Energy audit in Finland

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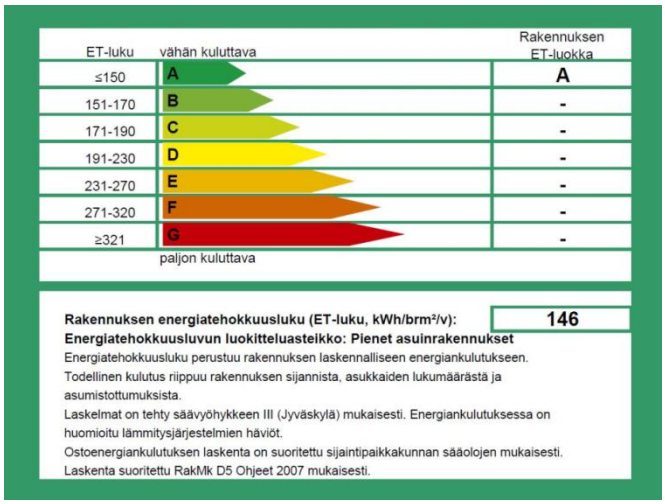


An energy audit tells about the energy efficiency and total energy consumption in a building, including all consumed heating, cooling and electrical energy. In the end, the energy efficiency of the building is described with E – number (“E – luku” or ET – luku in Finnish). The value of the E – number determines the energy class of the building, which can be from A to G, where A is the most energy efficient result and G the most energy consuming one, respectively. Conventional buildings generally have energy class of D in Finland. (Ympäristöministeriö, 2012)

Generally, every new building in Finland requires the energy audit. The energy audit calculation procedure for each building is determined by the type of the building. So buildings are classified in nine different classes, having different kind of regulations and calculating procedures (setting points) for e.g. inside temperature, heat conductivity of walls, ventilation rate and so on, as shown in the table 1 below.

Table 1. *Building categories with setting points used in energy demand calculations* (Ympäristöministeriö, 2012)

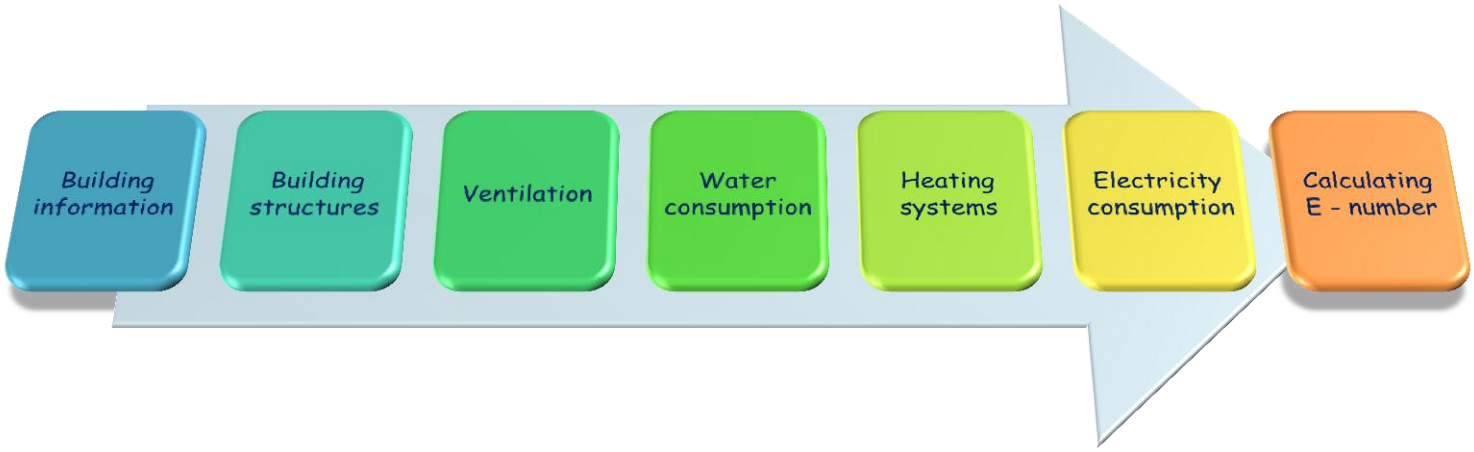
Class	Building type	Supply air rate from outside (dm3/sm2)	Heating limit (C°)	Cooling limit (C°)
Class 1	Individual one-family houses and row houses	0,4	21	27
Class 2	Residential apartment buildings	0.5	21	27
Class 3	Office buildings	2	21	25
Class 4	Shop/store buildings	2	18	25
Class 5	Accommodation buildings	2	21	25
Class 6	Teaching buildings and kindergartens	3	21	25
Class 7	Sport buildings excluding swimming halls and ice stadiums	2	18	25
Class 8	Hospitals	4	22	25
Class 9	Other buildings	-	-	-

Still, there are some exceptions in some cases when the audit is not needed. Such cases include:

- A building having a gross heating area less than 50 m^2
- Manufacturing buildings that are not requiring notable heating energy because the production processes give out enough heat to the building. This kind of case can also include those buildings where better insulation might increase too much the inside temperature and/or to lead excess use of cooling energy
- Non-occupied buildings consuming little energy (agriculture buildings)
- Holiday buildings having seasonally operating heating system
- Buildings negative impacts from energy auditing (greenhouses, bomb shelters etc.)

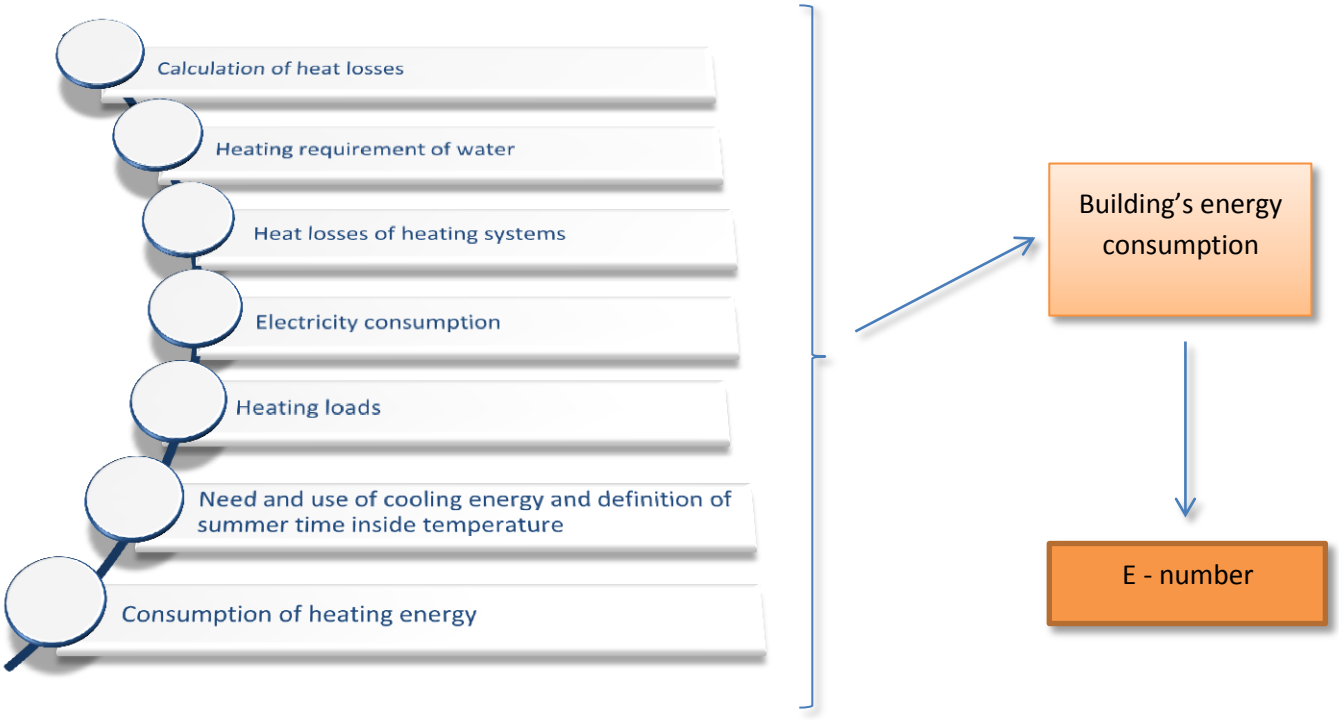
The value of E – number (kWh/m^2) is obtained by dividing the building's annual total energy use (bought energy!) by the gross area of the building and multiplying the result with energy coefficients. Different forms of energy such as district heat, electricity and fossil fuels have different coefficients affecting thus the final result. In different building sizes and types there are also limiting value for E – number that is not allowed to exceed in any case. (Ympäristöministeriö, 2012)

The general procedure in order to get the energy audit for class 1 building is illustrated in Figure 1 below. Figure 1 presents required data of the building in order to calculate the E – number. Figure 2 presents the actual factors to be calculated in order to define E – number. Other buildings (building communities having more than six houses and service buildings) require basically same kind of data, but the standards and some requirements are different. (Ympäristöministeriö, 2012)



- ***Building information*** includes the type, location, construction year and the number of rooms of the building. Other essential requirements include the gross surface area (m^2), the volume of the building (m^3), room surface area (m^2), air volume (m^3) and number of persons.
- ***Building structures*** includes the part where the U-values, surface areas and heat losses for outer walls, base floor, roof, doors, windows and thermal bridges are defined. In addition, the compass points, perpendicular g-value (solar energy transmittance) and F-values (ratio of windowpane and the whole window structure) of the windows are required. Also the effective heat capacity of the building is needed.
- ***Ventilation*** part requires the information about air exchange rate n_{50} (1/h) (50 Pa pressure difference), outgoing and incoming air velocity rates (m^3/s) of ventilation and annual efficiency of heat recovery of the ventilation system (%).
- ***Water consumption*** part requires the data of hot water consumption (m^3/year). This part can also require some data about existing water measurement and billing system.
- ***Heating systems*** part needs the information about the use of an existing heating system. Data involved to heat distribution (e.g. floor radiator) have to be known.
- ***Electricity consumption*** includes the data of annual use of electricity consumed by lighting, ventilation and electric appliances. (The amount of consumed electrical energy equals to the amount of thermal load from electrical appliances and lighting) (kWh/m^2)

Figure 1. *The required data for calculating the E – number* (Energiatodistus, 2012)



- ***Calculation of heat losses*** defines the heat losses involving to building structures, including heat conduction through building envelope and heating requirements due to air leakages.
- ***Heating requirement of water*** specifies the need of energy (kWh) in warm water applications.
- ***Heat losses of heating system*** include the heat losses of space heating systems, air conditioning and water heating systems.
- ***Electricity consumption*** includes the electricity use of ventilation system, lighting and other electric appliances.
- ***Heating loads*** includes heat generated by occupants, lighting, electrical appliances, solar energy through windows and heat losses from heating systems.
- ***Need of cooling energy and definition of summer time inside temperature.*** The aim of this part is to define required cooling energy during warmer seasons. In addition, the monthly average of inside temperature during warmer seasons have to be determined in order to calculate the amount of required cooling energy and avoid too high room temperature.
- ***Consumption of heating energy*** defines the amount of thermal energy including both heating energy for space and heating energy for water (second step from above). Heat recovered by energy recovery system must be taken into account.

Figure 2. *Calculation procedure of E – number* (Ympäristöministeriö, 2012)

As seen from figures above, the calculation of the E – number lefts out the external use of energy of the property. The calculation procedure takes into account only the consumption of energy in the building (building structure defines the boundaries of the system). As mentioned before, calculation of E – number takes into account different forms of energy, having thus different coefficients (Table 2), which are weighing the result (renewable energy generated by house does not have any coefficient). So in the end the E – number is defined by calculating weighed consumed bought energy per building's square meters, while the building is operating under standard conditions. The numerical result, E – number, defines then the energy class of the building. (Ympäristöministeriö, 2012)

Table 2. *Coefficients for different forms of energy* (Ympäristöministeriö, 2012)

Electricity	1,7
District heating	0,7
District cooling	0,4
Fossil fuels	1
Renewable fuels	0,5

The energy audit for new buildings is admitted by a leading designer. For existing buildings, the audit can be admitted by a separate person who has the rights to do so. (Ympäristöministeriö, 2012)

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