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TRENING CENTAR

Modeliranje termotehničkog sustava na reprezentativnoj zgradi

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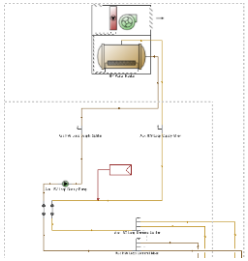
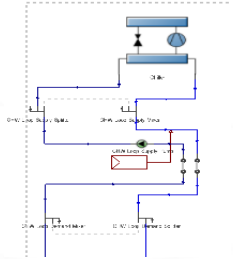
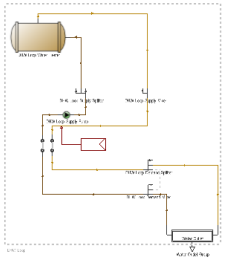
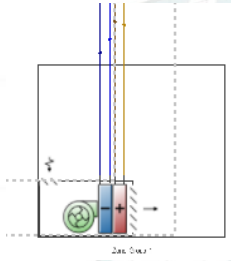
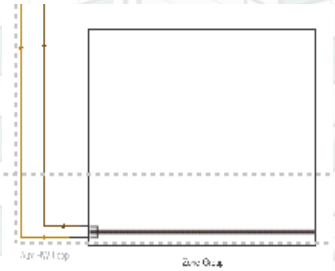
EIHP
Energetski institut Hrvoje Požar
Iceland Liechtenstein Norway grants
Sveučilište u Zagrebu Građevinski fakultet

Projekt je financiran iz programa „Energija i klimatske promjene" u sklopu Financijskog mehanizma Europskog gospodarskog prostora za razdoblje 2014. – 2021. godine.

Opis termotehničkog sustava

- Centralni sustav grijanja i hlađenja s **dizalicom topline zrak-voda** kao izvorom grijanja i hlađenja i **ventilokonvektorima** kao ogrjevnim i rashladnim tijelima u kombinaciji sa **sustavom podnog grijanja** za prostorije dnevnog boravka i kupaonica
- Za pripremu potrošne tople vode predvidjeti **električni bojler** volumena 80 litara

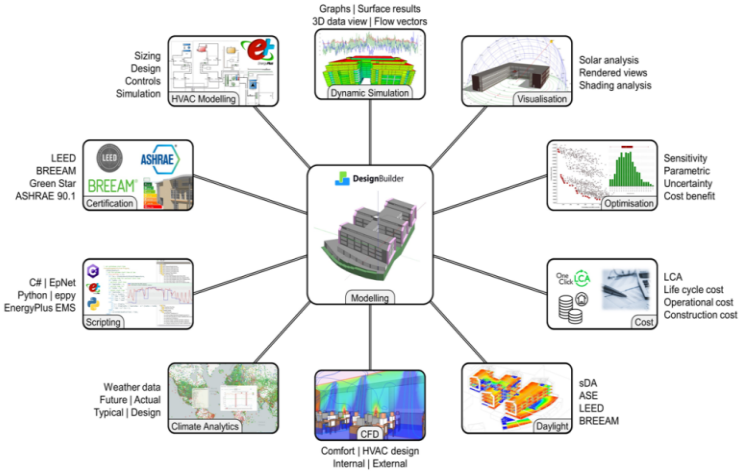






Koristiti Designbuilder Help

- https://designbuilder.co.uk/helpv7.0/index.htm

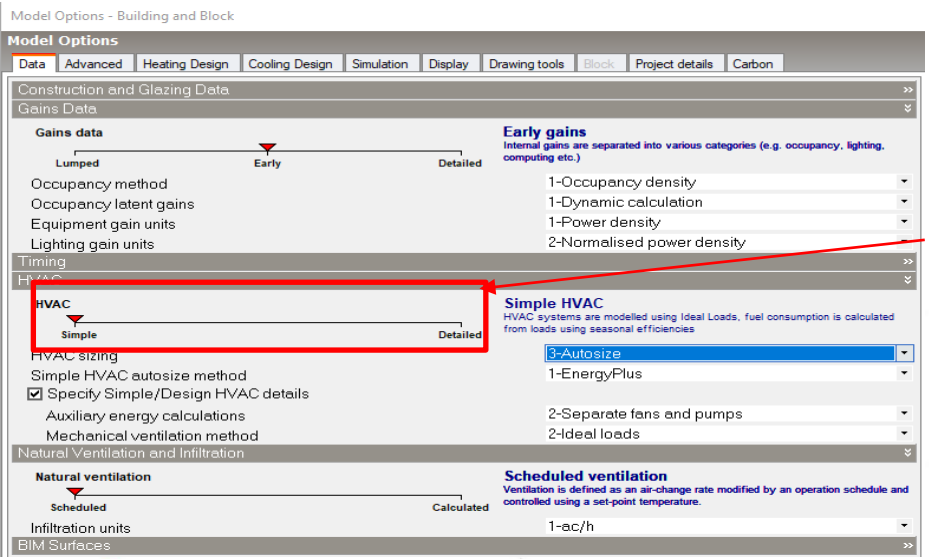
Welcome To DesignBuilder V7

DesignBuilder is a user-friendly modelling environment where you can work (and play) with virtual building models. It provides a range of environmental performance data such as: energy consumption, carbon emissions, comfort conditions, daylight illuminance, maximum summertime temperatures and HVAC component sizes.

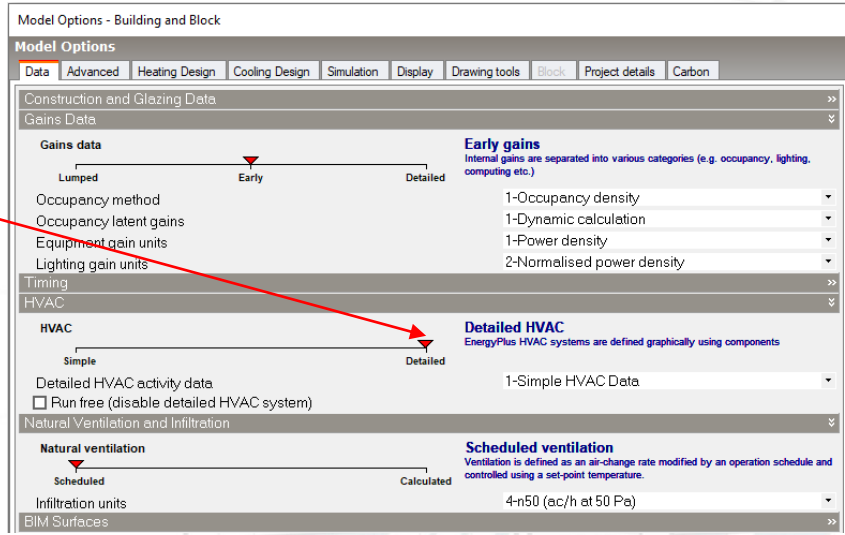


Kako uključiti mode za detaljno modeliranje termotehničkog sustava?

Kliknuti na ključ ili shortcut key F11



Povući slider na Detailed



Activity & HVAC tab template

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- Activity Template
  - **Template**: stanovi
  - Sector: Copy of Residential spaces
  - Zone multiplier: 1
  - ☑ Include zone in thermal calculations
  - ☑ Include zone in Radiance daylighting calculations
- Floor Areas and Volumes
- Occupancy
  - **Occupancy density (people/m2)**: 0,0208
  - **Schedule**: _Obiteljska_okupiranost
  - Metabolic
  - Clothing
  - Comfort Radiant Temperature Weighting
- Contaminant Generation and Removal
- Holidays
- DHW
  - **Consumption rate (l/m2-day)**: 0,635
- Environmental Control
  - Heating Setpoint Temperatures
    - **Heating (°C)**: 20
    - Heating set back (°C): 12,0
  - Cooling Setpoint Temperatures
    - **Cooling (°C)**: 26
    - Cooling set back (°C): 28,0
  - Heating Comfort PMV Setpoints
  - Cooling Comfort PMV Setpoints
  - Humidity Control
  - Ventilation Setpoint Temperatures
  - Minimum Fresh Air
  - CO2/Contaminant Setpoints
  - Lighting

- HVAC Template
  - **Template**: Heated floor, Boiler HW, Nat Vent
- Mechanical Ventilation
  - ☐ On
- Heating
  - ☑ Heated
  - Sizing Zone Equipment
    - Natural ventilation load: 1-Met by zone equipment
  - Type
    - Supply Air Condition
      - Maximum supply air temperature (°C): 35,00
      - Maximum supply air humidity ratio (g/g): 0,0156
  - Operation
    - **Schedule**: OK_heating
- Cooling
  - ☑ **Cooled**
  - Cooling system: Default
  - Supply Air Condition
  - Operation
    - **Schedule**: OK_cooling
- Humidity Control
- DHW
  - ☑ On
  - Operation
    - **Schedule**: _obiteljska_DHW
- Natural Ventilation
- Earth Tube
- Air Temperature Distribution
- Environmental Impact Factors
- Cost

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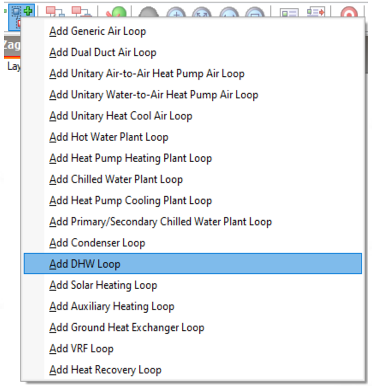
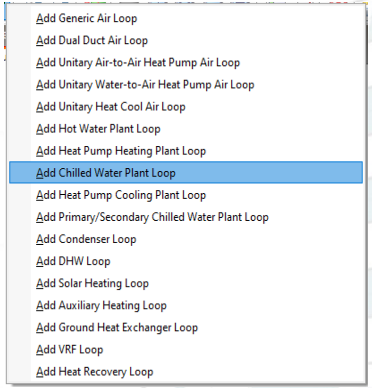
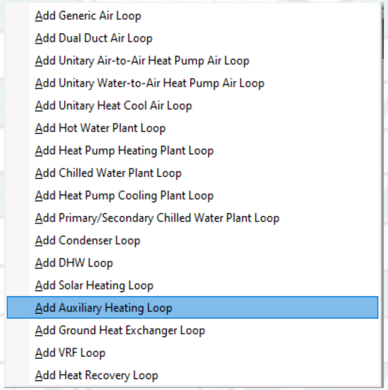
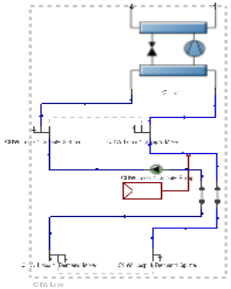
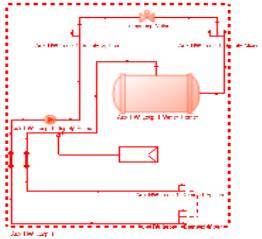
- Dodati dvije Zonske grupe klikom na Add Zone group
- Dodati Loop-ove za pripremu PTV-a (**Add DHW Loop**), rashladni dio dizalice topline (**Add Chilled Water Plant Loop**) i ogrjevni dio dizalice topline (Add **Auxilary Heating Loop**)

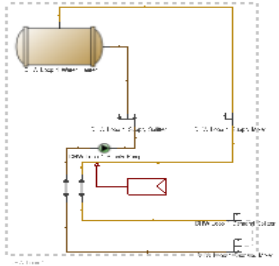












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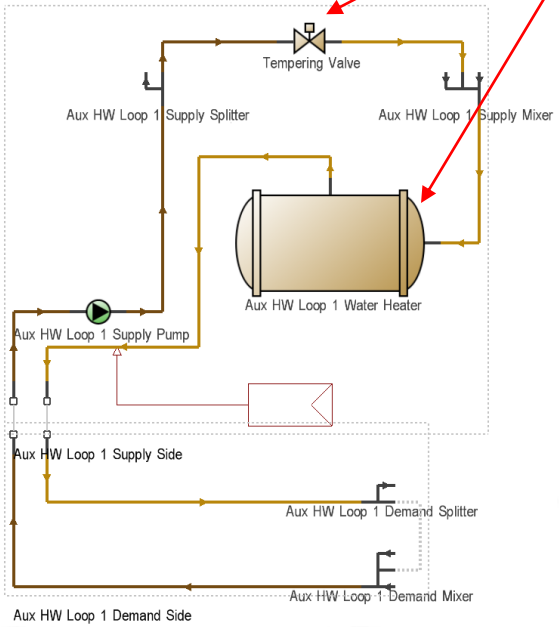
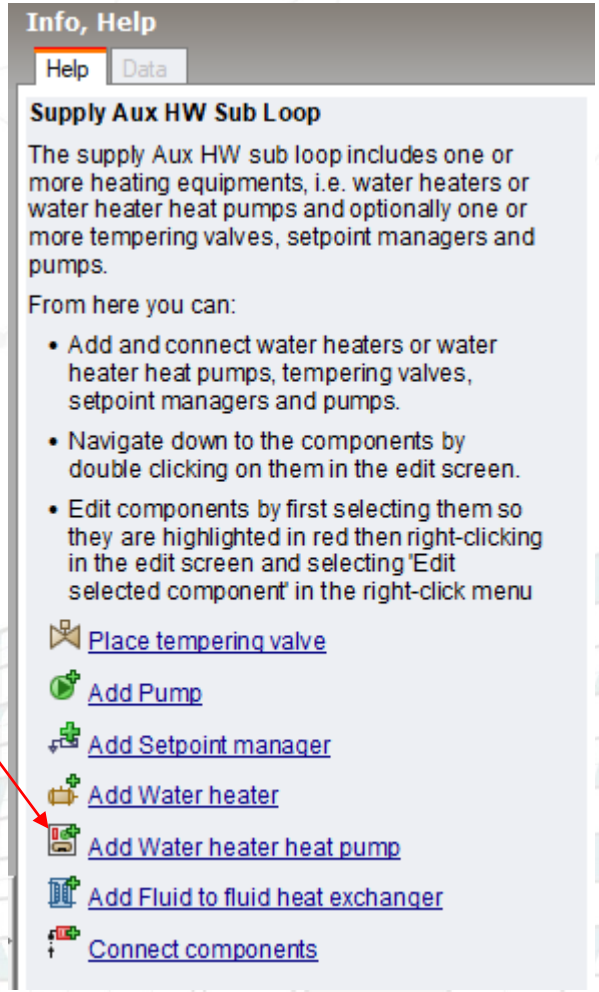
Obrisati Tempering Valve i Aux HW Loop Water Heater



S desne strane na Info, Help kliknuti na Add Water heater heat pump i postaviti na mjesto Tempering Valve



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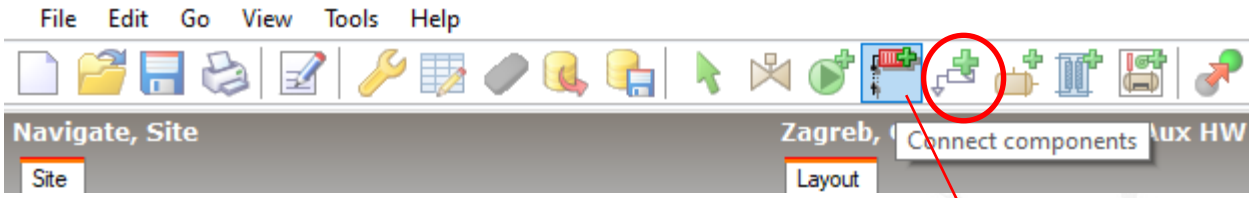
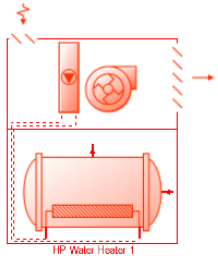
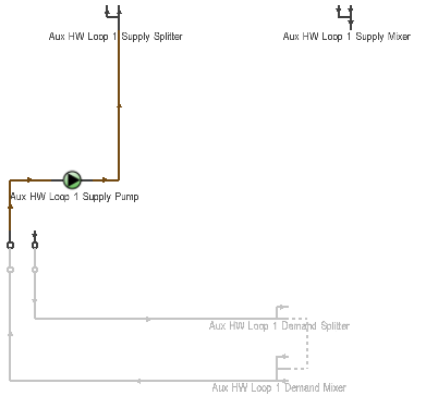
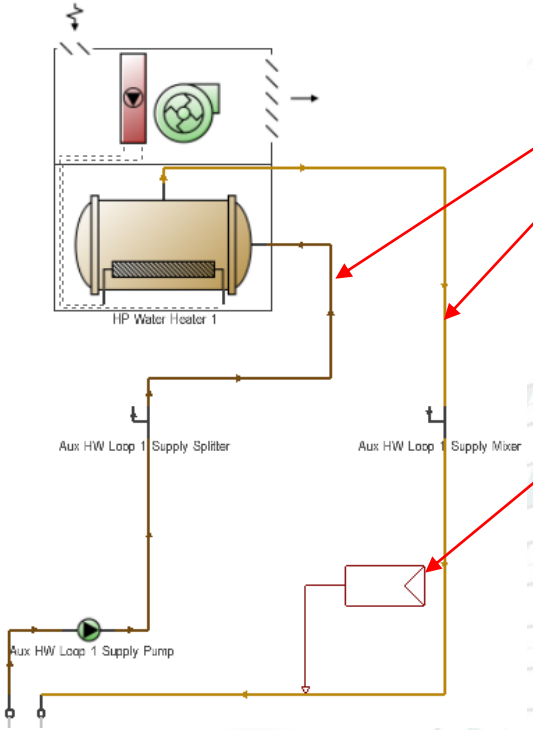
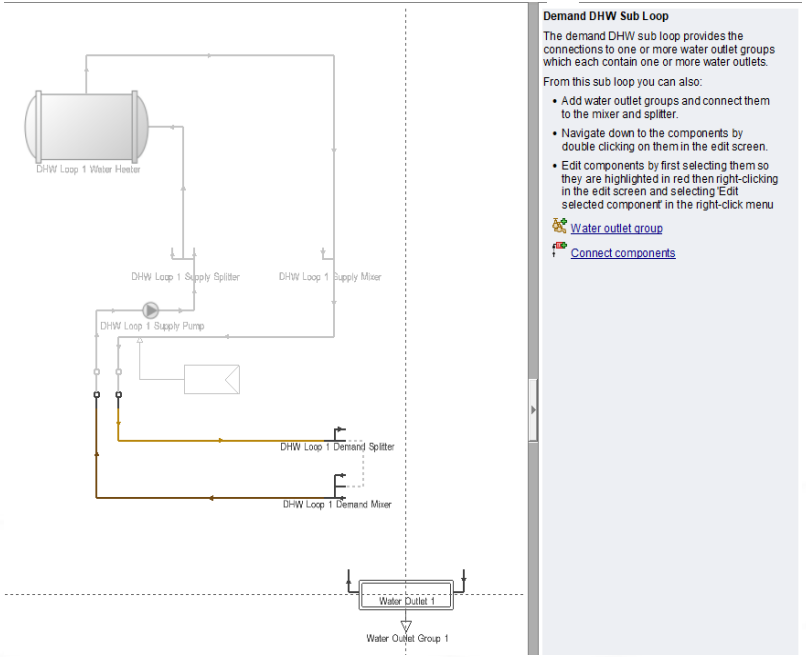




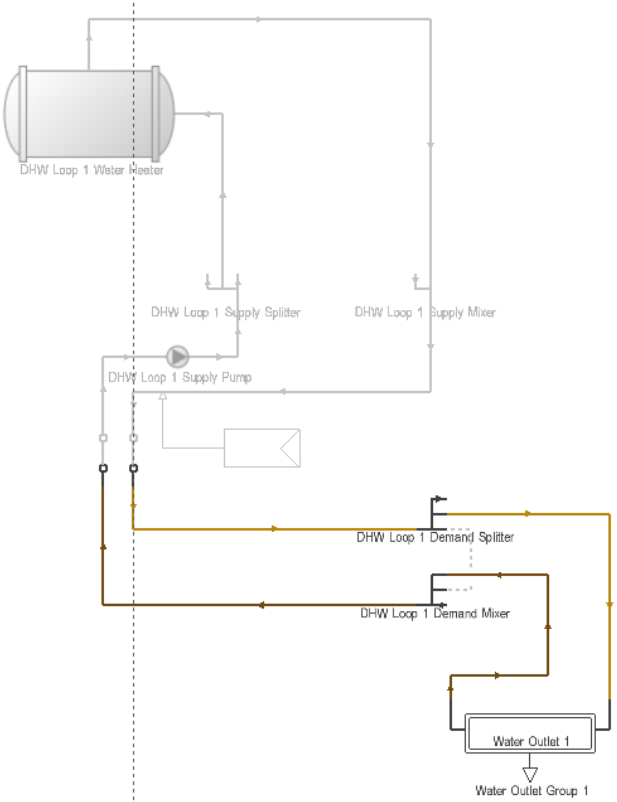


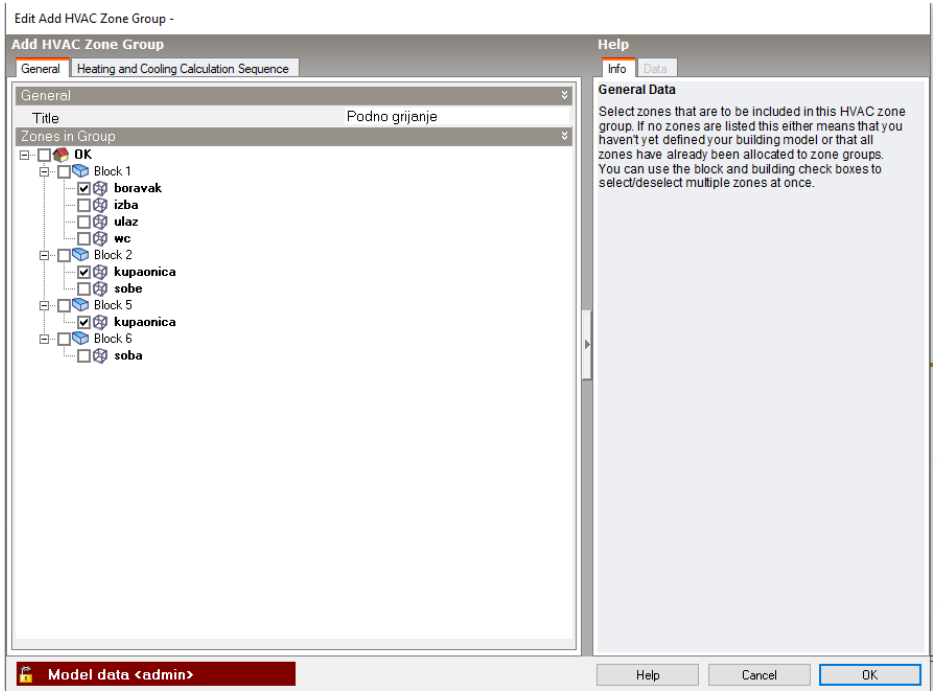


Pomoću Connect components, spojiti dijelove heatera sa Splitter-om i Mixer-om prema slici te dodati Setpoint Manager

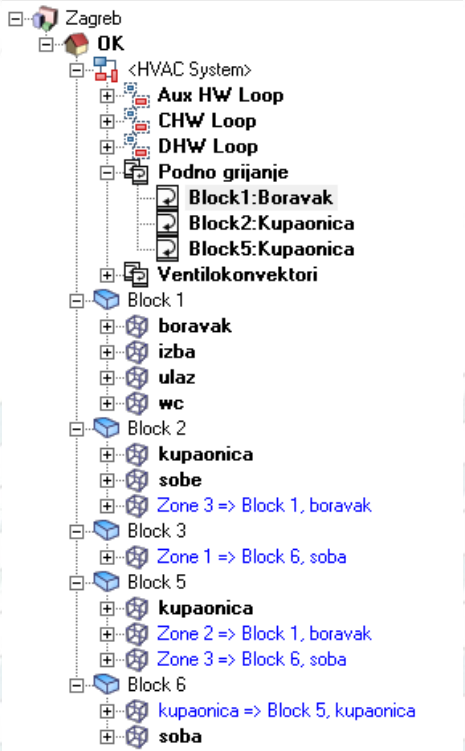


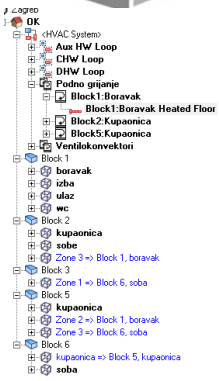
U DHW Loopu dodati Water outlet group te opet spojiti komponente pomoću Connect Components

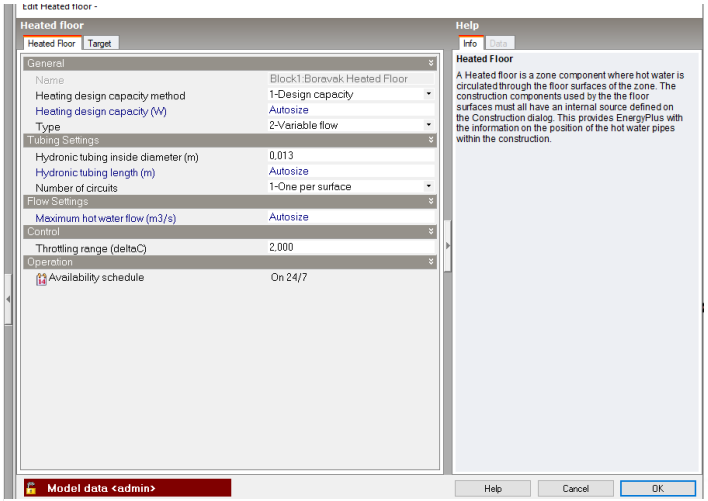




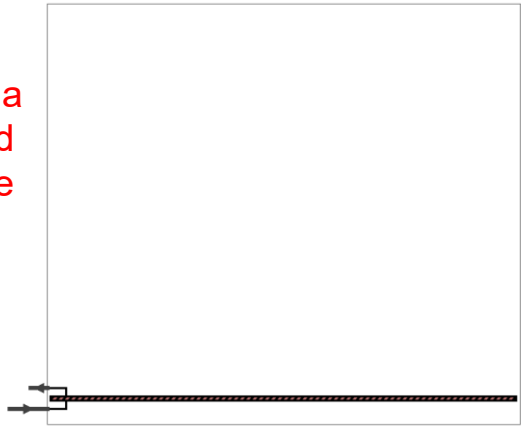
U Zone Group kliknuti i odabrati zone ‘boravak’, ‘kupaonica’ I ‘kupaonica’ te moguće imenovati grupu ‘Podno grijanje’ na Title tabu, kliknuti na Block1:Boravak



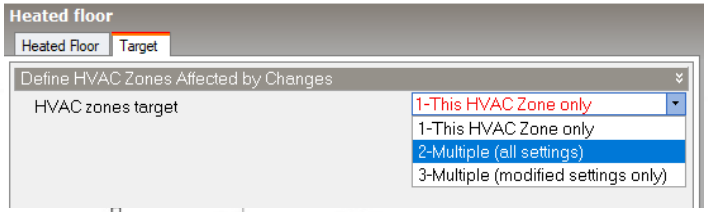


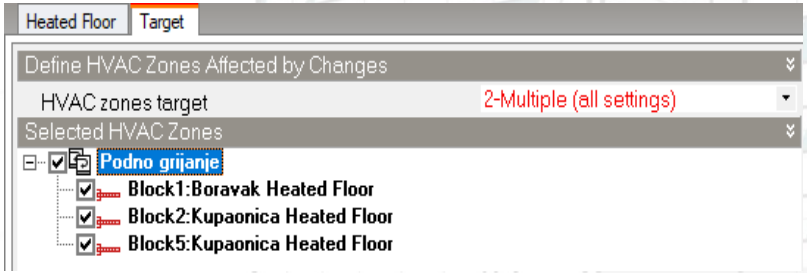


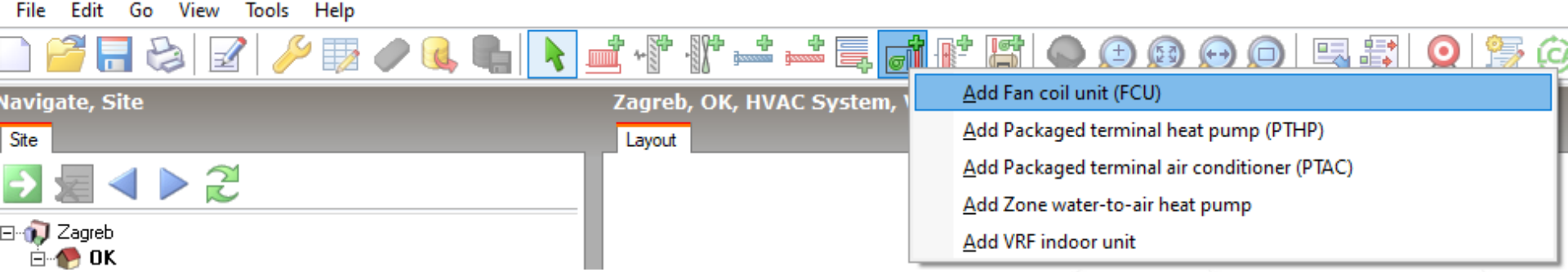
Dodati Heated floor u zoni boravka, kliknuti na Block1:Boravak Heated Floor->Target->Multiple (all settings) i odabrati sve

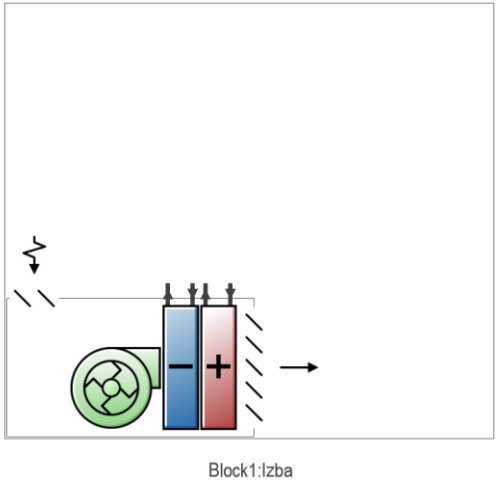


Edit Heated floor -

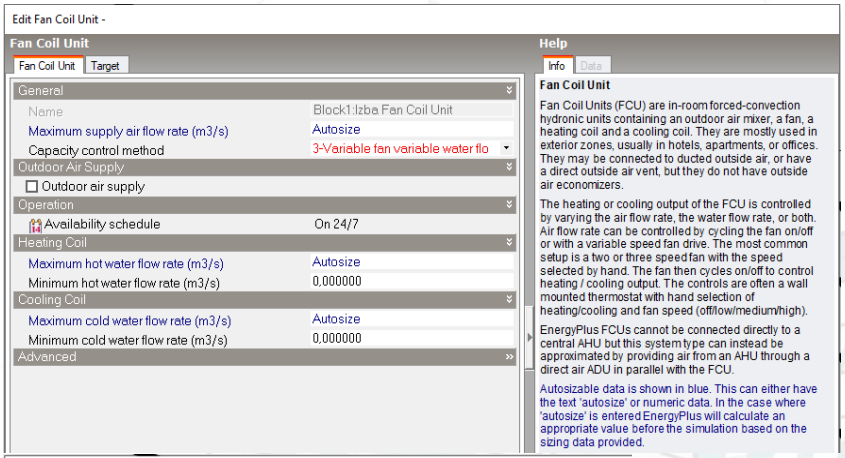


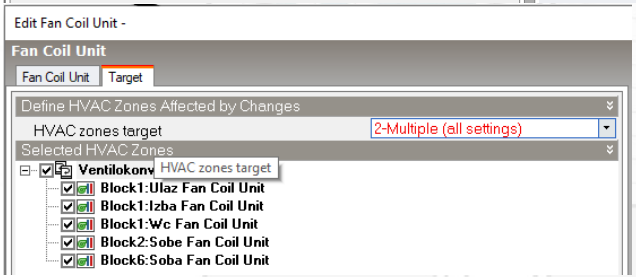


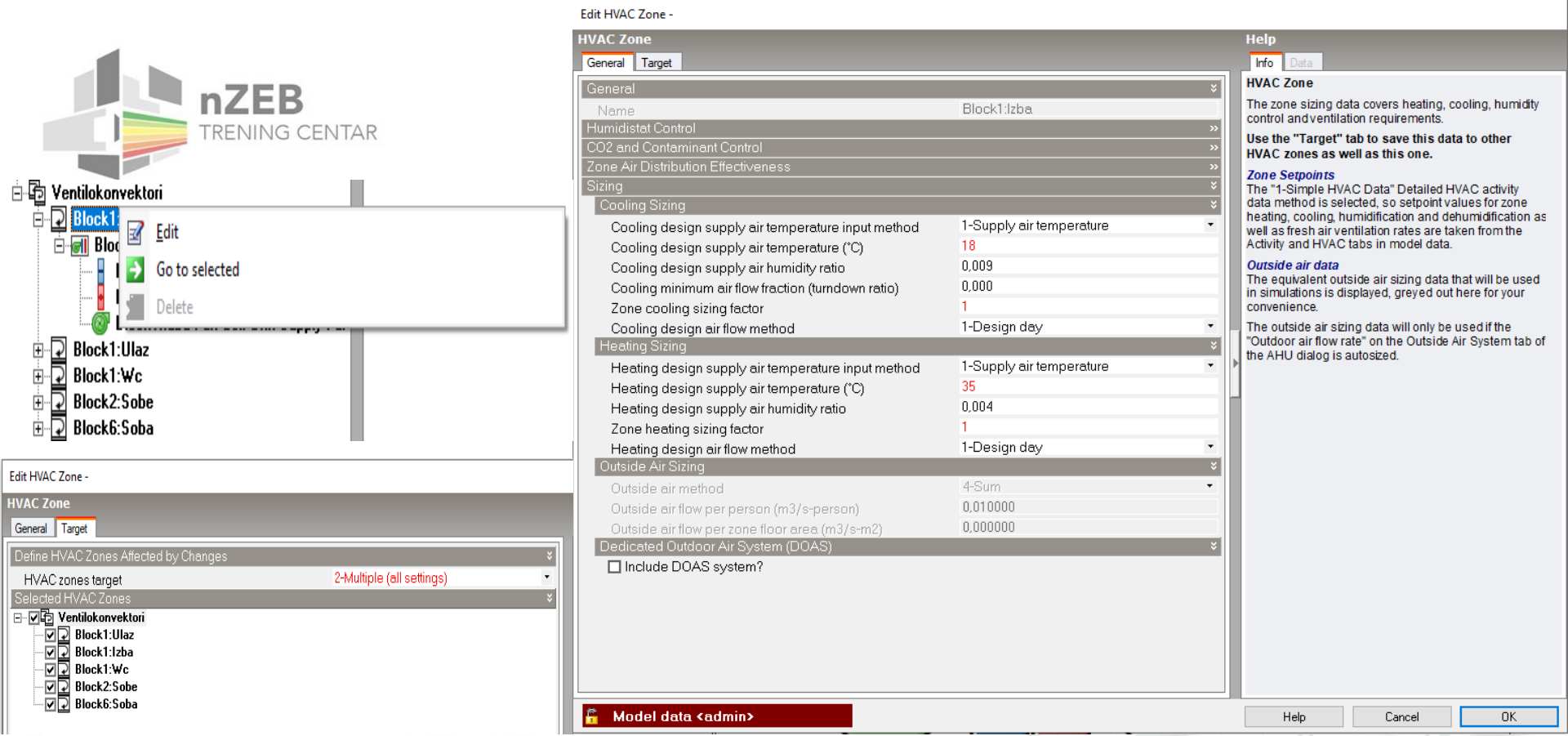




Slično kao s podnim grijanjem, ponoviti postupak u Zone Group 1 i dodati Fan coil unit (FCU), promijeniti Capacity control method na 3- i Target na sve blokove



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Ventilokonvektori
Block1:
Edit
Go to selected
Delete
Block1:Ulaz
Block1:Wc
Block2:Sobe
Block6:Soba
Edit HVAC Zone -
HVAC Zone
General
Target
Define HVAC Zones Affected by Changes
HVAC zones target
2-Multiple (all settings)
Selected HVAC Zones
Ventilokonvektori
Block1:Ulaz
Block1:Izba
Block1:Wc
Block2:Sobe
Block6:Soba
Edit HVAC Zone -
HVAC Zone
General
Target
Help
Info
Data
General
Name
Block1:Izba
Humidistat Control
CO2 and Contaminant Control
Zone Air Distribution Effectiveness
Sizing
Cooling Sizing
Cooling design supply air temperature input method
1-Supply air temperature
Cooling design supply air temperature (°C)
18
Cooling design supply air humidity ratio
0,009
Cooling minimum air flow fraction (turndown ratio)
0,000
Zone cooling sizing factor
1
Cooling design air flow method
1-Design day
Heating Sizing
Heating design supply air temperature input method
1-Supply air temperature
Heating design supply air temperature (°C)
35
Heating design supply air humidity ratio
0,004
Zone heating sizing factor
1
Heating design air flow method
1-Design day
Outside Air Sizing
Outside air method
4-Sum
Outside air flow per person (m3/s-person)
0,010000
Outside air flow per zone floor area (m3/s-m2)
0,000000
Dedicated Outdoor Air System (DOAS)
Include DOAS system?
HVAC Zone
The zone sizing data covers heating, cooling, humidity control and ventilation requirements.
Use the "Target" tab to save this data to other HVAC zones as well as this one.
Zone Setpoints
The "1-Simple HVAC Data" Detailed HVAC activity data method is selected, so setpoint values for zone heating, cooling, humidification and dehumidification as well as fresh air ventilation rates are taken from the Activity and HVAC tabs in model data.
Outside air data
The equivalent outside air sizing data that will be used in simulations is displayed, greyed out here for your convenience.
The outside air sizing data will only be used if the "Outdoor air flow rate" on the Outside Air System tab of the AHU dialog is autosized.
Model data <admin>
Help
Cancel
OK

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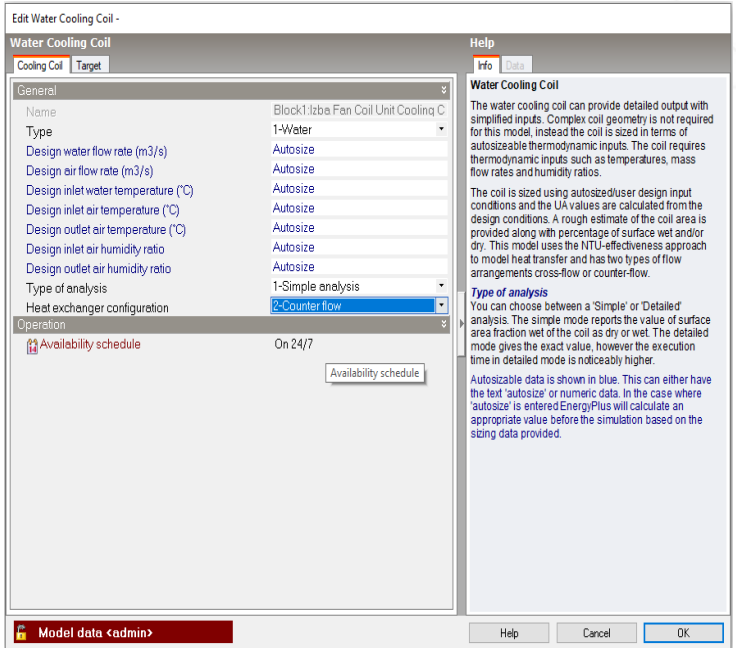
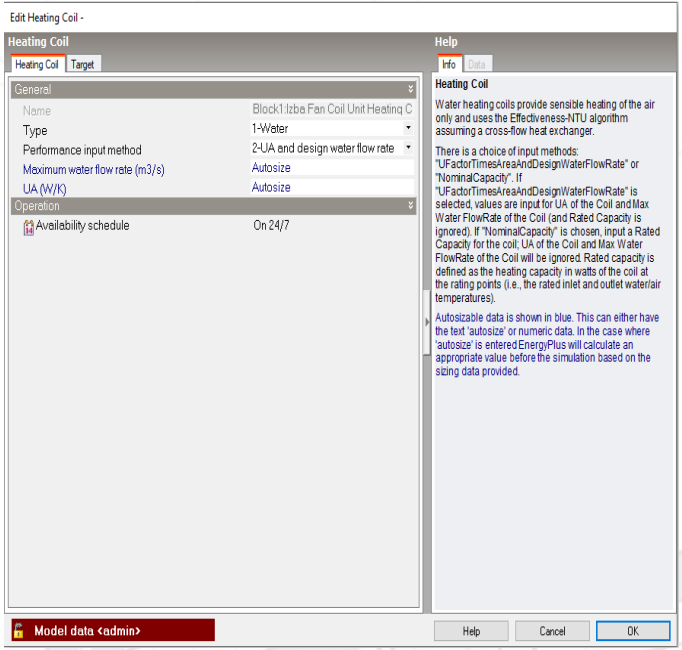
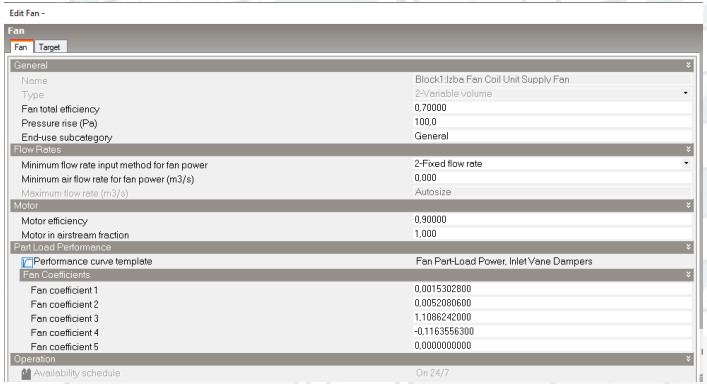
Unutar Fan coil unit, odabrati parameter za Cooling coil, Heating coil i Fan te Target za sve blokove







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CHW Loop & Chiller

Edit Plant loop -

Plant loop

General | Plant Equipment Operation

General	
Name	CHW Loop
Fluid type	2-EthyleneGlycol
Glycol concentration	0,250
Plant loop volume (m3)	Autocalculate
Flow Type	
Plant loop flow type	2-Variable flow
Temperature	
Maximum loop temperature (°C)	80,00
Minimum loop temperature (°C)	0,00
Flow Rate	
Maximum loop flow rate (m3/s)	Autosize
Minimum loop flow rate (m3/s)	0,000000
Load distribution scheme	1-Sequential
Plant loop demand calculation scheme	1-SingleSetPoint
Sizing	
Design loop exit temperature (°C)	7,00
Loop design temperature difference (deltaC)	5,00
Operation	
Availability schedule	OK_cooling
Outside Temperature Operation	
☐ Outside temperature operation	

Edit Plant loop -

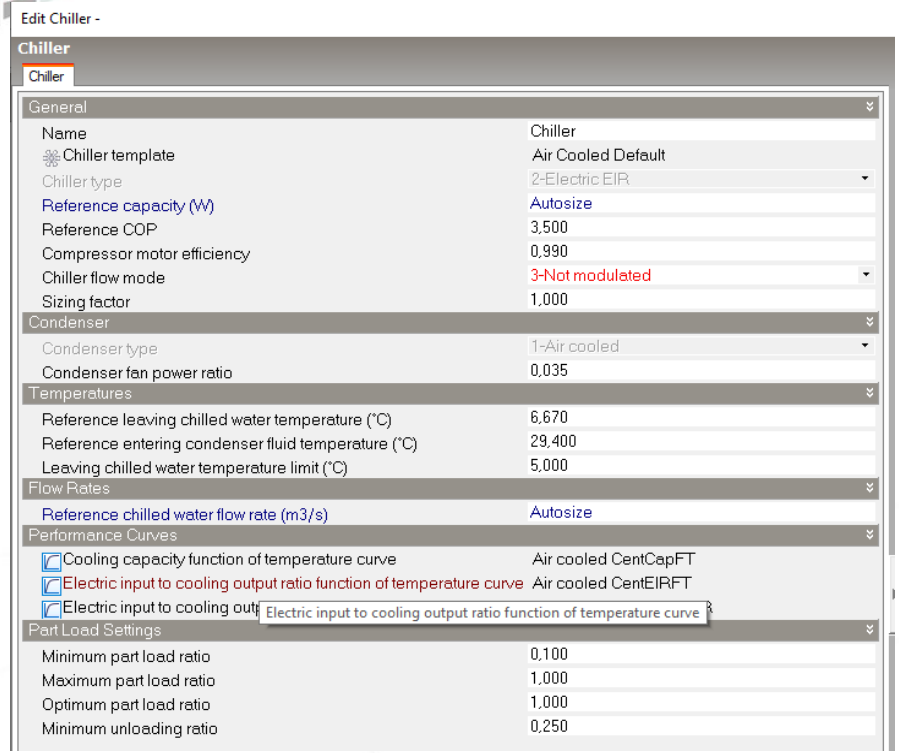
Plant loop

General | Plant Equipment Operation

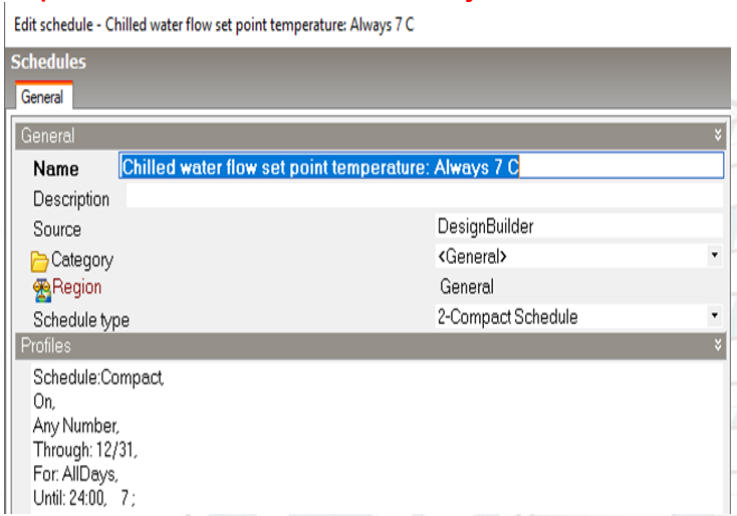
General	
Number of schemes	1
Scheme 1	
Operation type	2-Cooling load
Operation schedule	OK_cooling
Number of ranges	
Range 1	
Lower limit (W)	0,00
Upper limit (W)	1000000000000000,00
Equipment	
☑ Chiller	
Priority	1

Operation schedule

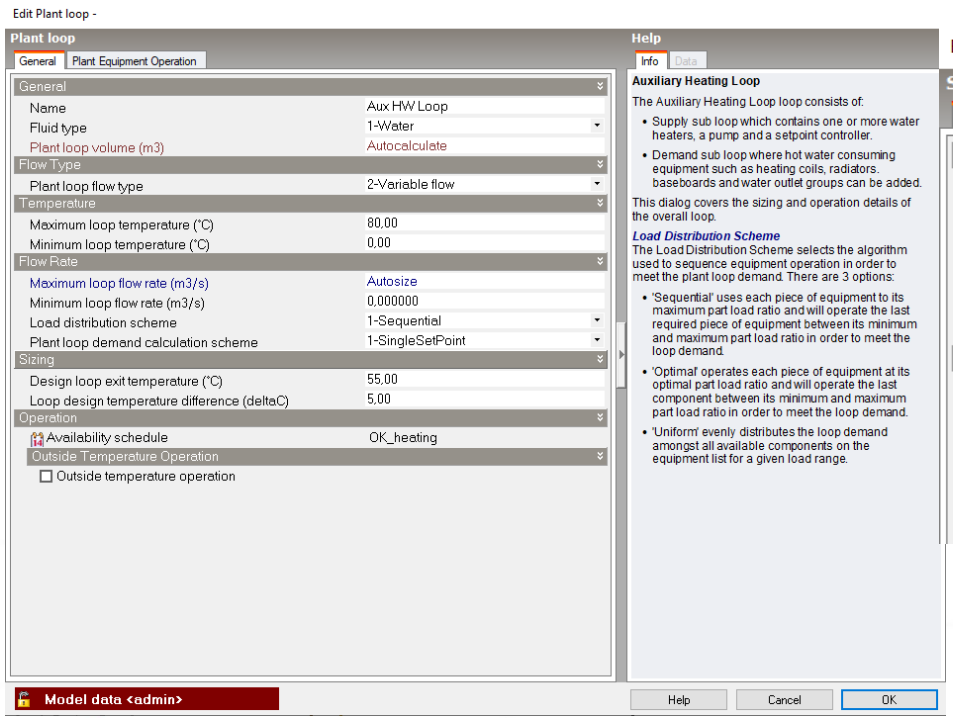
CHW Loop & Chiller

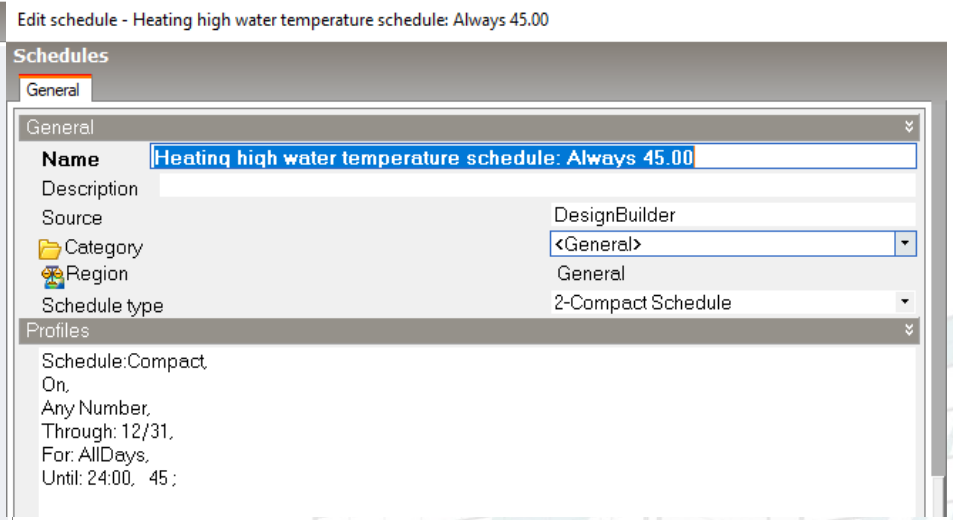


Odabrati Chiller template pod sekcijom ‘Air Cooled’ Air Cooled Default template i promijeniti Reference COP na vrijednost 3.5.
U CHW Loop Setpoint Manager postaviti schedule s ‘Always 7 C’.

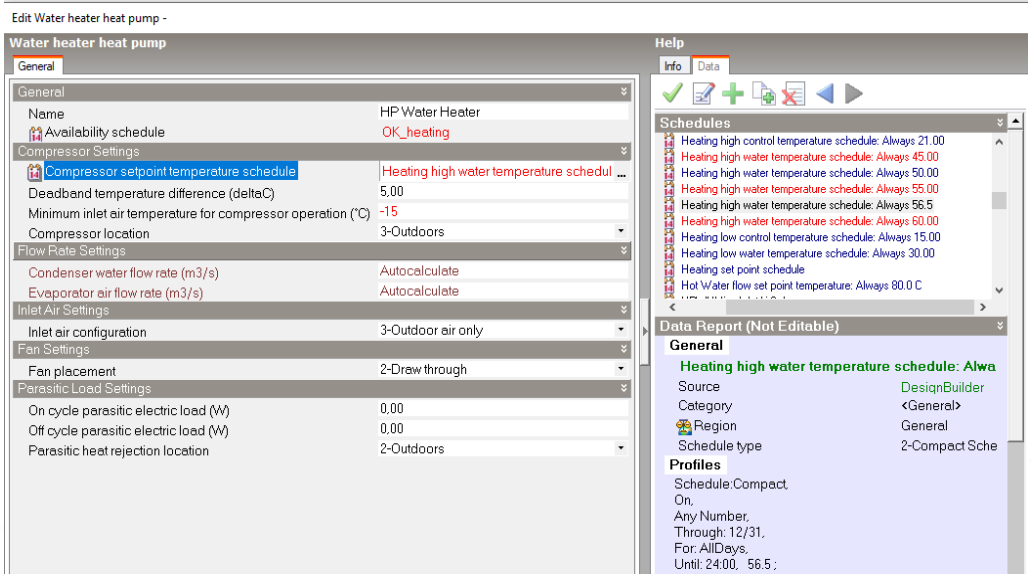


Aux HW Loop


Edit Plant loop -
Plant loop
General
Plant Equipment Operation
General
Name
Aux HW Loop
Fluid type
1-Water
Plant loop volume (m3)
Autocalculate
Flow Type
Plant loop flow type
2-Variable flow
Temperature
Maximum loop temperature (°C)
80,00
Minimum loop temperature (°C)
0,00
Flow Rate
Maximum loop flow rate (m3/s)
Autosize
Minimum loop flow rate (m3/s)
0,000000
Load distribution scheme
1-Sequential
Plant loop demand calculation scheme
1-SingleSetPoint
Sizing
Design loop exit temperature (°C)
55,00
Loop design temperature difference (deltaC)
5,00
Operation
Availability schedule
OK_heating
Outside Temperature Operation
Outside temperature operation
Help
Info
Data
Auxiliary Heating Loop
The Auxiliary Heating Loop loop consists of:
Supply sub loop which contains one or more water heaters, a pump and a setpoint controller.
Demand sub loop where hot water consuming equipment such as heating coils, radiators, baseboards and water outlet groups can be added.
This dialog covers the sizing and operation details of the overall loop.
Load Distribution Scheme
The Load Distribution Scheme selects the algorithm used to sequence equipment operation in order to meet the plant loop demand. There are 3 options:
'Sequential' uses each piece of equipment to its maximum part load ratio and will operate the last required piece of equipment between its minimum and maximum part load ratio in order to meet the loop demand.
'Optimal' operates each piece of equipment at its optimal part load ratio and will operate the last component between its minimum and maximum part load ratio in order to meet the loop demand.
'Uniform' evenly distributes the loop demand amongst all available components on the equipment list for a given load range.
Model data <admin>
Help
Cancel
OK

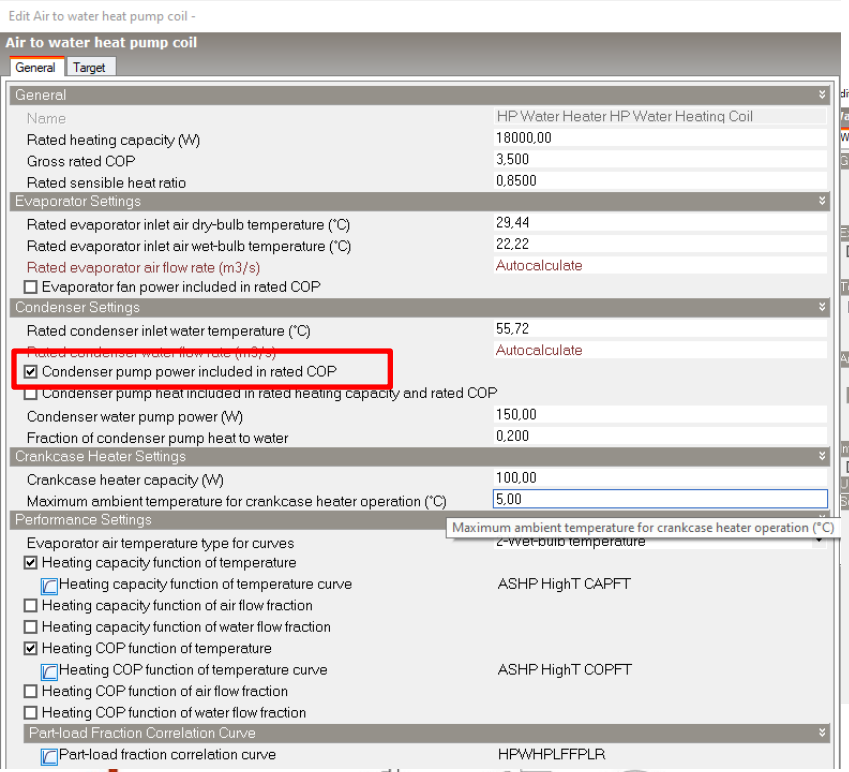

Edit schedule - Heating high water temperature schedule: Always 45.00
Schedules
General
General
Name
Heating high water temperature schedule: Always 45.00
Description
Source
DesignBuilder
Category
<General>
Region
General
Schedule type
2-Compact Schedule
Profiles
Schedule:Compact,
On,
Any Number,
Through: 12/31,
For: AllDays,
Until: 24:00, 45;

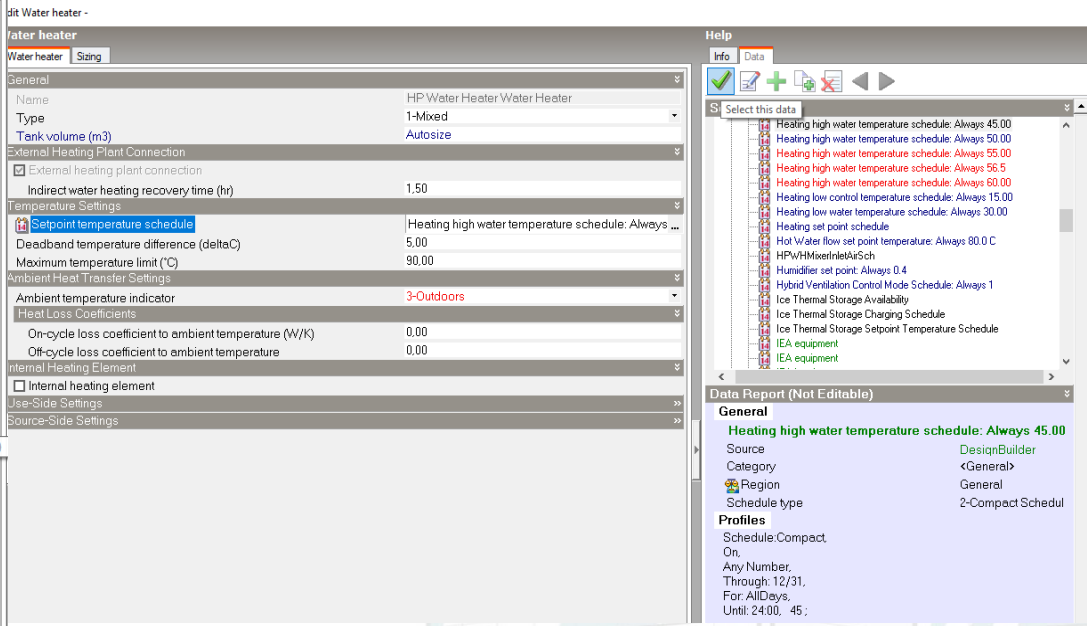
Aux HW Loop



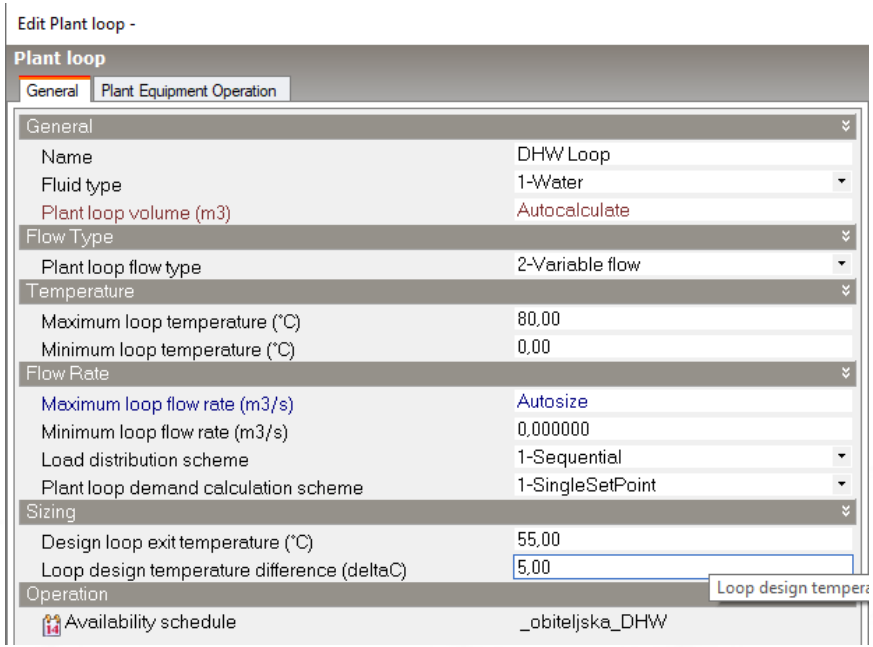
Izuzetno bitno je postaviti temperature Compressor setpoint temperature schedule 1.5 °C iznad sizing temperature. Također postaviti Minimum inlet air temperature for compressor operation na -15 °C.

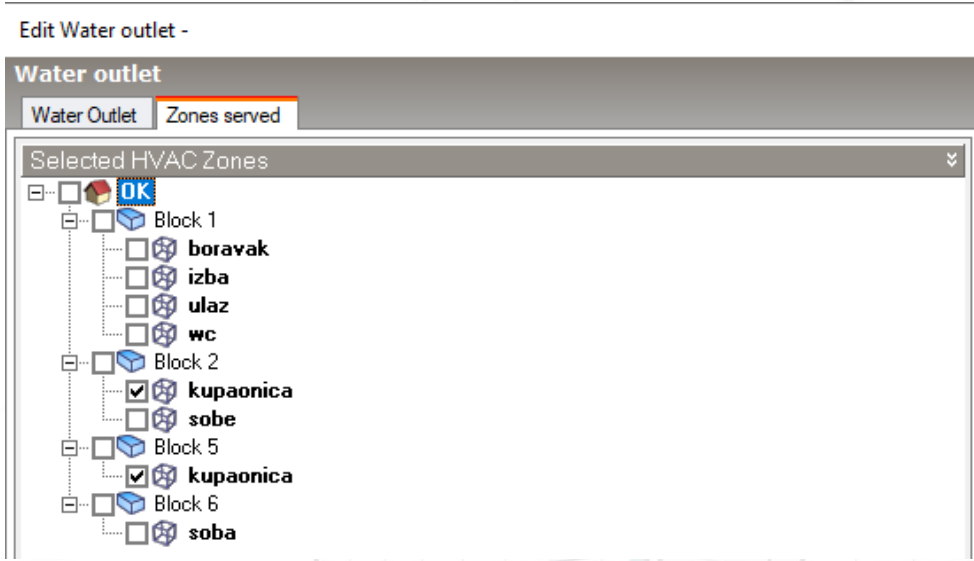
Aux HW Loop


Edit Air to water heat pump coil -
Air to water heat pump coil
General
Target
General
Name
HP Water Heater HP Water Heating Coil
Rated heating capacity (W)
18000,00
Gross rated COP
3,500
Rated sensible heat ratio
0,8500
Evaporator Settings
Rated evaporator inlet air dry-bulb temperature (°C)
29,44
Rated evaporator inlet air wet-bulb temperature (°C)
22,22
Rated evaporator air flow rate (m3/s)
Autocalculate
Evaporator fan power included in rated COP
Condenser Settings
Rated condenser inlet water temperature (°C)
55,72
Autocalculate
Condenser pump power included in rated COP
Condenser pump heat included in rated heating capacity and rated COP
Condenser water pump power (W)
150,00
Fraction of condenser pump heat to water
0,200
Crankcase Heater Settings
Crankcase heater capacity (W)
100,00
Maximum ambient temperature for crankcase heater operation (°C)
5,00
Maximum ambient temperature for crankcase heater operation (°C)
Performance Settings
Evaporator air temperature type for curves
Heating capacity function of temperature
Heating capacity function of temperature curve
ASHP HighT CAPFT
Heating capacity function of air flow fraction
Heating capacity function of water flow fraction
Heating COP function of temperature
Heating COP function of temperature curve
ASHP HighT COPFT
Heating COP function of air flow fraction
Heating COP function of water flow fraction
Part-load Fraction Correlation Curve
Part-load fraction correlation curve
HPWHPLFFPLR

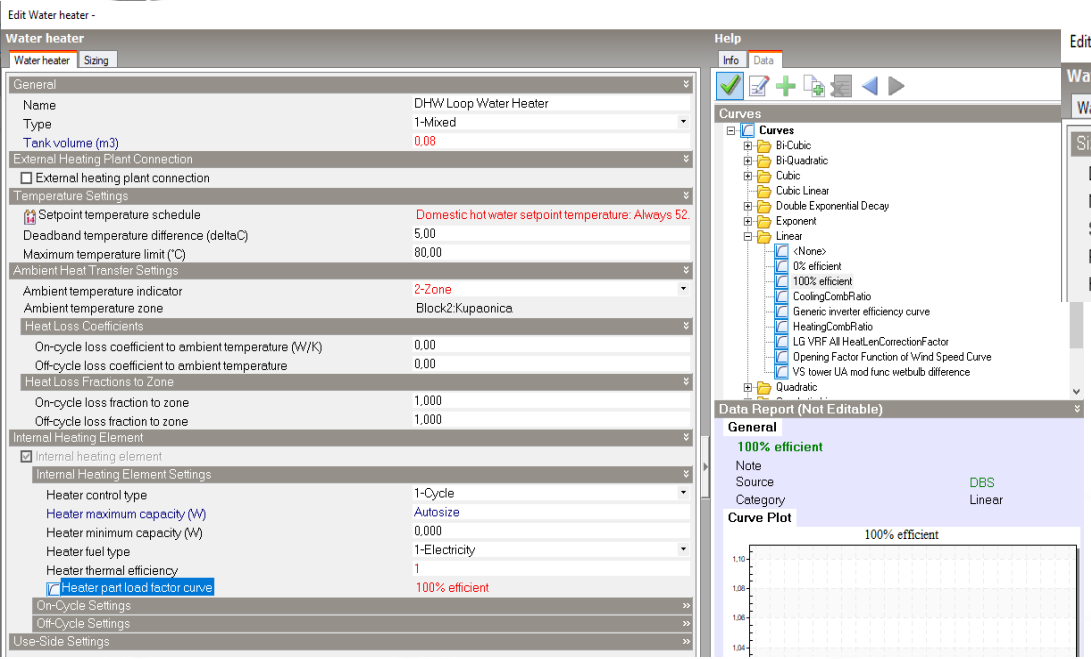

dit Water heater -
Water heater
Water heater
Sizing
General
Name
HP Water Heater Water Heater
Type
1-Mixed
Tank volume (m3)
Autosize
External Heating Plant Connection
External heating plant connection
Indirect water heating recovery time (hr)
1,50
Temperature Settings
Setpoint temperature schedule
Heating high water temperature schedule: Always ...
Deadband temperature difference (deltaC)
5,00
Maximum temperature limit (°C)
90,00
Ambient Heat Transfer Settings
Ambient temperature indicator
3-Outdoors
Heat Loss Coefficients
On-cycle loss coefficient to ambient temperature (W/K)
0,00
Off-cycle loss coefficient to ambient temperature
0,00
Internal Heating Element
Internal heating element
Use-Side Settings
Source-Side Settings
Help
Info
Data
Select this data
Heating high water temperature schedule: Always 45.00
Heating high water temperature schedule: Always 50.00
Heating high water temperature schedule: Always 55.00
Heating high water temperature schedule: Always 56.5
Heating high water temperature schedule: Always 60.00
Heating low control temperature schedule: Always 15.00
Heating low water temperature schedule: Always 30.00
Heating set point schedule
Hot Water flow set point temperature: Always 80.0 C
HPWHMixerInletAirSch
Humidifier set point: Always 0.4
Hybrid Ventilation Control Mode Schedule: Always 1
Ice Thermal Storage Availability
Ice Thermal Storage Charging Schedule
Ice Thermal Storage Setpoint Temperature Schedule
IEA equipment
IEA equipment
Data Report (Not Editable)
General
Heating high water temperature schedule: Always 45.00
Source
DesignBuilder
Category
<General>
Region
General
Schedule type
2-Compact Schedul
Profiles
Schedule:Compact,
On,
Any Number,
Through: 12/31,
For: AllDays,
Until: 24:00, 45 ;

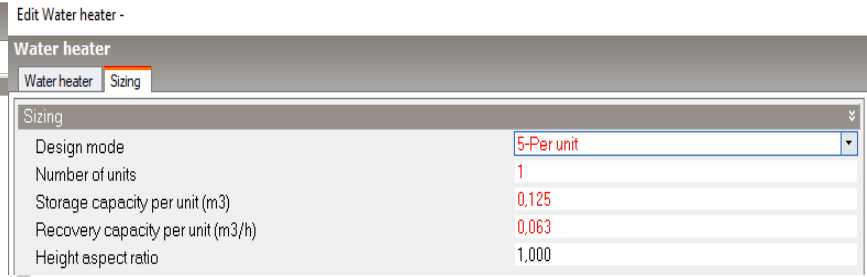
DHW Loop


Edit Plant loop -
Plant loop
General
Plant Equipment Operation
General
Name
DHW Loop
Fluid type
1-Water
Plant loop volume (m3)
Autocalculate
Flow Type
Plant loop flow type
2-Variable flow
Temperature
Maximum loop temperature (°C)
80,00
Minimum loop temperature (°C)
0,00
Flow Rate
Maximum loop flow rate (m3/s)
Autosize
Minimum loop flow rate (m3/s)
0,000000
Load distribution scheme
1-Sequential
Plant loop demand calculation scheme
1-SingleSetPoint
Sizing
Design loop exit temperature (°C)
55,00
Loop design temperature difference (deltaC)
5,00
Loop design tempera
Operation
Availability schedule
_obiteljska_DHW


Edit Water outlet -
Water outlet
Water Outlet
Zones served
Selected HVAC Zones
OK
Block 1
boravak
izba
ulaz
wc
Block 2
kupaonica
sobe
Block 5
kupaonica
Block 6
soba

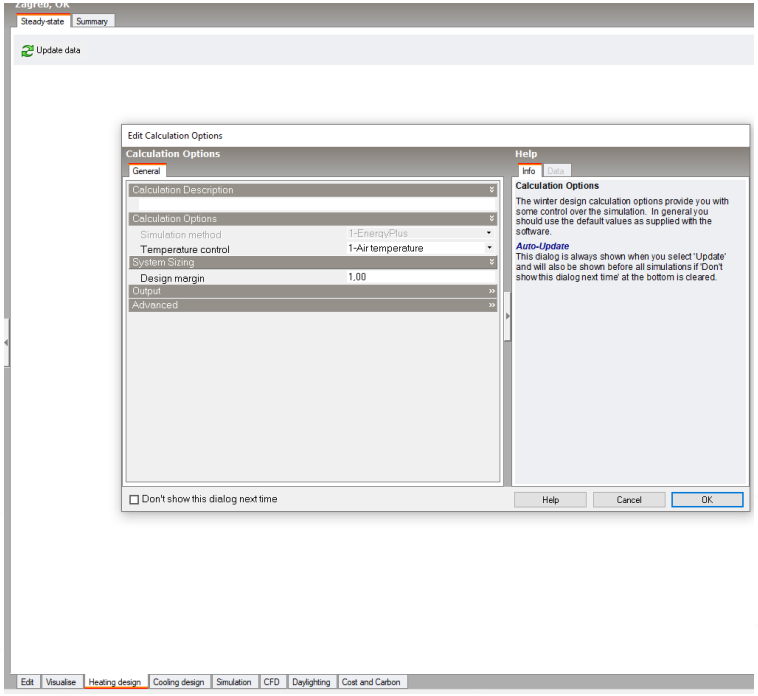
DHW Loop

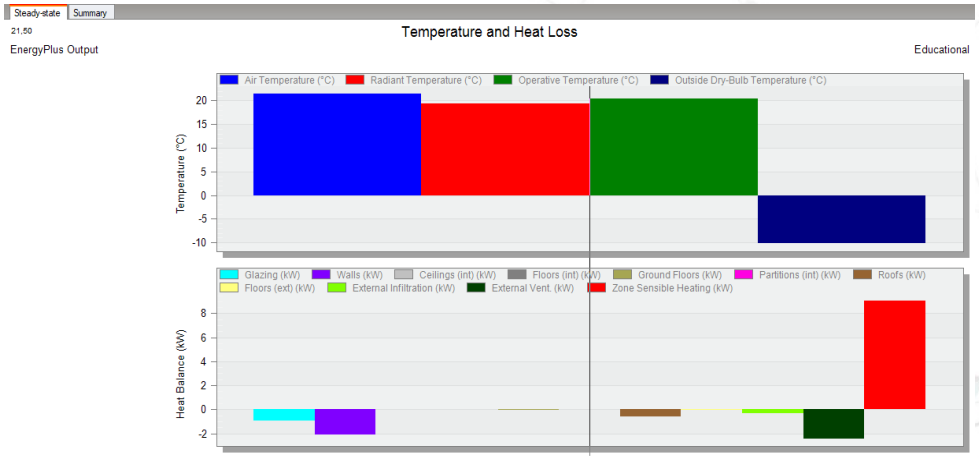




Modelirati električni bojler volumena 80 L s linearnom krivuljom 100 % efficient.

Heating design





Air Temperature (°C)	21,50
Radiant Temperature (°C)	19,31
Operative Temperature (°C)	20,41
Outside Dry-Bulb Temperature (°C)	-10,20
Glazing (kW)	-0,94
Walls (kW)	-2,07
Ceilings (int) (kW)	-0,01
Floors (int) (kW)	0,02
Ground Floors (kW)	-0,02
Partitions (int) (kW)	0,00
Roofs (kW)	-0,60
Floors (ext) (kW)	-0,03
External Infiltration (kW)	-0,34
External Vent. (kW)	-2,45
Zone Sensible Heating (kW)	9,06

Cooling design

Calculation Options - OK

Calculation Options

General

Calculation Description

Calculation Options

Simulation method	1-EnergyPlus
Temperature control	1-Air temperature

Summer Design Day

Day	15
Start month	Jul
End month	Sep
Day of week	9-SummerDesignDay

- ☐ Exclude all zone natural ventilation (infiltration is always included)
- ☐ Exclude all zone mechanical ventilation
- ☑ Exclude heat recovery

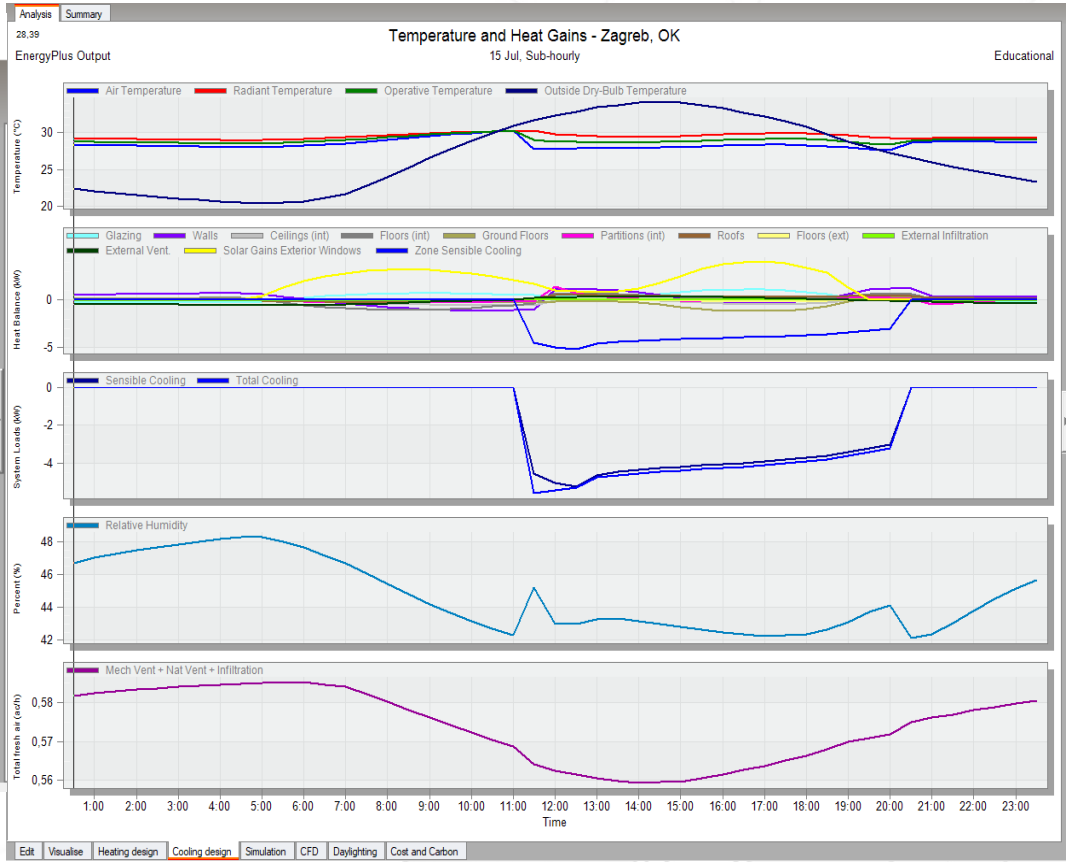
System Sizing

Design margin	1,00
Sizing method	1-ASHRAE
Airflow calculation method	1-Sensible only

Output

Solar

Advanced



Validacija toplinskog i rashladnog opterećenja

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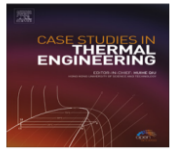

Actual validation of energy simulation and investigation of energy management strategies (Case Study: An office building in Semnan, Iran)

Afshin Fathalian[a], Hadi Kargarsharifabad[a,b,*]

Citat:

investigated only by simulating all factors interfering in energy efficiency of the building [3,4]. Various types of software have been developed in this regard that must be carefully selected [2]. Researcher simulated the energy consumption in a commercial building using EnergyPlus and compared the results with actual values [5]. In a research conducted by Skin and Torkaman [6], heating and cooling loads were simulated for a residential building in a cold and dry climate for 24 h using EnergyPlus and the results were compared to those of actual samples, so that the difference in heating and cooling loads was 3% and 5% respectively. In a study by

nZEB
TRENING CENTAR

Hvala na pažnji!

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