Structure and operation of the EVIA-tool

„Calculation of building air infiltration and exfiltration“

Basics

The basis for the tool is a physical calculation model which is described in the EN 15242 – “Ventilation for buildings - Calculation methods for the determination of air flow rates in buildings including infiltration”.

The calculation of the building air infiltration an exfiltration under steady-state conditions is performed with constant conditions defined by the user:

- Wind (wind direction and wind speed, obstacles and shape of the building)
- Temperature (inside and outside, in consideration of vertical flow resistance)
- Ventilation systems (supply/exhaust air flow, characteristics of pressure loss)
- Building (air tightness of the building envelope (n_{50}), distribution of leakages, determination of flow resistance (doors, joints, windows, air inlets))

The air flow rates for all connections to the outside (for example joints of windows or air inlets) and between the rooms (for example joints of doors) can be calculated for defined steady-state conditions with this tool in consideration of wind pressure, thermal lift and - if there is one - the ventilation system.

Changes in version 1.1:

- Extension of Cp values for buildings with an aspect ratio of 1:1 or 2:1
- Consideration of main and secondary wind directions
- Automatic optimization of the calculation exactness

Changes in version 1.2:

- Integration of device characteristics for centralized and decentralized ventilation units
- Consideration of single room ventilation units with and without storage type heat exchanger

Step 1: Starting the tool

By clicking the “Start Input” button in the worksheet “Input” the calculation tool starts. The program window (shown in Figure 1) appears. This window gives a compact description of the calculation tool. Click on the „Next” button to go to the next step.

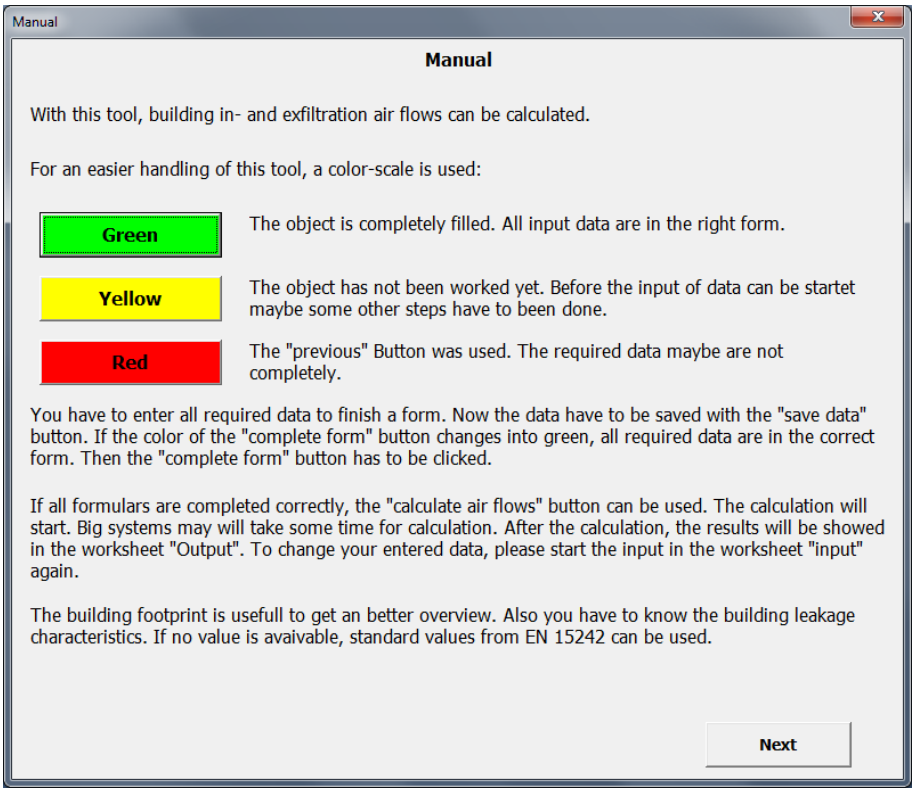

Figure 1: Information window - description of the calculation tool

Step 2: General project and object details

In the input mask “Overview” under the heading project details the user can provide information regarding the designer, the date and comments. Under the heading object details following input fields can be filled:

- Name
- Street
- Postal code
- Location
- Country.

After choosing the calculation unit: m³/h, m³/s or l/s further input fields are enabled, see Figure 2.

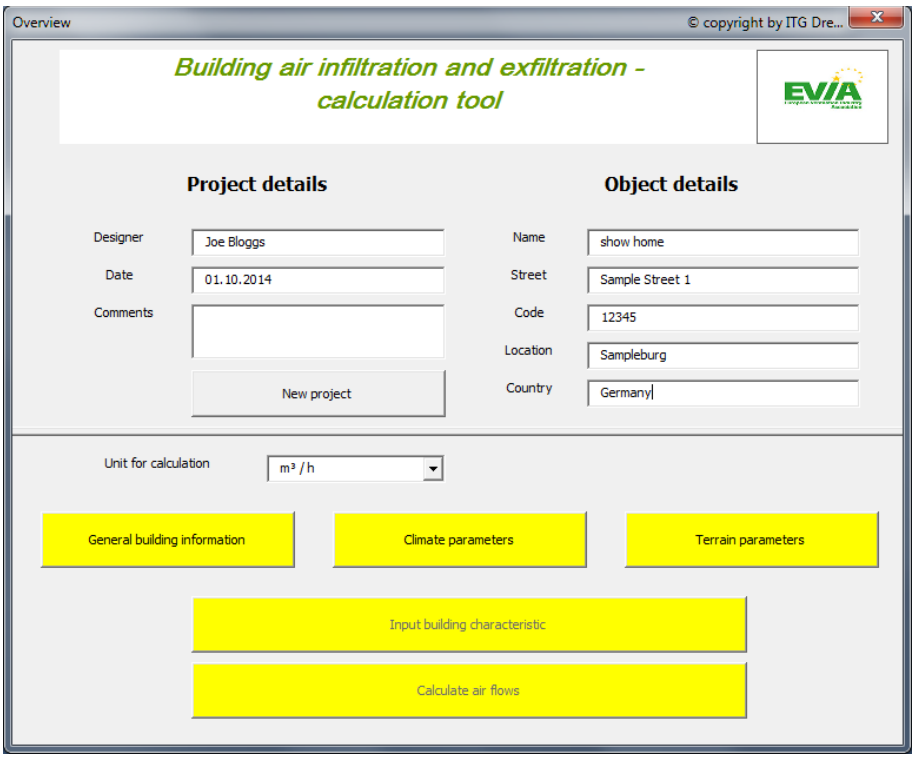

Figure 2: Input mask "Overview" with enabled input fields

Step 3: Data of the building

The input mask “General building information” (Figure 3) is divided into three aspects:

- General building information
- Information of the calculated flat
- Ventilation system

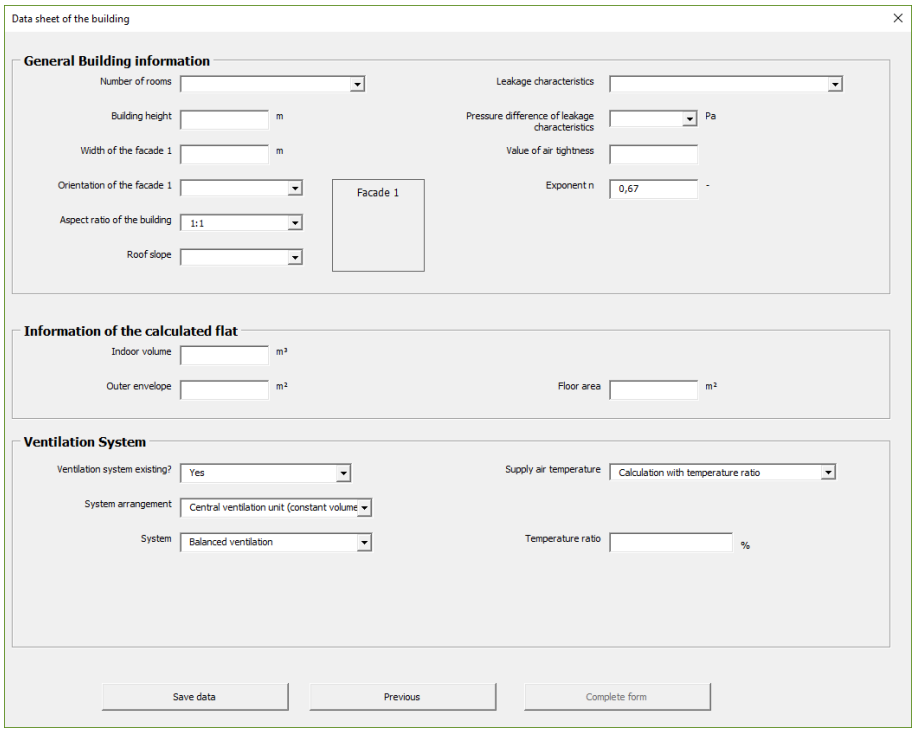

Figure 3: Input mask "General building information"

Step 3.1: General building information

In the aspect “General building information” the user can provide following details:

- Number of rooms (up to 20 rooms)
- Building height in m
- Width of façade 1 in m
- Orientation of façade 1
- Aspect ratio of the building
- Roof slope in °
- Leakages characteristics
- Pressure difference for leakage characteristics in Pa
- Value of air tightness in m³/(h·m²)
- Exponent n (registered default value 0,67)

Step 3.2: Information of the calculated flat

In the aspect “Information of the calculation flat” the input field, which is needed for the calculation, is highlighted in yellow depending on the selected leakages characteristics. The three possible input fields are:

- Indoor volume in m³ (selecting n (relative to indoor volume))
- Outer envelope in m² (selecting q (relative to outer envelope))
- Floor area in m² (selecting w (relative to floor area))

Step 3.3: Ventilation System

Information on the ventilation system is requested in the aspect "Ventilation systems" depending on the selection:

- Ventilation system existing?
- Arrangement of the system (central ventilation unit (constant volume flow), central ventilation device (with device characteristic), room-by-room ventilation units)
- System (supply air ventilation, exhaust air ventilation, balanced ventilation)
- Supply air temperature (free input, supply air temperature = outdoor temperature, temperature ratio)

For central devices with device characteristic curve and room-by-room ventilation units, additional information on the device characteristic curve is requested. However, the device characteristic curve for room-by-room devices is specified at room level.

In addition to free inputs, you can also select from sample characteristic curves. For the free inputs, at least three value pairs (volume flow with corresponding total pressure difference) must be entered (minimum volume flow, nominal volume flow and maximum volume flow).

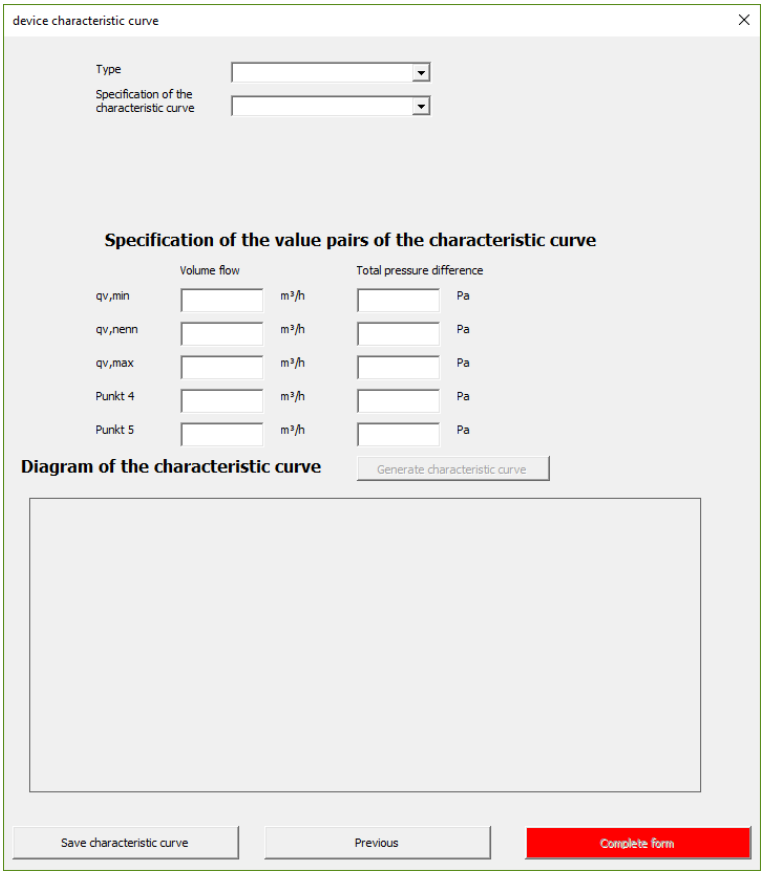

Figure 4: Input mask "device characteristic curve"

Step 4: Climate parameters

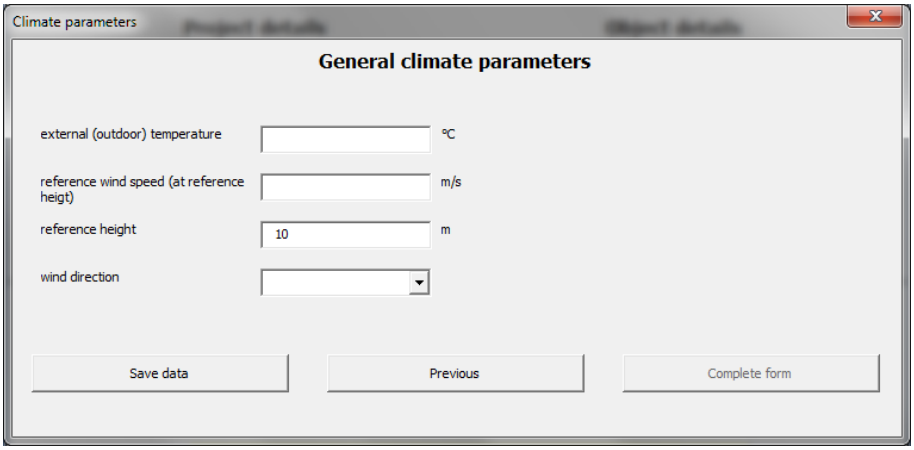

Figure 5: Input mask "Climate parameters"

In the input mask ”Climate parameters“ (Figure 5) information about the following values has to be completed:

- External (outdoor) temperature in °C
- Reference wind speed (at reference height) in m/s
- Reference height in m (registered default value 10 m)
- Wind direction

Step 5: Terrain information

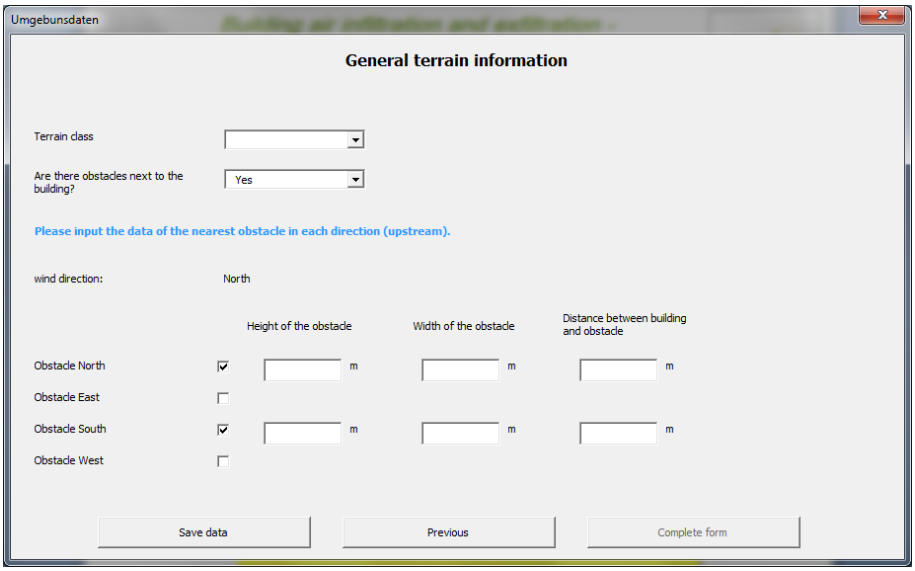

Figure 6: Input mask "General terrain information"

Depending on the selection made in the input mask „General terrain information“ (Figure 6) different input fields have to be filled with information from the user:

- Terrain class
- Are there obstacles next to the building?
- Height of the obstacles in m
- Width of the obstacles in m
- Distance between building and obstacles in m

Step 6: Input building characteristic

Before the rooms can be configured (Figure 7), it is possible to name the rooms, which makes the input easier. If this possibility is not selected, the rooms are named as “room 1”, “room 2” and so on and the configuration of each room can start.

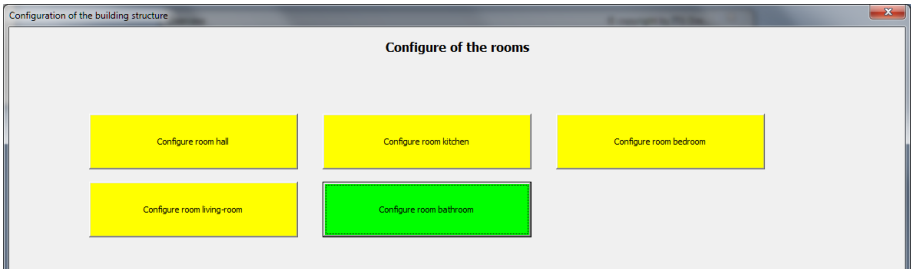

Figure 7: Input mask "Configure of the rooms"

After choosing one room and activating the for example „Configure room 5” or “Configure room bathroom” button, the input mask “General information of the room” appears.

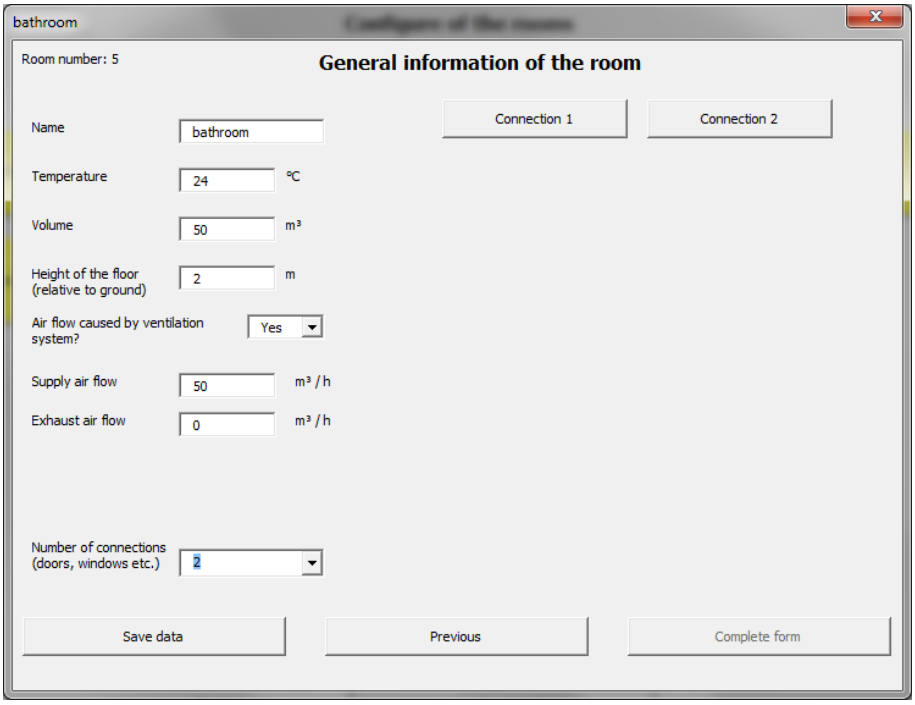

Figure 8: Input mask "General information of the room"

All information given in this input mask (Figure 8) has reference to the selected room and following values:

- Temperature in °C
- Volume in m³
- Height of the floor (relative to ground) in m
- Air flow caused by ventilation system?
- Supply/Exhaust air flow in m³/h
- Number of connections (doors, windows etc.) (up to 20 connections per room)

By activating the for example “Connection 1”button the input mask „Connection data” appears, see Figure 9.

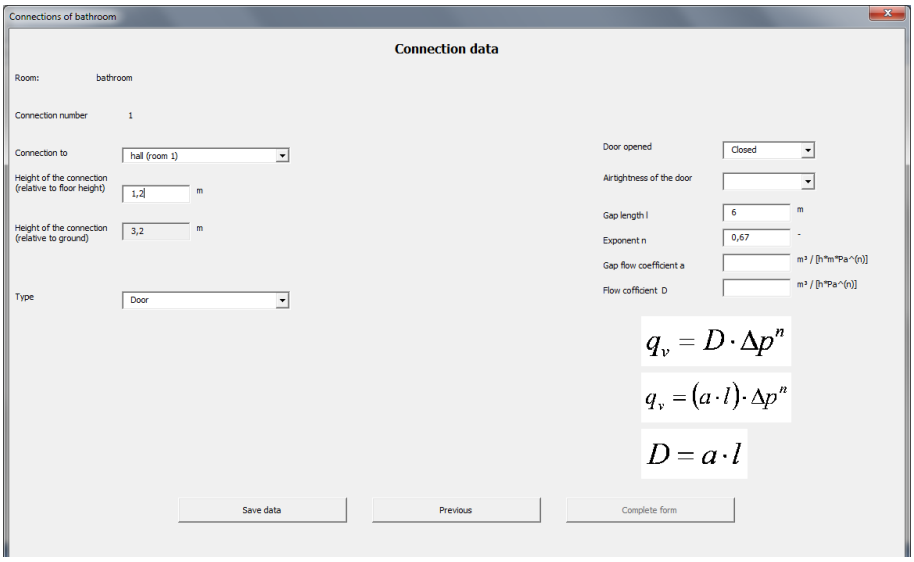

Figure 9: Input mask "Connection data"

Information about the selected room and the global number of connection will be continue to be provided on further information in the input mask:

- Connection to
- Height of the connection (relative to floor height) in m
- Type
- Orientation of the connection
- Source of C_P-Values
- C_p-Value
- Outer area of the wall in m²
- Portion of the airtightness from the building
- Portion in %
- Door opened?
- Air tightness of the door
- Gap length l in m
- Exponent n
- Gap flow coefficient a in $\frac{m^3}{h \cdot m \cdot Pa^n}$
- Flow coefficient D in $\frac{m^3}{h \cdot Pa^n}$
- Required air volume flow rate,
- Valve authority (default value 0.5)
- Input of device characteristic curve (if room-by-room ventilation units are selected)

Are the values of the air tightness of all connections determined relative to the outdoor wall area, the portion can be manual chanced for example reduced (portion of the leakage of the roof area rises) calling the input mask “Connection data” again.

If all necessary values for the connection of each room are complete and all rooms configurated, the input mask „Overview“ appears again, see Figure 10.

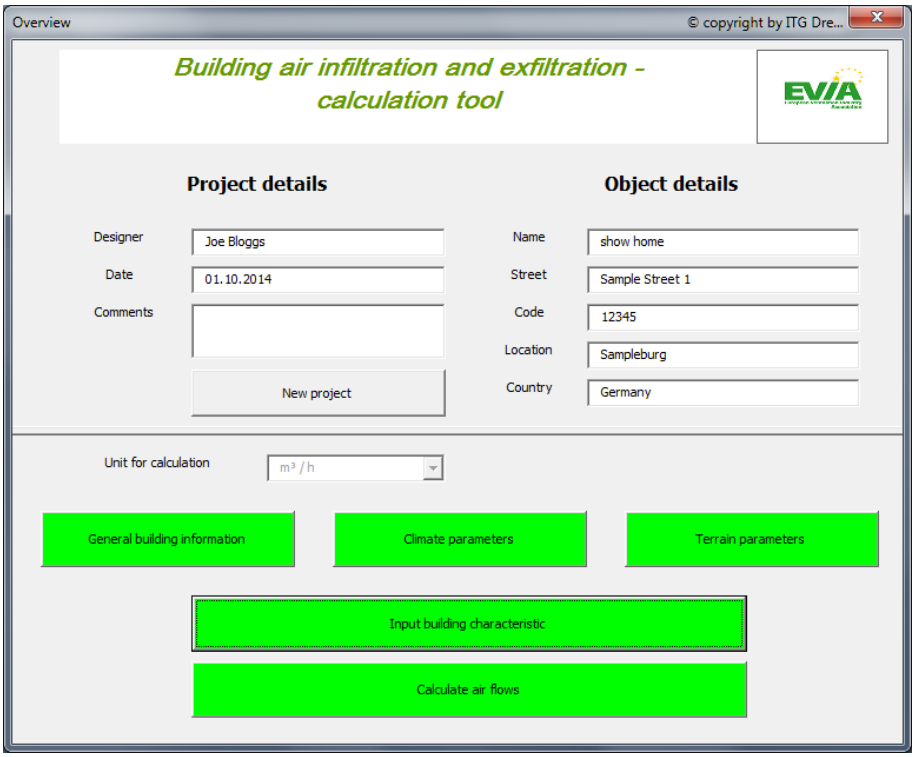

Figure 10: Input mask "Overview" after all necessary input fields are complete to calculate the air flows

Clicking on the “Calculate air flows” button, the calculation starts.

An information field appears (see Figure 11) with the information that the automatic optimization of the calculation exactness is activated and this can lead to an increased calculation time. The progress of the calculation can be monitored discontinuously in the status bar of Excel. If a calculation time of 15 minutes is reached, the algorithm stops and the user also receives a message box, see Figure 12.

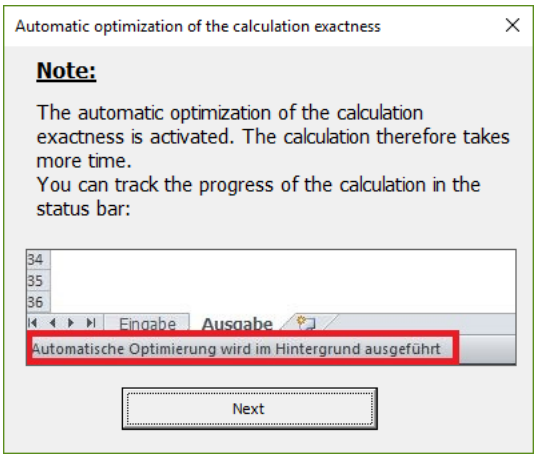

Figure 11: Note field for automatic optimization of the calculation exactness

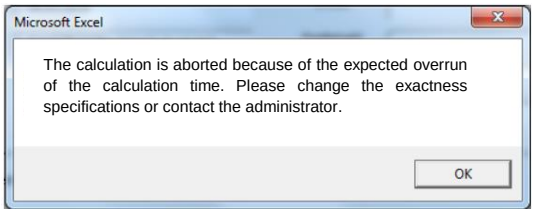

Figure 12: Note field for aborting the algorithm due to timeout

The results are shown in the worksheet “Output”, see Figure 13.

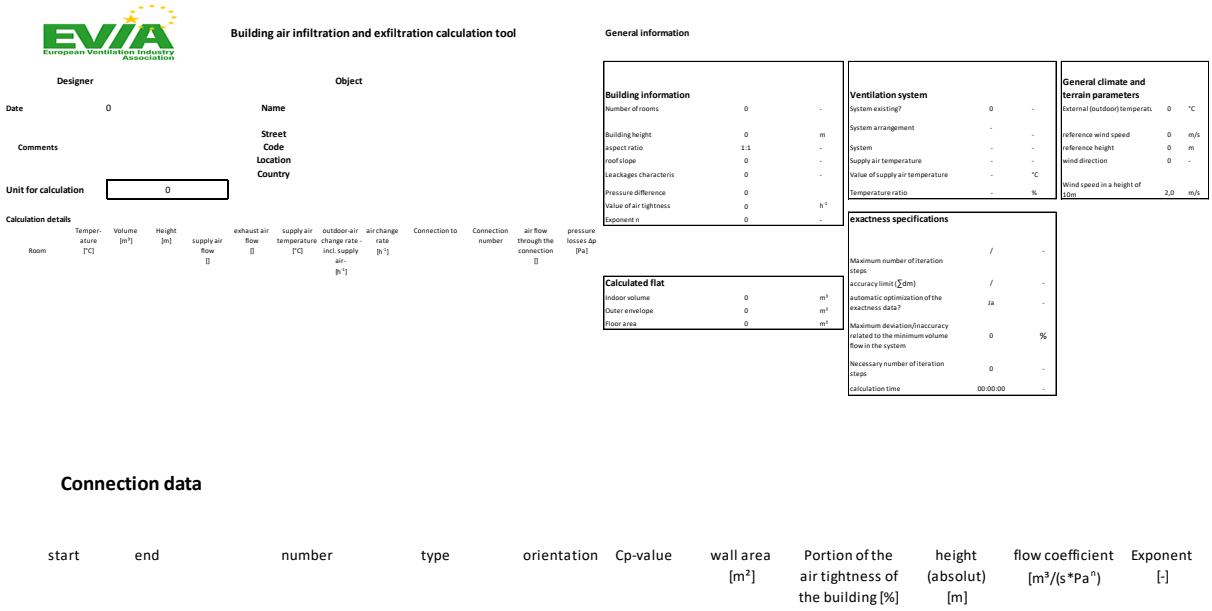

Figure 13: Table with the outputs

Changes of the input data/Calculation of variants

It is possible to calculate variants by changing conditions like wind direction, air tightness of the building envelope, ventilation systems, etc. in relevant input masks. All changes have to be saved and completed.

Input data can be rejected or changed in the previous input mask by clicking the “Previous” button, see Figure 14.

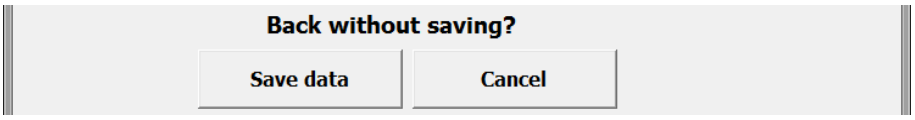

Figure 14: Message window ”Back without saving?“

Changing the number of rooms (adding rooms or reducing the number of rooms) can be done in the input mask “General building information” as long as there do not exist the first

connection. After entering the first connection it is not possible to change the number of rooms in this project and a new project has to be started, see Figure 15.

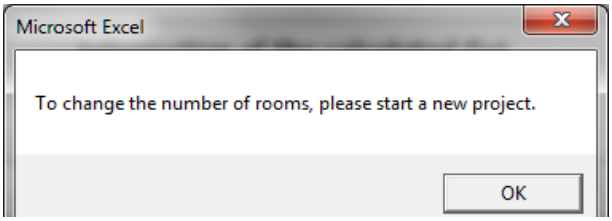

Figure 15: Message window: subsequently changing the number of rooms

If the choice has been made for the arrangement of the ventilation systems (central unit (constant volume flow), central device (with device characteristics), room-by-room units), this cannot be changed again within the project. If the choice of the arrangement of the ventilation system is to be changed, a new project must be created.

Changes of the connection of the rooms like orientation, type or increase the number of connections can be done without problems in the relevant windows “General information of the room”, see Figure 16. However to reduce the number of the connection, a new project has to be started or a saved version has to be used.

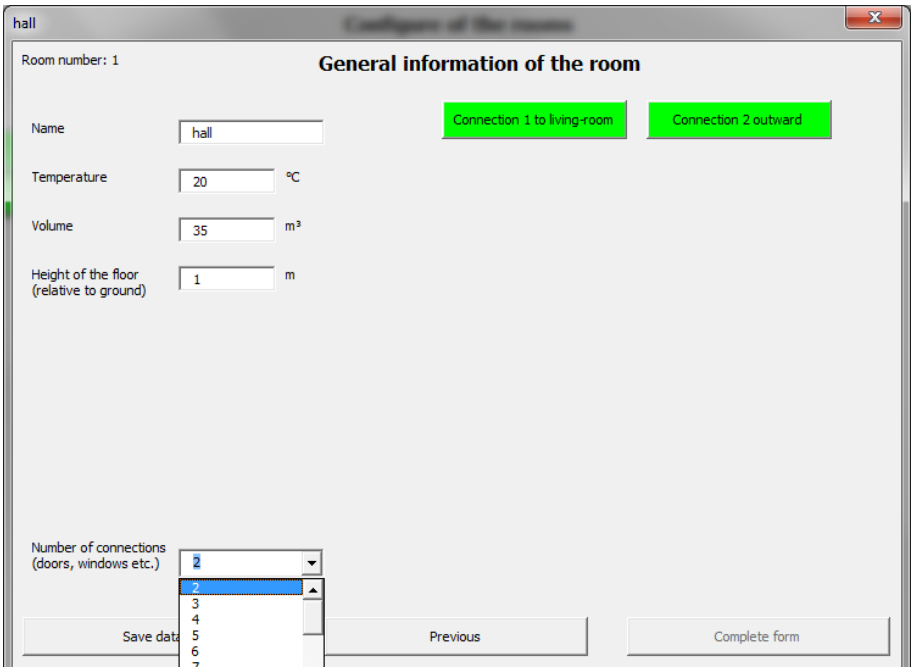

Figure 16: Input mask "General information of the room" for changing the number of connections