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Energy Saving in Apartment Buildings

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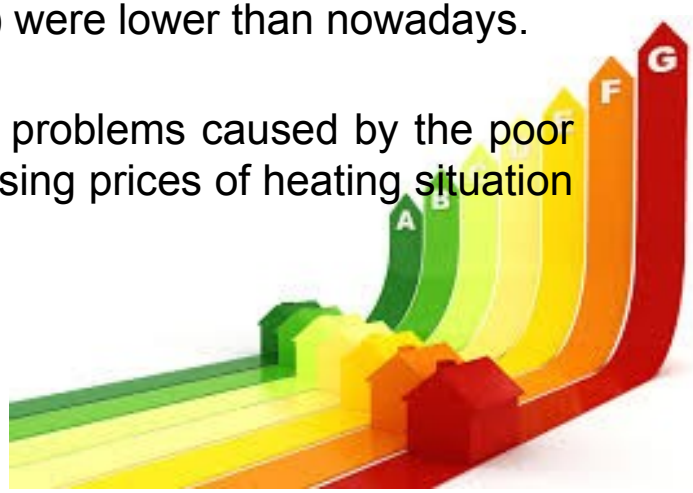
Energy Consumption in the Public Sector

Vast majority of the existing buildings are ineffective in terms of the energy consumption. According to the experts, an average annual level of the energy use in Estonia is 55-60% higher than the level of the developed neighboring countries with similar climate.

This is because the houses built in the period of 1960-1980's were designed in accordance with the old building standards. Due to the fact that the energy was very cheap then, the requirements of these standards to the heat resistance of the building structures (walls, roofs, windows, etc.) were lower than nowadays.

Currently, many apartment owners are facing the problems caused by the poor quality of insulation and in light of the constantly rising prices of heating situation is becoming more serious.



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Activities aimed at the analysis of the building:

- Energy Audit
- Energy Performance Certificate
- Thermal Inspection
- Use of the Energy Saving Technologies in the Construction

Prior to the renovation of a house, it is important to assess the condition of the building.
One of these assessments is the ***Energy Audit*****.**

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What is Energy Audit?

Energy audit **is a procedure which can be used to find out how energy is being utilized, what are the measures to save it and how to reduce the energy consumption of the audited object.**

Energy audit **gives an overview of the technical condition of the buildings and of their energy losses. With the help of the audit it is possible to identify the priority works on the renovation of the building and to make the calculations for their payback.**

Energy audit **can be seen as a part of the examination of the building, which aims to clarify the technical condition and energy consumption efficiency of the building.**

Energy audit **will help to make a long-term program of the building renovation.**

The result of the audit is a list of actions which are aimed to achieve the energy savings. By taking these actions, one can greatly reduce the cost of the energy consumption of the building.

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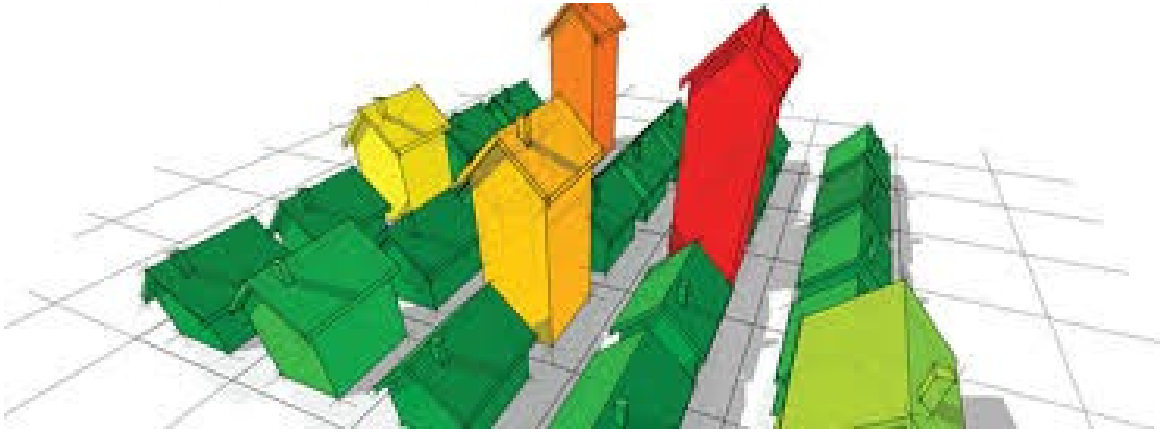
Condition of the House

- Presently most of the houses are by 2/3 high-rise multiple apartment buildings.
- The average age of the panel multistory buildings is 25-35 years. Therefore it is important to pay great attention to the preservation of the property, its renovation and its life-time extension.
- Due to the fact of the rising costs of energy resources, it is important to pay attention to their more economic use.



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In 2003 European Parliament and the European Council have accepted the Directive about the energy efficiency of the buildings (Directive 2002/91/EU), which aims to reduce the energy efficiency of the buildings in the European Union countries.

The Directive obliges the member states of the European Union to take the following measures :

- development of the methodology for the energy consumption calculation;
- implementation of the minimum energy efficiency requirements;
- implementation of the minimum requirements for the renovation of buildings of more than 1000 m2;
- introduction of the designations for the energy consumption levels;
- regular monitoring of boilers and air conditioning systems.

Euroopa Parlament

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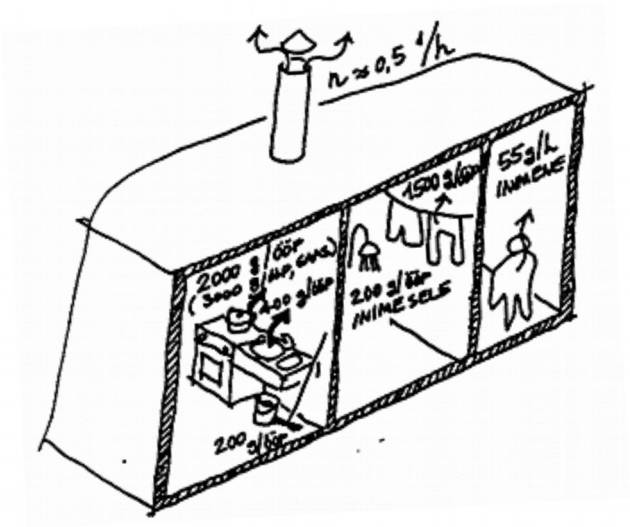
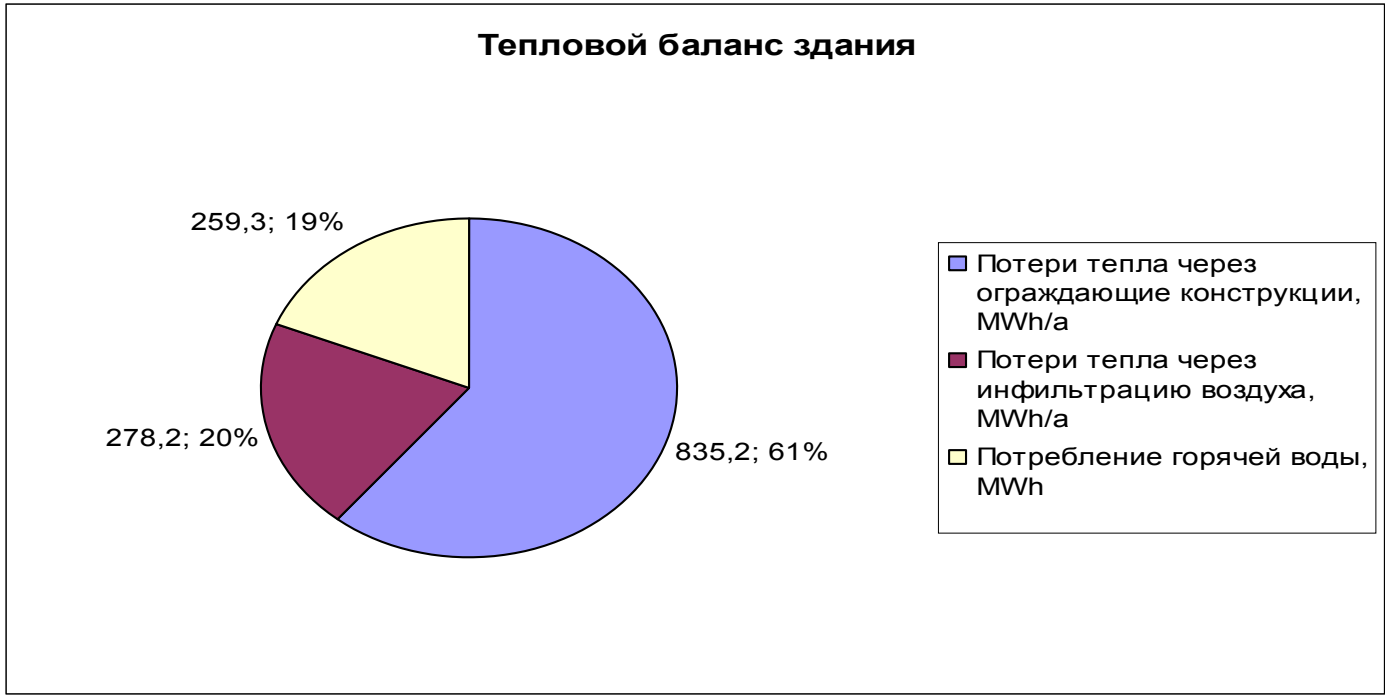
How do we consume the heat?



To obtain a complete picture of the energy consumption there should be assessed a thermal balance of the building that shows energy consumption and various heat losses.

Example of the thermal balance for a 5-storey brick house, having 108 apartments.



Where 61% is the heat loss through the boardering constructions (MWh/a); 20% is the heat loss through the air infiltration (MWh/a) and 19% is the hot water consumption (Mwh).
Q boardering constructions + Q air exchange + Q hot water preparation = Q total consumption (according to the power meter or the fuel consumption).
Q b.c.(MWh) + Q a (MWh)+ Q h.w.(MWh) = Q tot (MWh))

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Examples of the heat losses

Protrusive concrete panels act like bridges for the cold.

In the motorcycle engine similar shape ribs serve as a cooler.

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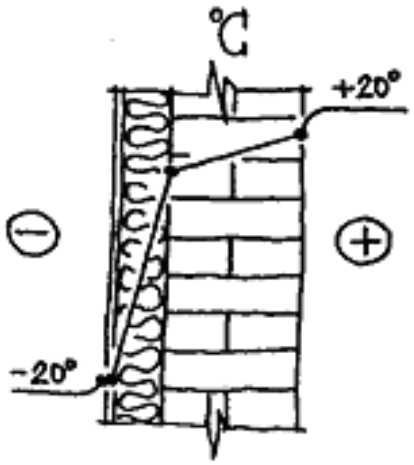
Heat Losses Through the Building Envelope



The Walls

The thermal conductivity of the walls of an ordinary apartment house of concrete panels is approximately 0,7-1,2 W / m² K. This number can be reduced to 0,4-0,3 W / m² K by installing an insulation to the outer wall surface.
Due to the additional insulation of the building envelope obtained energy savings are within 4 - 12 kWh /m³ per year.

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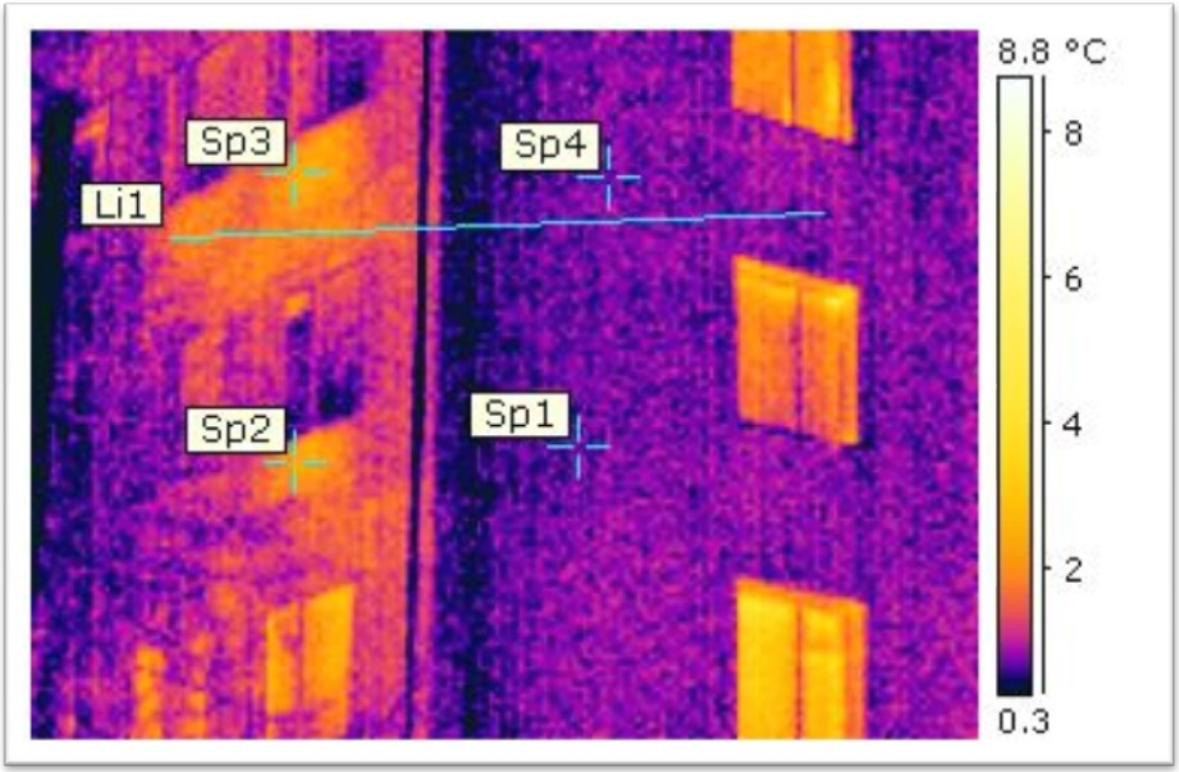
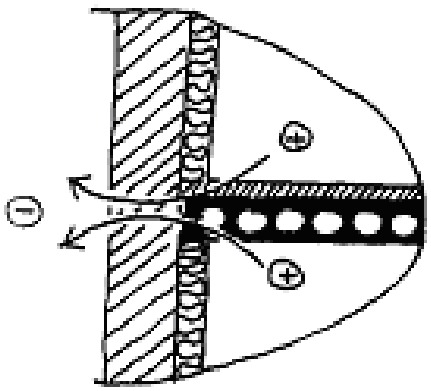
Heat Losses Through the Building Envelope

Thermographic Picture of a building:

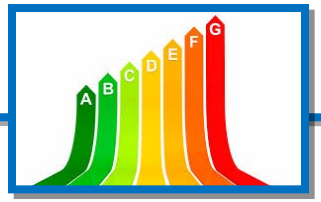


heat loss through the walls (the left wall has no insulation)

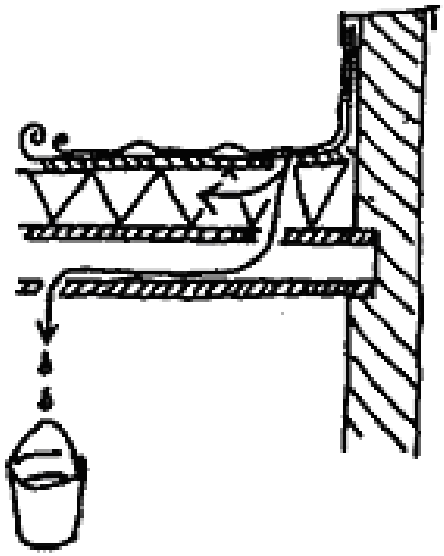
Heat loss Through the Building Envelope



An active infiltration happens through the joints of the external walls.
This serves a reason for the temperature decrease in the panel houses, especially in case of the windy weather.
As it is assumed, joints insulation with a special elastic filling gives 1-2 kWh / m³ of energy savings annually.

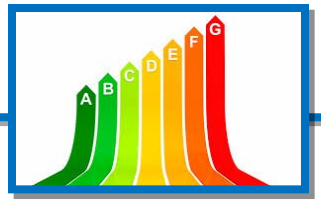


Heat loss Through the Building Envelope



Roof

In case there is a need for the roof maintenance due to its bad condition, it is highly advisable to consider the possibility to isolate it.
Both inclination roofs over the panel house and additional insulation of an attic (U is reduced from 0,7 to 0,22) gives savings of 3 to 5 kWh / m³ annually.



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Examples of the Heat Losses

Through the roof

Old Heating System (example of an old heat exchanger for hot water)

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Examples of the Heat Losses

Through the old windows

Airing through the windows in case of the clogged ventilation

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Factors influencing the energy efficiency of the buildings: hot water

- From the total water consumption hot water fraction is around 25-40 %.
- The amount of energy to heat up one liter of water to 50 degree is the same like to power a 60 watt light bulb for an hour.
- According to the raugh estimations, one person consumes from 1 000 to 2 000 kWh per year.
- Hot water demand depends on the needs of the habitants and the effectiveness of the devices in the water supply system.
- For example, using a mixing tap can save from 5 to 15% of hot water.

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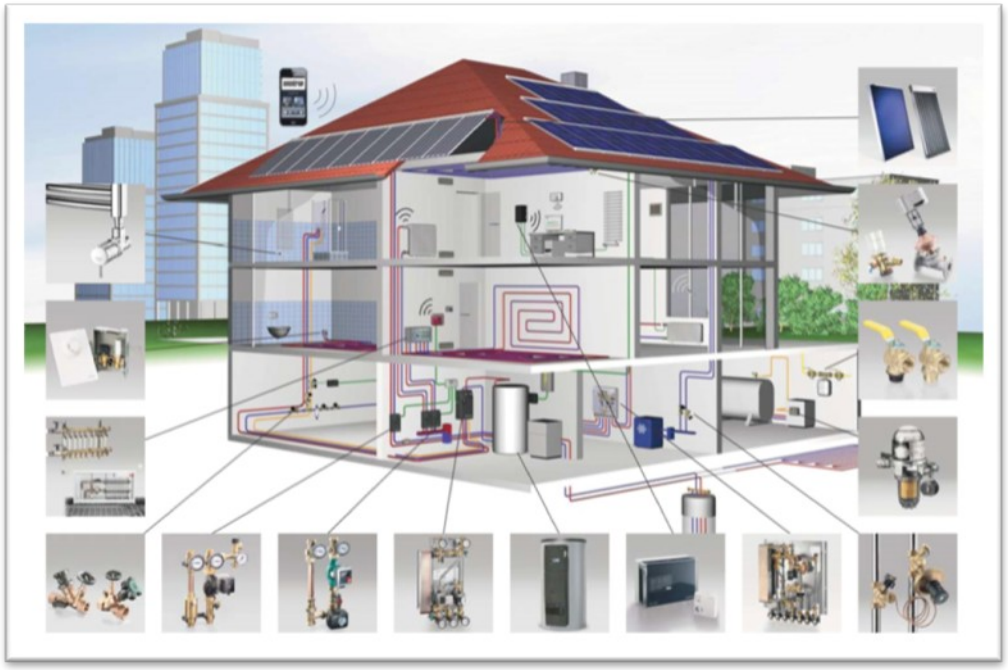
Factors Affecting the Energy Efficiency of the Buildings: Heating System

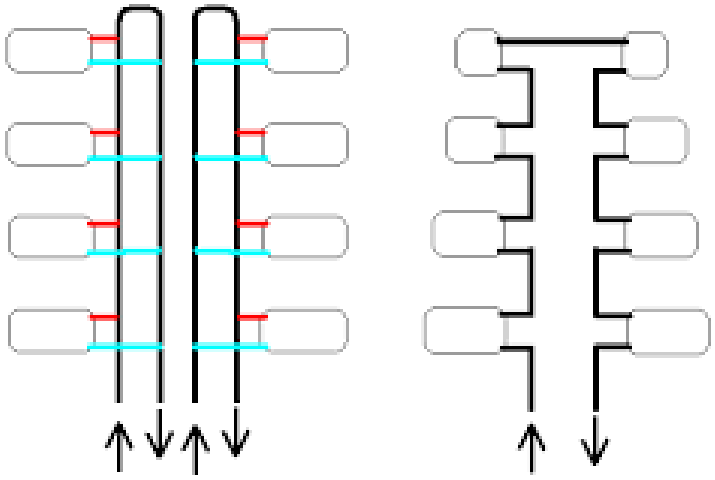


Installation of a current district heating substation automatically saves energy due to the possibility of adjustment of the heating system. The obtained saving is around 2-3 kWh / m³ per year.

Heating System

Installation of the balancing valves on the risers for the heating system balance provides 4-18 kWh / m³ savings per year.

Heating System



Replacement of one-pipe heating system for two-pipe system for uniform distribution of the water coolant saves between 10 - 30 kWh / m³ per year.

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Heating System

Installation of the thermostatic control valves. The temperature control valve can be installed on two-and on a one pipe system.
Savings estimated are 8 - 25 kWh / m³ per cubic meter per year, with a relatively small investment.

Heating System

Pipe insulation is necessary in the district heating substation, in basements and in rooms without heating.
Replacing the old insulation in the basement pipes allows to save around 2 - 3 kWh / m³ per year.

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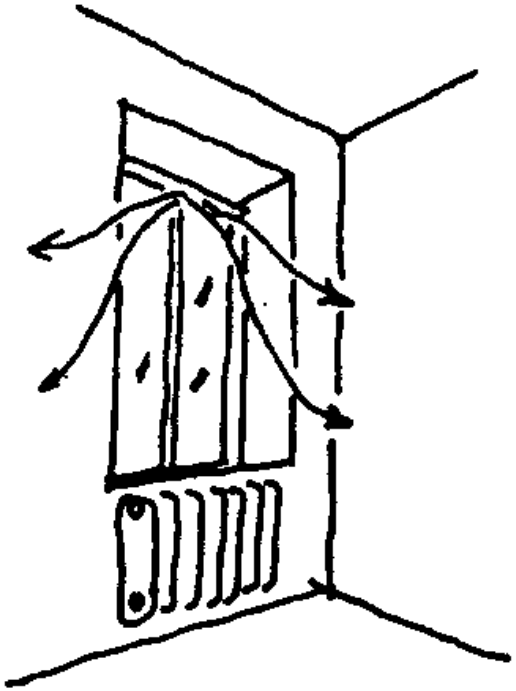
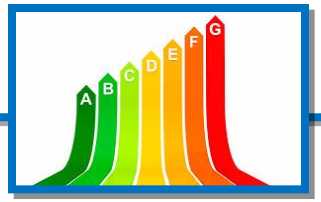
Factors Affecting the Energy Efficiency of the Buildings: Heat Losses Through the Windows



Windows require special attention. When replacing old windows with new ones, there can be reached the effect of up to 10 kWh / m³ energy savings.



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Windows Replacement

It is important to treat the windows replacement with caution, because when when installing new windows without air inlets, the air flow into the room is stoped and natural ventilation does not occur.

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Problems in case of an absence of the natural ventilation and airing by opening the windows.

High heat losses through the open windows during the heating season

Fungus and mold due to the humidity

Pollen is the cause of many allergical diseases

Noice from the outside

Overheating in case of the closed windows

Risk of bulgrary due unlocked windows can that be easily opened from the outside

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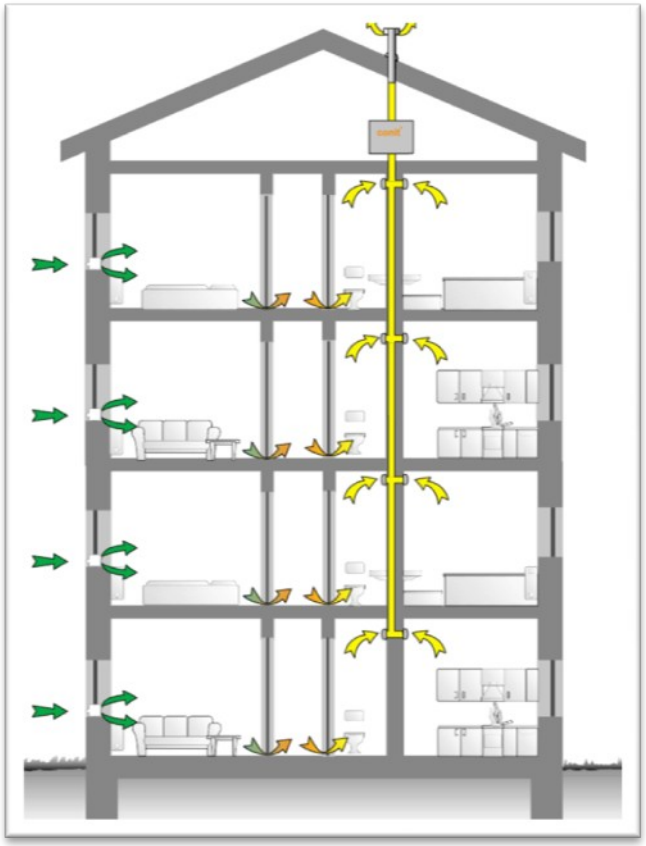
Natural Ventilation Reconstruction



The idea of the air exchange is that the fresh air should move in the direction of the contaminated air.

To do this, the inlet air diffusers should be installed in the living and bedrooms.

When energy for the heating is being saved, the air exchange is normalized.

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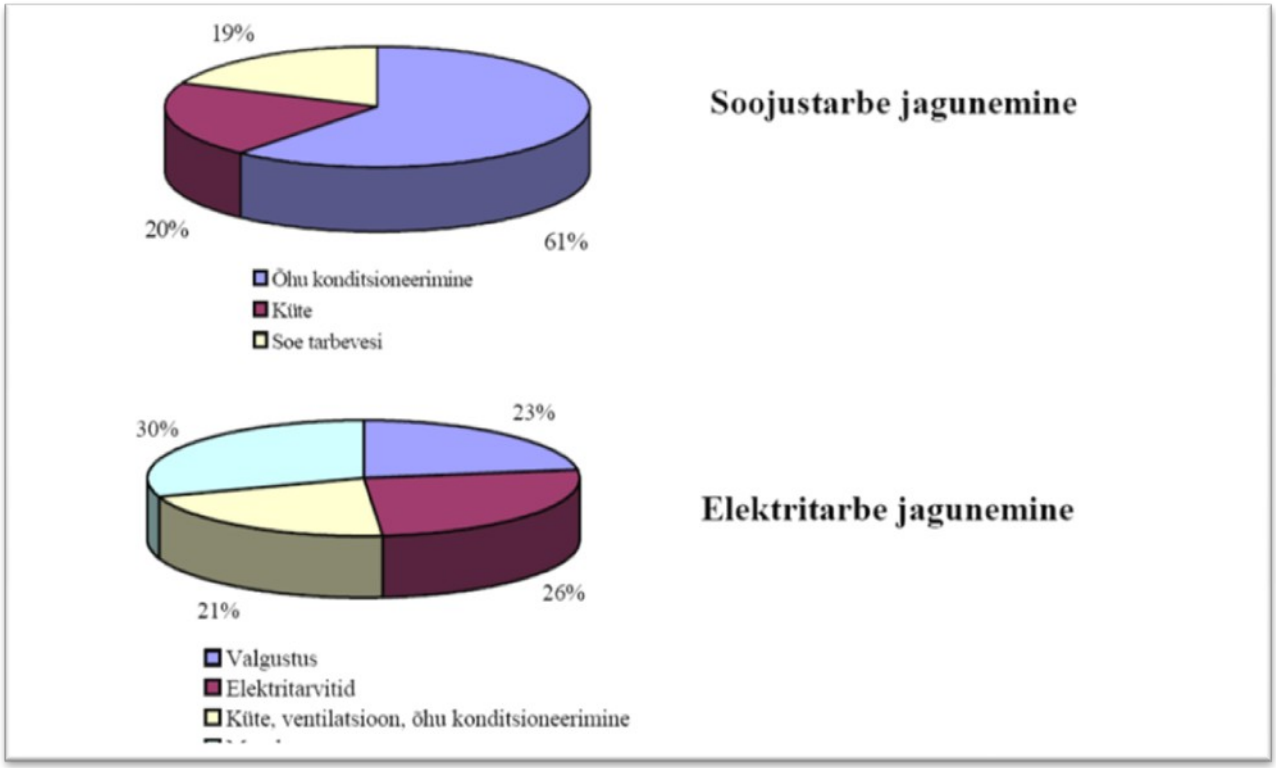
Significant energy losses occur through the ventilation, therefore normalizing the air exchange in the building can give a great energy saving effect.



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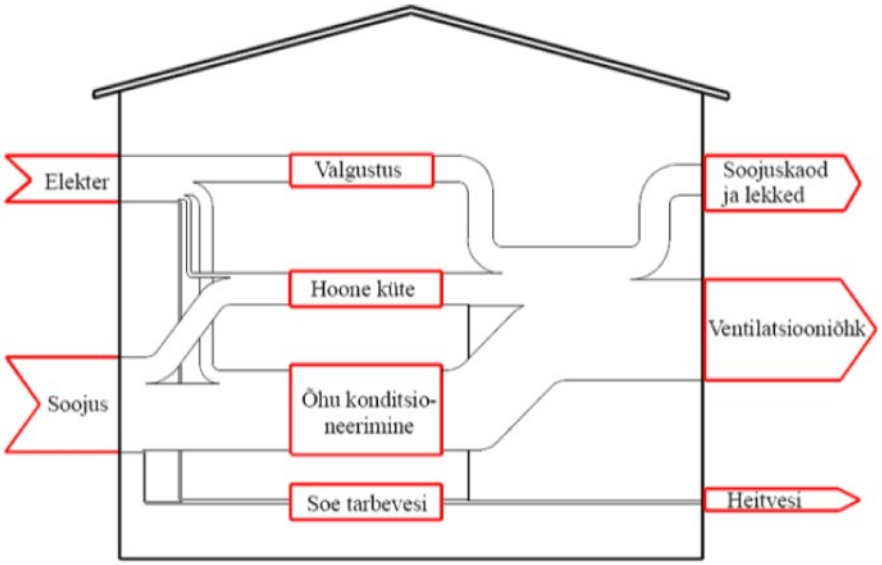
Energy audit shows the ways of the energy income and its consumption in the form of the heat balance.



Joonis 3.3. Näitlik hoone Sankey-diagramm

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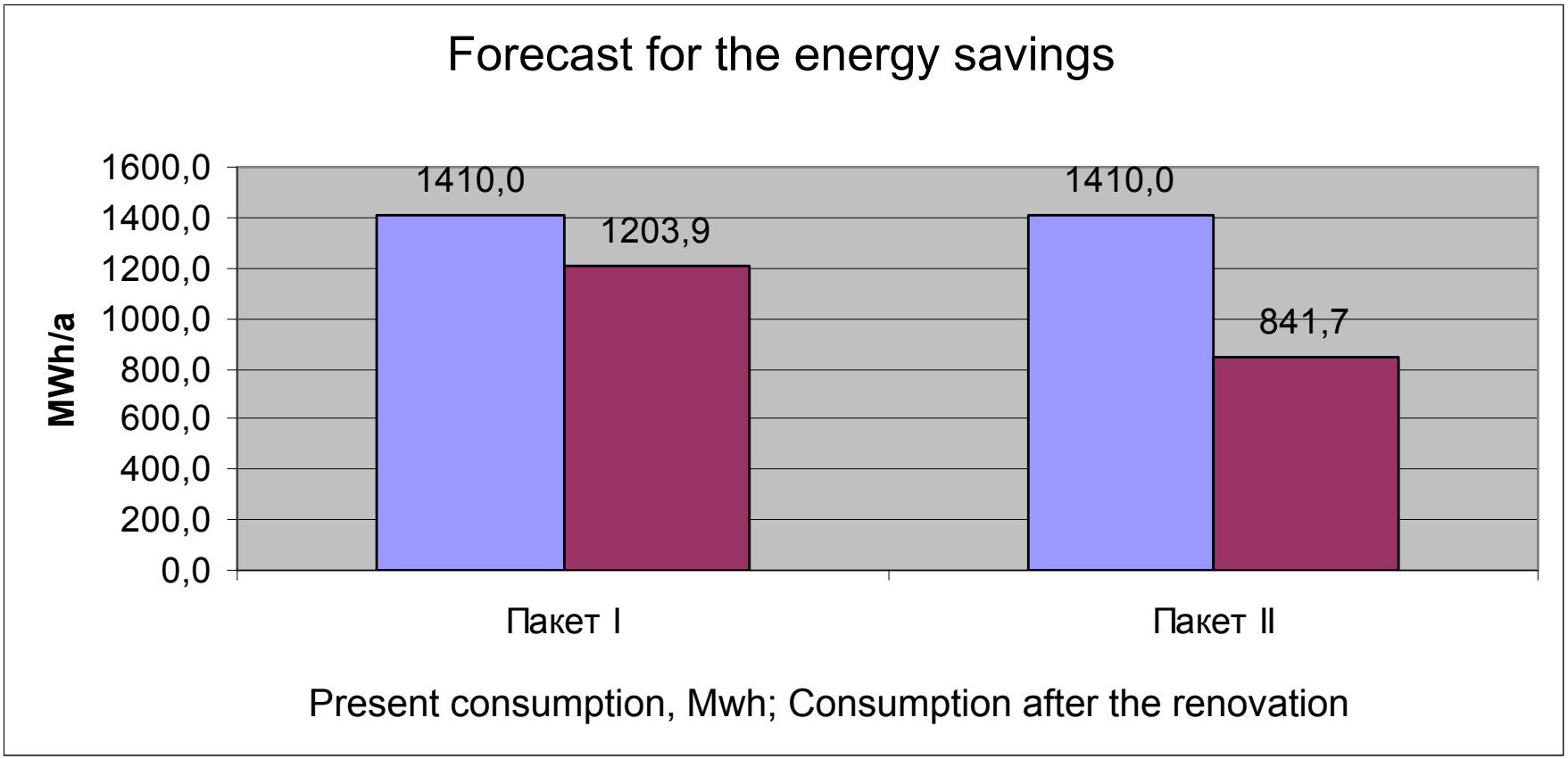
As an example, the result of the energy audit for the five-storey brick building having 108 apartments

Average energy consumption for the period of 2010-2012 years was 1410 Mwh/year, what equals 70 500 euro per year.

During the energy audit there were compiled two renovation packages, thanks to which it was possible not only to reduce the costs associated with heating the house, but also to improve the indoor microclimate of the apartments.

Results of the Energy Audit



Renovation Package I

In the first renovation project it was suggested to perform:

- isolation of the roof
- isolation of the end walls
- replacement of the basement windows

Annual energy saving would be 206,1 MW/year.

The payback period for such works is around 10 years.

Renovation Package II

In the forst renovation project it was suggested to perform:

- Isolation of the roof
- Isolation of the facade
- Replacement of the basement windows
- Renovation of the heating system
- Insulation of the cellar roof
- Renovation of the natural ventilation system

Annual energy savings would be 568,3 Mwh/year.

The payback period for such works is around 8 years.

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Examples of the finished projects

After the renovation, the buildings do not only start to comply to the high standards of energy efficiency, but also obtain nicer outlook.

Not renovated building. Price for heating: 1.91 EUR/month for 1 m2

Similar building, renovated according to the energy saving project. Worked performed: isolation of the facade and the roof; replacement of the windows. Price for heating: 0.96 EUR/month for 1 m2.

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Examples of the Completed Projects

Not renovated building.
Price for heating: .94 EUR/month for 1 m2

Similar building, renovated according to the energy saving project. Worked performed: isolation of the attic ceiling and the facade; replacement of the windows; normalization of the ventilation system.
Price for heating: 0.96 EUR/month for 1 m2.

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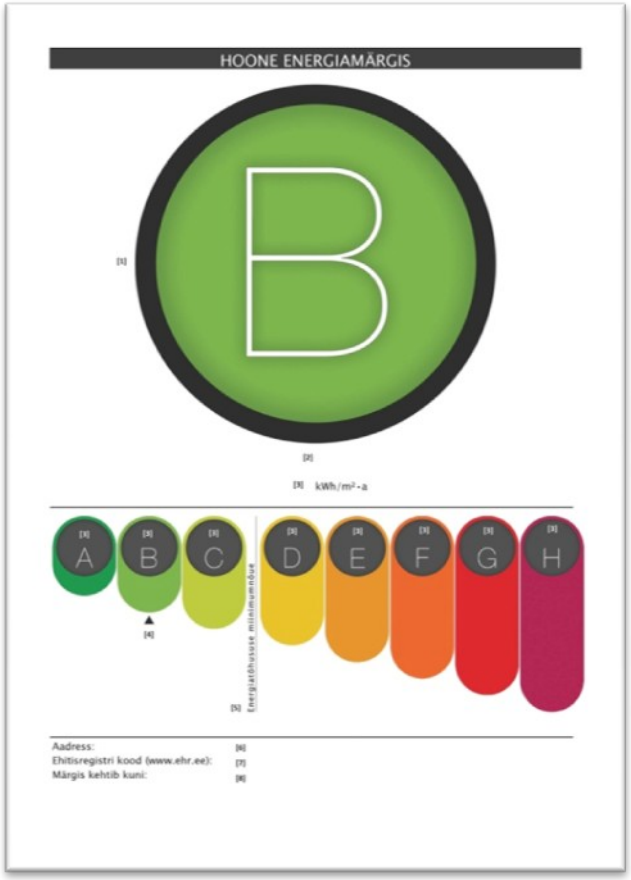
Examples of the Completed Projects

In the houses built during the period of 1960 to 1972 years there were performed works of the basement, facade and roof isolation; windows and heating system replacement and the ventilation system renovation.

Energy Efficiency Certificate



Besides the concept of the energy audit, there is the concept of the Energy Performance Certificate.

Energy audit is needed to determine the priorities and means of the energy-saving renovation of buildings.

Energy Performance Certificate is needed to classify the building according to the level of energy consumption.

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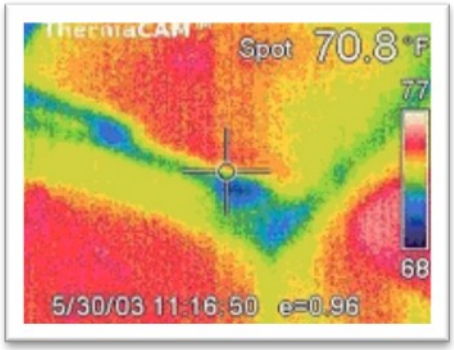
Thermography of the building

Infrared (thermal) camera can detect heat losses in buildings, on heating mains, identify overheated contacts and insulators in electrical networks overage or improperly installed devices and equipment for industrial plants.

Thermography of the building

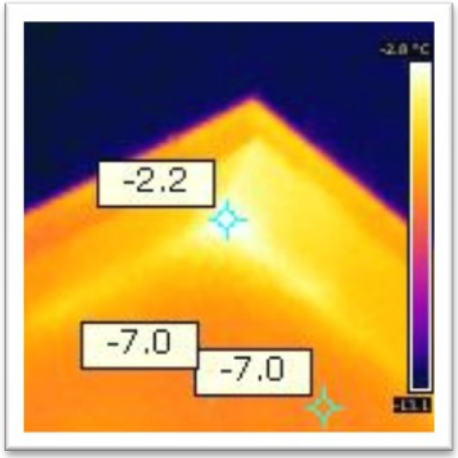


Heat loss through the ceiling

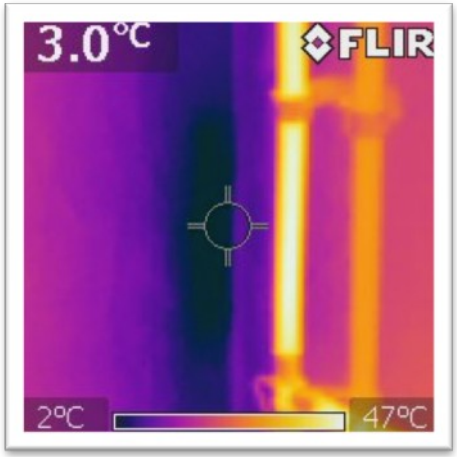
Thanks to the thermography it is possible to get a comprehensive picture of the heat resistance of the building. Thermographic picture reveals "visible" heat fluxes passing through the foundations, walls, doors, etc. This allows to develop optimal designs insulation for the buildings.

Thermography of the building

Examples

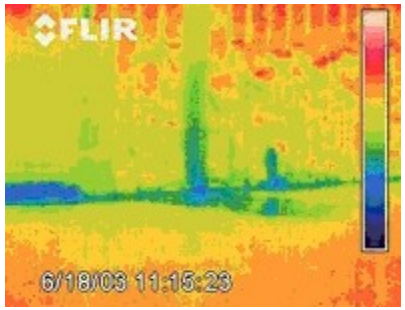


Heat loss from the facade side in a private residence



Non isolated joint of a panel in an apartment house

Thermography of the building



Raw wall after the fire

In addition to the heat resistance evaluation of the barriers (walls, ceiling, roofs), thermography can also assess the condition of the engineering systems. Camera "sees" overheated fuses, circuit breakers and other electrical connections, establishes location of the central heating pipes or even detects "plug" in the sewer pipes.

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Energy-Saving Building

Examples of implementation of the modern (renewable) technologies

Utilization of the sun energy

Utilization of the earth energy

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Energy-Saving Building

Utilization of the earth energy
Heating by means of a grounded heat pump

The main reason to use the heat pump for the heating of houses and buildings in Europe is the cheapness of the obtained heat and hot water, compared to the energy obtained by other means.

Energy received from the heat pump is by 30% cheaper than derived by coal, four times cheaper than the stove fuel, three times cheaper than gas and 1,5 cheaper than the wood pellets.

<u>In normal operating mode, the heat pump consumes as much electricity as the average household refrigerator.</u>