

- *Brno University of Technology*
- *Faculty of Mechanical Engineering*
- *Energy Institute*
- *Dept. of Thermodynamics and Environmental Engineering*

# *Control Systems of Buildings by Using Modeling and Simulation*

*« Create a Model of a Hall by Using TRANSYS 16 »*

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➤ **Gains**

**5- Summary**

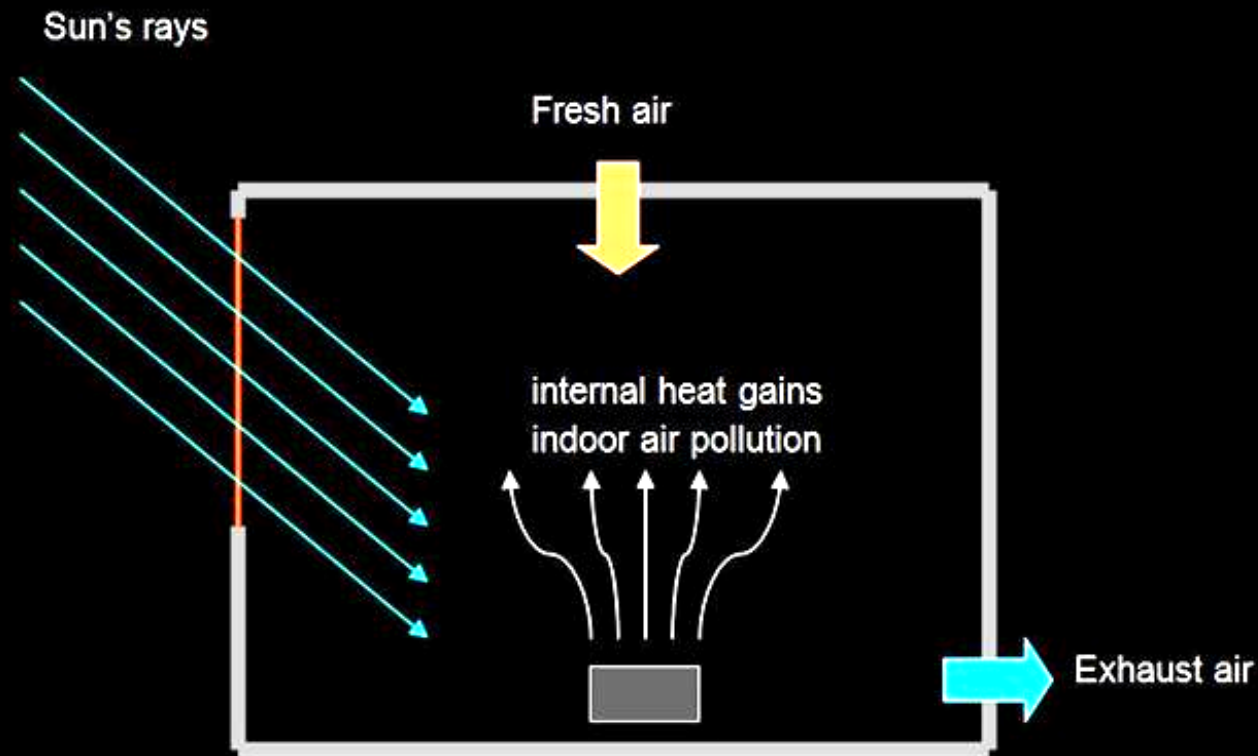
**6- Outlook**

## *1- Motivation*

- *Find an easy and available method that can control the climatic conditions in the building.*
- *achieve adaptability and adjustability.*
- *minimize the required input data.*

## *2- Description of the problem*

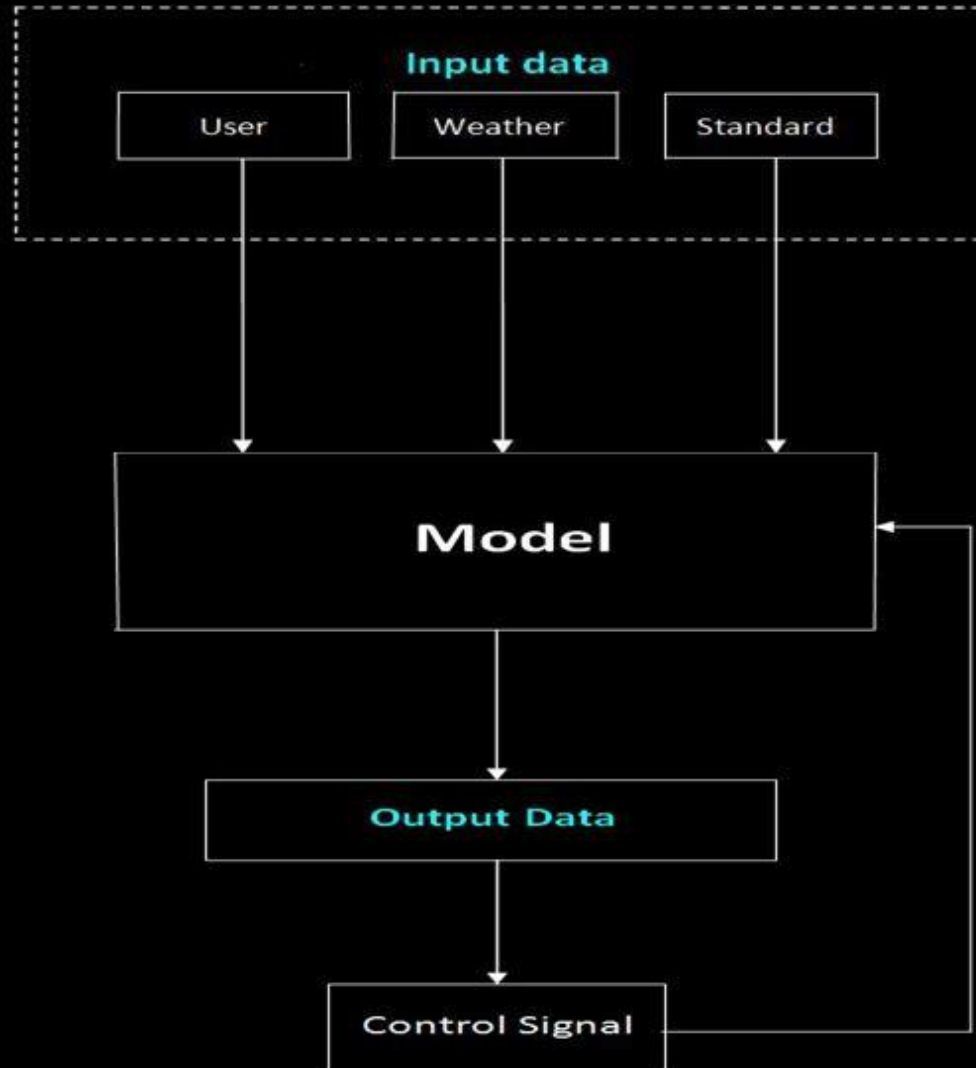
*we should create a computer model can control climate conditions inside an imposed building by using TRANSYS 16 software*



*Some problems that model should deal with:*

- transmission heat (loss/gain)*
- ventilation (indoor air quality)*
- internal heat gains*
- solar heat gain*
- control of HVAC*

# *Supposed algorithm model*



### ***3- Steps to resolve the problem by TRANSYS 16 software:***

***1- create thermal zones***

***2- enter dimensions of the room***

***3- set the glazing fraction of each side of the building and a global rotation angle for the building***

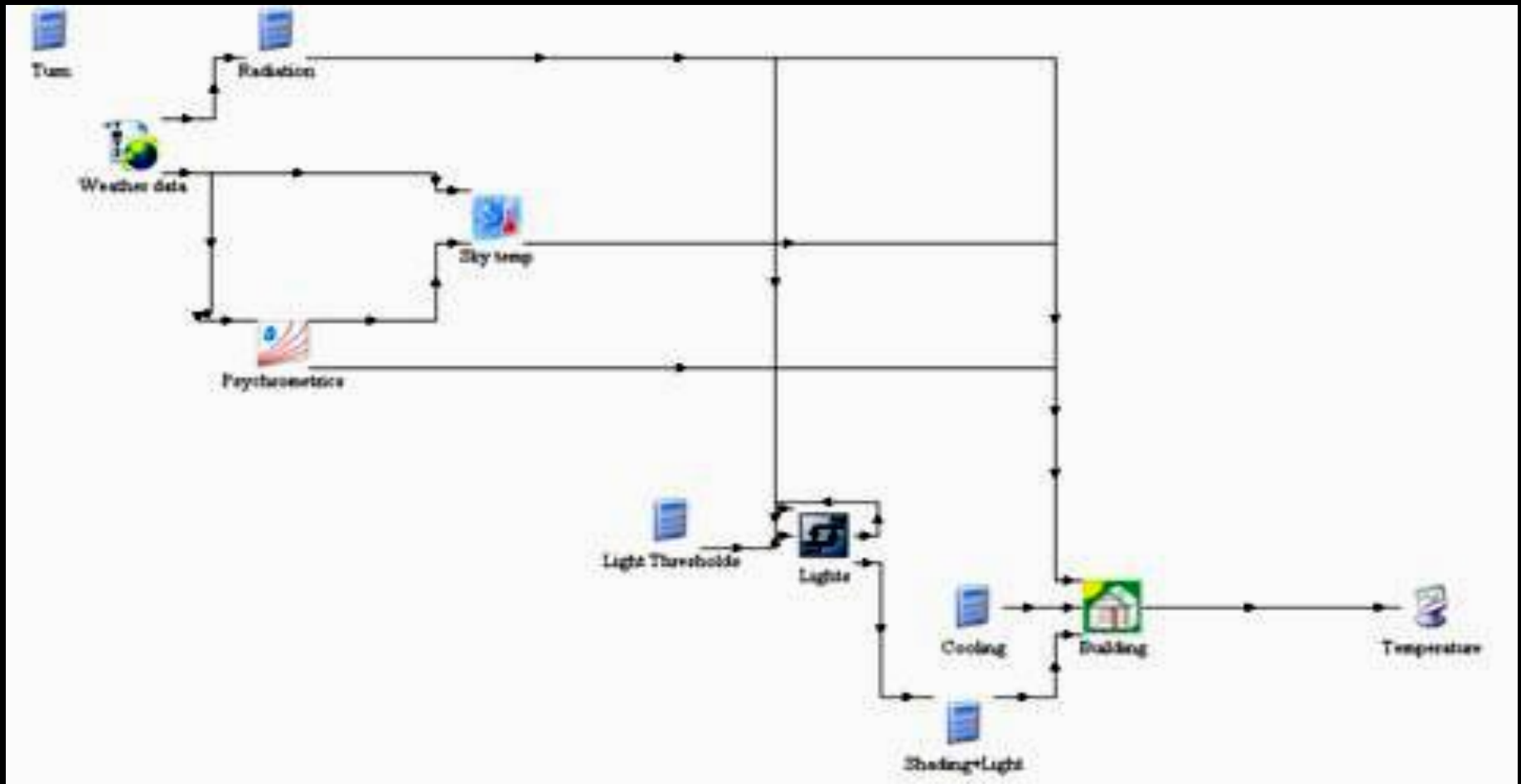
***4- define the parameters of the infiltration and ventilation***

***5- define the parameters of the heating and the cooling***

***6- define Internal gains***

# *generate the model*

*The TRNSYS project created by the building wizard has all the necessary components .*





# Modifying the wizard-generated project

- change the simulation period

The screenshot shows the Simulation Studio interface. The main workspace displays a project diagram with components like 'Weather data', 'Radiation', 'Psychrometrics', 'Light Thresholds', 'Lights', 'Cooling', 'Shading+Light', 'Building', and 'Temperature'. A 'Global Infos' dialog box is open, showing a table of simulation parameters. The 'Simulation stop time' is highlighted with a red circle.

Control Cards	Project	Component Order
0	Simulation start time	0 hr
1	Simulation stop time	8760 hr
2	Simulation time step	1 hr
3	Solution method	Successive
4	The minimum relaxation factor	1
5	The maximum relaxation factor	1
6	Equation solver	0
7	Equation trace	True

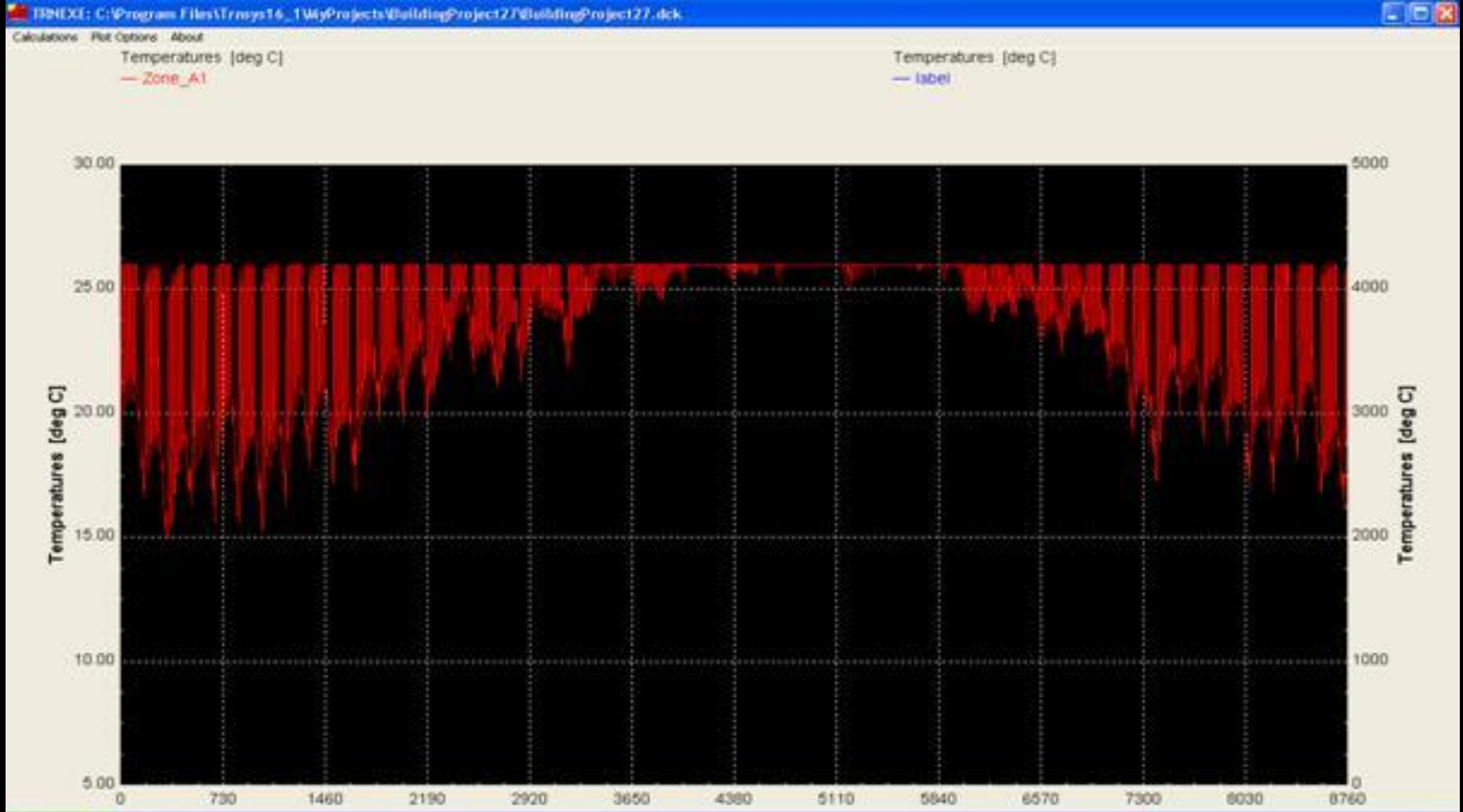
- *change the axis limits on the online plotter*

The screenshot displays the Simulation Studio interface for a building project. The main workspace shows a simulation model with components like 'Weather data', 'Radiation', 'Sky temp', 'Psychrometrics', 'Light Thresholds', 'Lights', 'Cooling', 'Shading+Light', and 'Building'. A 'Temperature' component is highlighted with a hand-drawn oval.

An inset window titled '(BuildingProject27) Temperature' is open, showing a table of parameters. The table has columns for 'Parameter', 'Input', 'Output', 'Derivative', 'Special Cards', 'External Files', and 'Comment'. The 'Parameter' column lists various settings, and the 'Output' column shows their current values. A hand-drawn oval highlights the 'Left axis minimum' and 'Left axis maximum' rows.

Parameter	Input	Output	Derivative	Special Cards	External Files	Comment
1	Nb. of left-axis variables	4				More...
2	Nb. of right-axis variables	2				More...
3	Left axis minimum	5				More...
4	Left axis maximum	30				More...
5	Right axis minimum	0.0				More...
6	Right axis maximum	100				More...
7	Number of plots per simulation	1				More...
8	X-axis gridpoints	12				More...
9	Shut off Online with removing	0				More...

# Run simulation



# Steps to read values of the relative humidity

- change the number of variables representing on the plotter

The screenshot displays the Simulation Studio interface for a building simulation project. The main workspace shows a schematic diagram of the simulation model. On the left, 'Weather data' feeds into 'Radiation' and 'Sky temp'. 'Psychrometrics' also receives input from 'Weather data'. 'Radiation' and 'Sky temp' feed into 'Lighting', which is influenced by 'Light Thresholds'. 'Lighting' then feeds into 'Cooling' and 'Shading+Light'. Both 'Cooling' and 'Shading+Light' feed into the 'Building' component. The 'Building' component outputs to a 'Temperature' sensor, which is circled in red. A dialog box titled '(BuildingProject27) Temperatures' is open in the foreground, showing a table of parameters for the temperature plotter. The 'Nb. of right-axis variables' parameter is highlighted with a red circle.

Parameter	Input	Output	Derivative	Special Cards	External Files	Comment
1	Nb. of left-axis variables	1	-	-	-	More...
2	Nb. of right-axis variables	2	-	-	-	More...
3	Left axis minimum	5	-	-	-	More...
4	Left axis maximum	30	-	-	-	More...
5	Right axis minimum	0.0	-	-	-	More...
6	Right axis maximum	100	-	-	-	More...
7	Number of plots per simulation	1	-	-	-	More...
8	X-axis gridpoints	12	-	-	-	More...
9	Shut off Online vrb removing	0	-	-	-	More...

- *insert the relative humidity as a new output of the building*

**Project**

File:

Description:

Created by:

Address:

City:

Comments:

**Orientations**

No.	Orientation
1	NORTH
2	SOUTH
3	EAST
4	WEST
5	HORIZONTAL

Other:

**Output Data**

**Thermal Zones**

undefined

default

thermal zones

No.	Thermal Zone
1	ZONE_A

**NTypes**

zone outputs  group of zone outputs  surface outputs  balances

No.	NType	Key	Additional Data
1	5	relatv	not available

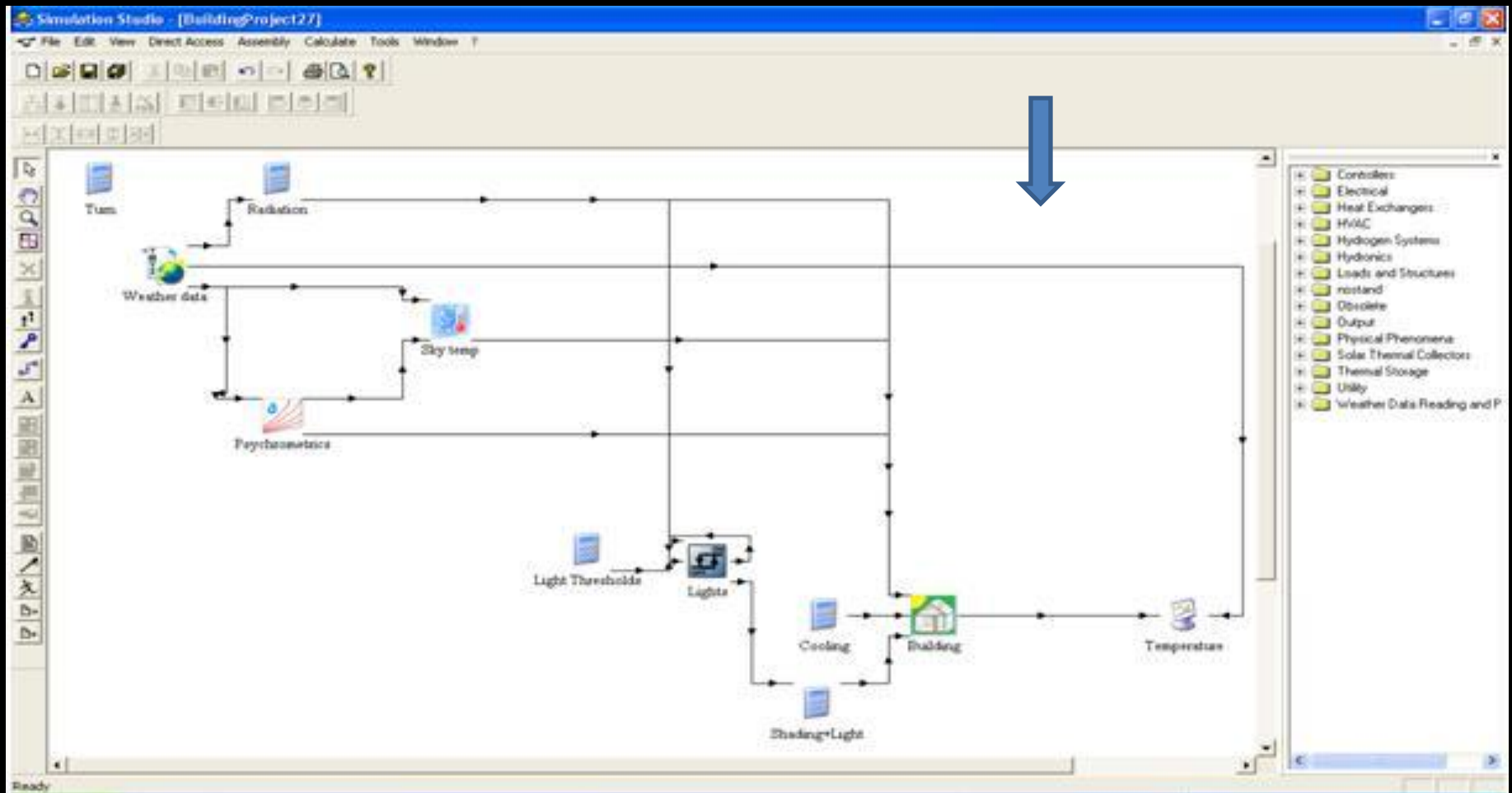
**Possible Outputs (NTYPES)**

NType	Key	Description
1	TAIR	air temperature of zone
2	QSENS	sensible energy demand of zone, heating (+), cooling (-)
3	QCSUFF	total convection to air from all surfaces within zone (incl. int)
4	QINF	sensible ventilation energy gain of zone
5	QVENT	transferable ventilation energy gain of zone
6	QCOUP	transferable coupling energy gain of zone
7	QGCCNV	internal convective gains of zone
8	QOAR	change in internal sensible energy of zone air since beginn
9	RELHUM	relativ humidity of zone air
10	QLATD	latent energy demand of zone, humidification (+), dehumidific
11	QLATG	latent energy gains including ventilation, infiltration, coupling
12	QSOLTR	total shortwave solar radiation transmitted through external v

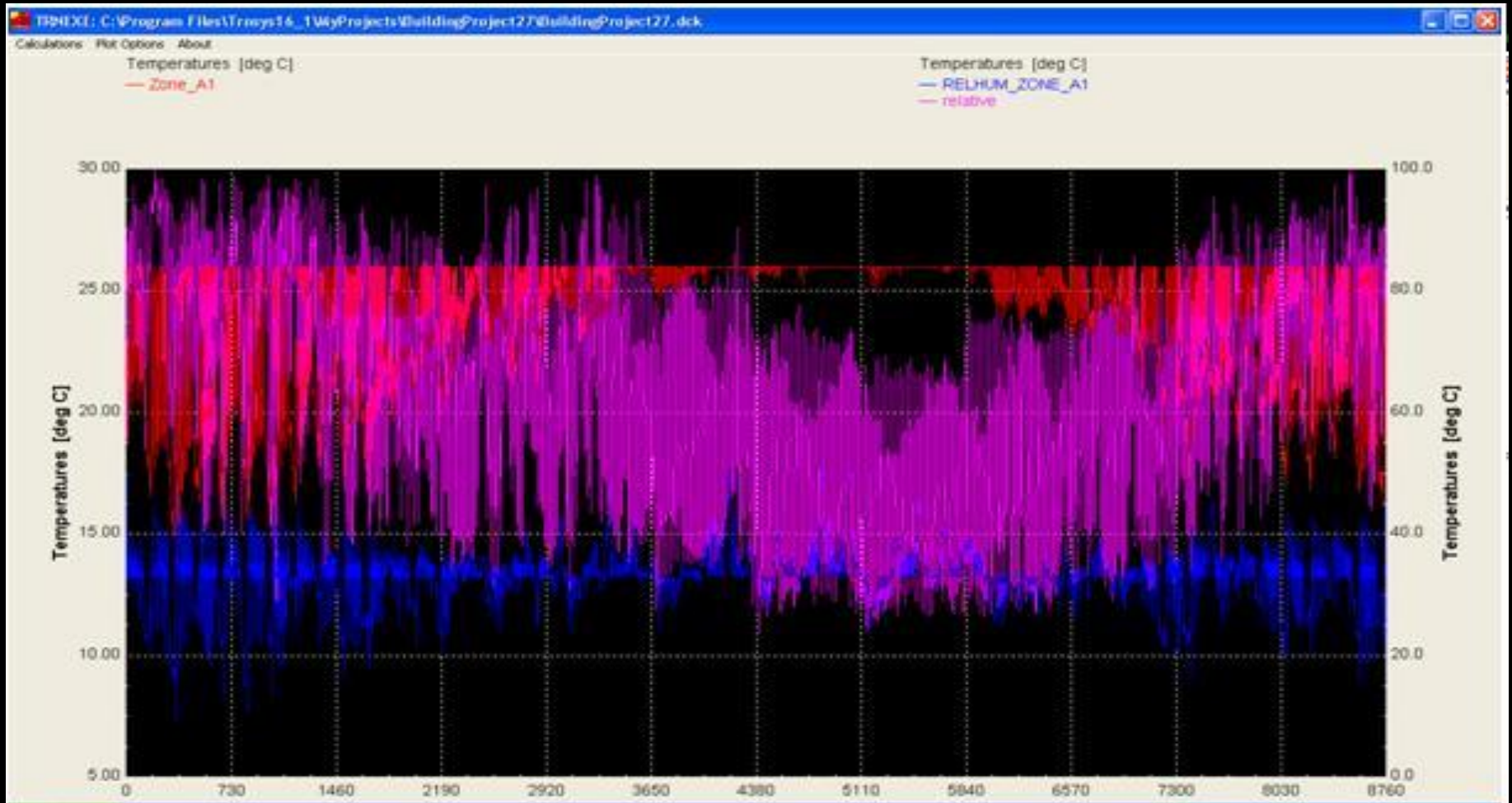
Buttons: Properties, Inputs, **Outputs**, OK, Cancel



- *connect between the weather data and building on the one hand and the online plotter on the other hand by humidity*



*run simulation again*



## *4- change the basic conditions indoor*

➤ **Infiltration**

➤ **Ventilation**

➤ **Heating**

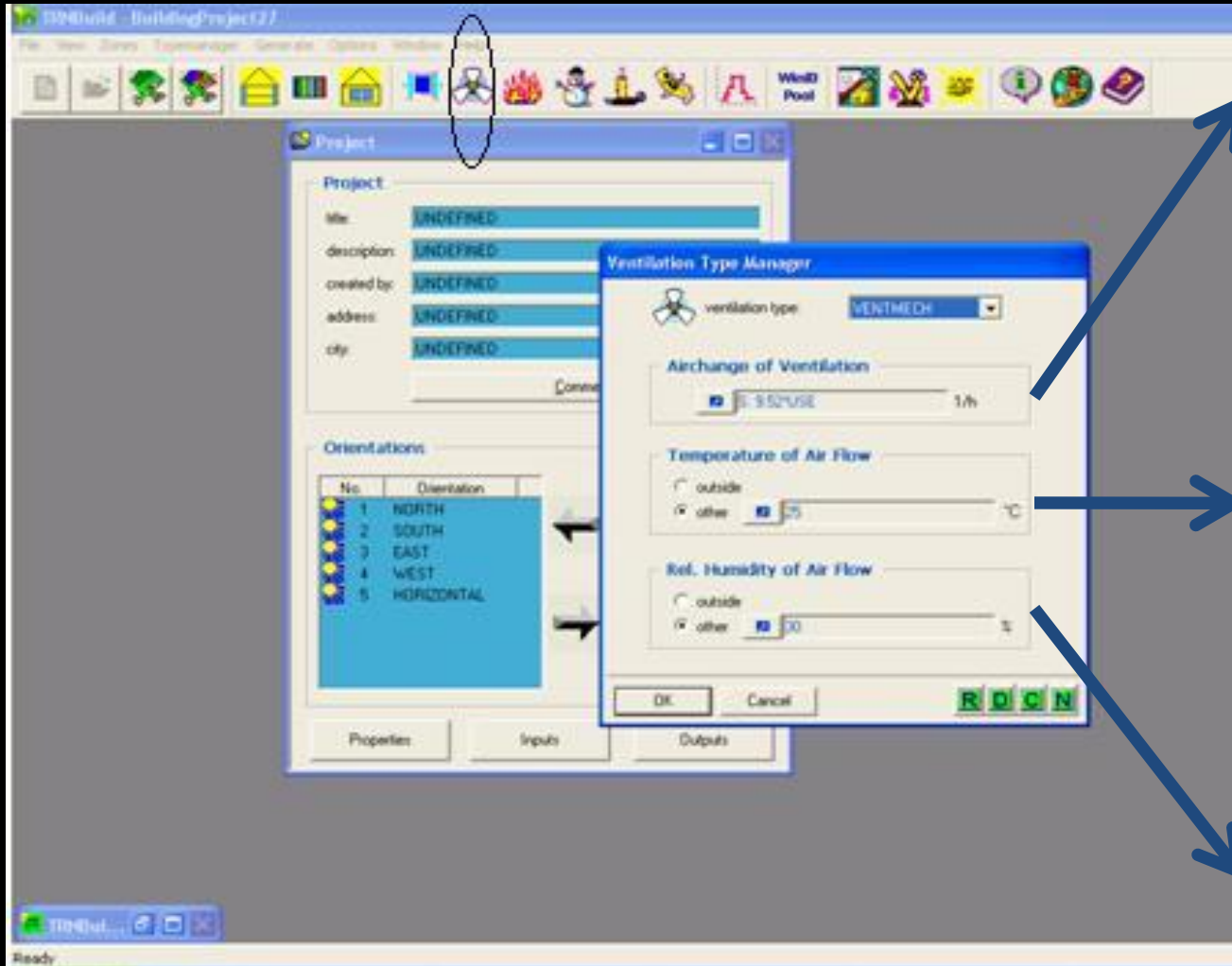
➤ **Cooling**

➤ **Gains**





# Ventilation



Airchange of Ventilation

Airchange of Ventilation [ 1 / h ]

Constant Value

Input

Schedule

Please, enter the airchange of the ventilation air flow.

OK Cancel

Temperature of Air Flow

Temperature of Air Flow [ °C ]

Constant Value

Input

Schedule

Please, enter the temperature of the ventilation air flow.

OK Cancel

Rel. Humidity of Air Flow

Rel. Humidity of Air Flow [ % ]

Constant Value

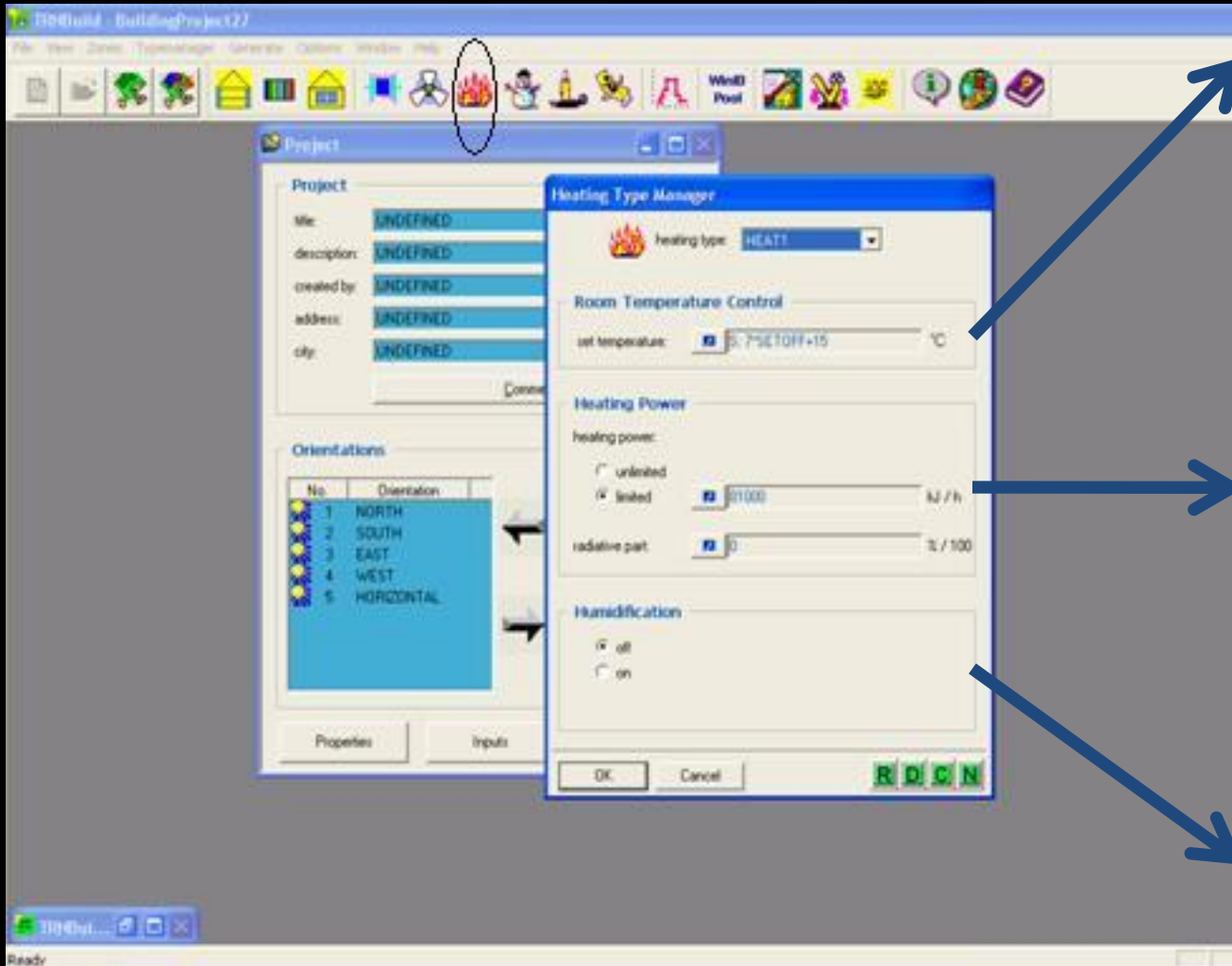
Input

Schedule

Please, enter the relative humidity of the ventilation air flow.

OK Cancel

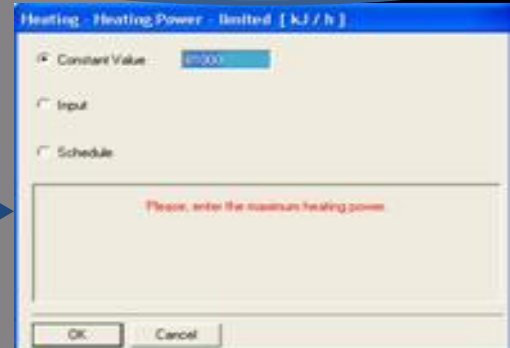
# Heating



## Room Temperature Control



## Heating Power



## Humidification



# Cooling

## Room Temperature Control

Cooling - room temperature control [ °C ]

Constant Value

Input: 1 - T\_COOL\_ON - 0

Schedule

Please, enter the temperature above which there is cooling active.

OK Cancel

## Cooling Power

Cooling Power - limited [ kJ/h ]

Constant Value: 1000

Input

Schedule

Please, enter the maximum cooling power.

OK Cancel

## Dehumidification

Cooling - Dehumidification on [ % ]

Constant Value: 100

Input

Schedule

Please, enter the humidity above which there is dehumidification.  
100 - for free floating humidity.

OK Cancel

Project

file: UNDEFINED  
description: UNDEFINED  
created by: UNDEFINED  
address: UNDEFINED  
city: UNDEFINED

No.	Orientation
1	NORTH
2	SOUTH
3	EAST
4	WEST
5	HORIZONTAL

Cooling Type Manager

cooling type: COOL1

Room Temperature Control

set temp.: T\_COOL\_ON °C

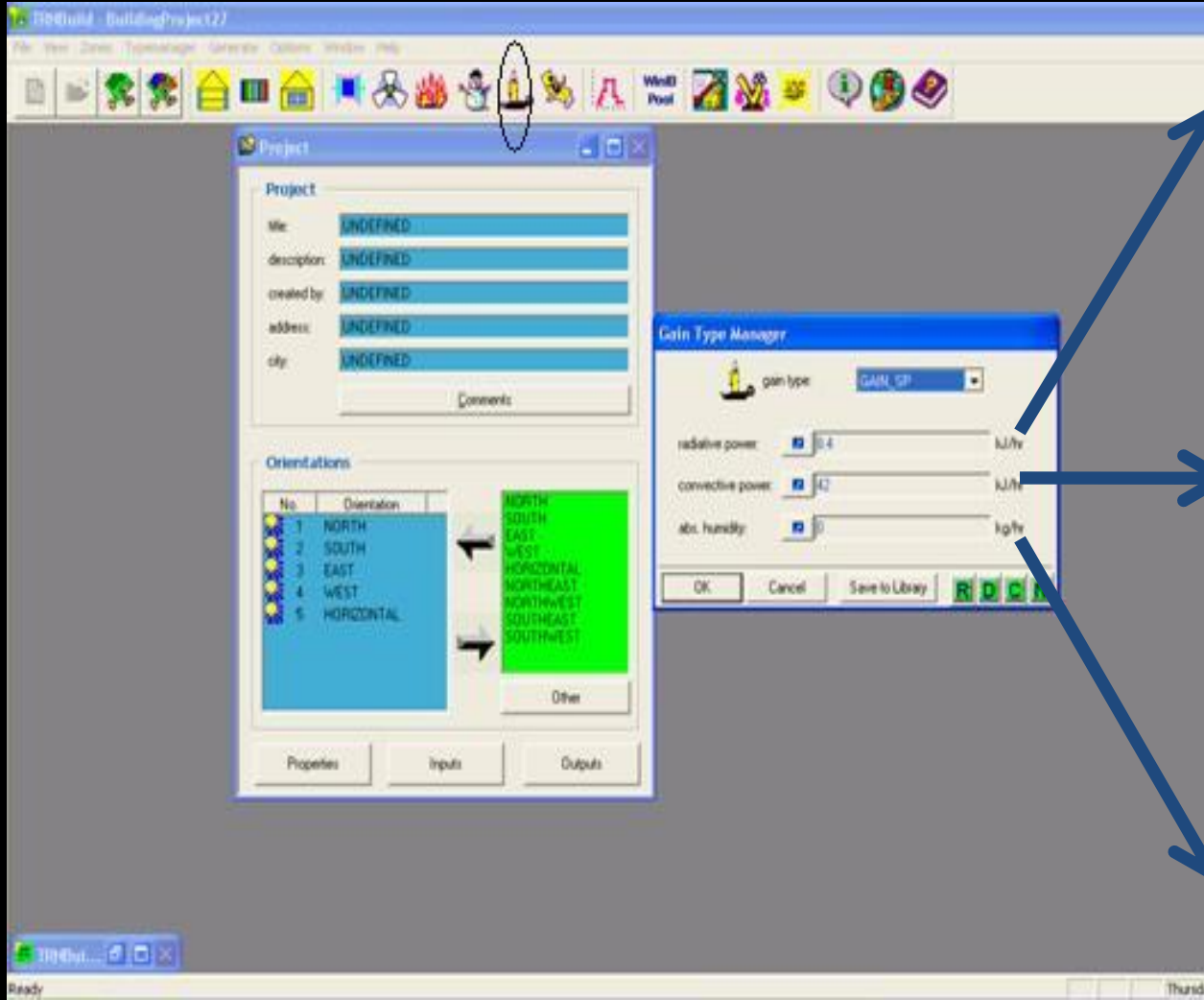
Cooling Power

unlimited  
 limited: 1000 kJ/h

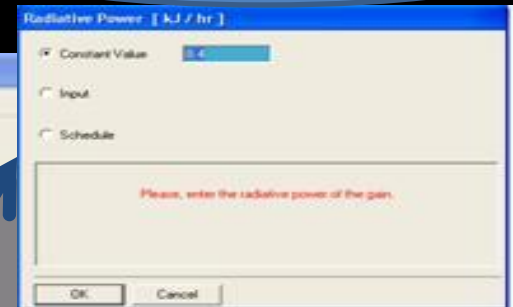
Dehumidification

off  
 on

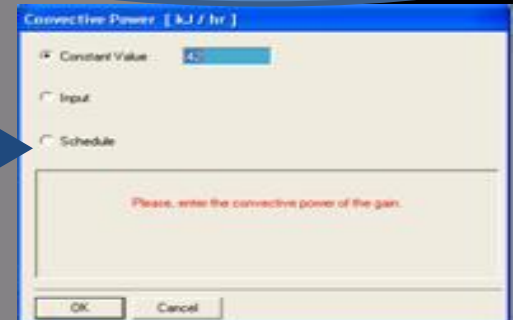
# Gains



Radiative power



Convective Power



abs. humidity



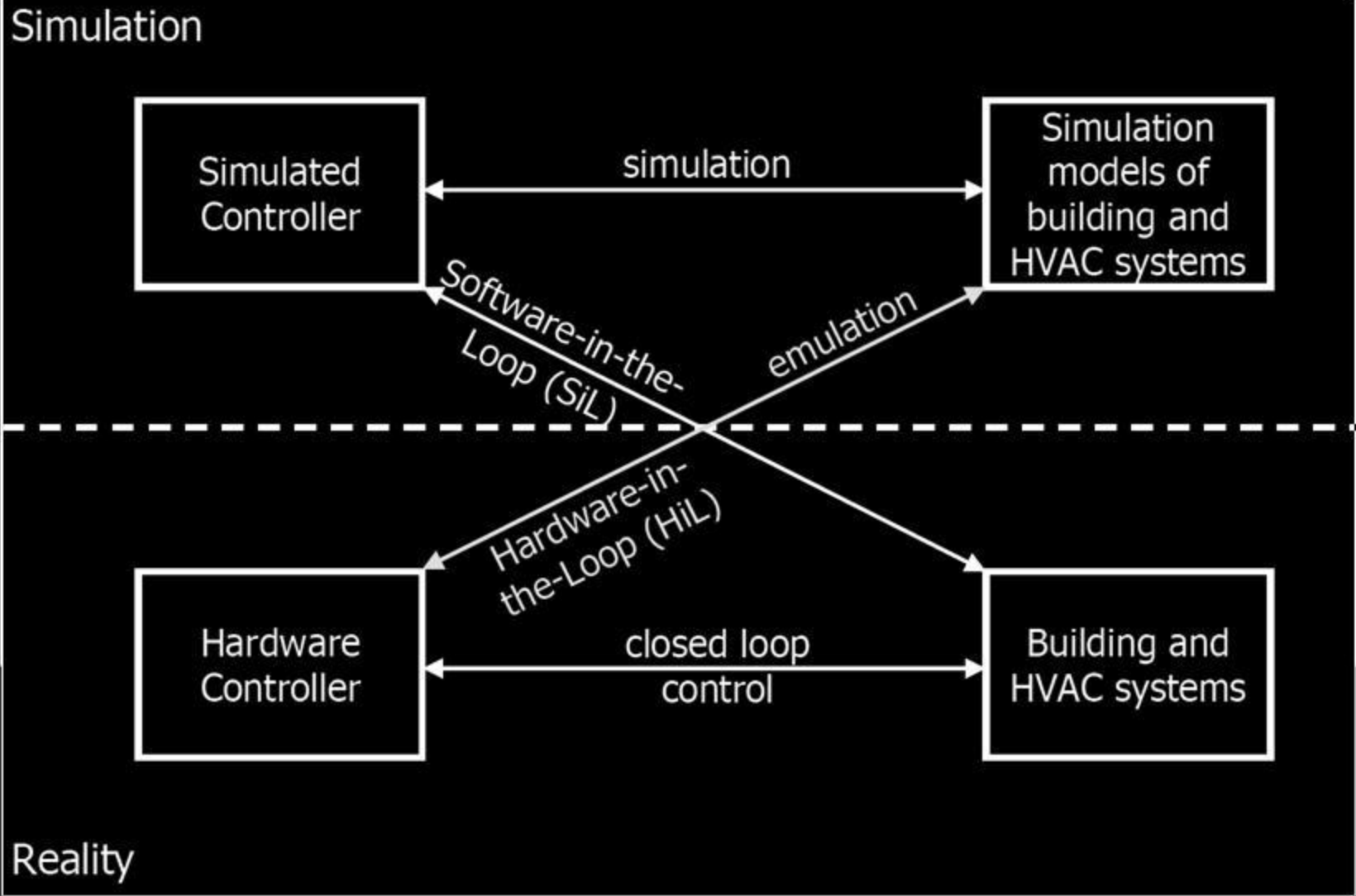
## *5- Summary*

- ✓ *Use TRANSYS 16 software to create model of simple building.*
- ✓ *Change the basic conditions to become compatible with the requirements of the user.*

## *6- Outlook*

- ❖ *Taking into account all the design requirements of building such as installation of walls and the presence of extensions and windows .....*
- ❖ *Taking into account the climatic requirements other than those mentioned, such as comfort and other different requirements .....*
- ❖ *Model CO<sub>2</sub>*
- ❖ *Hardware in the loop (HIL)*
- ❖ *Virtual building*







*Thank you very much  
for your attention*