Heatmod 7.0

User Guide

Version 1.0

Table of contents:

Table of figures:

Introduction

Online calculation tool *Heatmod 7.0* (*http://www.heatmod.lv*) use the same mathematical algorithms as for monthly and annual energy consumption, also for the determination of heating/cooling power, replacing the average temperatures with the minimum (in case of heating) un maximum (in case of cooling) values, thus, simulating regime at highest possible temperature difference. Therefore, a power needed to provide the set indoor temperature in extreme outdoor conditions is calculated.

Calculation tool landing page (**Figure 1**) has a small description, ability to log in for registered users, change languages (currently 2 languages are supported – English and Latvian), create new project, read the terms and conditions and register for the usage.

For **public users** (**Figure 1**), one can use all the features of the tool to make calculation only for one project and its related data within the session. After leaving the web page session and all its data will be lost.

For **registered users** (**Figure 2**), one can save and use unlimited number of projects, constructions, materials and climate data cities, in addition to group and tag all the data for more convenient usage.

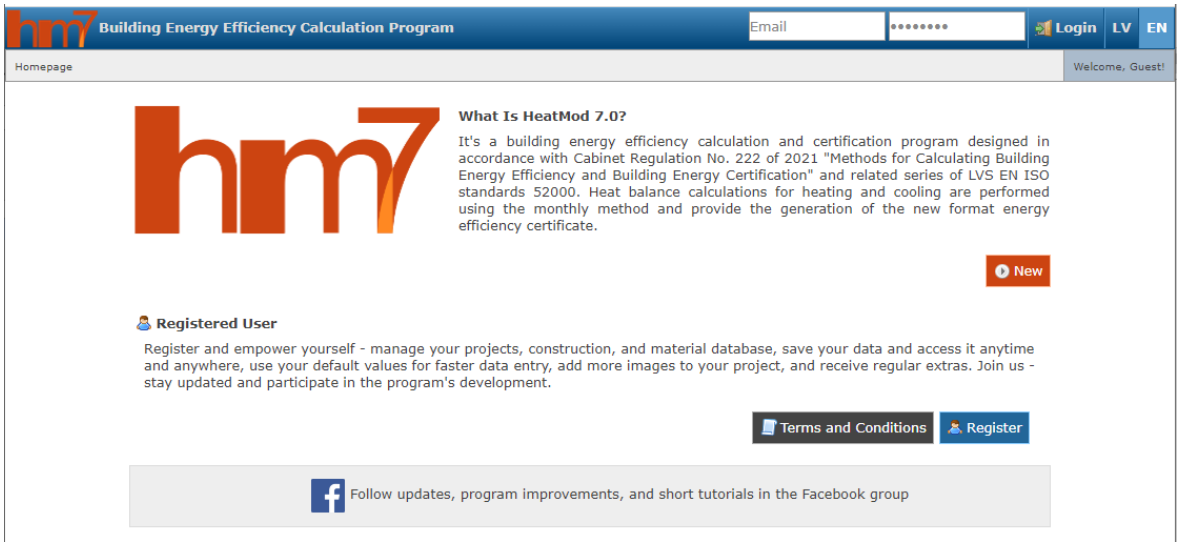

Figure 1 *Heatmod 7.0: landing page for public user.*

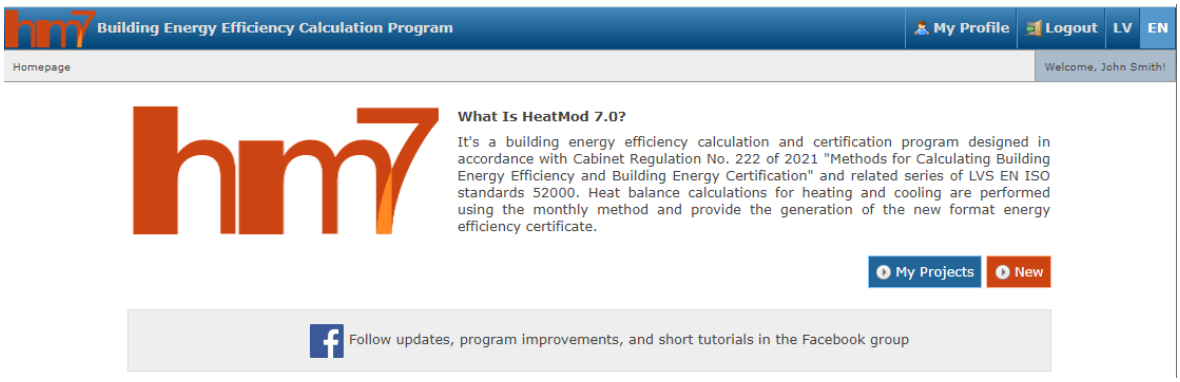

Figure 2 *Heatmod 7.0: landing page for registered and logged in user.*

Main structure & features

The program structure consists of such main choices:

- **Projects** (**Figure 3**), where all user-generated calculations are created, copied or deleted. Typically, one project corresponds to one building with defined set of parameters, every change of them (e.g., replacing the windows or insulation of walls) should be stored as a new project with following grouping feature. One project contains data and results for both - heating and cooling seasons. In addition, user can join multiple projects for comparison reason, also add tags, tag projects to them, archive or export projects.

- **Constructions** (**Figure 4)** with user-set thermal transmittance values (*U*-values) and more complex composite building structures, whose *U*-values are calculated (**Figure 5**) based on material parameters (thickness and thermal conductivity). Constructions may be connected to a specific project, or they may not be related to them - in that case, the created construction can be used for calculation in any project.

- **Materials Database** (**Figure 6**), in which the data from the Latvian Building Code LBN 002-19 are collected in a grouped form. The user also has the possibility to create his own materials and group them in a free form by specifying the name and the value of the thermal conductivity.

- **Common Data** (**Figure 7**) is for different cities in Latvia containing information about monthly average outdoor temperatures, solar irradiation for different orientations. There is also Latvian statistics on average consumption of different type of buildings. In addition, user can add its own custom cities and related climate data for it.

- **My Profile** (**Figure 8**) is for saving user profile data, change password and manage some default values for projects.

The interface of the calculation tool is divided into some parts (**Figure 9**). At the top there are described main menu with following short path. In the left part there are 3 top-level items – the project level, engineering systems level and the building construction level. The right part displays all the information about selected top-level item, allowing enter and view the content.

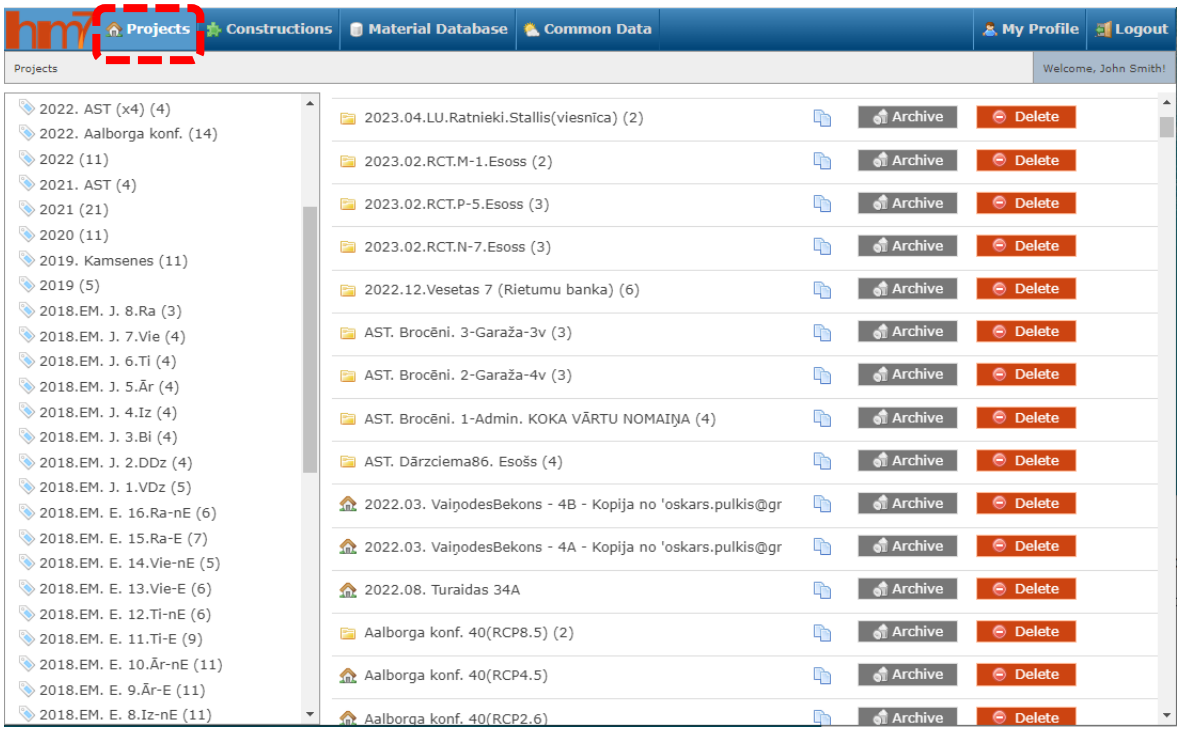

Figure 3 *Heatmod 7.0: project and group level.*

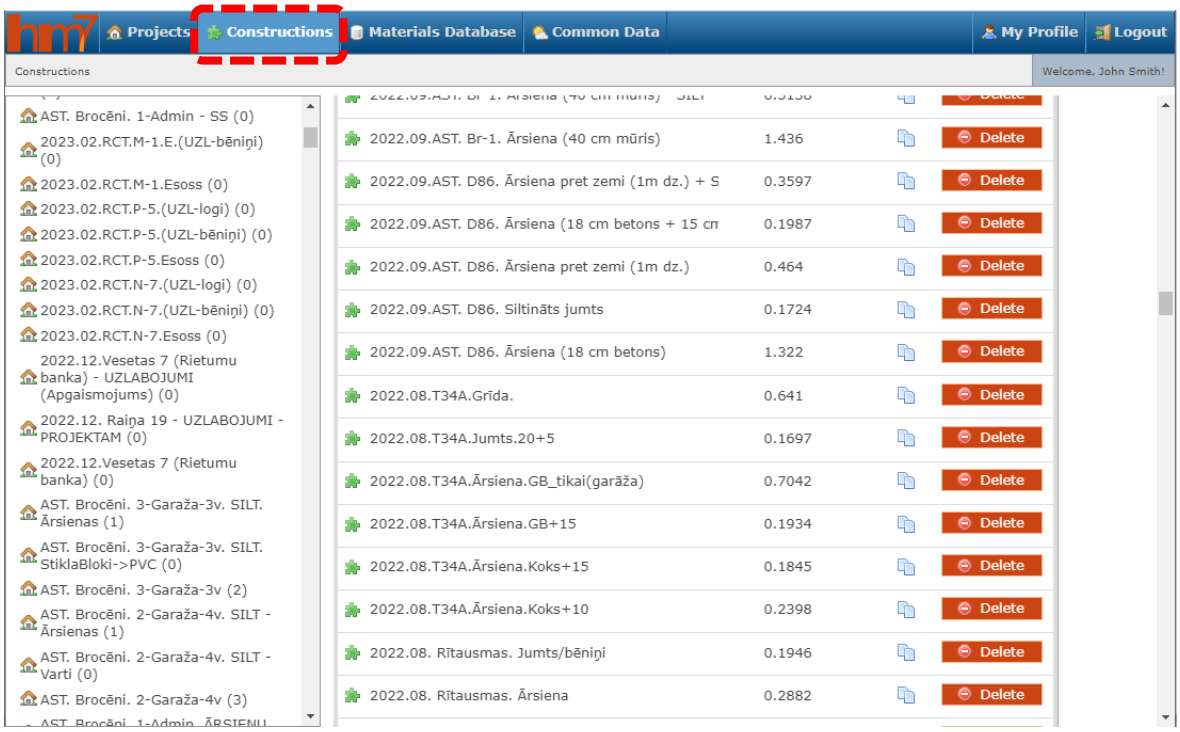

Figure 4 *Heatmod 7.0: construction level.*

Figure 5 *Heatmod 7.0: U-value calculator at construction level.*

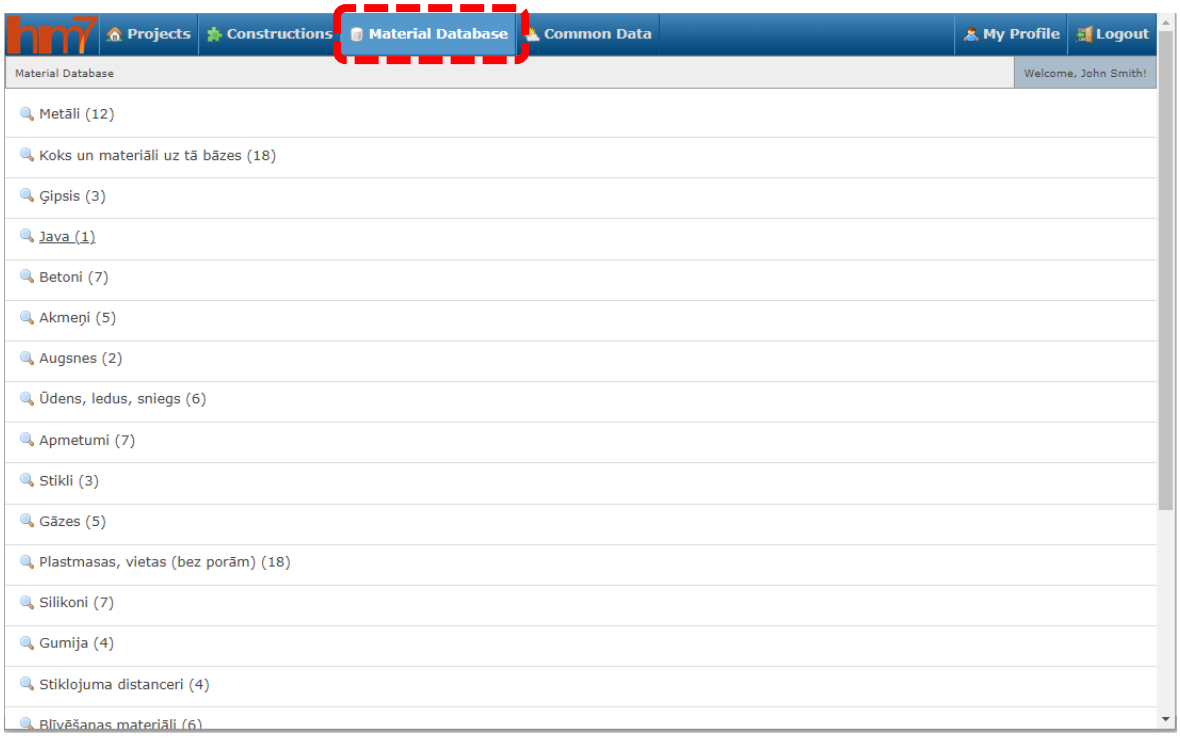

Figure 6 *Heatmod 7.0: materials database.*

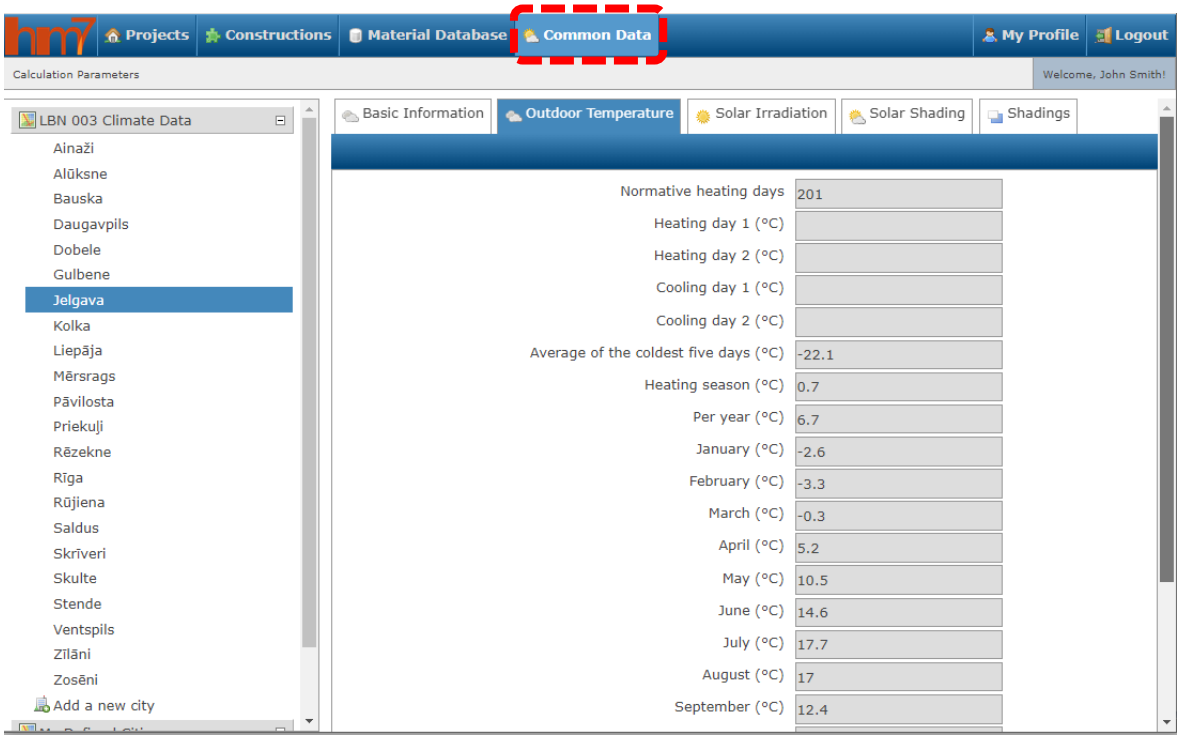

Figure 7 *Heatmod 7.0: Climatic data for different locations.*

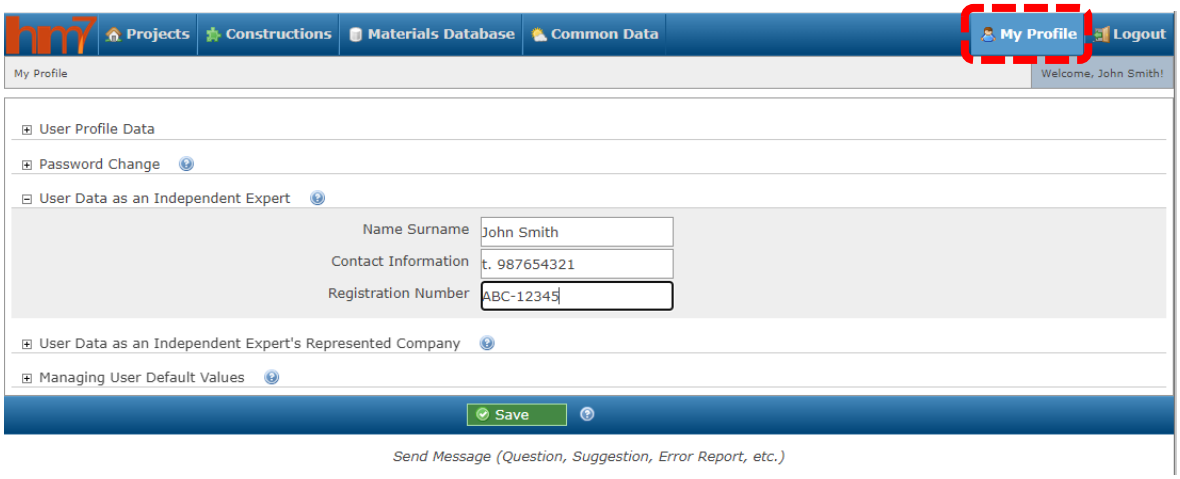

Figure 8 *Heatmod 7.0: User profile data.*

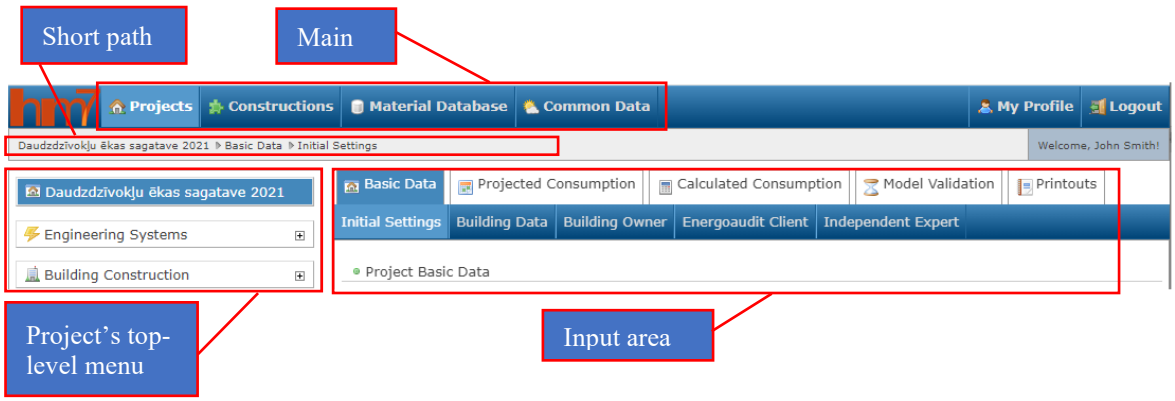

Figure 9 *Heatmod 7.0: structure.*

Working with projects

The project top-level menu **project** (**Figure 9**) contains all the information (input and output data) about the building that is being calculated:

- **Basic data** of the project, incl. initial data (name, calculation date, calculation type, building condition and life cycle, energy efficiency assessment type), building data (building type/category/usage, address, year of construction volume, number of floors, area and volume etc. (**Figure 10**), as well as geographic location, which is needed for reading the climatic data from the database (**Figure 11**). In addition, there can be added building owner, client and expert data.

- **Measured (or projected) consumptions** (**Figure 12**) are the consolidation of the consumption data entered by the user on **engineering systems** top-level (**Figure 9**). For data required for the consumption data, see section **Engineering systems**.

- **Calculated consumptions** (**Figure 13**), displaying calculated values for the cooling and heating by data entered by user on **building construction** top level (**Figure 9**). For data required for the calculation, see section **Building constructions**. Here it is also possible to visualize the calculated data using different views – by months, energy types (losses, sources), building constructions etc. (**Figure 14**).

- **Model validation** (**Figure 15**), showing differences between measured and calculated values. As heat balance model includes only heating and cooling balance, all other consumptions are to be entered manually (ventilation, DHW, lighting and other). Model is valid, if difference between measured and calculated values is less than 10% and not exceeding 10 kWh/m^2.

- **Printouts** (**Figure 16**), where it is possible to upload images, certificates and additional data files to be saved within active project. Here is possible also to print out all the project's input data and calculation results as temporary certificate. In addition, there can be planned building improvements and compared to other linked projects data.

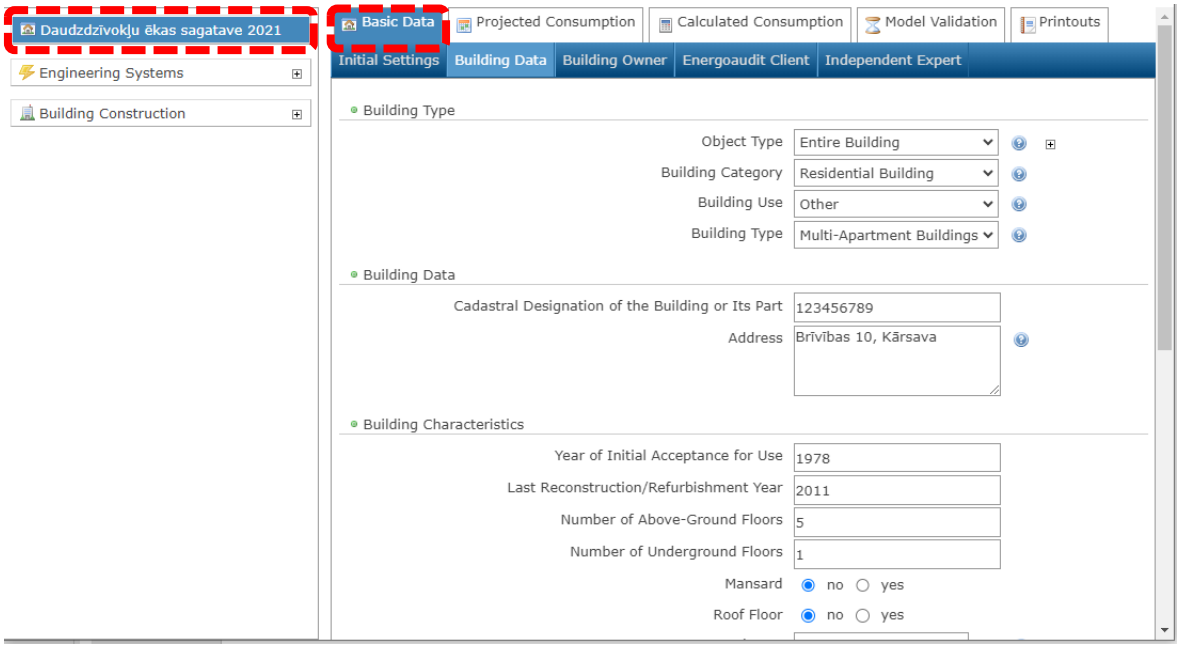

Figure 10 *Heatmod 7.0: Basic data of the building.*

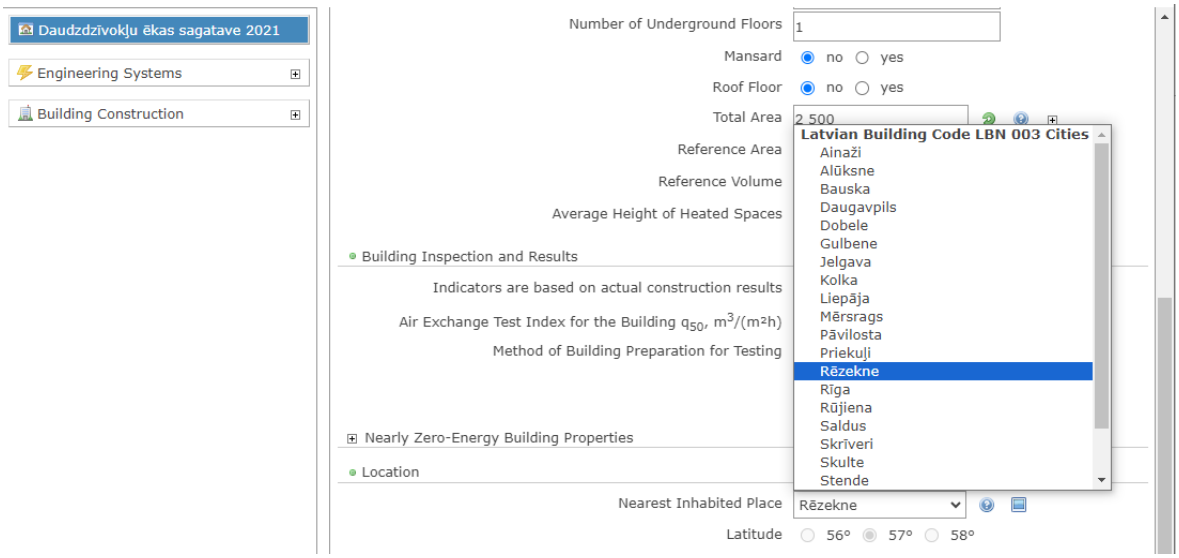

Figure 11 *Heatmod 7.0: Geographic location of the building.*

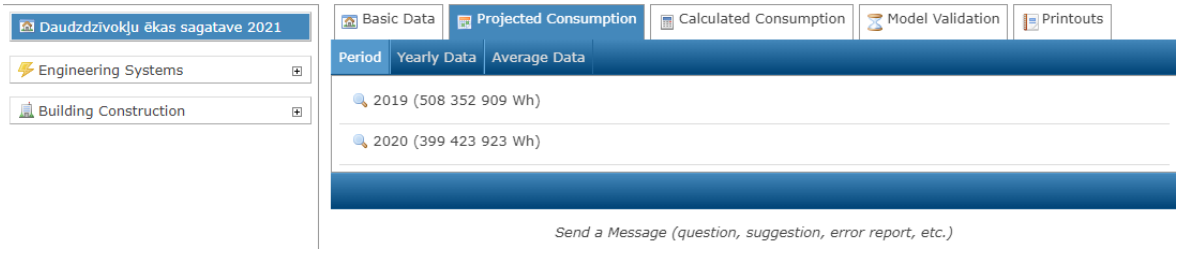

Figure 12 *Heatmod 7.0: Measured values.*

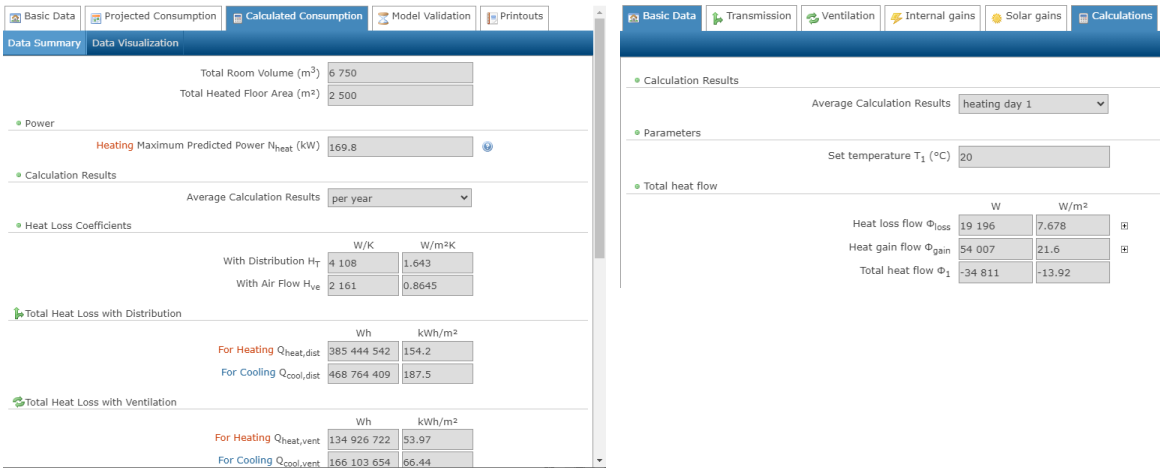

Figure 13 *Heatmod 7.0: Calculated values – for heating and cooling amount (left) or power (right).*

Figure 14 *Heatmod 7.0: Calculated values – graphs.*

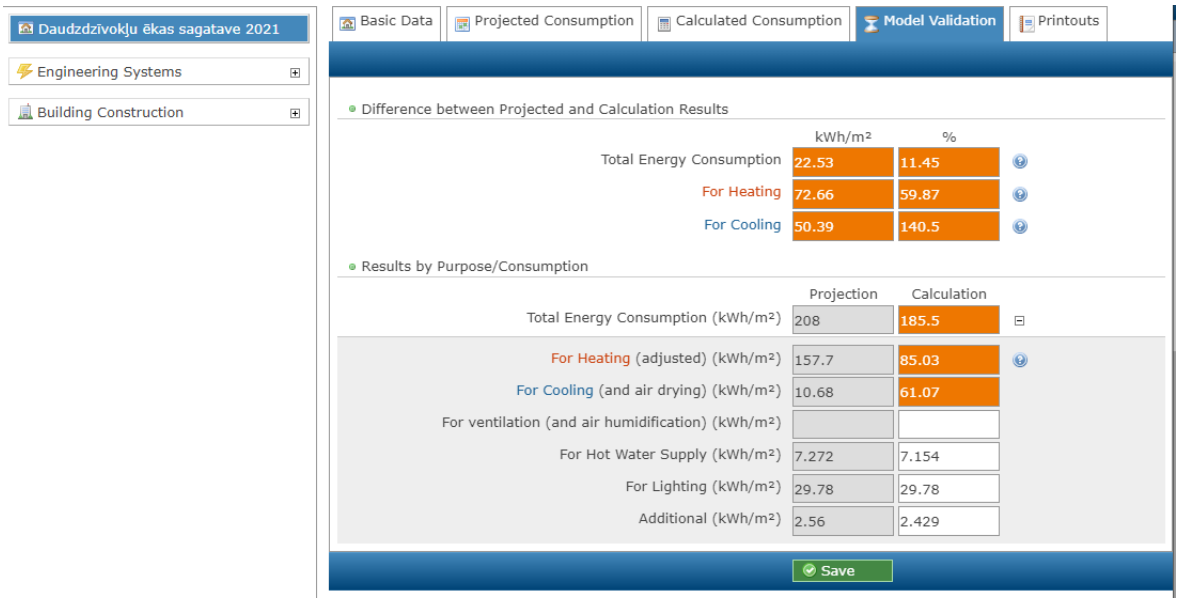

Figure 15 *Heatmod 7.0: Model validation.*

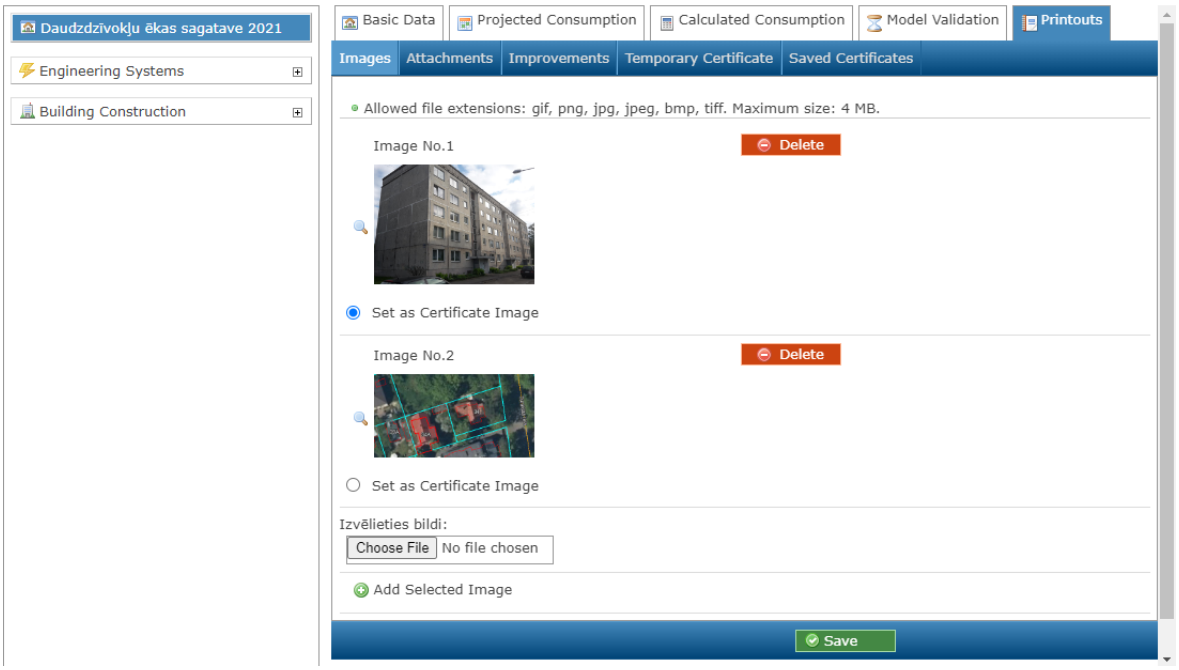

***Figure 16** Heatmod 7.0: Data for printout.*

After entering the basic project data, the information should be entered in the following two top-menu items: **engineering systems** and **building constructions** (**Figure 9**):

- **Systems (or engineering systems)** - a list of the main engineering systems used in the building, the measured (or designed) consumptions for them are to be entered here. The results of this section are further summarized in the "Measured values" section of the project (**Figure 12**).

- **Building (or building constructions)** – a main data of the whole building (or their zones) and the list of the boundary structures with following heat balance modelling and the heating/cooling demand and power. Includes heat losses and sources. The results of this section are further summarized in the "Calculated values" section of the project (**Figure 13**).

Notes:

- Depending on the project data (condition, like life cycle etc.) its input area (**Figure 9**) menu is adjusted, by showing only appropriate items.

- Depending on weather user needs to calculate heating and cooling consumption or maximal powers, input area (**Figure 9**) field are adjusted.

Engineering systems

The project's top-level menu **engineering systems** (**Figure 17**) is being created from the user entered information about following engineering systems presented is the building: heating, cooling, domestic hot water (DWH), mechanical ventilation and lighting. Additional non-specified energy also can be added to ensure the work of other systems (e.g., circulation pumps for the heating system or DHW).

Each of the engineering systems has the possibility to enter energy into and out of it. For incoming energies, it is possible to indicate the measured data (energy consumption,

length of heating season an indoor/outdoor temperatures) for different years (**Figure 18**), while for outgoing energies the consumption amounts are automatically calculated depending on the efficiency of the engineering system. In case of the heating boiler, the typical efficiency is within the range 85…95%. In case of heat pump, the seasonal coefficient of performance (SCOP) should be used, which it greater than 1 – in this case all the energy difference is assumed to be produced from renewable energy resources (**Figure 19**). Schematic drawing of energy flows is shown near the input form for better understanding of the process (**Figure 20**).

A list of all entered engineering systems is displayed on the left side in a tree structure, each of the items can be collapsed or expanded by clicking on a plus/minus button on the right. The results of this section are summarized in the "Measured values" section of the project (**Figure 12**).

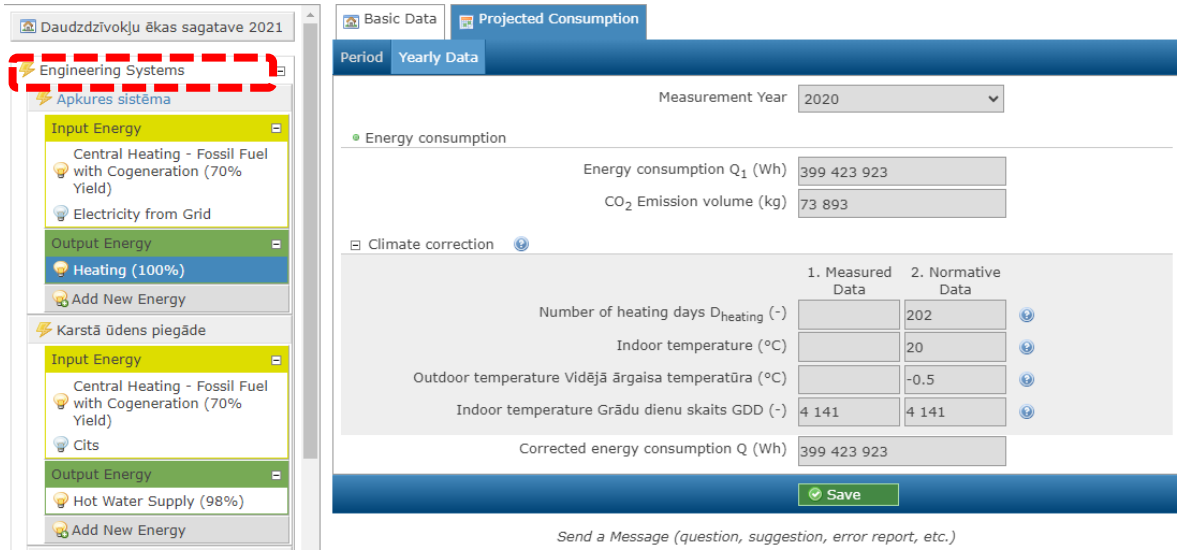

Figure 17 *Heatmod 7.0: System top-level menu.*

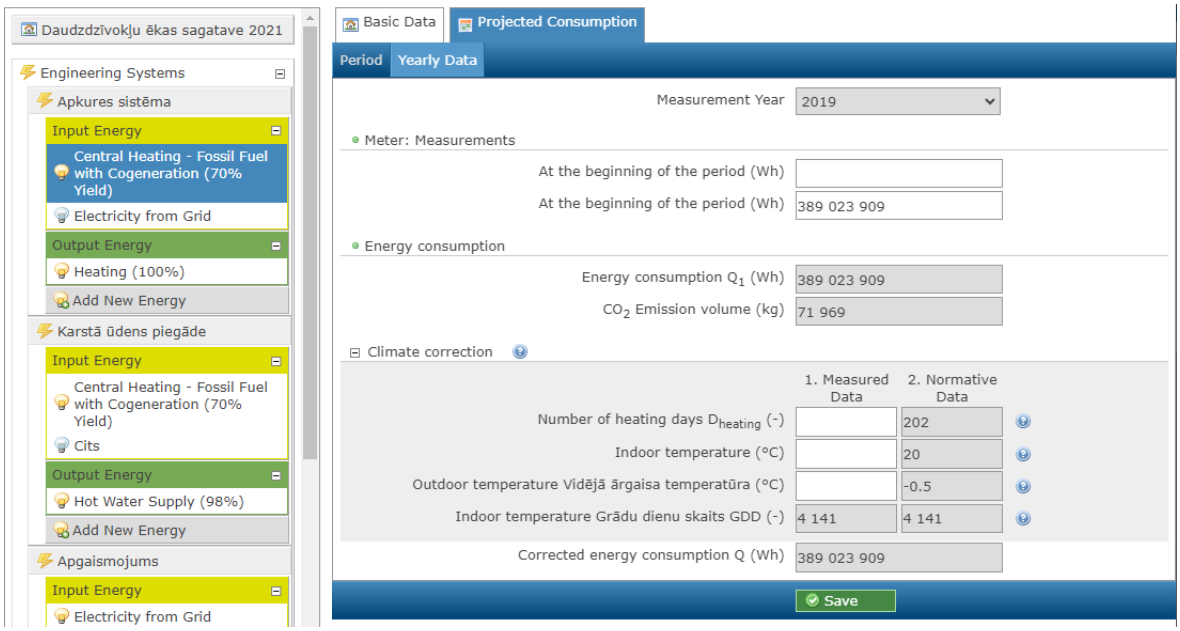

Figure 18 *Heatmod 7.0: Heating data (energy consumption, heating days and temperatures) input for one year.*

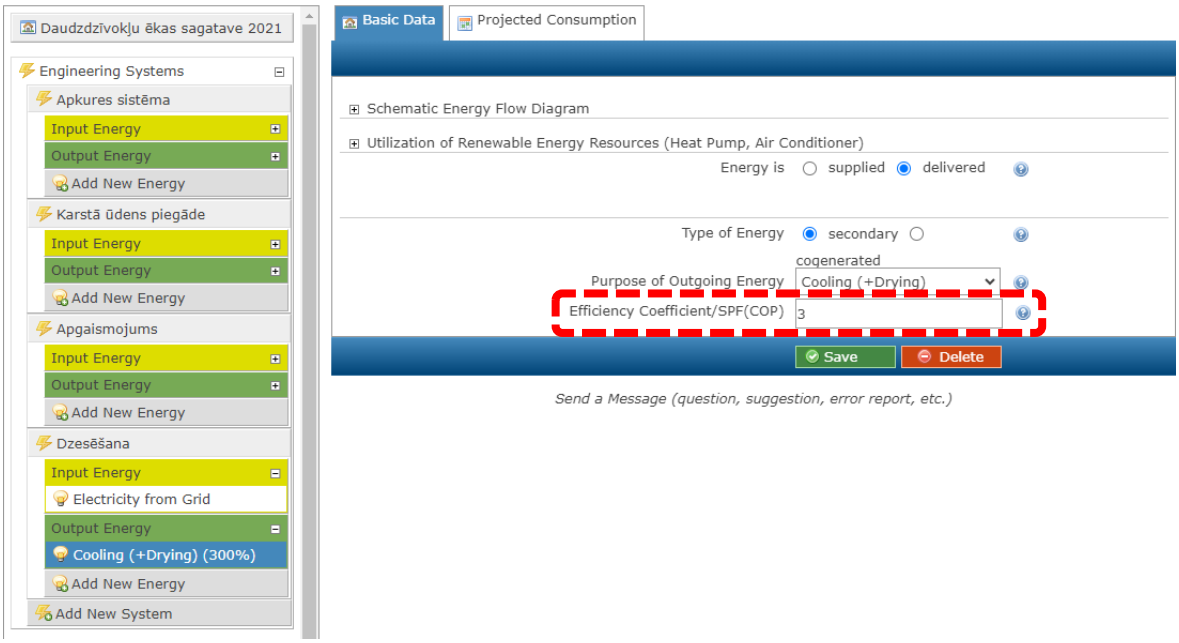

Figure 19 *Heatmod 7.0: Definition of the heat pump for cooling with SCOP of 3.*

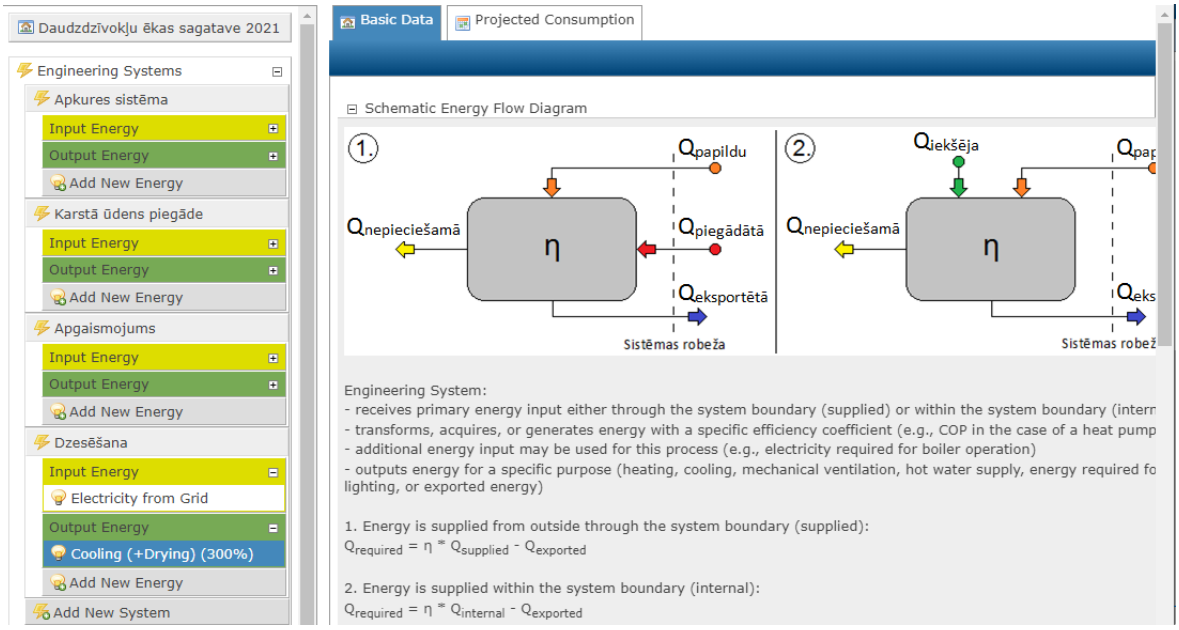

Figure 20 *Heatmod 7.0: Schematic drawing of energy flows in one zone.*

Building constructions

The project's top-level menu **building constructions** (**Figure 21**) is the frame for heat balance model of the selected building. It contains at least one building zone (number of zones is unlimited), for which heat losses and gains are defined and needed energy amount and power is calculated according [2]. Each zone consists of set of general parameters (for ventilation and internal heat sources) and boundary structures with their own parameters describing transmittance and solar heat gains (number of structures is unlimited).

A list of all entered zones with corresponding boundary structures is displayed on the left side in a tree structure, each of the items can be collapsed or expanded by clicking on a plus/minus button on the right. The results of this section are summarized in the "Calculated values " section of the project (**Figure 13**, **Figure 14**). Any zone or boundary structure can be copied and deleted. Boundary structures can be copied to another zone as well.

Operations within zone includes:

- **Basic data** (**Figure 22**): name, description, type (residential, office, etc.), main construction material and classification, heated floor area, average height and total volume, as well as monthly indoor temperature for heating and cooling in of annual calculation method or one temperature for power calculations (**Figure 23**).

- **Transmission** – contains a summary of heat transmission losses in the selected zone, which is calculated from data on building elements of the zone (**Figure 24**). It includes area of all defined boundary structures (m^2), heat transfer coefficient H_T (W/K), power and energy as absolute (W, Wh) or normalized (W/m^2, kWh/m^2) value.

- **Ventilation** – provides an opportunity to define the ventilation parameters in the selected zone (**Figure 25**) for both – natural and mechanical ventilation cases. For the natural ventilation it is possible to define an air exchange rate (h^{-1}) or an air flow (m^3/h), in case or mechanical ventilation – also heat recovery coefficient (%), which affects the inlet air temperature (**Figure 26**). Calculation of the related heat transfer coefficient H_T (W/K), power and energy as absolute (W, Wh) or normalized (W/m^2, kWh/m^2) value are shown as the results on this page (**Figure 27**). In addition, there is a possibility to add multiple windows and night ventilation calculations for further use in ventilation (**Figure 28**).

- **Internal sources (heat gains)** – provides an opportunity to define all internal heat gains (**Figure 29**) inside the zone. The minimum needed input data consists of parameters characterizing residents, appliances and lighting. Additionally, the data about domestic hot water system incl. heat release from the circulation may be defined. Another specific internal heat gains form processes and objects may be defined here too.

- **Solar heat gains** – contains a summary of solar heat gains through transparent and opaque building elements according to EN ISO 52016-1 standard [2] as power distribution over the cardinal directions, and total energy as absolute (W, Wh) or normalized (W/m^2, kWh/m^2) values for selected zone (**Figure 30**).

- **Calculation** – summarizes all the results of heat balance calculations for one zone according to EN ISO 52016-1 standard [2] both – heating and cooling seasons. The main data includes set indoor temperature, transmittance and ventilation power and energy, indoor and solar heat gains, as well the overall results – heating and cooling energy demand for the whole year in kWh and kWh//m^2 (**Figure 31**). In case of only one room modelling, the power for pre-set 4 days are displayed (**Figure 32**)

- **Heating interruptions (or breaks)** – provides a way to define interruptions and "holidays" in the zone, thereby correcting the total required energy for heating and/or cooling (**Figure 33**).

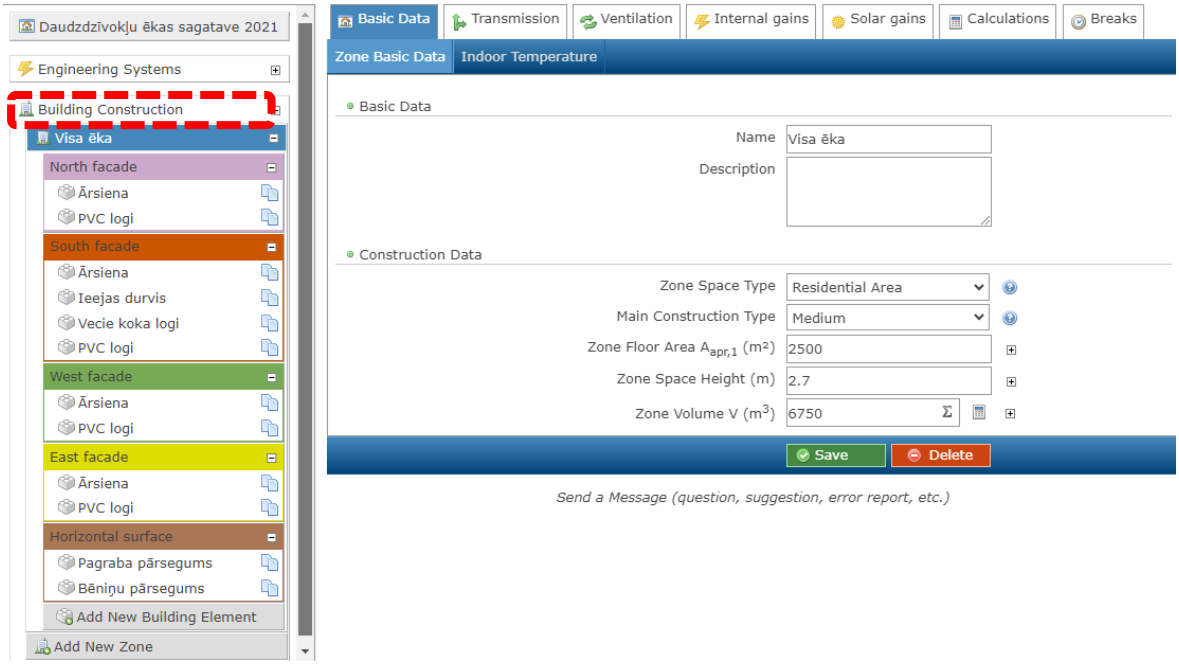

Figure 21 *Heatmod 7.0: Building top-level menu.*

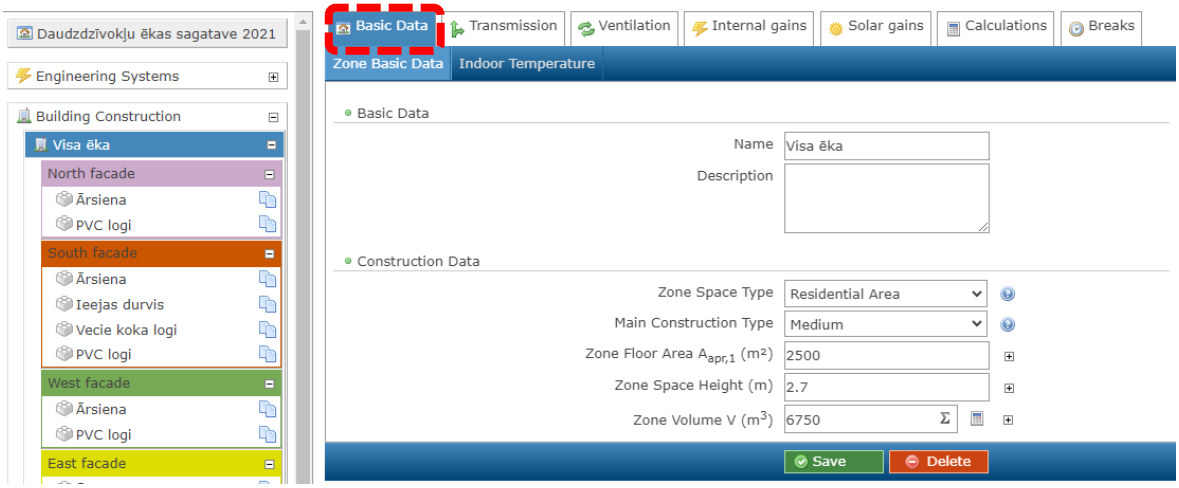

Figure 22 *Heatmod 7.0: Basic data for the zone.*

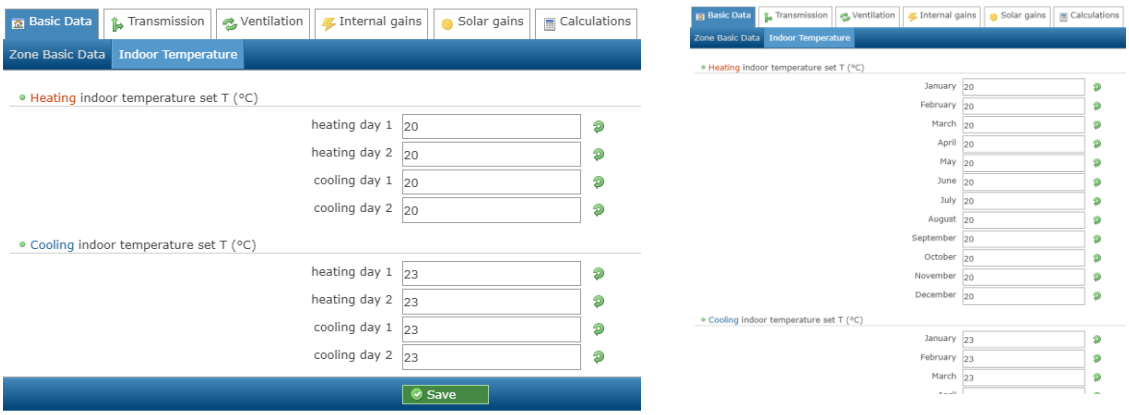

Figure 23 *Heatmod 7.0: Input of temperatures for power (left) and monthly (right) calculations.*

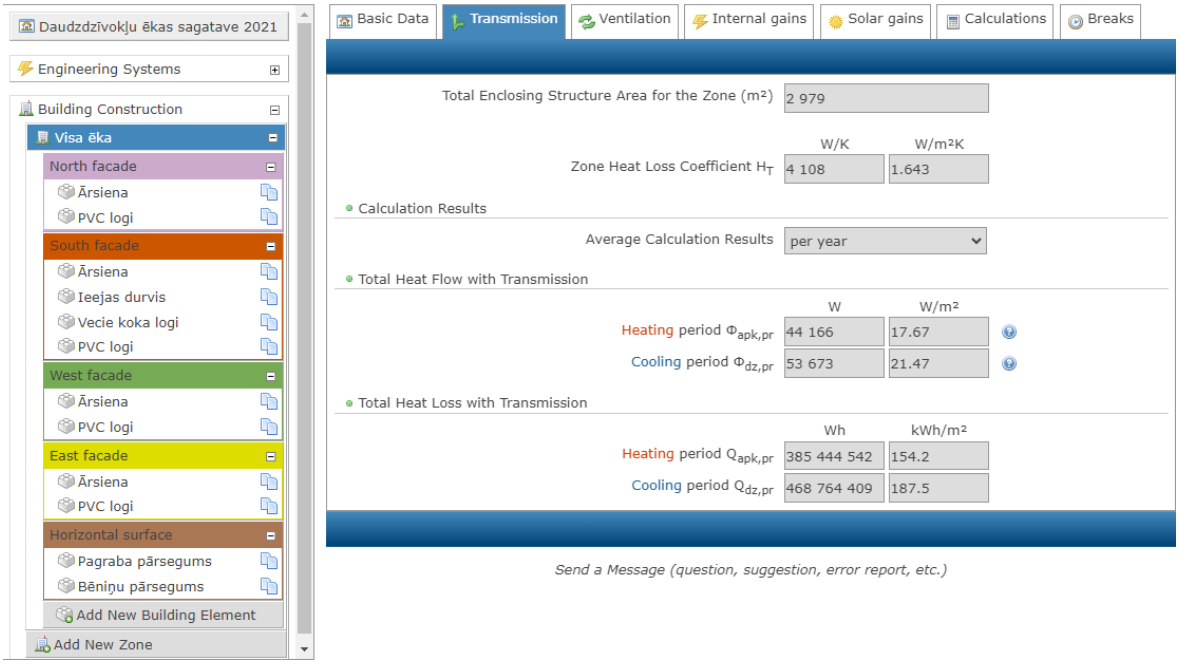

Figure 24 *Heatmod 7.0: Summary of transmission heat losses for one zone.*

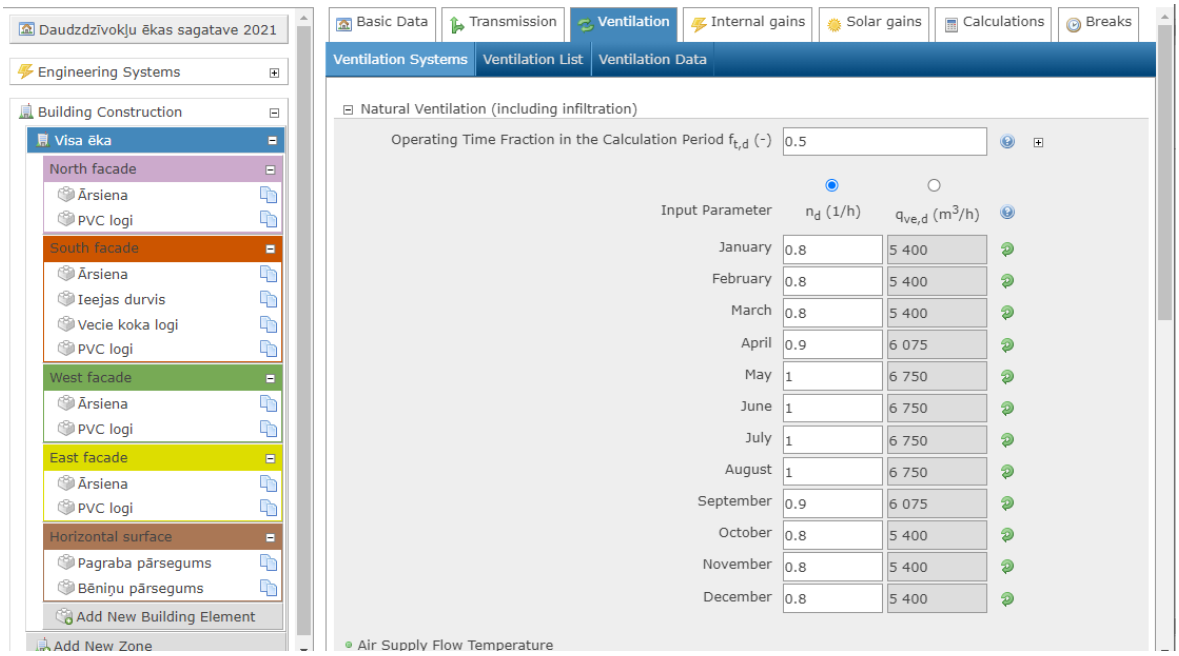

Figure 25 *Heatmod 7.0: Defining the air exchange rate for ventilation calculations.*

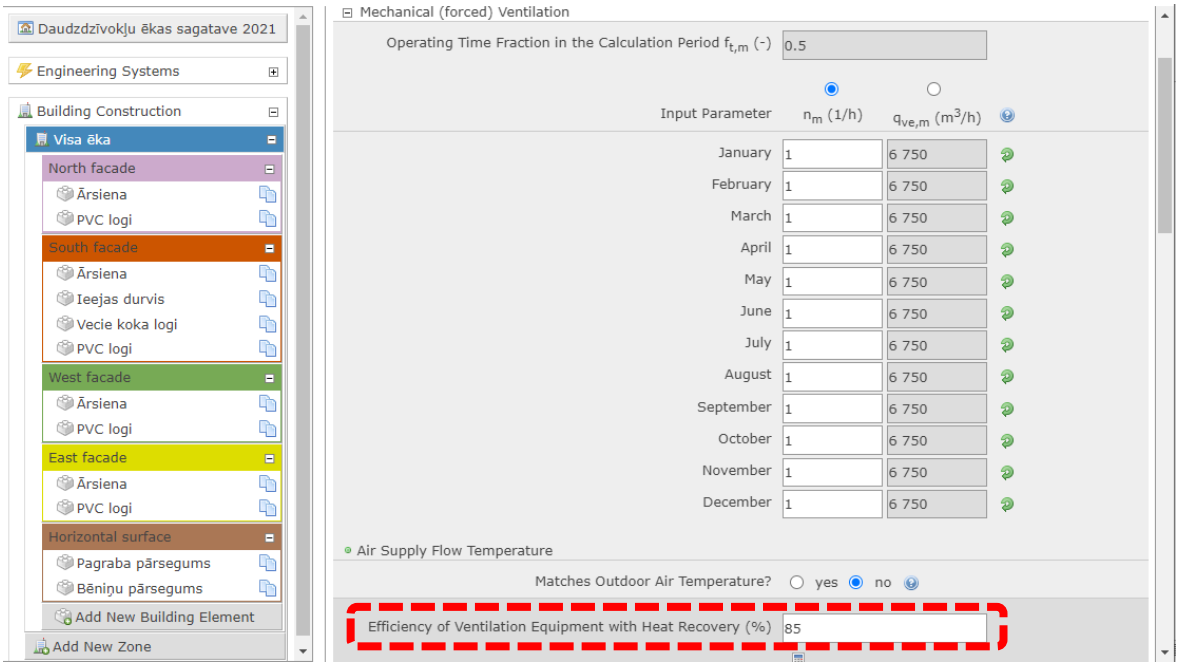

Figure 26 *Heatmod 7.0: Defining the heat recovery for mechanical ventilation calculations.*

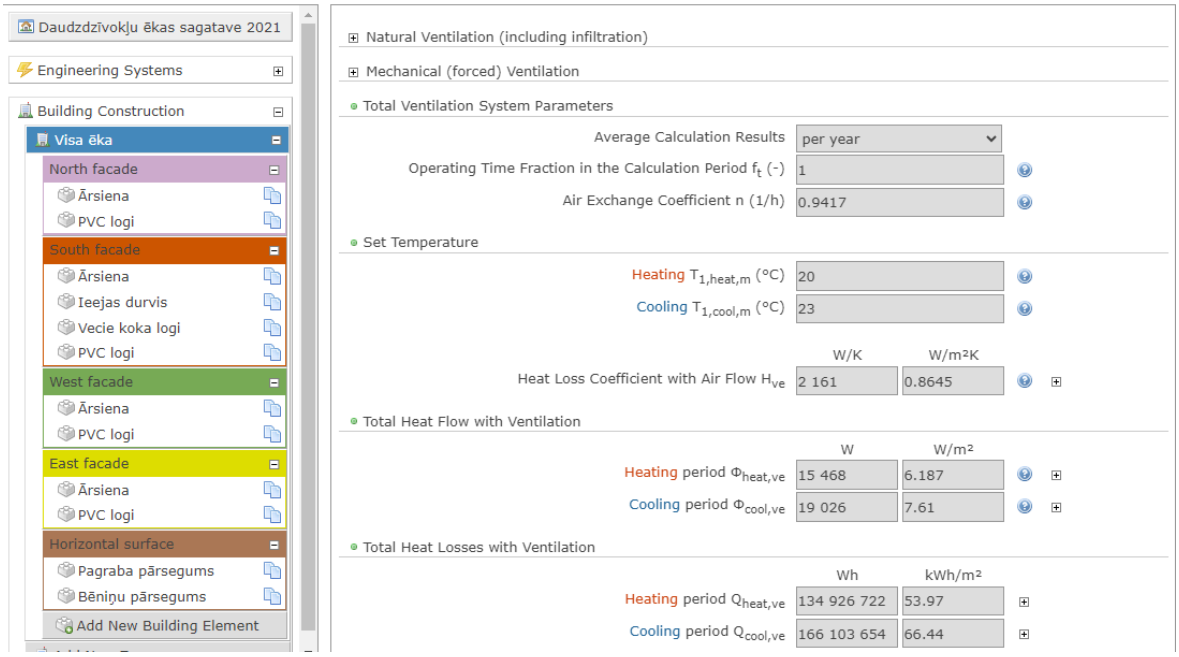

Figure 27 *Heatmod 7.0: Ventilation heat losses for one zone.*

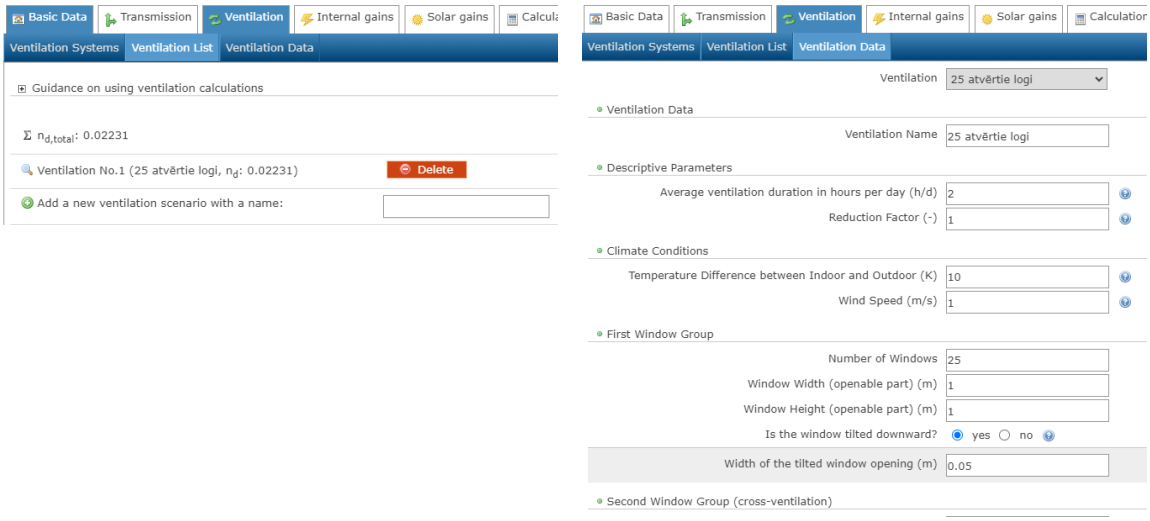

Figure 28 *Heatmod 7.0: Window and night ventilation calculations – list (left) and data form (right).*

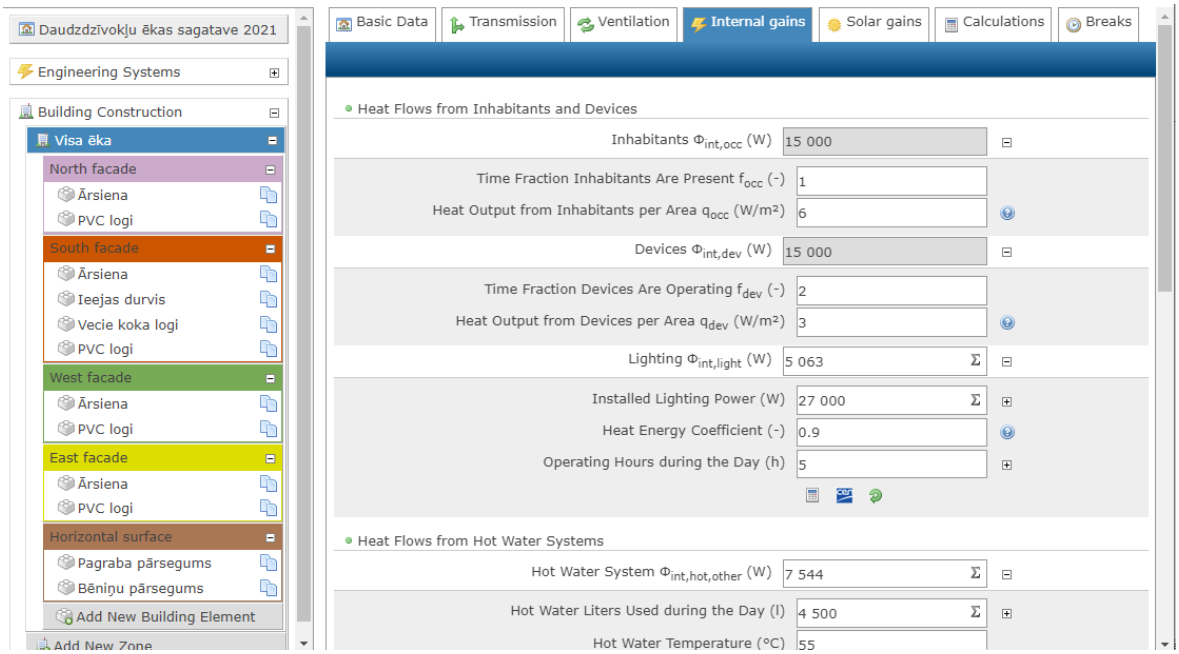

Figure 29 *Heatmod 7.0: Defining of internal heat gains for one zone.*

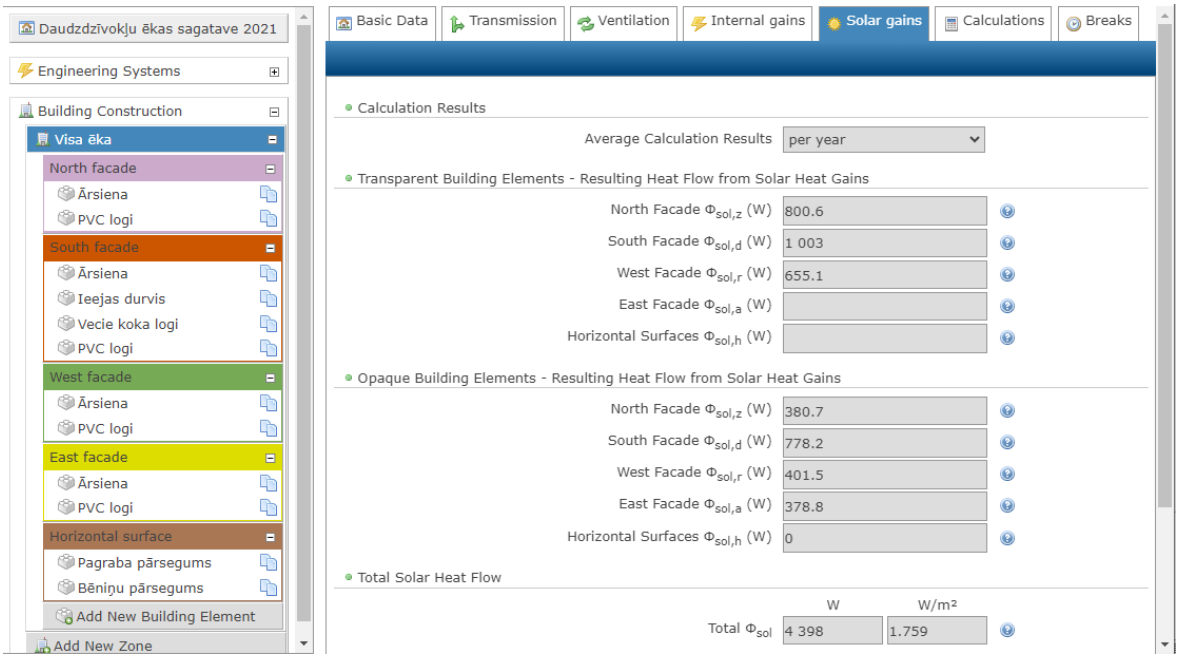

Figure 30 *Heatmod 7.0: Summary of solar heat gains for one zone.*

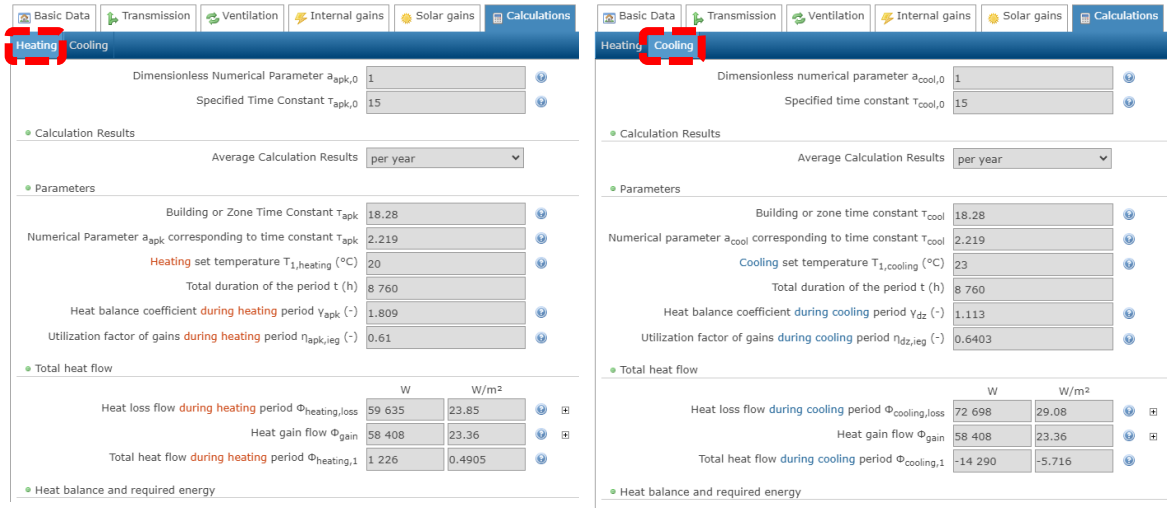

Figure 31 *Heatmod 7.0: Calculation results for monthly calculations (heating – left, cooling - right).*

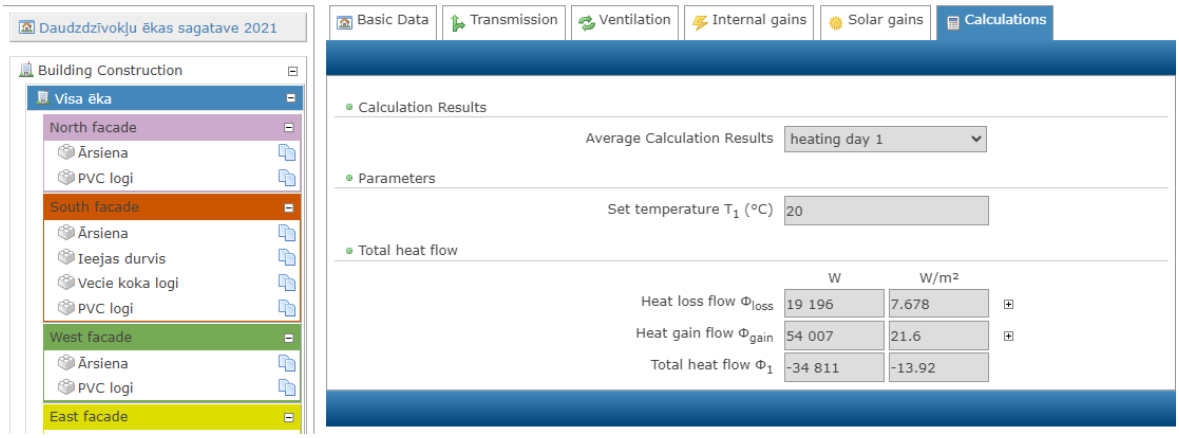

Figure 32 *Heatmod 7.0: Calculation results in case of one room calculations.*

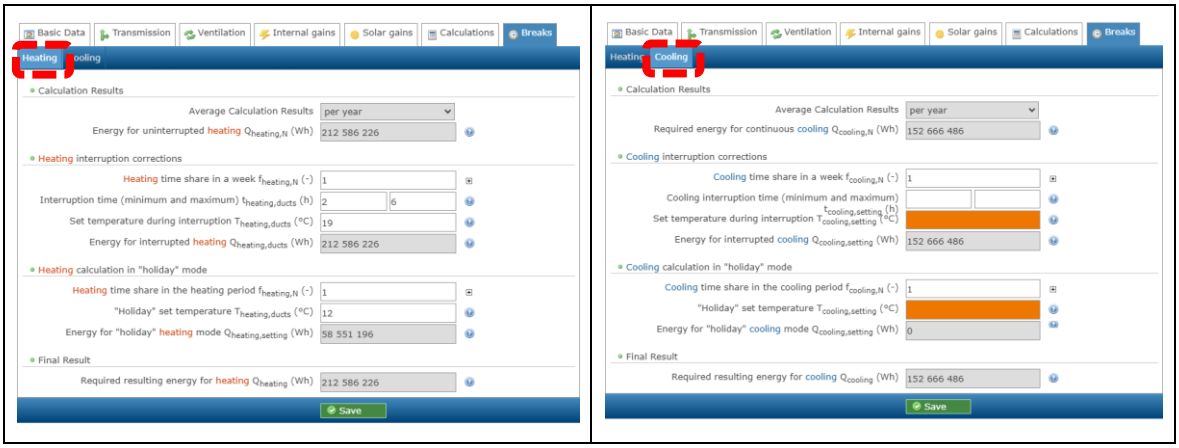

Figure 33 *Heatmod 7.0: Heating or cooling breaks (or interruptions) and "holidays" – heating (left) and cooling (right).*

Without parameters describing one zone as one object (ventilation and internal heat gains), there are parameters characterizing different boundary structures individually – transmittance heat losses and solar heat gains. Generally, they depend on the construction's area and spatial orientation, therefore, should be defined separately. Operations for each building element (boundary structure) includes:

- **Basic data** (**Figure 34**) – type (wall, ceiling, floor, window, door), orientation (north, south, east, west or horizontal), name, optional description.
- **Transmission heat losses** (**Figure 35**) with
  - **main data** – area (m^2) with build-it calculator option, *U*-value ($W/m^2/K$), optional thermal bridges, and resulting heat transfer coefficient H_T (W/K);
  - **calculations of *U*-value** for adjoining rooms (**Figure 36**) and floor (**Figure 37**) or ceiling (**Figure 38**) constructions;
  - possibility to set different **temperature outside** (e.g., to other rooms - **Figure 39**).
- **Solar heat gains** (**Figure 40**) with
  - **main data** – proportion of the frame and type of glazing for *g*-value selection;
  - adding multiple shading to element (**Figure 41**), for each making calculations of different types of shadings (**Figure 42**);
  - summary of solar heat gains for one building element for heating and cooling seasons (**Figure 43**).

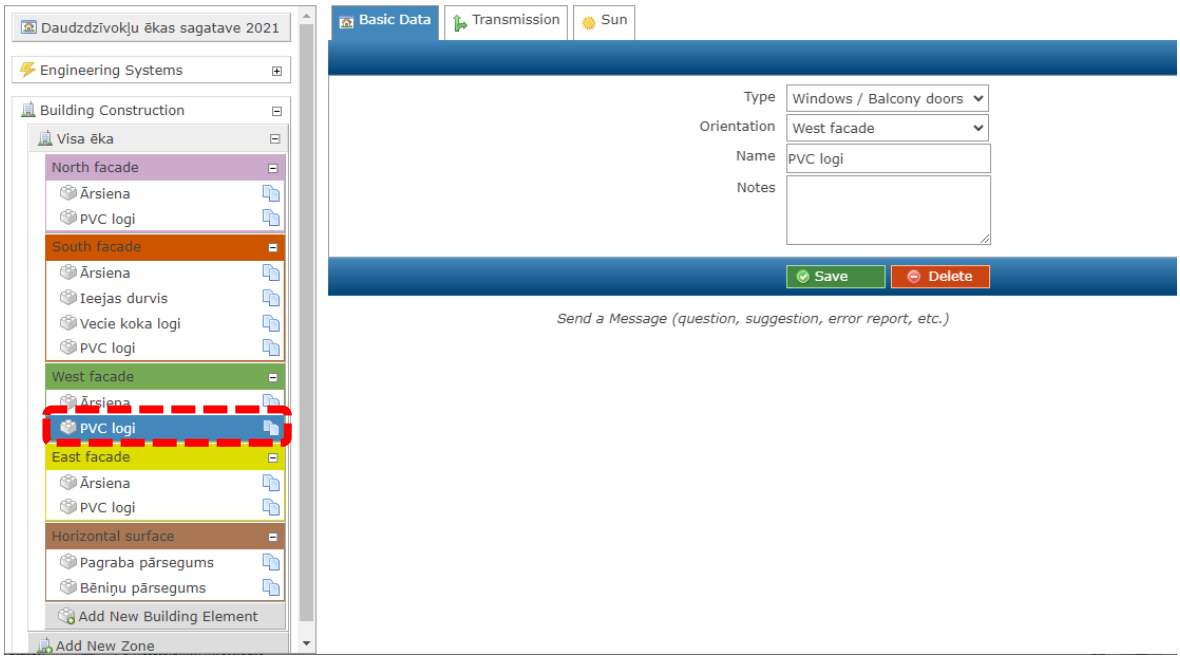

Figure 34 *Heatmod 7.0: data entry for one building element.*

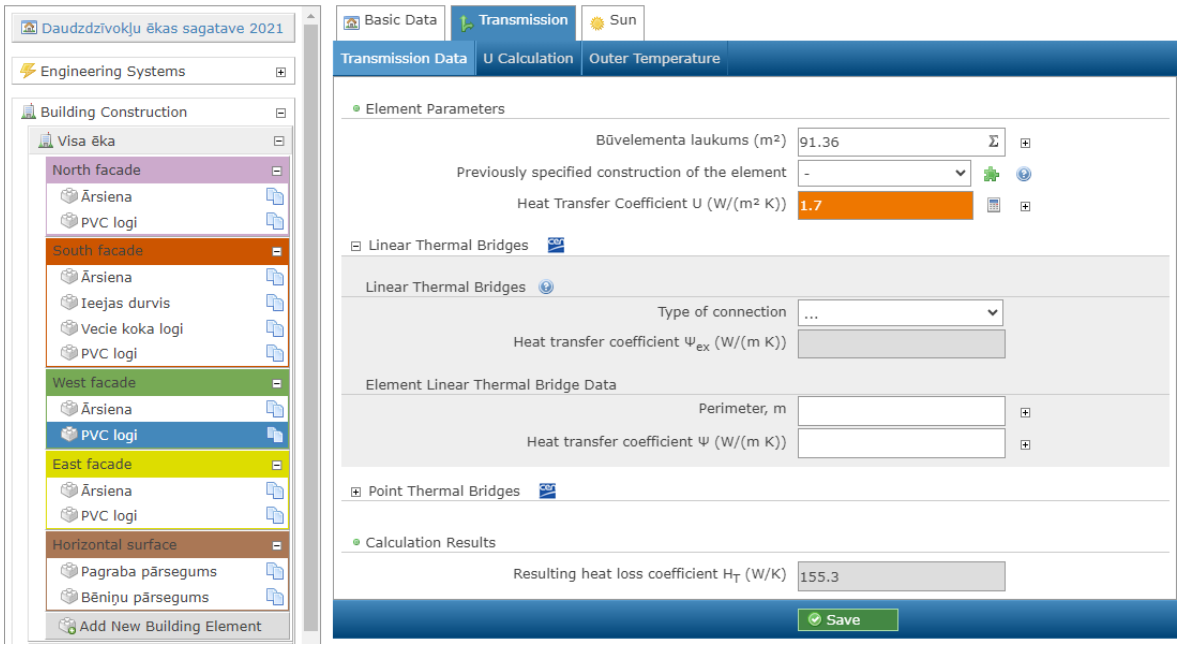

Figure 35 *Heatmod 7.0: Transmission heat losses thought one building element.*

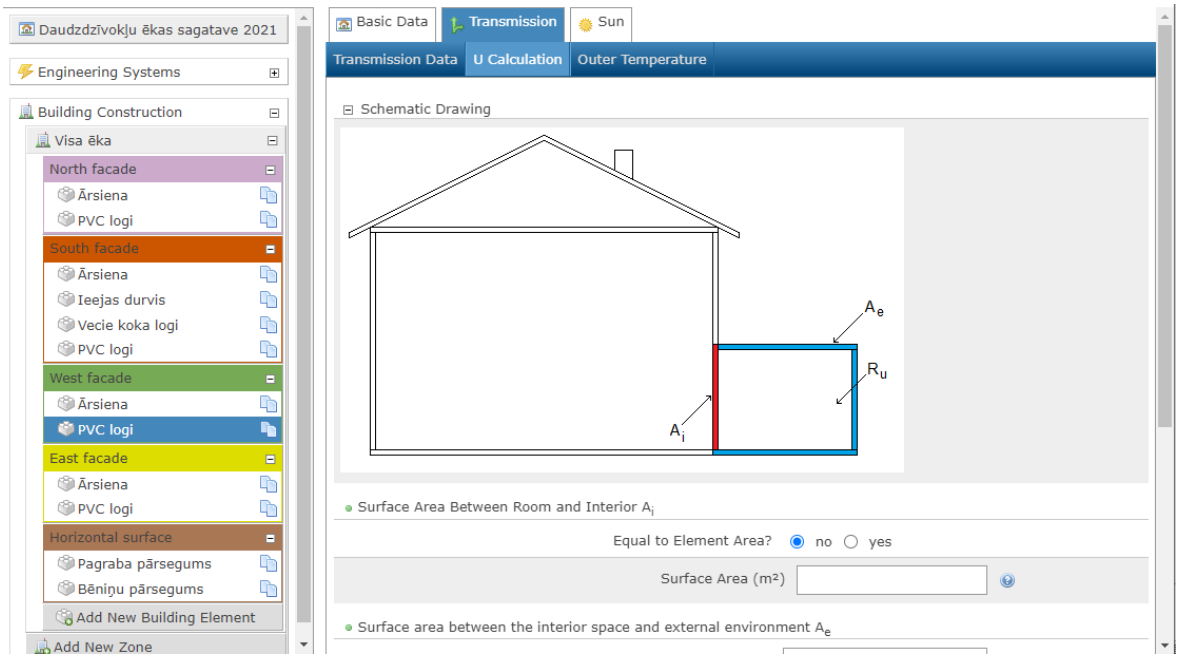

Figure 36 *Heatmod 7.0: Calculation of U value for adjoining rooms.*

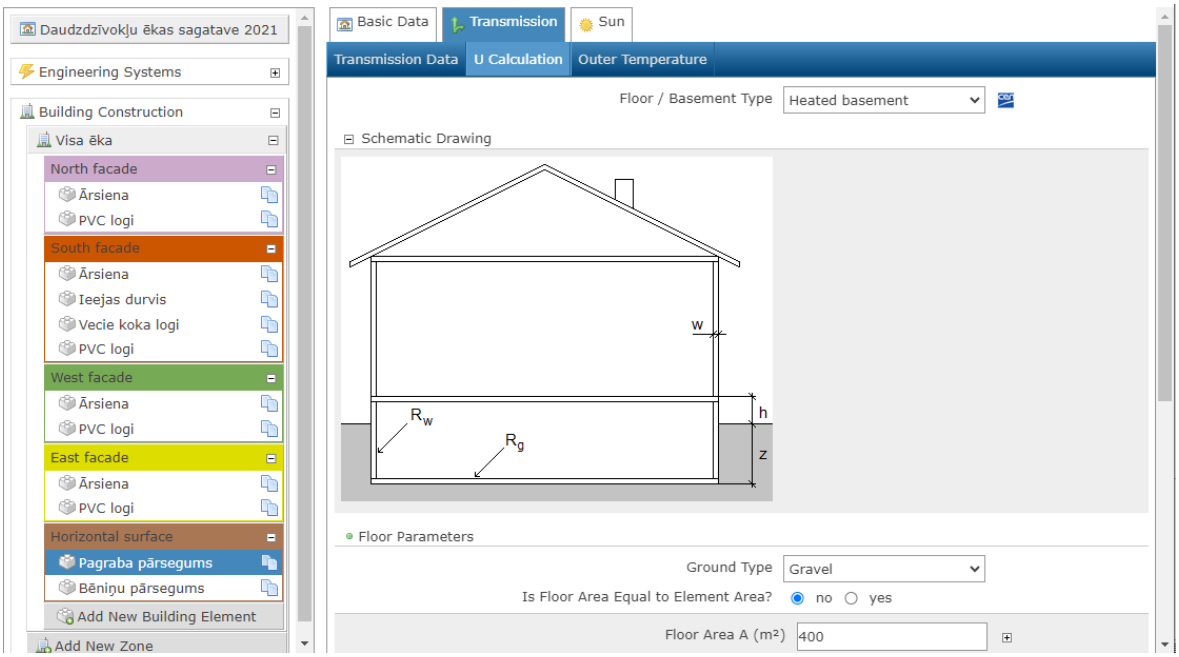

Figure 37 *Heatmod 7.0: Calculation of U value for floor.*

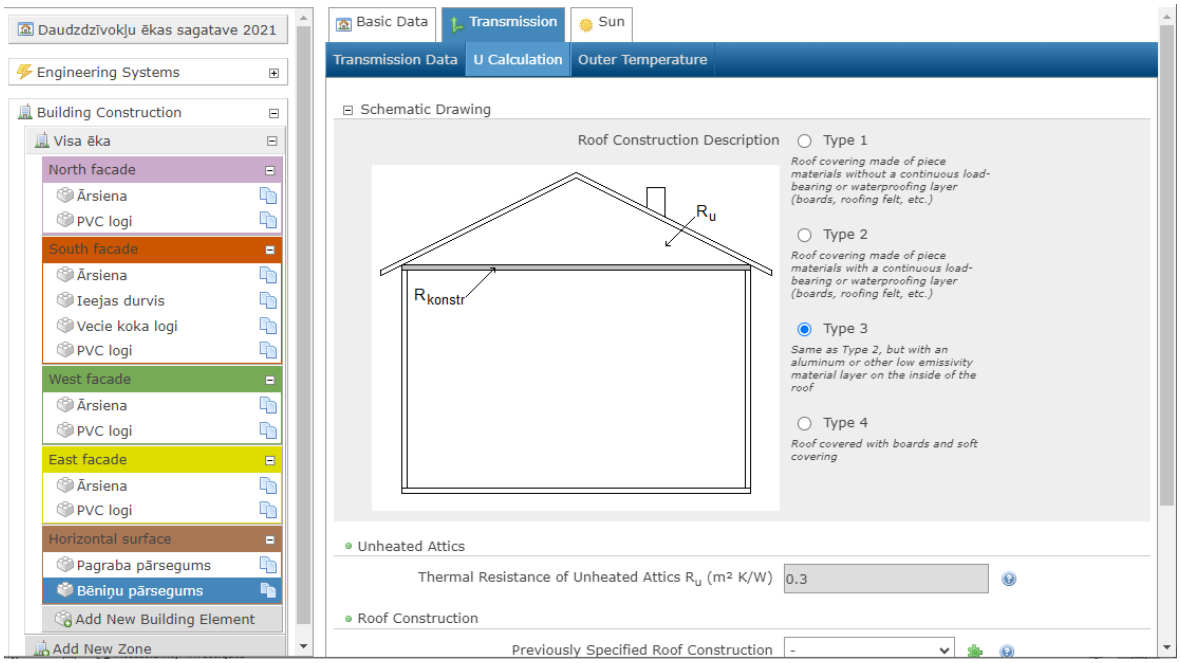

Figure 38 *Heatmod 7.0: Calculation of U value for ceiling.*

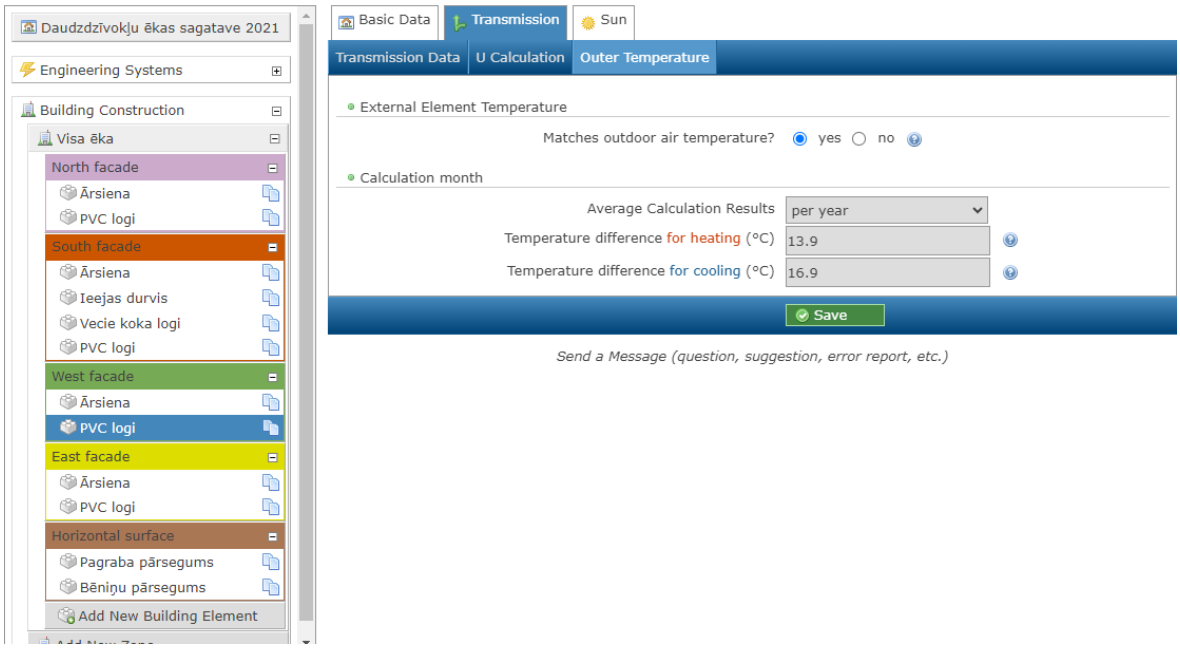

Figure 39 *Heatmod 7.0: Setting different outside temperature for element.*

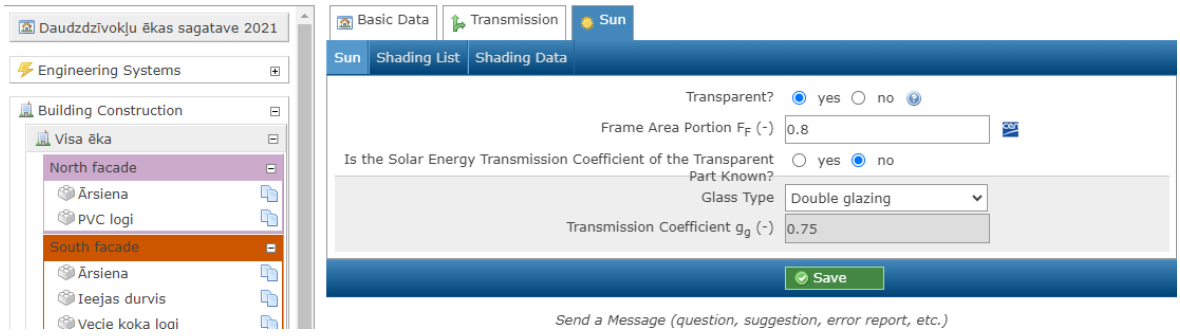

Figure 40 *Heatmod 7.0: Parameters for solar heat gains thought one building element.*

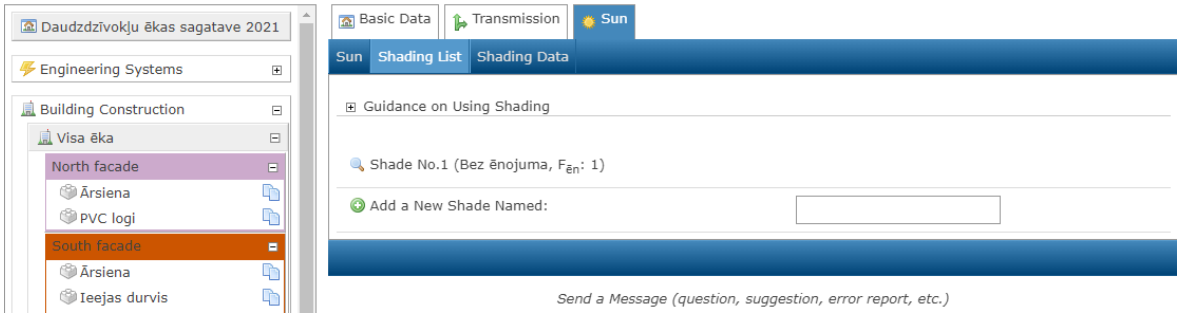

Figure 41 *Heatmod 7.0: Elements solar shading list.*

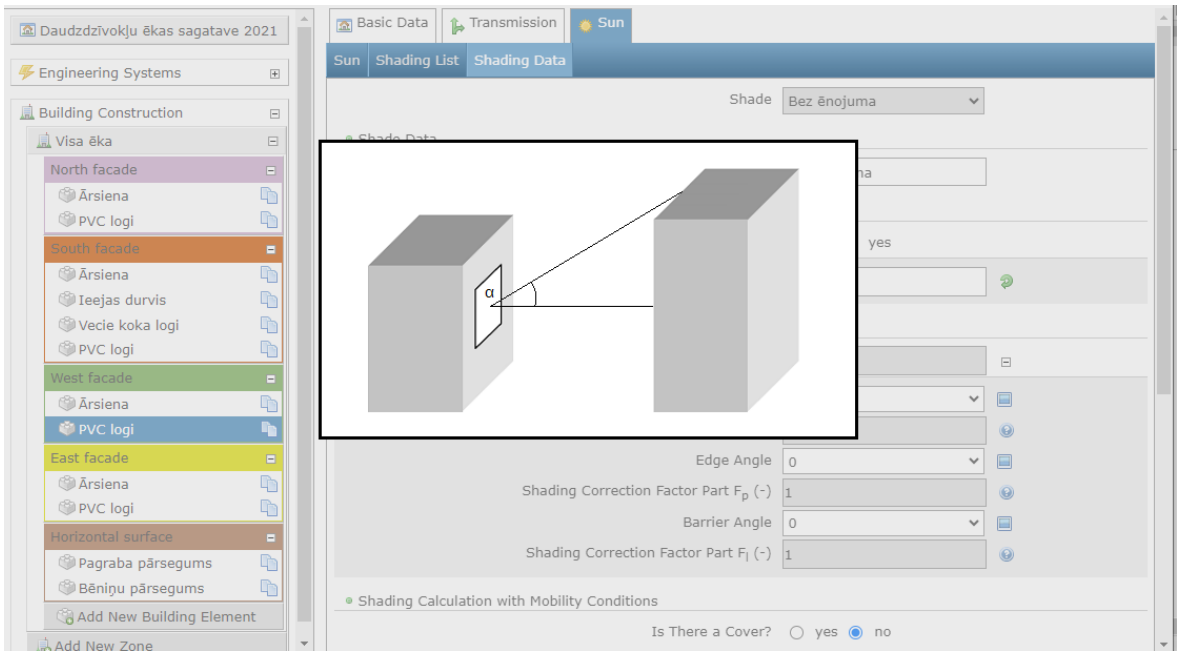

Figure 42 *Heatmod 7.0: Solar shading options for solar heat gain calculations.*

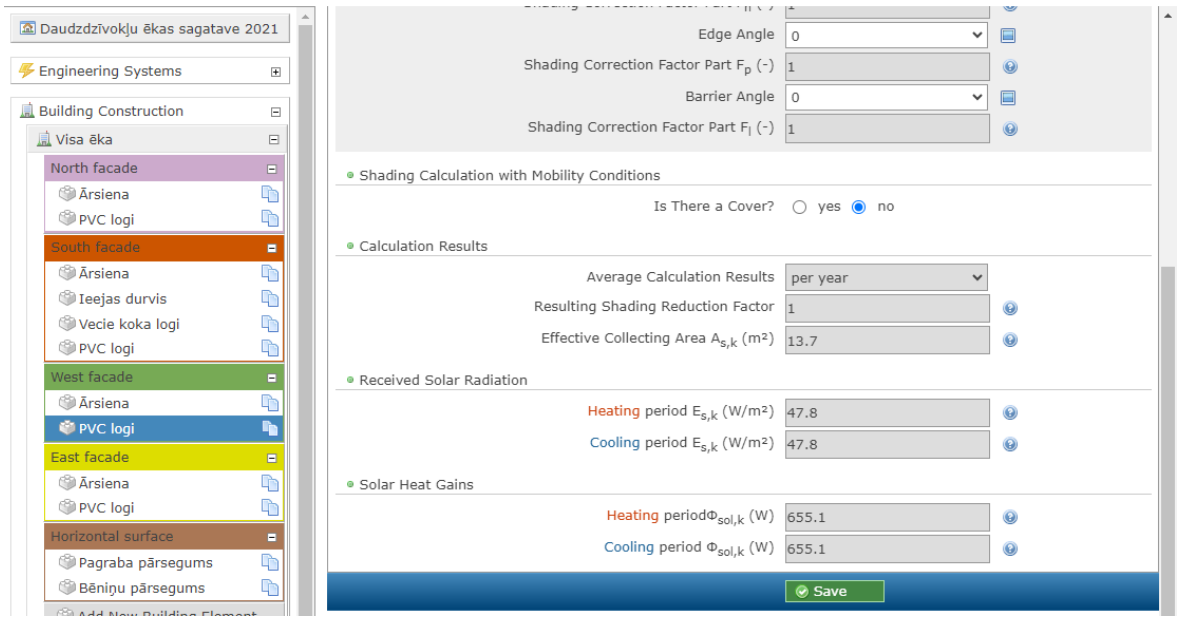

Figure 43 *Heatmod 7.0: Summary of solar heat gains for one building element.*

Literature

[1] EN ISO 52000-1, Energy performance of buildings — Overarching EPB assessment – Part 1: General framework and procedures (2017).

[2] EN ISO 52016-1, EPB – Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads – Part 1: Calculation procedures (2017).

[3] *Heatmod 7.0* – a web-based application for calculating of the building's energy performance in accordance with LVS EN ISO 52000 series standards. [Online]. [Accessed 13.05.2022]. Available: *http://www.heatmod.lv*.

[4] Latvian Building Code LBN 003-19 "Construction Climatology", Cabinet of Ministers of Latvia, 2019. [in Latvian]. [Online]. [Accessed 19.05.2022]. Available: https://likumi.lv/ta/id/309453-noteikumi-par-latvijas-buvnormativu-lbn-003-19-buvklimatologija