating, is 140 kWh / m<sup>2</sup>.

The energy use, which will be used further as existing building is the estimated total energy for the building's office section, excluding the control hall:

Specific energy use before measures	193,9 kWh/m <sup>2</sup> ,Year
Whereas	
Heat energy	99,4 kWh/m <sup>2</sup> ,Year
Electricity for tenants	60,7 kWh/m <sup>2</sup> ,Year

## Identified energy saving measures

Six major energy efficiency measures are defined for the Road Office in Steinkjer. The measures are defined as energy savings and investment costs from building code requirements (TEK10 minimum) to passive house level. An action package is to be formed by the measures that satisfies the client's internal rate of return requirement of 4.15%.

1. Walls- added insulation, improved air tightness and thermal bridges
2. Roof added insulation
3. New windows and doors
4. Upgrading the ventilation system from CAV to demand controlled ventilation (DCV)
5. Artificial lighting, demand controlled LED
6. Installation of ground source heat pump instead of a air/water heat pump

Energy simulation is performed for the existing building, for energy efficiency measures up to the building code requirement and up to passive house level. The most profitable measure is selected as the first action. Furthermore, a new energy simulation is made with a new ranking of the remaining measures, measure 2 is selected and a new energy simulation is made, etc.

Profitability calculations were based on the building owners internal rate of return requirement of 4.15%. It is further estimated a relative increase of energy prices by 2% above inflation and economic lifetime is set to 60 years.

## Summary of the measures in the action package

### Results

With the help of the Total Concept method is an action package with 5 energy efficiency measures defined. The measures are ranked after profit in table 1.

**Table 1.** Cost and energy savings for the various measures

Measure		Investment cost kNOK	Cost saving kNOK/year	Energy saving MWh/year
1	Windows and doors	109	35	39
2	Roof - add isolation	58	4	5
3	Artificial lighting	286	29	27
4	Ventilation - from CAV to DCV	1335	116	129
5	Walls - add isolation and air tightness	1038	3	3
6	Heat pump - air to energy well	1400	5	6
-	Sum	4227	195	211

Five of the six identified measures satisfy the requirement of internal rate of return for the building owner.

The chosen action package with five measures reduces the delivered energy from building code to passive house level with 205 300 kWh/year, table 1.

The total energy savings from existing building to passive level is 394 896 kWh/year.

The action package total investment cost of TEK10 to passive level is 2 827 000 kr and gives an IRR of 4.22%, see picture 1.

**Picture 1.** The internal rate of return diagram for the Road Office in Steinkjer

