

Property name: Kiriku 2/4, office building
Property owner: State Real Estate Ltd.
Consultants: Estonian Society of Heating and Ventilation Engineers

Total Concept method

Step 3. Follow-up

Building and its use

Year built: End of the 18th century
Area: 1 877 m² Heated area
Type of building: Office

The building has two parts with different address, which are physically together. The buildings are located in the old town of Tallinn and are under the protection of cultural heritage.

The building is used as an office building after renovation; the main tenant in the building is the National Audit office of Estonia. The building is used from Monday to Friday 8:00-18:00.



Indoor climate

Indoor climate requirements set for the building are the same as commonly set for offices: minimum airflow rates + 2.0 l/s per heated area.

The indoor climate is not monitored in the building, because the building was not in use during the auditing period. In addition, information about the previous indoor climate measurements were not available. After the renovation, the indoor climate is in accordance with the 15251 II class.

The status of the building and its technical systems before measures

Building envelope

The building has a limestone foundation, but there are also sections of stacked bricks. In the walls are mainly two types of materials: brick and limestone. The walls are covered with lime plaster. Last plaster repairs and painting of facades were carried out in 1996. There are cracks in the walls caused by uneven sag of the foundation. The roof frame made of wooden and covered with stone roofing tiles. Attic floor is covered with additional insulation (approx. 200 mm). The basement floors are made of concrete. The basement floor has no thermal insulation.

The windows have wooden frames and are regularly maintained and updated. There are older double-glazed windows and newer triple-glazed windows.

Estimated thermal transmittance of building envelope:

External walls $U=1.7 \text{ W(m}^2\text{K)}$

Attic floor $U=0.4 \text{ W(m}^2\text{K)}$

Ground slab $U=2.7 \text{ W(m}^2\text{K)}$

Windows (old) $U=3.0 \text{ W(m}^2\text{K)}$

Windows (new) $U=1.8 \text{ W(m}^2\text{K)}$

Heating

Building has district heating with one sub-station. The existing distribution system is the two-pipe system with radiators. Radiators are partially equipped with thermostatic valves.

Ventilation

Building has natural ventilation system.

Cooling

There are no cooling system.

Lighting

Office premises have mainly type T8 fluorescent lamps. Switching of the lighting are controlled manually. Lighting system is technically out of date; part of the system is dismantled.

Equipment

Presently, there is no energy consuming equipment in the building.

Control and monitoring system(s)

Heating sub-station is equipped with a local controller. Heating system temperature is adjusted according to the outdoor air temperature. Domestic hot water temperature is kept constant.

Energy and resource use before renovation and baseline for energy savings

Specific energy use before measures $280 \text{ kWh/m}^2, \text{ year}$

Whereas:

- Heat energy $232 \text{ kWh/m}^2, \text{ year}$
- Electricity $48 \text{ kWh/m}^2, \text{ year}$

Heating energy consumption (adjusted with degree-days) per heated area was 215-235 kWh/year. Majority of heating energy is used for space heating. Energy need for heating domestic hot water was marginal.

Electricity use per heated area was 48 kWh/year and electricity is measured with one energy meter. Therefore, electricity consumption of different building parts and different tenants is unknown.

Baseline for the energy performance improvements is set on the basis that the indoor climate requirements are met in the building (indoor temperature $+21 \text{ }^\circ\text{C}$ and ventilation airflow rates $+ 2.0 \text{ l/s per heated area m}^2$).

Identified energy saving measures

Seven energy saving measures were identified during the auditing. However, only four of them met the property owner's profitability requirement of 5.5% internal rate of return.

It was proposed to adjust the heating curve, install new circulation pump for the heating system, insulate the attic floor and install a new ventilation system with heat recovery. Those four measures as a package fulfill the profitability requirement 5.5% internal rate of return.

Additionally the replacement of old windows, insulation of ground slab and installation of new T5 lighting system were proposed as possible measures. Those measures did not meet the profitability requirement but contributed to a reduction in energy demand and therefore reduced energy costs.

Summary of the measures in the action package

With the help of the Total Concept method, an action package with seven energy efficiency measures was found profitable. The measures are ranked after profit in table 1.

Table 1. Cost and energy savings for the various measures

Measure	Investment cost [kEuro]	Cost saving [kEuro/year]	Energy saving [MWh/year]
1 Adjustment of heating curve	1	3	59
2 Insulation of attic floor, 200mm	6	0	11
3 New circulation pump	1	0	2
4 Ventilation system with heat recovery	128	10	178
5 New windows $U=1.1 \text{ W}/(\text{m}^2\text{K})$	125	1	28
6 Insulation of ground slab, 200mm	55	0	3
7 New T5 lighting	44	0	5
- Sum	360	17	286

Summary of the outcome and follow-up in Step 3

Figure 1 shows the measurement outcomes in Step 3 compared to estimated baseline in Step 1 and calculated values in Step 2. There is no split between electricity for building operation a tenant.

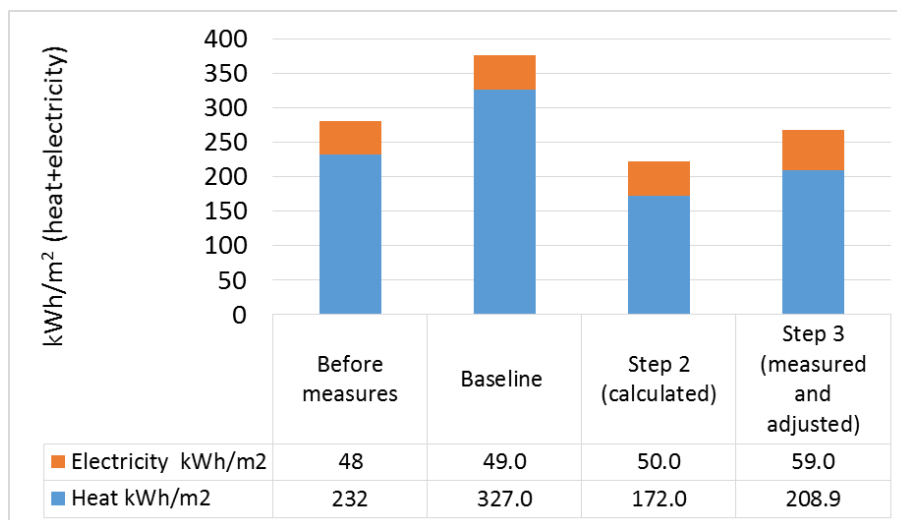


Figure 1. Outcomes after Step 3 compared to baseline.

According to the measurement outcomes of Step 3, the total net energy use is about 268 kWh/m². We expect net energy use to be further reduced due to operational experiences.

The action package carried out in Step 2 estimated to reduce the net energy use about 41 % compared to the energy use before renovation/baseline. The measured outcomes in Step 3 show the savings to be about 28.4 %.

The actual profitability outcomes are summarized in Table 2. Figure 2 shows the calculated profitability for the action package in Step 2 together with the true profitability that was calculated after Step 3. The calculated profitability for the package in Step 2 was negative as well as actual achieved profitability during Step 3.

Table 2. Summary of the outcomes of the action package carried out compared to the estimations made in Step 2.

	Step 2	Step 3
Total net annual energy savings:	41 %	28%
Calculated energy savings – district heating:	289 MWh/yr	219.6 MWh/yr
Calculated power savings – electricity:	-2 MWh/yr	-19.2 MWh/yr
Total annual cost savings:	17.6 kEuro/yr	11.6 kEuro/yr
Energy investment cost:	360 kEuro/yr	360 kEuro/yr
Internal rate of return for the package:	-%	- %

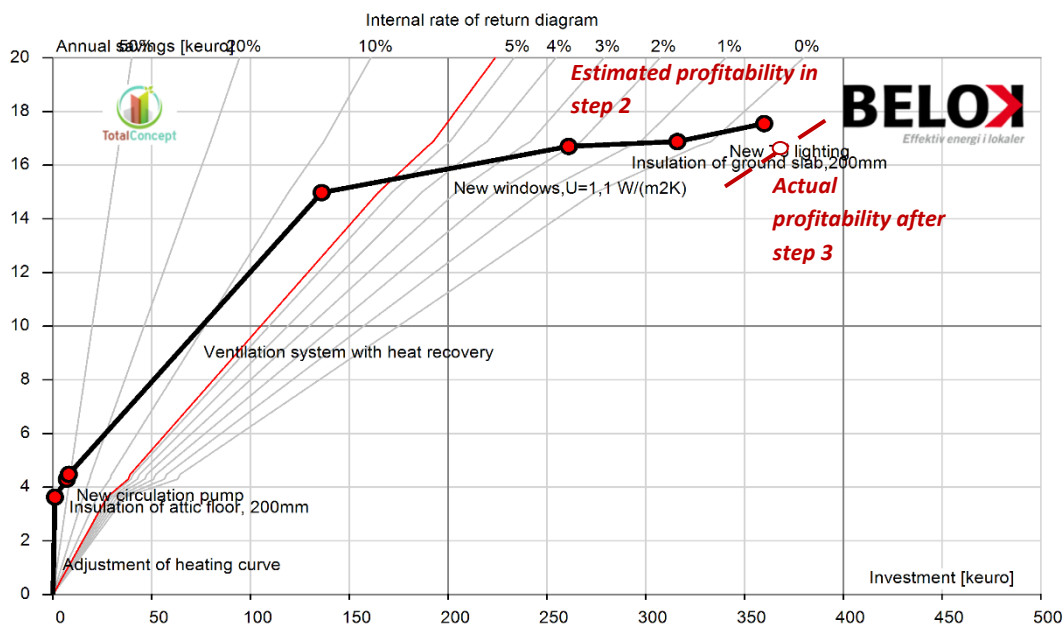


Figure 2. Outcomes of the profitability of the action package carried out at the Kiriku 2/4, office building. Relative energy price increase is 2 %.