

DEMONSTRATION OF MODELING OF RADIANT COOLING SYSTEM IN DESIGN BUILDER

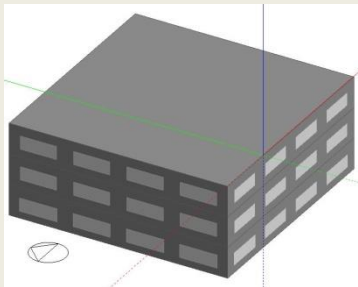
CONTENTS



- Introduction to Design Builder
- Building Energy Simulation
- Modeling procedure
 - Making a model
 - DOAS modeling
 - Chilled slab/ceiling modeling
- Results and comparisons
- Conclusion

INTRODUCTION

- Design Builder is a Graphical User Interface (GUI) for simulation tool “EnergyPlus”



Graphical User Interface

Simulation engine
- Energy Plus

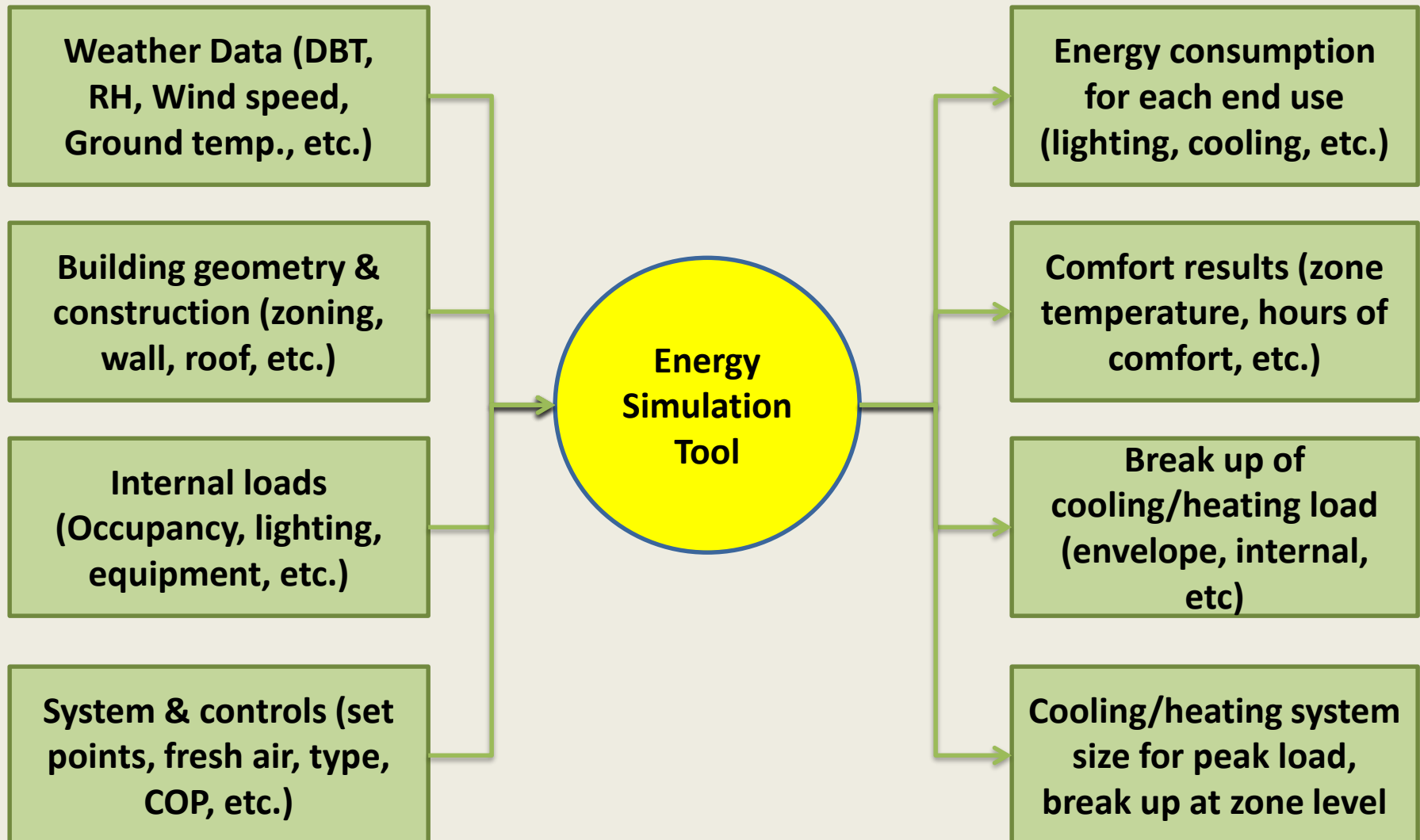
- Design Builder is available in different versions
- Latest one is 4.6 (Energy Plus - 8.3)

HISTORY OF DESIGN BUILDER



- **EnergyPlus**
 - Developed by US Department of Energy
 - Version 1.0 Launched April 2001; twice yearly updates
 - It is a modular, structured software tool based on the most popular features and capabilities of BLAST and DOE-2.1E.
 - It is primarily a simulation engine; input and output are simple text files.
- **Design Builder**
 - Developed by “DesignBuilder Software Ltd” based in London, UK
 - Version 1 of the product was launched in 2005; GUI to the EnergyPlus simulation engine
 - Version 2 (May 2009) adding CFD calculations linked to EnergyPlus
 - Version 3 (August 2011), advanced GUI to EnergyPlus HVAC systems & daylight evaluation tool using Radiance
 - Version 4 (May 2014), renewable, optimization, etc.

INPUTS AND OUTPUTS OF A BUILDING SIMULATION TOOL



BUILDING ENERGY SIMULATION PROCEDURE

– 2 STEPS



Step 1: Making Building Simulation Model

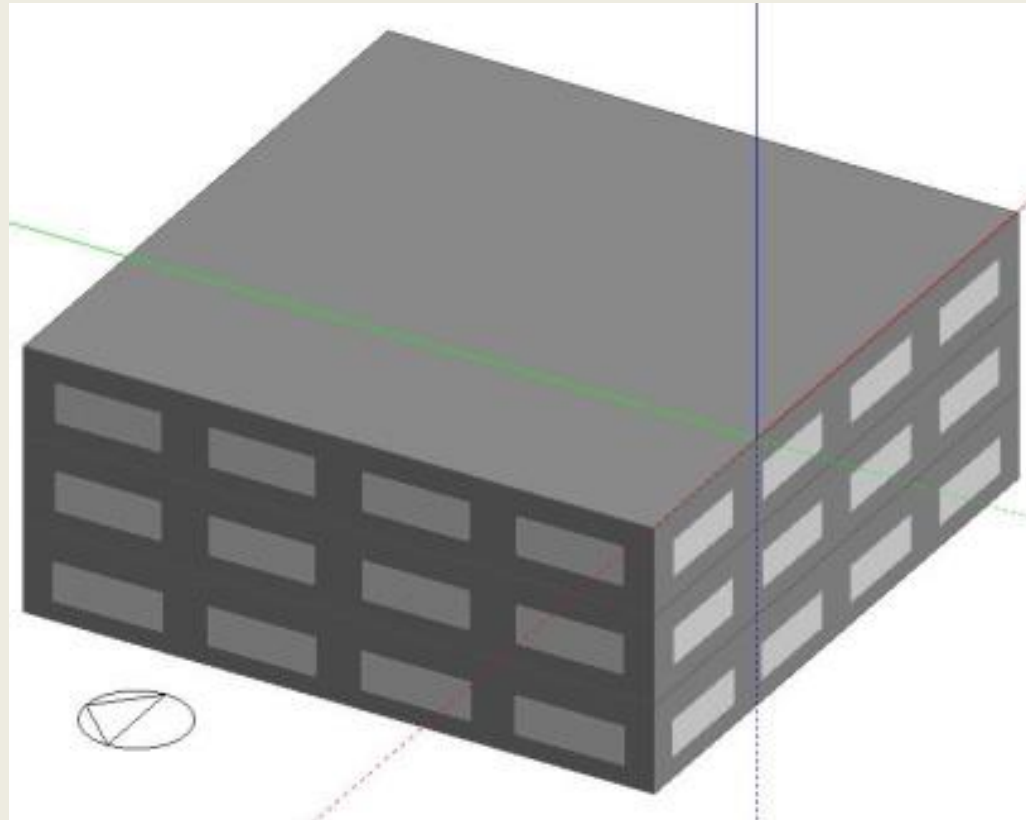
- Building envelope (walls, floors, ceilings, windows, glass etc.)
- Loads (Occupancy, Lighting and equipment etc.)
- Schedules

Step 2: HVAC modeling

- Air loops
- Chilled water loops
- Controls

STEP 1: BUILDING A SIMULATION MODEL

- Area = 625 m² (25 x 25 m)
 - Floor to floor - 3.5 m
 - Office building
 - Day time operation
 - 3 storey building
 - Ground floor
 - Intermediate
 - Top floor
- (3 zones)



STEP 1: BUILDING A SIMULATION MODEL



Building envelope:

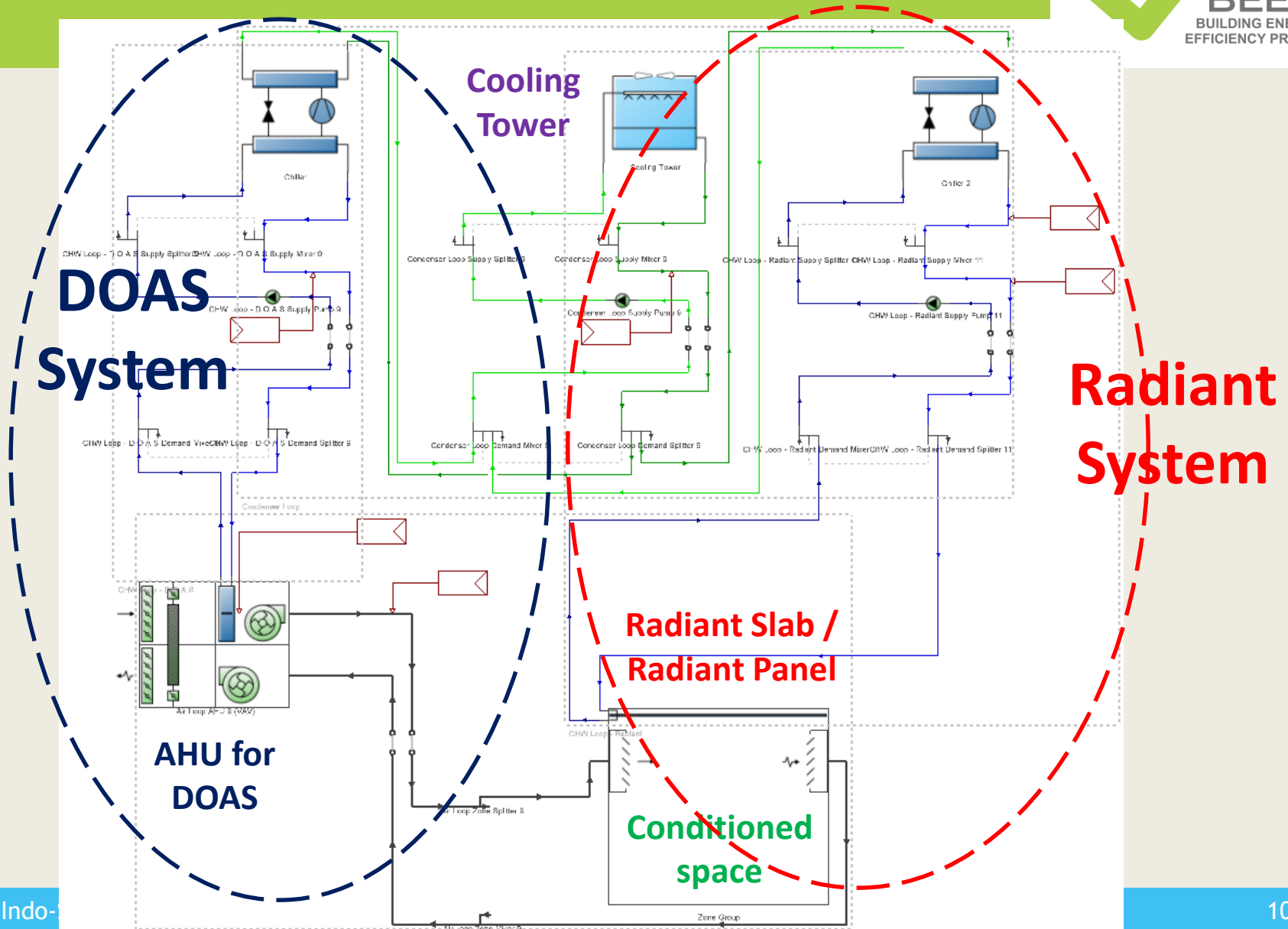
- Wall: 230 mm brick (U value - 0.438 W/m^2)
- Roof: RCC 150 mm + XPS Insulation (U value - 0.409 W/m^2)
- Internal floor: RCC 150 mm (U value - 2.47 W/m^2)
- Ground floor: RCC 150 + XPS insulation (U value - 0.409 W/m^2)
- Glazing: Double glazing
 - Window to Wall ratio = 30 %
 - SHGC = 0.27
 - VLT = 0.49
 - U Value = 1.5 W/m^2

Internal loads: (8 am to 6 pm; Monday to Friday)

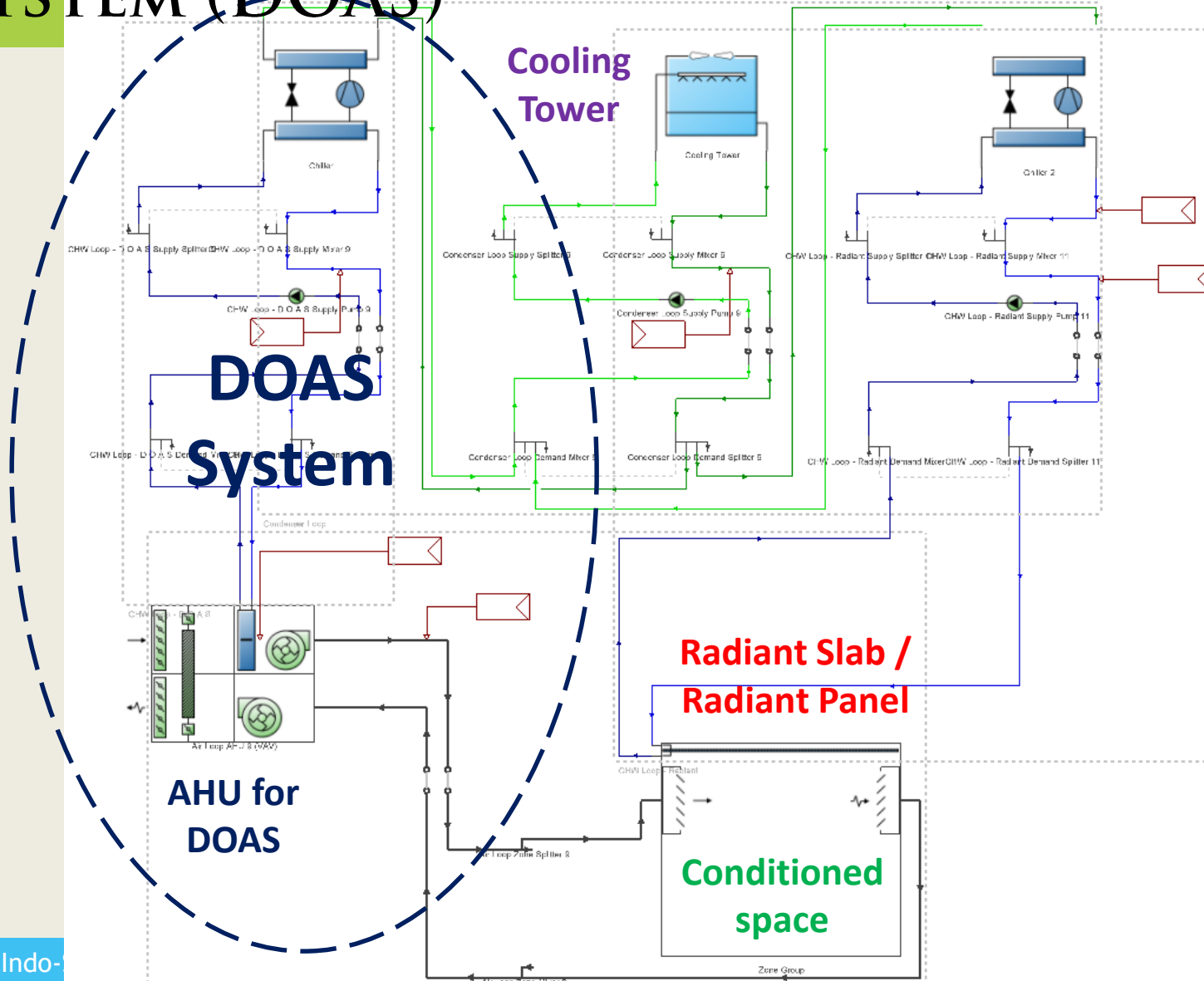
- Occupancy = 9.29 m^2 / person
- Equipment = $10 \text{ W} / \text{m}^2$
- Lighting = $7 \text{ W} / \text{m}^2$
- Ventilation rate = 5.2 liter / sec / person

DEFINING SLAB COOLING IN DESIGN BUILDER

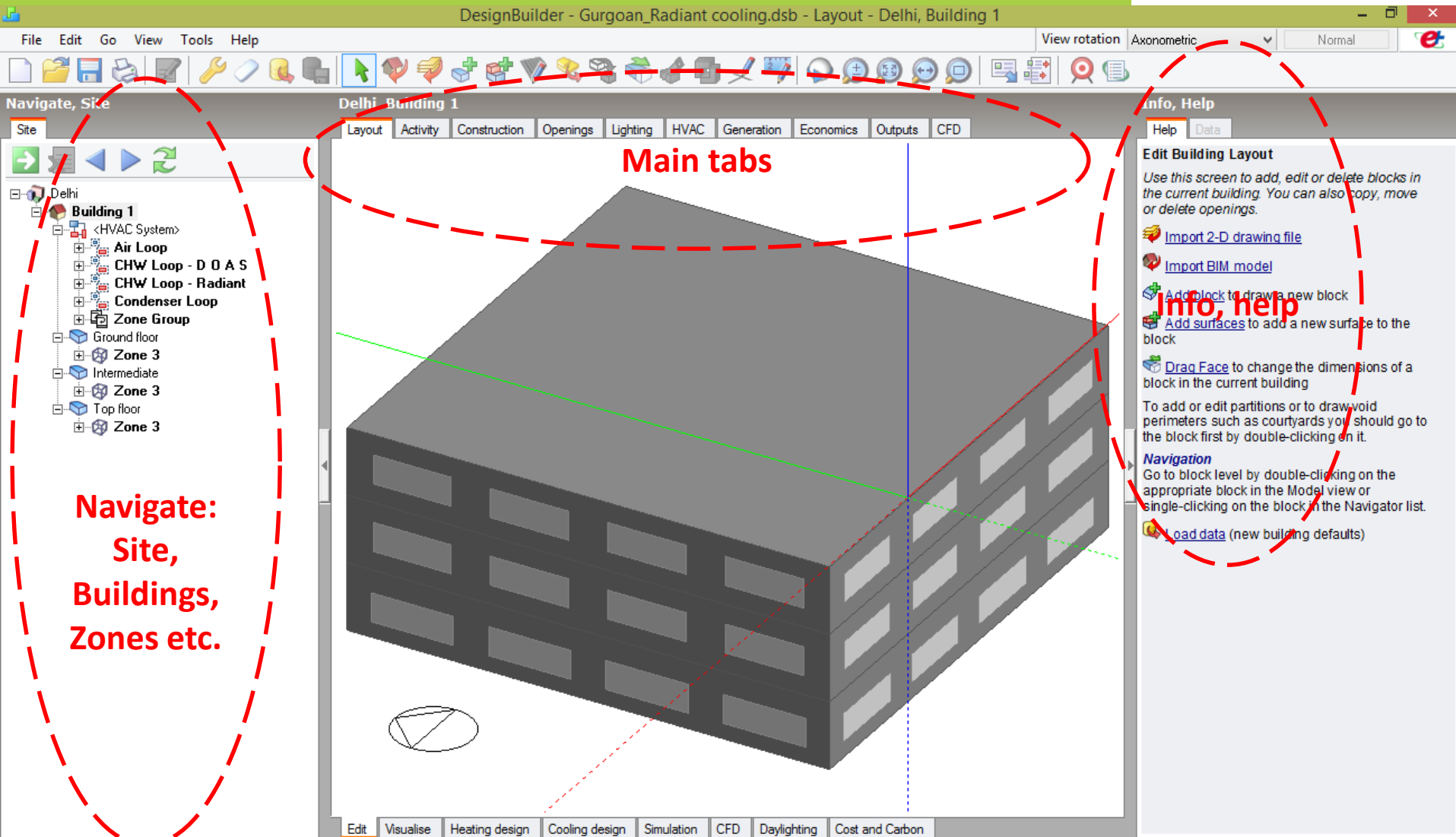
OBJECTIVE – MODELING RADIANT SLAB COOLING SYSTEM



STEP 2: SLAB COOLING MODELING – DEDICATED OUTDOOR AIR SYSTEM (DOAS)



STEP 2: DESIGN BUILDER – WAY TO BUILD A MODEL



Navigate:
Site,
Buildings,
Zones etc.

Main tabs

Info, help

STEP 2: SLAB COOLING MODELING – D O A S



- Go to help/info tab
 - Add zone group using (3 zones)
- Go to navigate tab, zone level
 - Define set points: 24°C (operative); RH - 50%
 - Define fresh air rate (5.2 l/s-person)
 - Target all 3 zones
 - Ground floor
 - Intermediate
 - Top floor

- Ground floor
- Intermediate
- Top floor

Zone Group

HVAC Zone Data

General

Target

General

Name GroundFloor:Zone3

Thermostat Schedules

Thermostat heating setpoint schedule Heating set point schedule

Thermostat cooling setpoint schedule Cooling set point 24 C @ 8:00 - 18:00 Mon - Fri

Comfort PMV Setpoint Schedules

Heating PMV setpoint schedule Heating Fanger comfort setpoint: Always -0.5

Cooling PMV setpoint schedule Cooling Fanger comfort setpoint: Always 0.1

Humidistat Control

☒ Humidistat control

Humidifying RH setpoint schedule Off 24/7

De-humidifying RH setpoint schedule Relative humidity setpoint schedule: Always 50.00

CO2 and Contaminant Control

☐ CO2 and contaminant control

Cooling Sizing

Cooling design supply air temperature input method 1-Supply air temperature

Cooling design supply air temperature (°C) 14.000

Cooling design supply air humidity ratio 0.009

Cooling minimum air flow fraction (turndown ratio) 0.000

Zone cooling sizing factor 1.150

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) 50.000

Heating design supply air humidity ratio 0.004

Zone heating sizing factor 1.250

Heating design air flow method 1-Design day

Outside Air Sizing

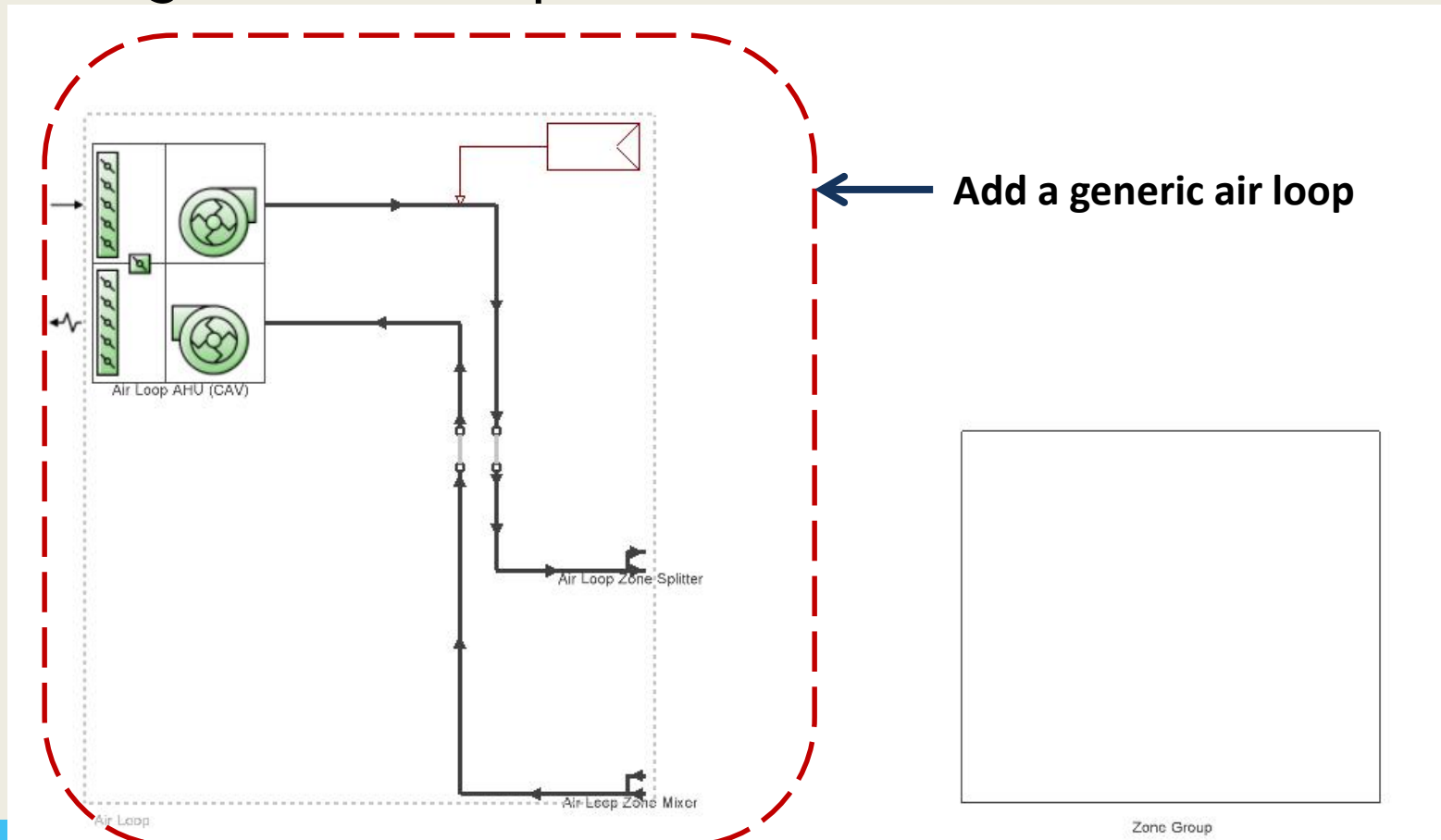
Outside air method 1-Flow/Person

Outside air flow per person (m3/s-person) 0.0052

Zone Air Distribution Effectiveness

STEP 2: SLAB COOLING MODELING – D O A S

- Go to help/info tab
 - Add generic air loop



STEP 2: SLAB COOLING MODELING - D O A S



Go to navigate tab

- Select AHU
- Go to edit at info tab
- Define supply air flow rate as 1.05 m³/sec (fresh air only)
- Add Schedule

Air handling unit Data

General Outdoor Air System

General

Name Air Loop AHU

Fan type 1-Constant volume

Design supply air flow rate (m3/s) 1.05

Operation

Availability schedule 8:00 - 18:00 Tue - Fri - Monday precooling - AHU

Night Cycle

☐ On

Extract Fan

☒ Include extract fan

Mixed Mode Zone Equipment

☐ Mixed mode on

STEP 2: SLAB COOLING MODELING – D O A S



- AHU data:
Outdoor air system
 - No recirculation
 - Heat recovery (75% Sensible & Latent)

Air handling unit Data

General Outdoor Air System

Recirculation ☐ On

Heat Recovery ☒ On

General

Nominal supply air flow rate (m3/s) Autosize

Nominal electric power (W) 0.000

Supply air outlet temperature control 1-No

Heat exchanger type 1-Plate

Economiser lockout 1-Yes

Effectiveness

Sensible

at 75% Heating air flow 0.750

at 75% Cooling air flow 0.750

at 100% Heating air flow 0.750

at 100% Cooling air flow 0.750

Latent

at 75% Heating air flow 0.750

at 75% Cooling air flow 0.750

at 100% Heating air flow 0.750

at 100% Cooling air flow 0.750

Frost Control

Frost control type 1-None

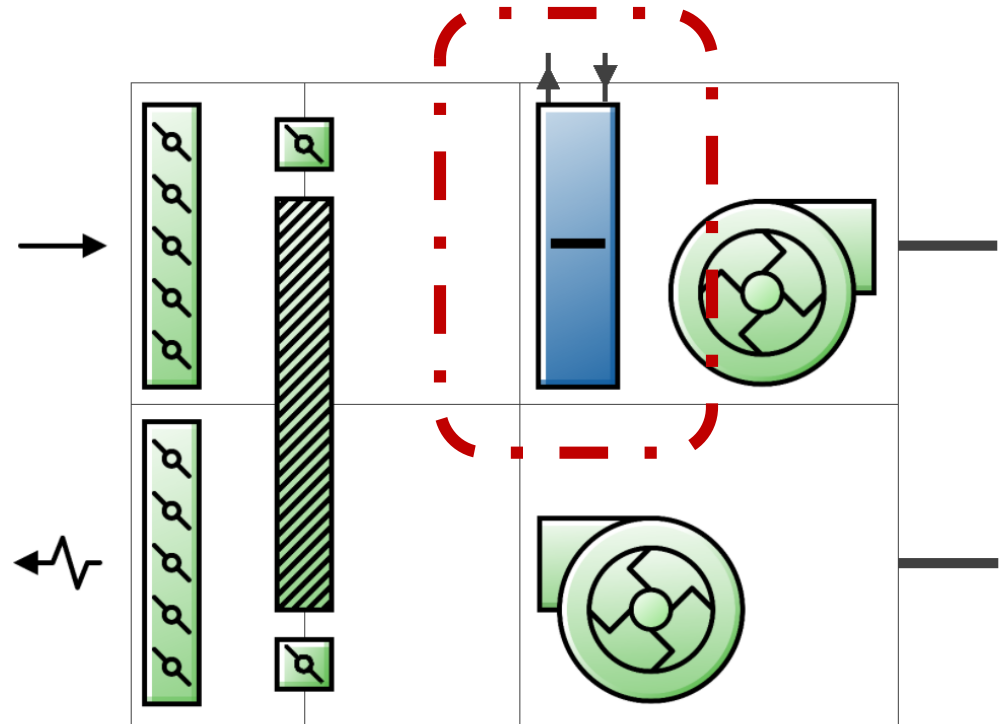
Heat Recovery Operation

Availability schedule On 24/7

Pre-Treatment

STEP 2: SLAB COOLING MODELING – D O A S

- In AHU Unit
 - Add cooling coil



STEP 2: SLAB COOLING MODELING – D O A S



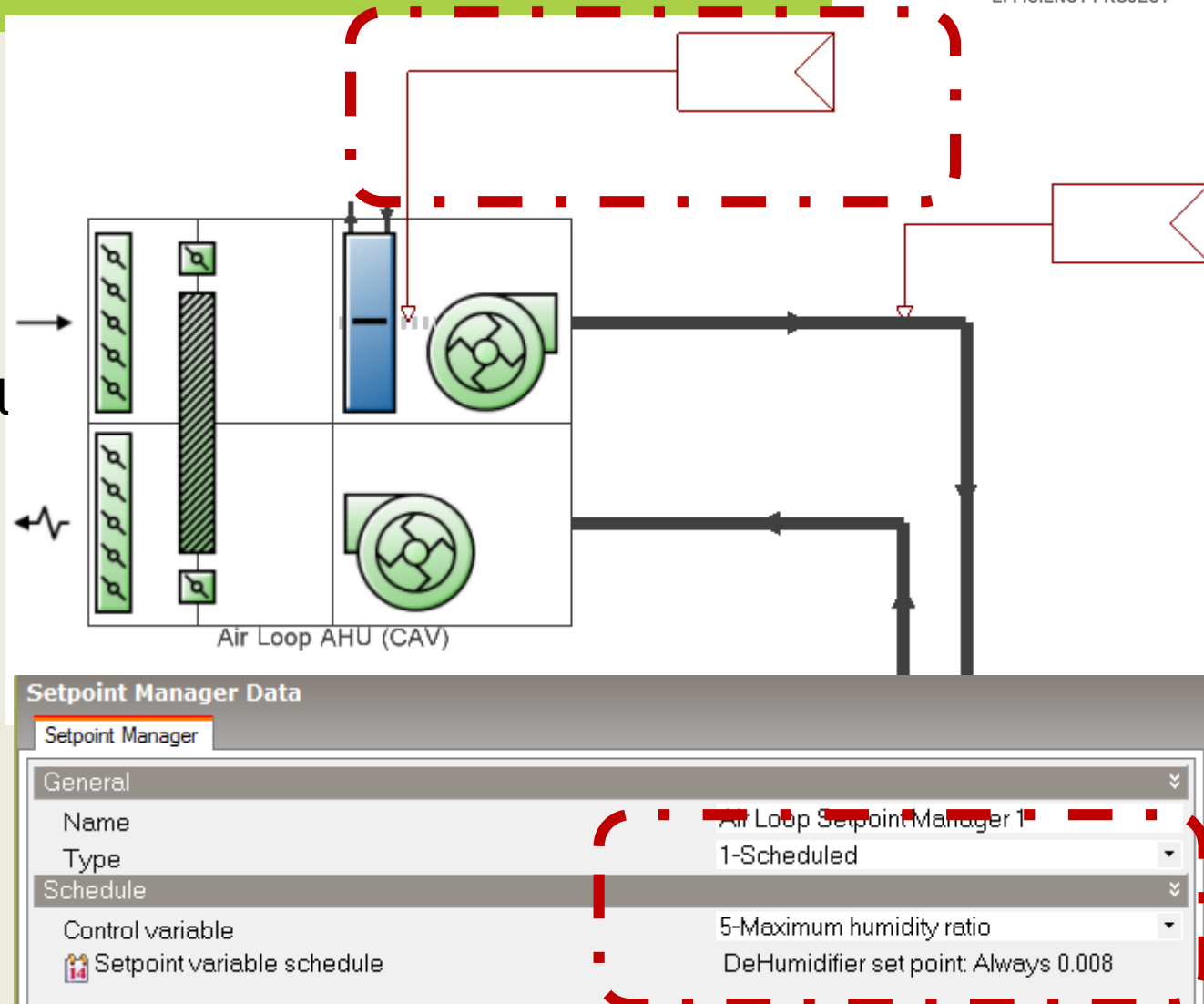
- Go to Water cooling coil data
 - Add scheduling
 - Select control type:
3-temperature and humidity control

A screenshot of the "Water Cooling Coil Data" form in a software application. The form has a tabbed interface with "Cooling Coil" selected. It is divided into three main sections: "General", "Operation", and "Controller". The "General" section contains fields for Name, Type, Design water flow rate, Design air flow rate, Design inlet water temperature, Design inlet air temperature, Design outlet air temperature, Design inlet air humidity ratio, Design outlet air humidity ratio, Type of analysis, and Heat exchanger configuration. The "Operation" section contains an "Availability schedule" field. The "Controller" section contains fields for Control variable, Control action, Actuator variable, Controller convergence tolerance, Maximum actuated flow, and Minimum actuated flow. Red dashed lines and arrows highlight the "Availability schedule" and "Control variable" fields, indicating the steps mentioned in the list to the left. The "Availability schedule" is set to "8:00 - 18:00 Tue - Fri - Monday pr" and the "Control variable" is set to "3-Temperature and humidity rati".

Water Cooling Coil Data	
Cooling Coil	
General	
Name	Air Loop AHU Cooling Coil
Type	1-Water
Design water flow rate (m3/s)	Autosize
Design air flow rate (m3/s)	Autosize
Design inlet water temperature (°C)	Autosize
Design inlet air temperature (°C)	Autosize
Design outlet air temperature (°C)	Autosize
Design inlet air humidity ratio	Autosize
Design outlet air humidity ratio	Autosize
Type of analysis	1-Simple analysis
Heat exchanger configuration	1-Cross flow
Operation	
Availability schedule	8:00 - 18:00 Tue - Fri - Monday pr
Controller	
Control variable	3-Temperature and humidity rati
Control action	2-Reverse
Actuator variable	1-Flow
Controller convergence tolerance (deltaC)	Autosize
Maximum actuated flow (m3/s)	Autosize
Minimum actuated flow (m3/s)	0

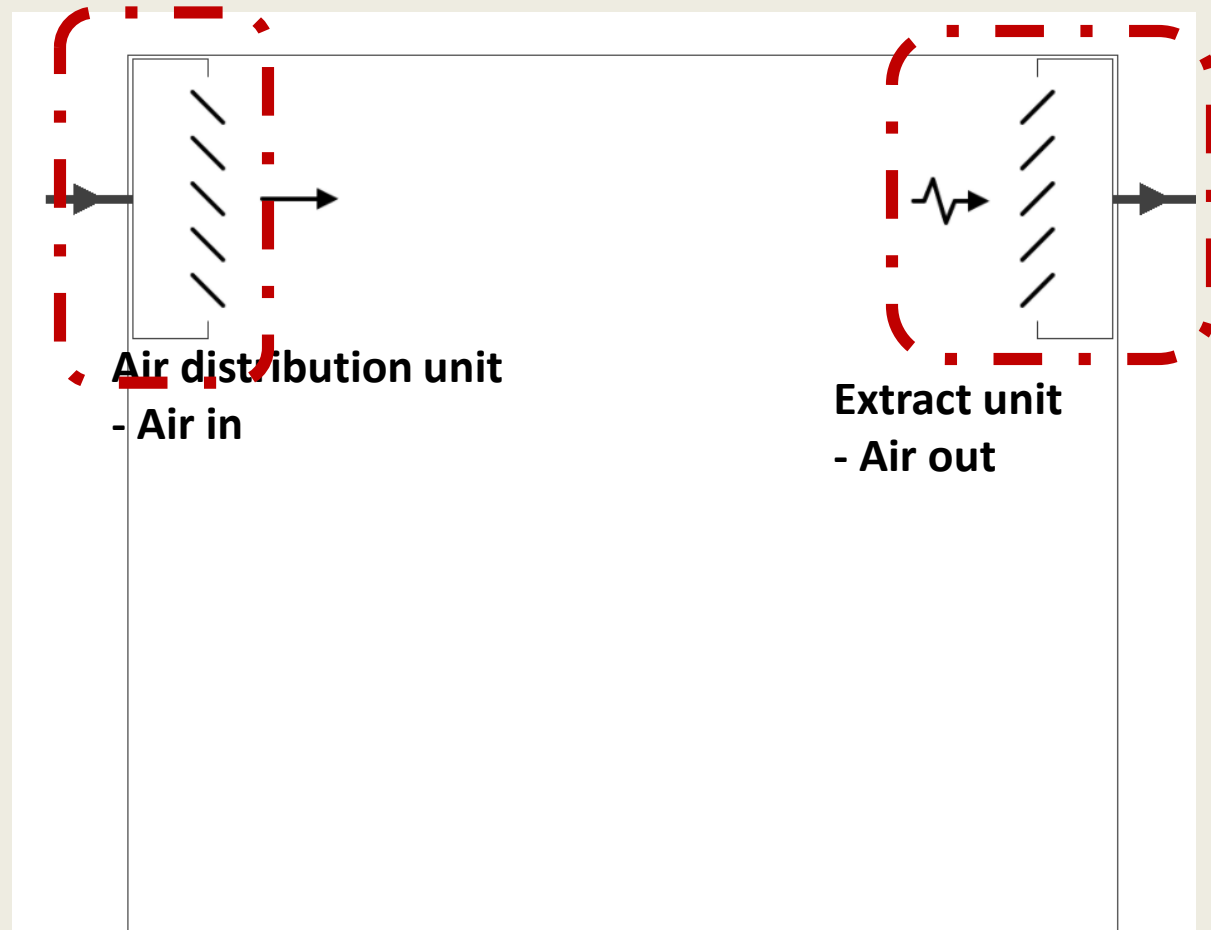
STEP 2: SLAB COOLING MODELING – D O A S

- Navigate tab
 - Go to air loop supply side
 - Add set point manager for humidity control

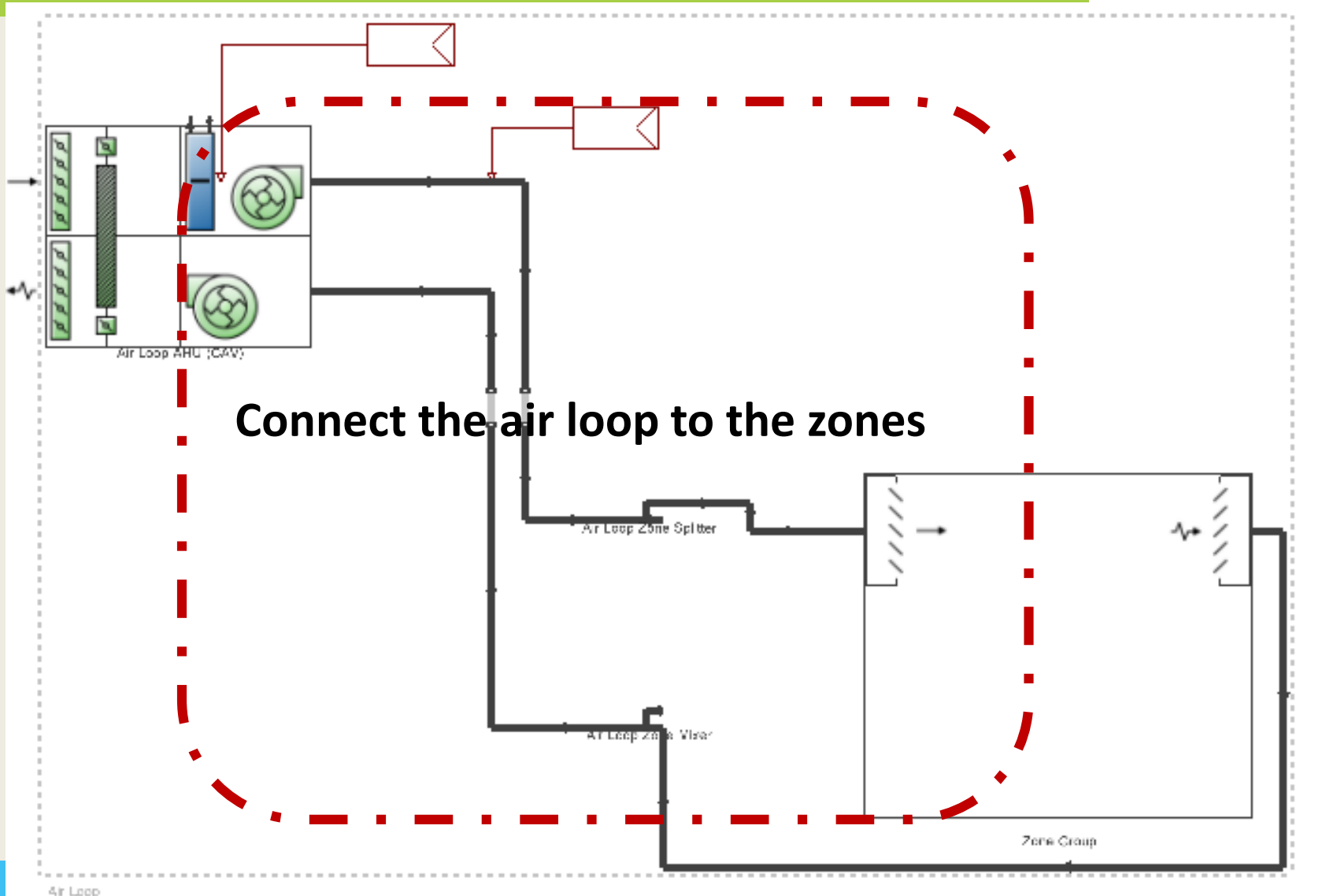


STEP 2: SLAB COOLING MODELING – D O A S

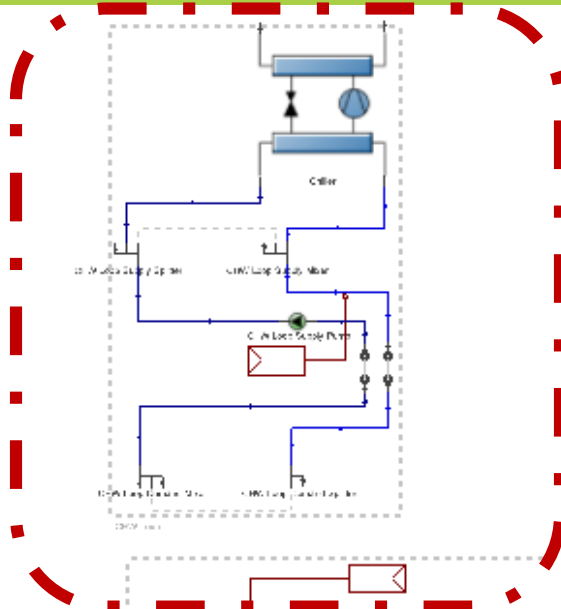
- Go to zone level
 - Add air distribution unit to the zones
 - Add extract unit to the zones



STEP 2: SLAB COOLING MODELING – D O A S

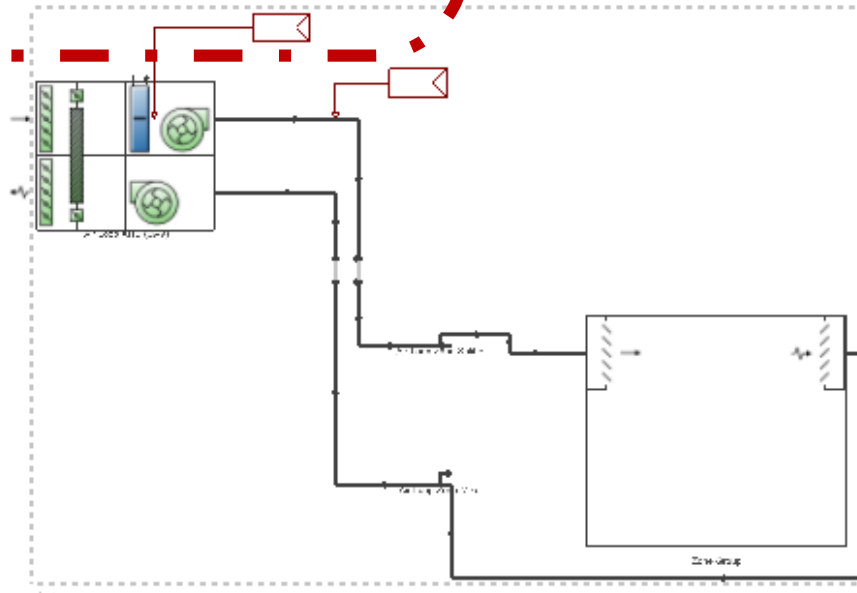


STEP 2: SLAB COOLING MODELING – D O A S



Add chilled water plant loop

- Name it as CHW loop – D O A S



STEP 2: SLAB COOLING MODELING – D O A S



- Chilled water loop - D O A S

- Define chilled water loop schedule
- Specify values under sizing header

Plant loop Data

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)	6.67
Loop design temperature difference (deltaC)	5

Operation

Availability schedule	8:00 - 18:00 Tue - Fri - Monday precooling - AHU
-----------------------	--

Outside temperature operation

☐ Outside temperature operation

STEP 2: SLAB COOLING MODELING – D O A S

- Chiller selection - VSD
- Auto-size capacity
- Auto-size flow rates

Chiller Data

Chiller

General

Name: Chiller

Chiller template: ElectricEIRChiller Centrifugal Carrier 19XR 1586kW/5.53

Chiller type: 2-Electric EIR

Reference capacity (W): Autosize

Reference COP: 5.530

Compressor motor efficiency: 1.000

Chiller flow mode: 3-Not modulated

Sizing factor: 1.00

Condenser

Condenser type: 2-Water cooled

Temperatures

Reference leaving chilled water temperature (°C): 8.890

Reference entering condenser fluid temperature (°C): 26.670

Leaving chilled water temperature limit (°C): 2.000

Flow Rates

Reference chilled water flow rate (m3/s): Autosize

Reference condenser water flow rate (m3/s): Autosize

Performance Curves

☒ Cooling capacity function of temperature curve: ElectricEIRChiller Carrier 19XR 1586kW/5.53COP/VSD

☒ Electric input to cooling output ratio function of temperature curve: ElectricEIRChiller Carrier 19XR 1586kW/5.53COP/VSD

☒ Electric input to cooling output ratio function of part load ratio curve: ElectricEIRChiller Carrier 19XR 1586kW/5.53COP/VSD

Part Load Settings

Minimum part load ratio: 0.190

Maximum part load ratio: 1.010

Optimum part load ratio: 1.000

Minimum unloading ratio: 0.190

Heat Recovery

☐ Heat recovery

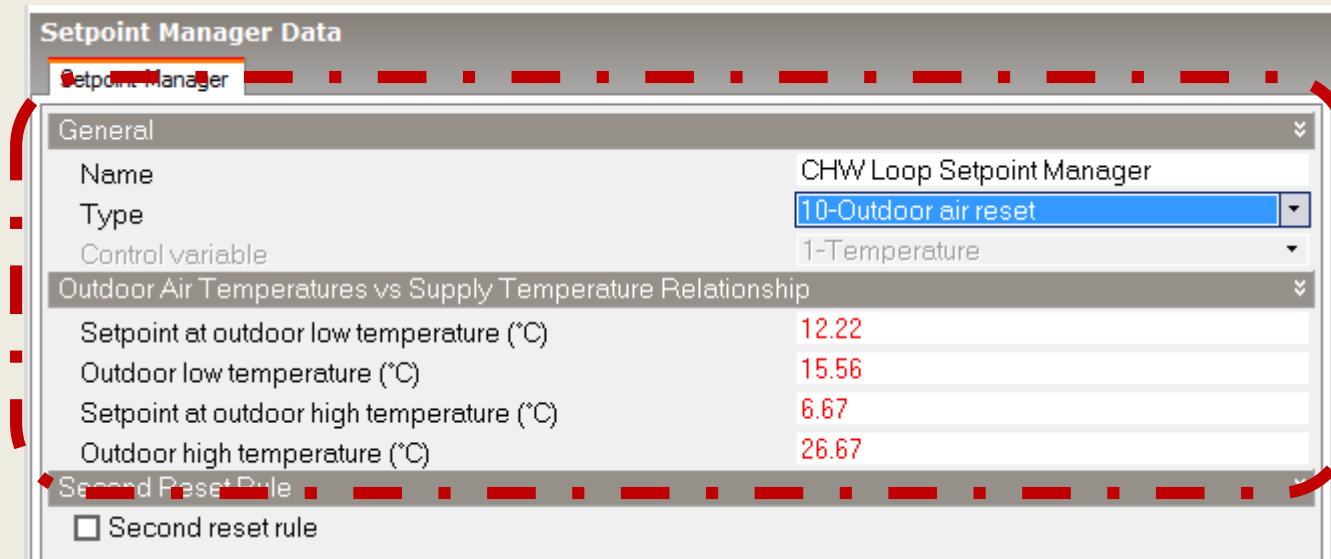
Chiller selection - Type

Flow sizing options

STEP 2: SLAB COOLING MODELING – D O A S

Chilled water loop - D O A S

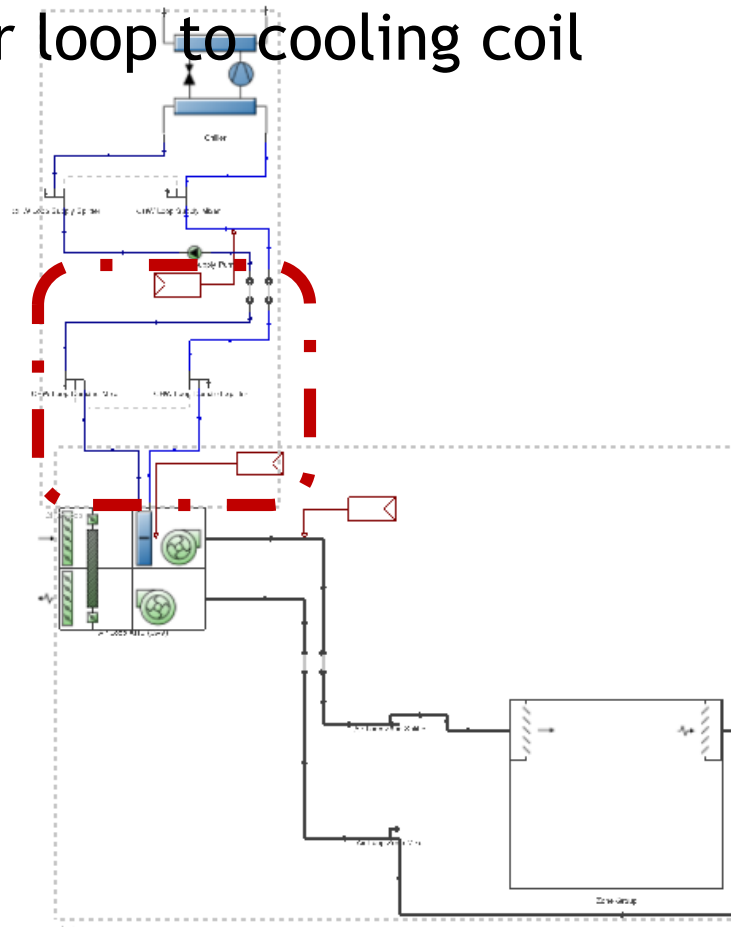
- Control: Outdoor air set point



Setpoint Manager Data	
Setpoint Manager	
General	
Name	CHW Loop Setpoint Manager
Type	10-Outdoor air reset
Control variable	1-Temperature
Outdoor Air Temperatures vs Supply Temperature Relationship	
Setpoint at outdoor low temperature (°C)	12.22
Outdoor low temperature (°C)	15.56
Setpoint at outdoor high temperature (°C)	6.67
Outdoor high temperature (°C)	26.67
Second Reset Rule	
<input type="checkbox"/> Second reset rule	

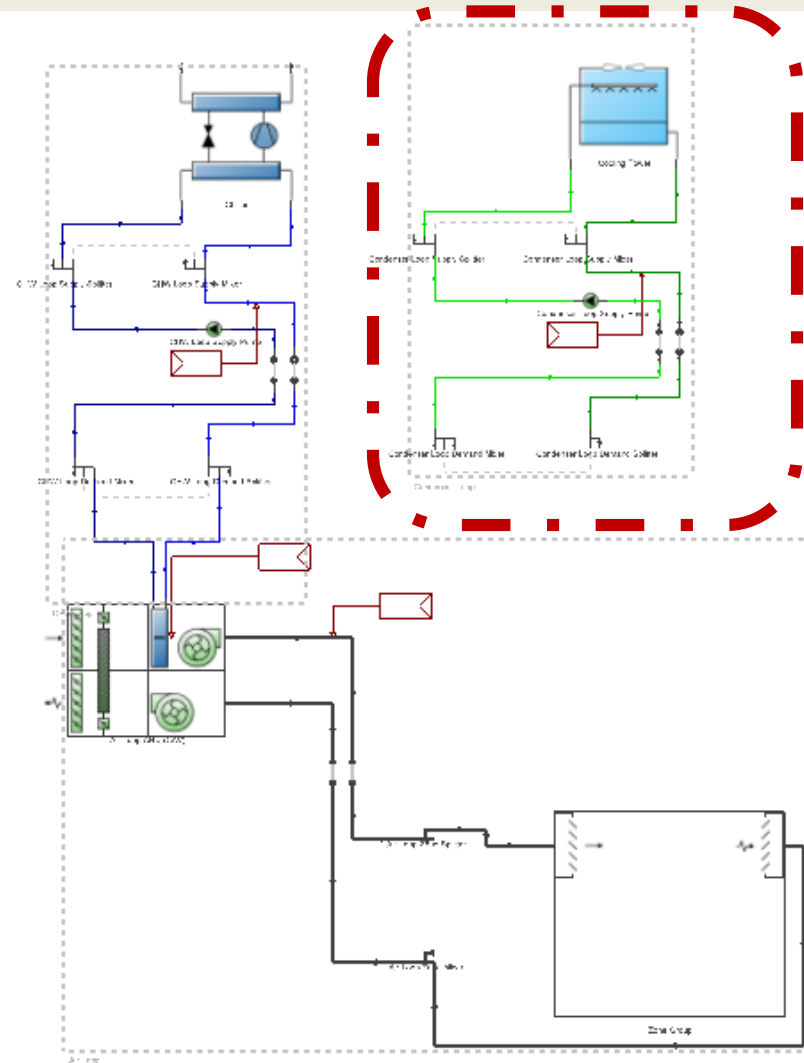
STEP 2: SLAB COOLING MODELING – D O A S

- Go to navigate tab
- Select CHW loop - D O A S demand side supply
 - Connect chilled water loop to cooling coil



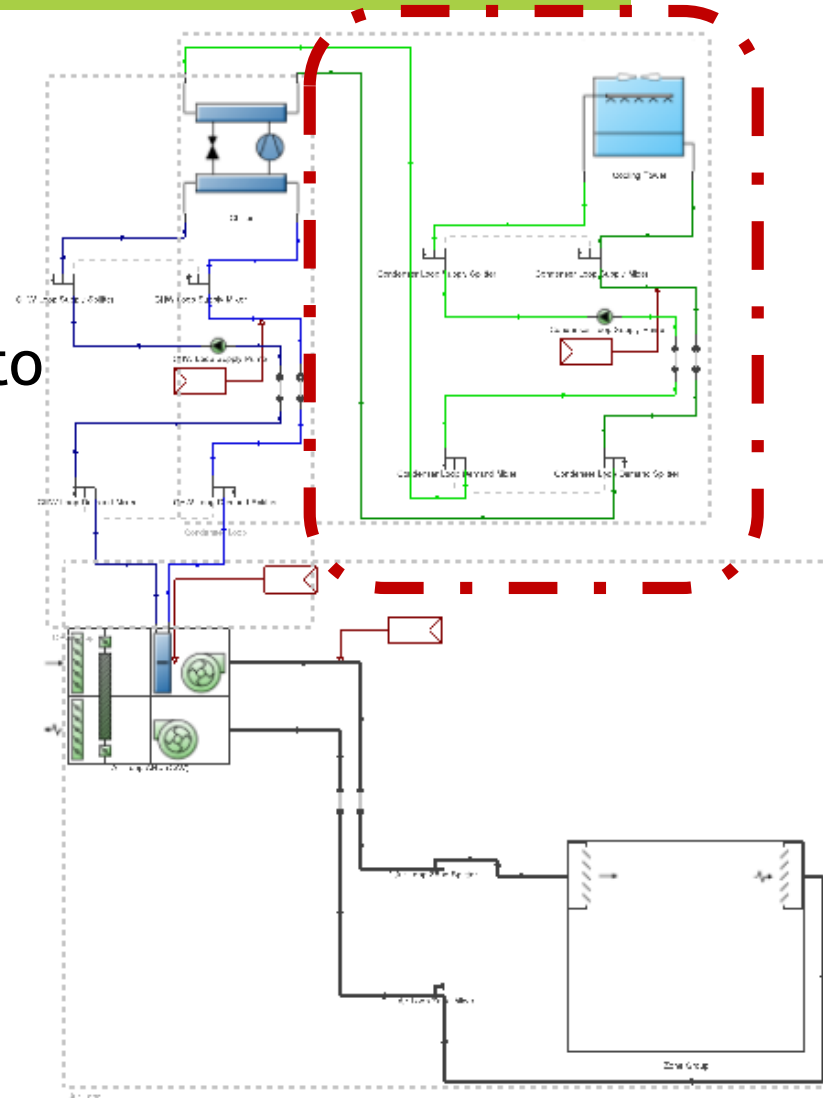
STEP 2: SLAB COOLING MODELING – D O A S

- Go to info tab
 - Add condenser loop
- Select condenser loop



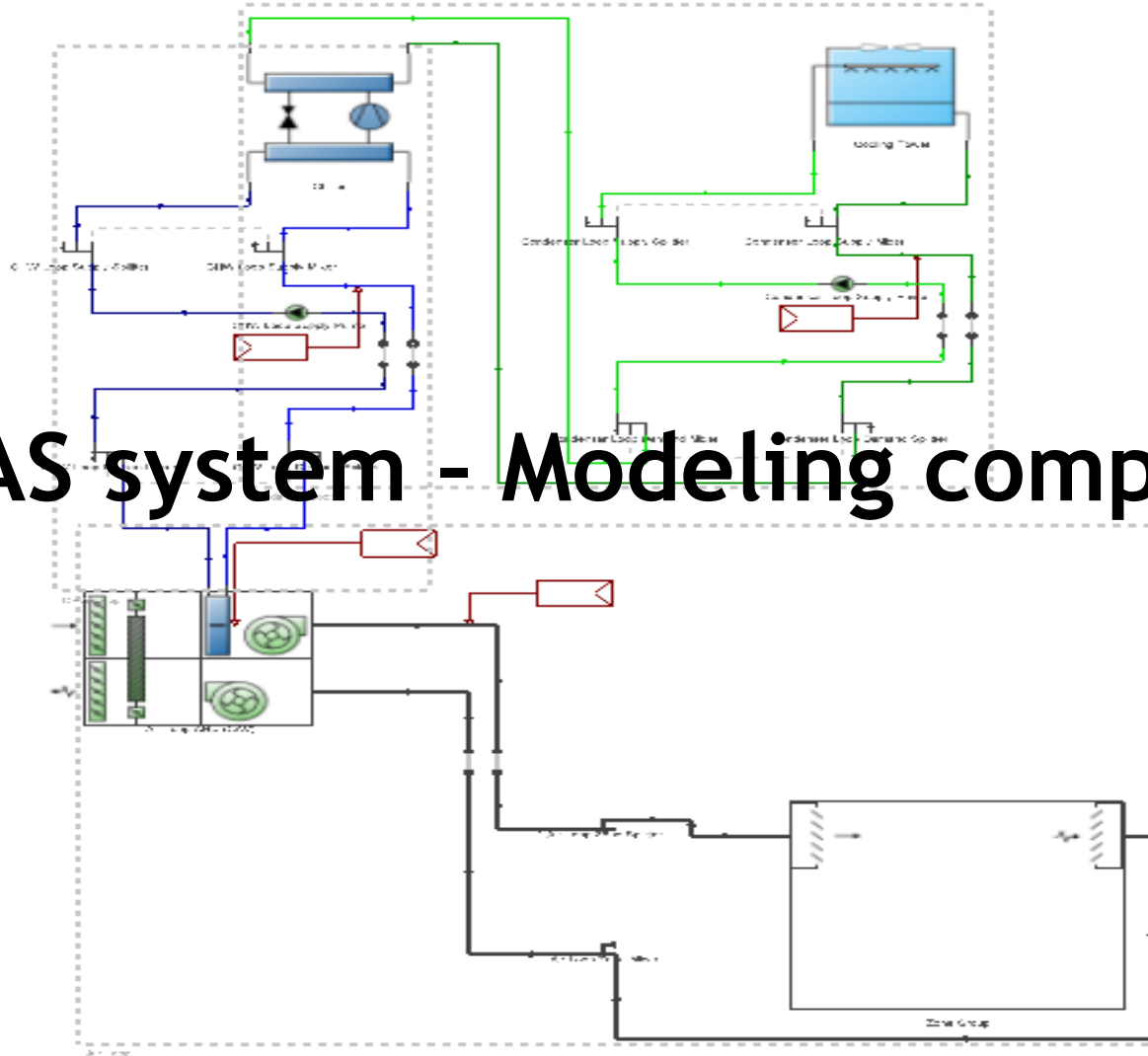
STEP 2: SLAB COOLING MODELING – D O A S

- Go to navigate tab
- Select Condenser loop demand side supply
 - Connect cooling tower to the chiller



STEP 2: SLAB COOLING MODELING – DOAS

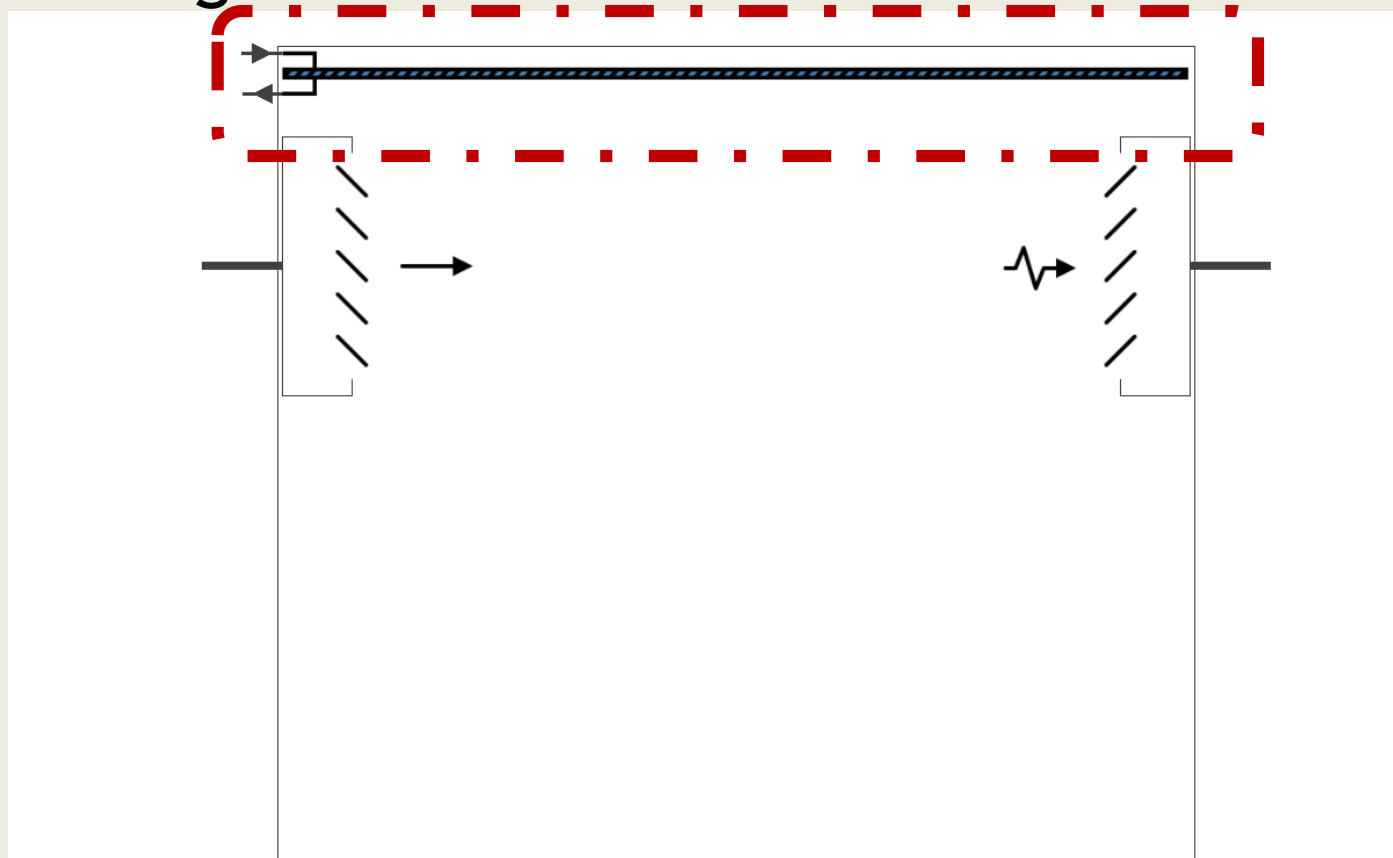
DOAS system - Modeling completed



STEP 2: SLAB COOLING MODELING – RADIANT SYSTEM

Radiant system modeling

- Add Chilled ceiling at zone level



STEP 2: SLAB COOLING MODELING

– RADIANT SYSTEM

Define parameters for chilled ceiling

- Tube dia., circuit length limited to 107 m,
- Zone control operative temperature
- Add cooling set point schedule
- Dew point offset (2°C)
- Define operation schedule
- Target “All”

Chilled ceiling Data

Chilled Ceiling **Target**

General

Name Intermediate:Zone3 Chilled Ceiling

Type 2-Variable flow

Tubing Settings

Hydronic tubing inside diameter (m) 0.0130

Hydronic tubing length (m) Autosize

Number of circuits 2-Calculate from circuit length


Circuit length (m) 106.700

Flow Settings

Maximum cold water flow (m3/s) Autosize

Control

Zone temperature control type 3-Operative temperature

 Cooling control temperature schedule Cooling set point 24 C @ 8:00 - 18:0


Throttling range (deltaC) 2.000

Condensation Control

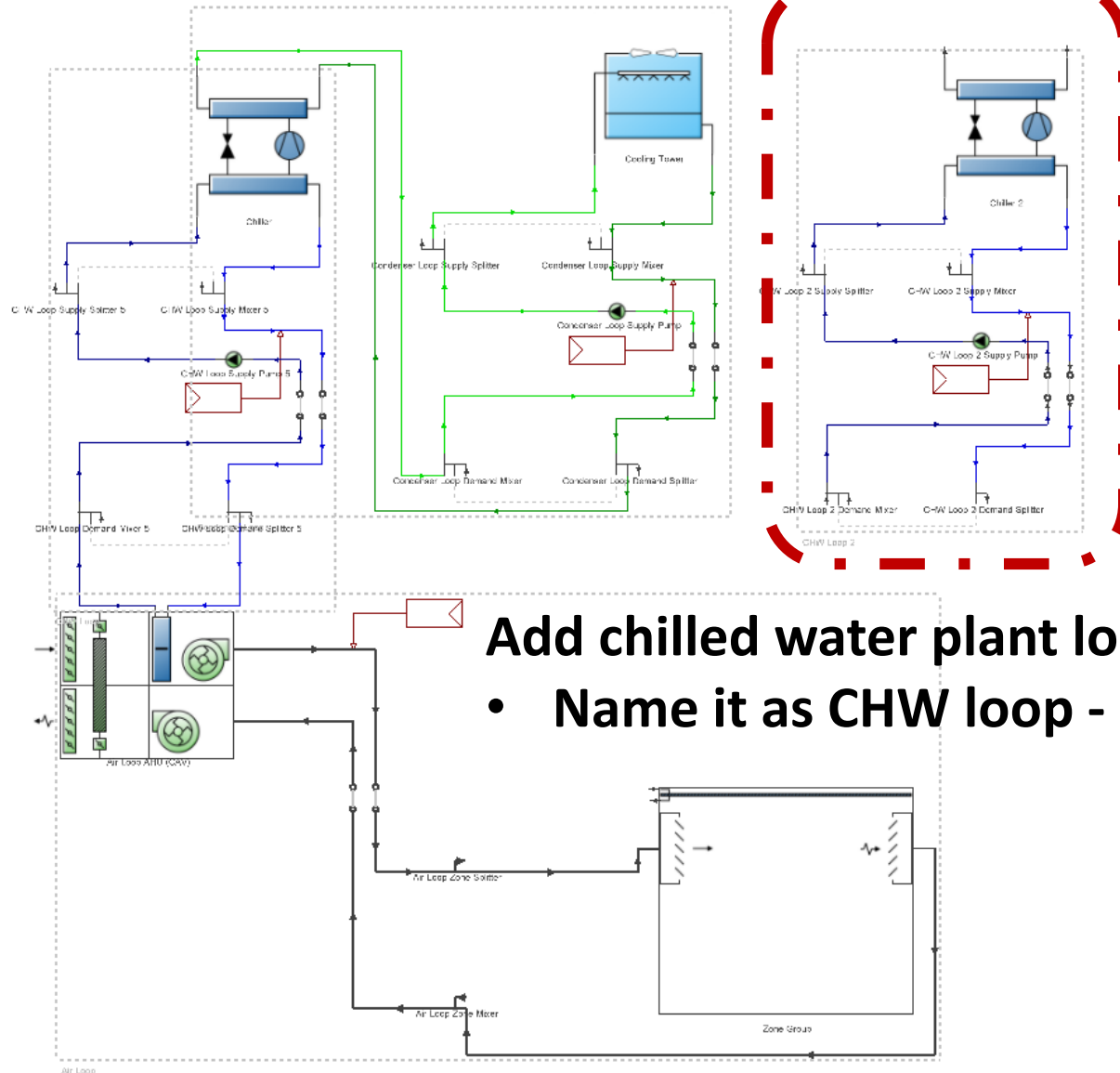
Condensation control type 1-Simple off

Condensation control dewpoint offset (°C) 2

Operation

 Availability schedule 8:00 - 17:00 Tue - Fri - Monday pr ...

STEP 2: SLAB COOLING MODELING – RADIANT SYSTEM



STEP 2: SLAB COOLING MODELING

– RADIANT SYSTEM



- Radiant CHW loop
 - Define chilled water loop schedule
 - Specify values under sizing header

Plant loop Data

General Plant Equipment Operation

General

Name	CHW Loop - Radiant
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)	13
Loop design temperature difference (deltaC)	5

Operation

Availability schedule	8:00 - 17:00 Tue - Fri - Monday precooling
Outside Temperature Operation	
<input type="checkbox"/> Outside temperature operation	

STEP 2: SLAB COOLING MODELING

– RADIANT SYSTEM



- Radiant CHW loop
 - Chiller selection – VSD
 - Auto-size Capacity
 - Auto-size flow rates

Chiller Data

Chiller

General

Name: Chiller
Chiller template: ElectricEIRChiller Centrifugal Carrier 19XR 1586kW/5.53
Chiller type: 2-Electric
Reference capacity (W): Autosize
Reference COP: 5.530
Compressor motor efficiency: 1.000
Chiller flow mode: 3-Not modulated
Sizing factor: 1.00

Condenser

Condenser type: 2-Water cooled

Temperatures

Reference leaving chilled water temperature (°C): 8.890
Reference entering condenser fluid temperature (°C): 26.670
Leaving chilled water temperature limit (°C): 2.000

Flow Rates

Reference chilled water flow rate (m3/s): Autosize
Reference condenser water flow rate (m3/s): Autosize

Performance Curves

☒ Cooling capacity function of temperature curve: ElectricEIRChiller Carrier 19XR 1586kW/5.53COP/VSD
☒ Electric input to cooling output ratio function of temperature curve: ElectricEIRChiller Carrier 19XR 1586kW/5.53COP/VSD
☒ Electric input to cooling output ratio function of part load ratio curve: ElectricEIRChiller Carrier 19XR 1586kW/5.53COP/VSD

Part Load Settings

Minimum part load ratio: 0.190
Maximum part load ratio: 1.010
Optimum part load ratio: 1.000
Minimum unloading ratio: 0.190

Heat Recovery

☐ Heat recovery

Chiller selection - Type

Flow sizing options

STEP 2: SLAB COOLING MODELING

– RADIANT SYSTEM



Radiant Chilled water loop

- Control: Outdoor air set point

The image shows a software interface for configuring a Setpoint Manager. The dialog box is titled "Setpoint Manager Data" and has a tab labeled "Setpoint Manager". The configuration is divided into three sections: "General", "Outdoor Air Temperatures vs Supply Temperature Relationship", and "Second Reset Rule".

General	
Name	CHW Loop 1 Setpoint Manager
Type	10-Outdoor air reset
Control variable	1-Temperature

Outdoor Air Temperatures vs Supply Temperature Relationship	
Setpoint at outdoor low temperature (°C)	16
Outdoor low temperature (°C)	15
Setpoint at outdoor high temperature (°C)	13
Outdoor high temperature (°C)	30

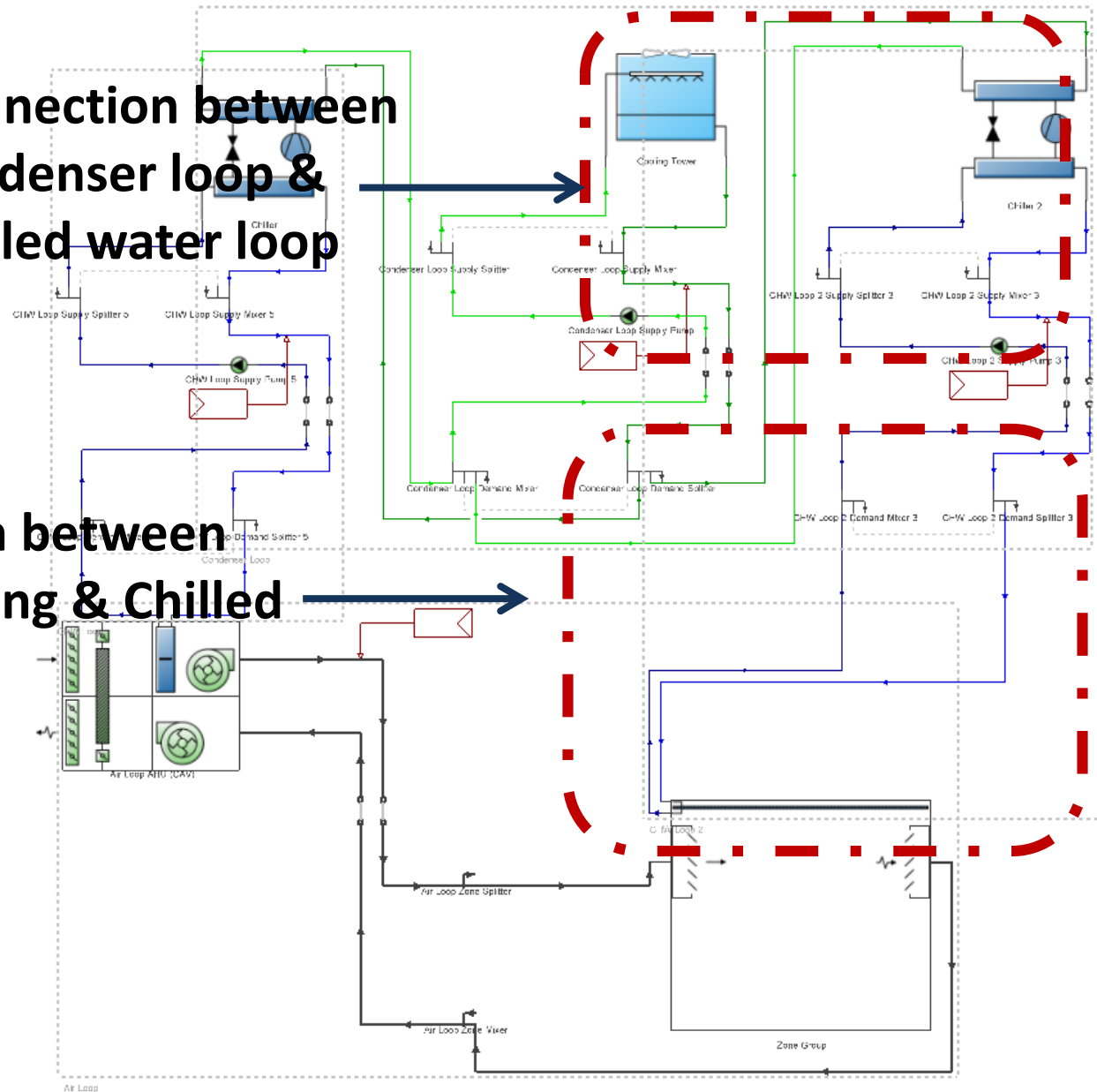
Second Reset Rule	
<input type="checkbox"/> Second reset rule	



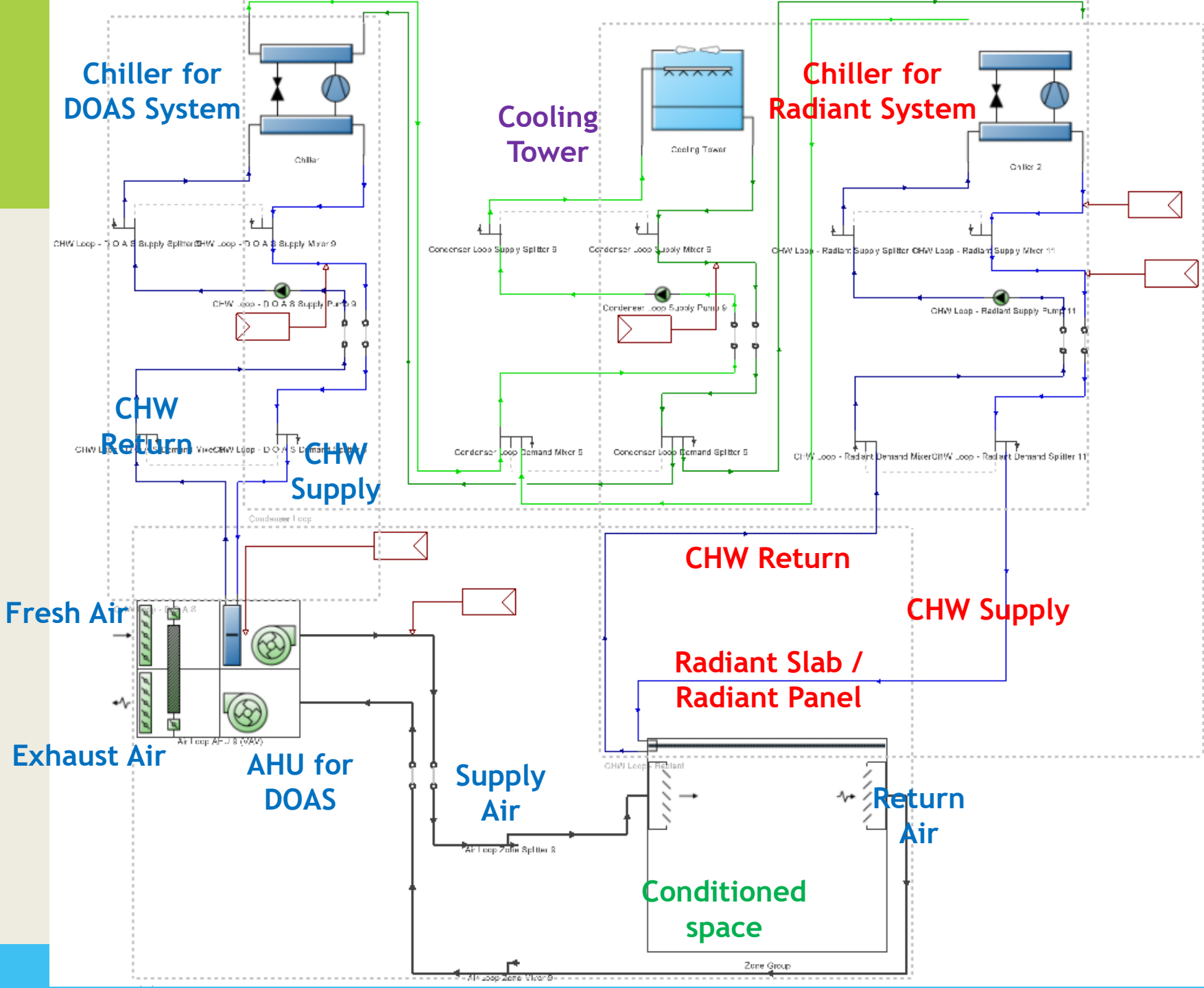
CT

**Connection between
condenser loop &
Chilled water loop**

**Connection between
chilled ceiling & Chilled
water loop**



OVERALL SYSTEM MODELING

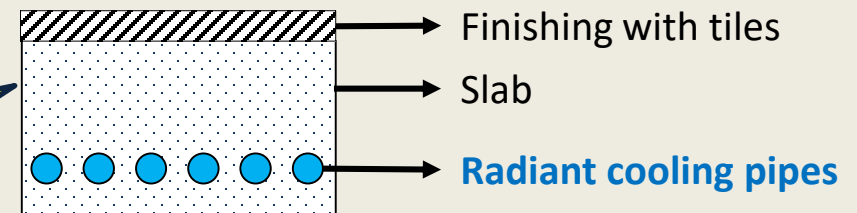
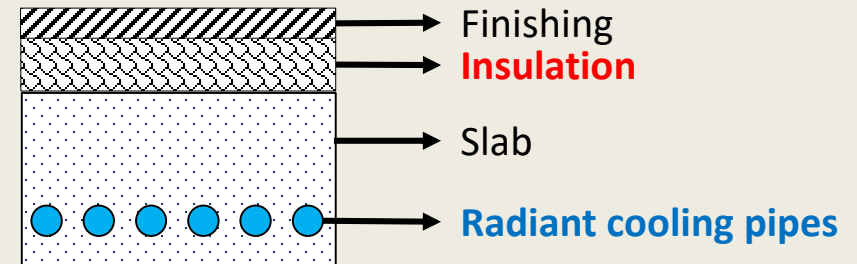
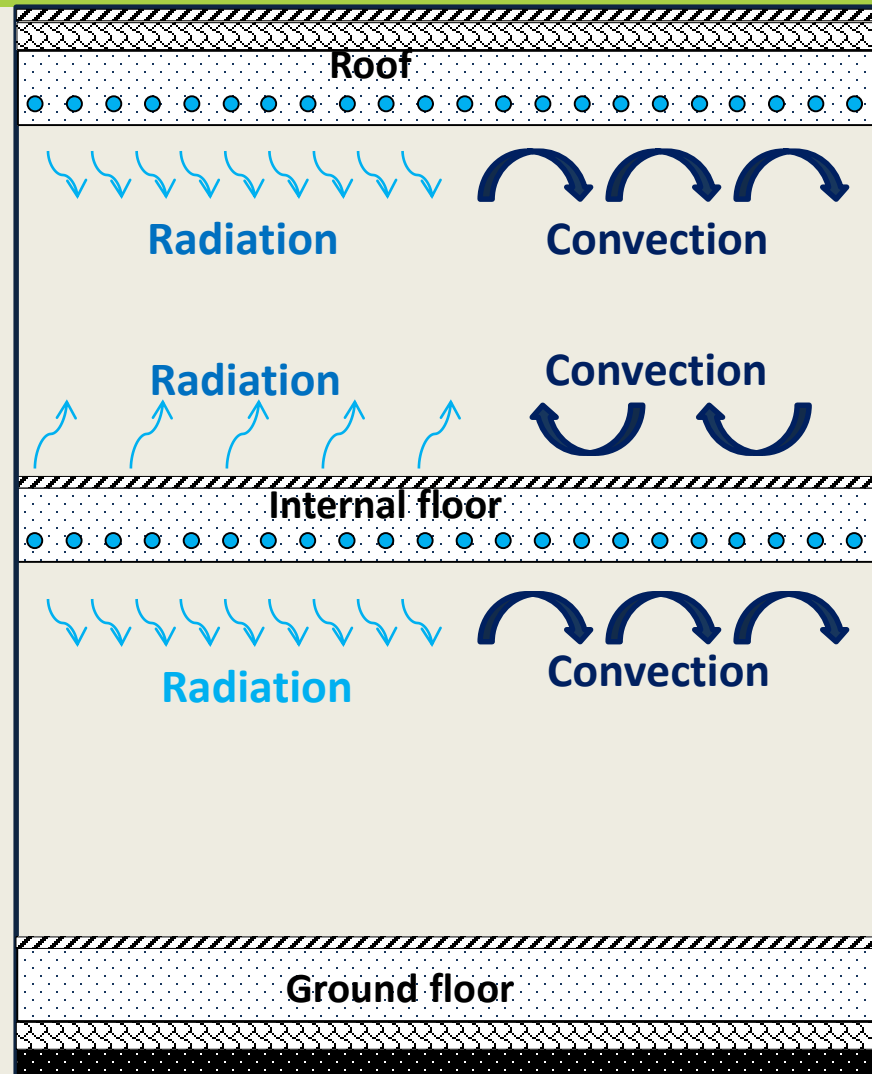


STEP 2: SLAB COOLING MODELING – INTERNAL SOURCE ACTIVATION



- In design builder, chilled pipes are considered as internal source
- Add internal source at ceiling/roof
 - Go to construction tab
 - Enable internal heat source option for ceiling/roof

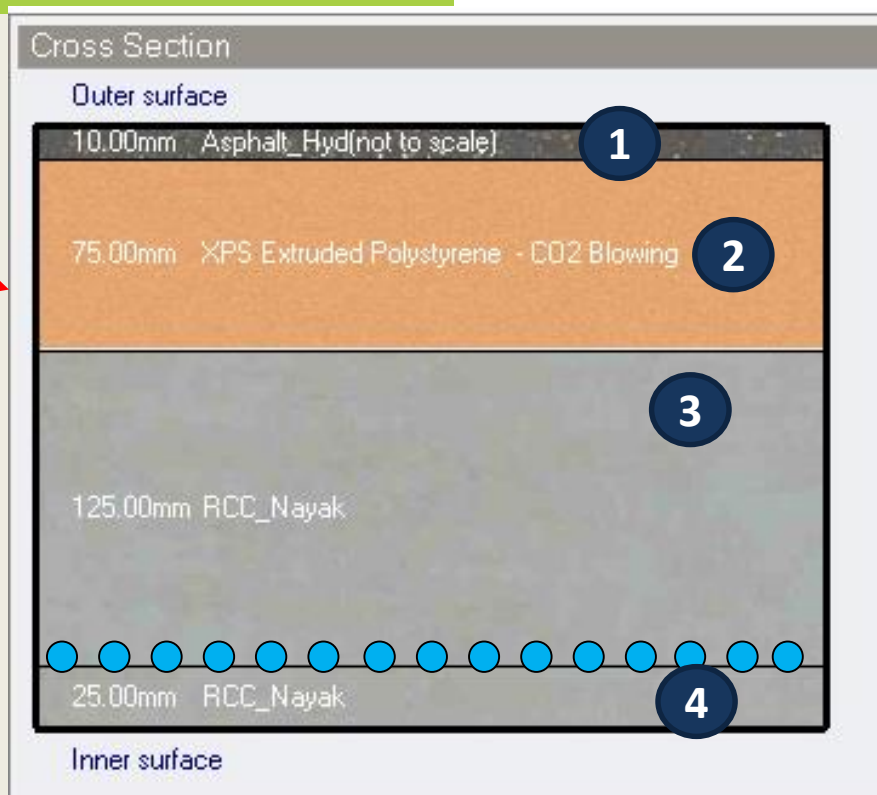
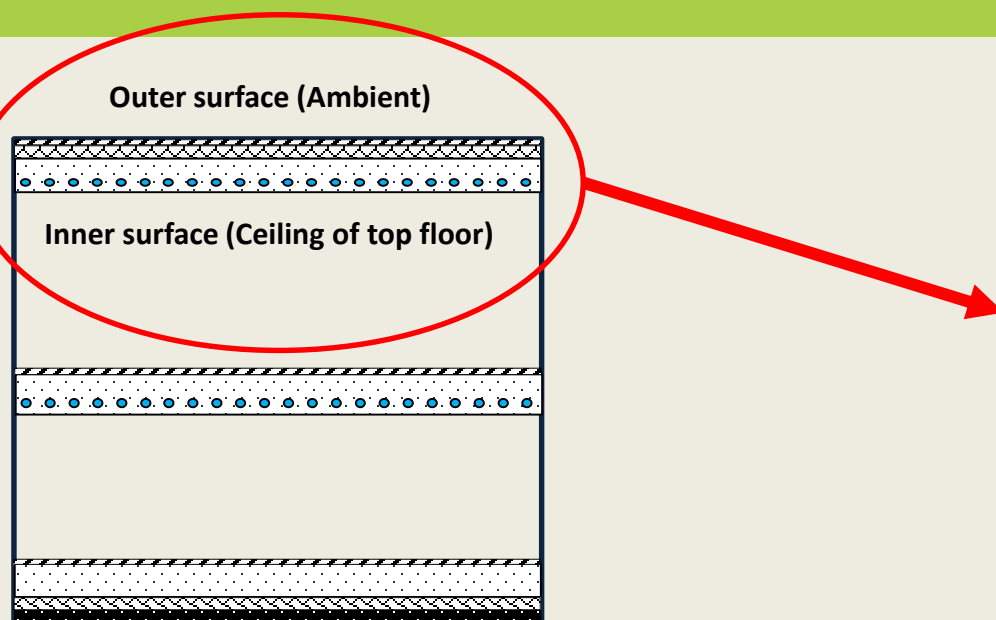
RADIANT SLAB COOLING SCHEMATIC



Modelling of slab cooling construction

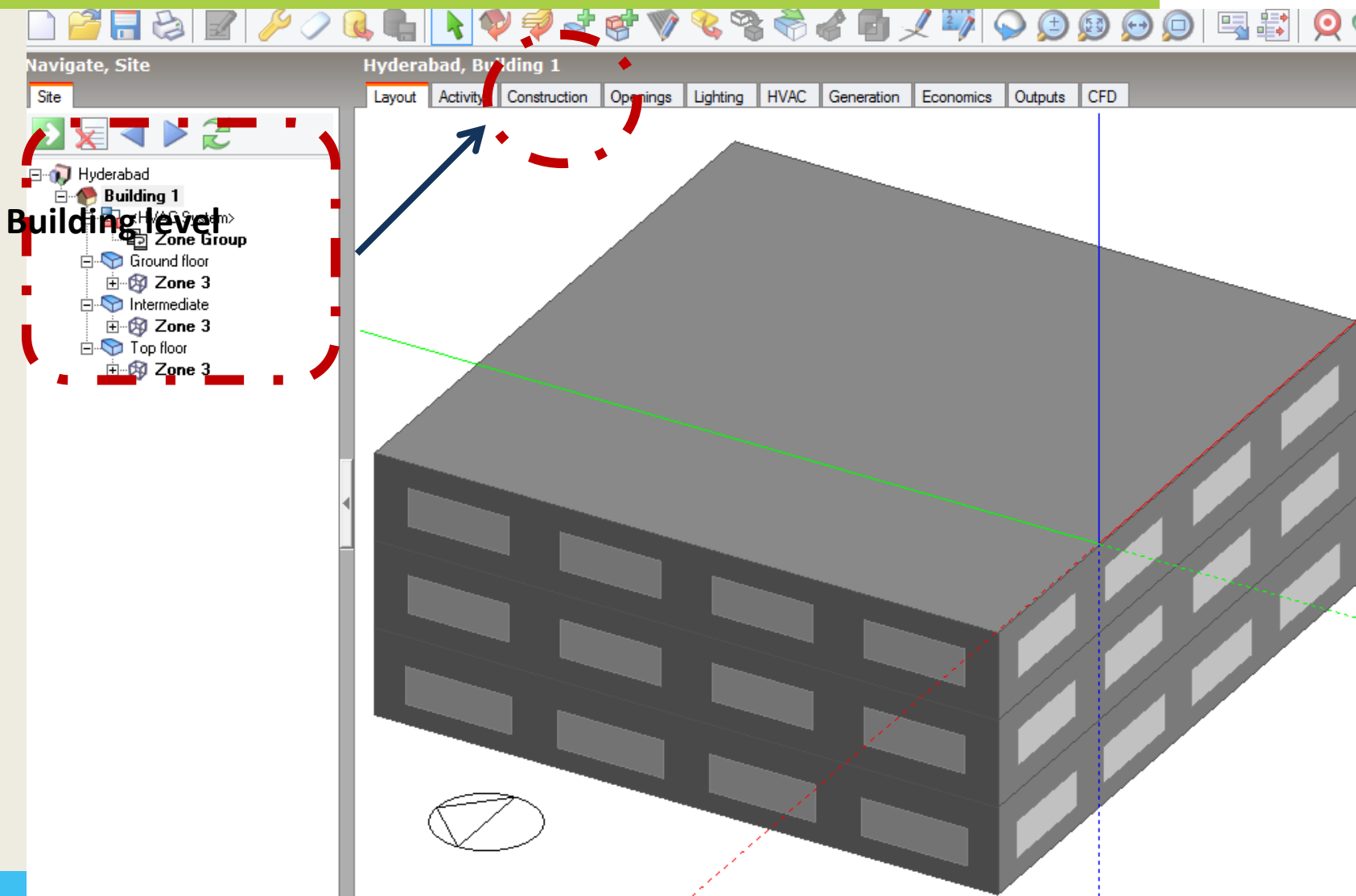
- Roof
- Internal floors

DESIGN BUILDER – ROOF SLAB CONSTRUCTION



- Construction is defined layer by layer
- Layer numbering always starts from outer surface
- Insert the cooling pipes (internal source) above the inner surface, which gives more cooling effect to the zone below

DESIGN BUILDER – ROOF SLAB CONSTRUCTION



DESIGN BUILDER – ROOF SLAB CONSTRUCTION

Constructions Data

Layers Surface properties Image Calculated Cost Internal source Condensation analysis

General

Name training module - chilled flat roof

Source

Category Roofs

Region England and Wales

Building level

Definition

Definition method 1-Layers

Calculation Settings

Layers

Number of layers 4

Outermost layer

Material Asphalt_Hyd

Thickness (m) 0.0100

Bridged?

Layer 2

Material XPS Extruded Polystyrene - CO2 Blowing

Thickness (m) 0.075

Bridged?

Layer 3

Material RCC_Nayak

Thickness (m) 0.1250

Bridged?

Innermost layer

Material RCC_Nayak

Thickness (m) 0.0250

Bridged?

Constructions Data

Condensation analysis

Layers Surface properties Image Calculated Cost Internal source

Internal source

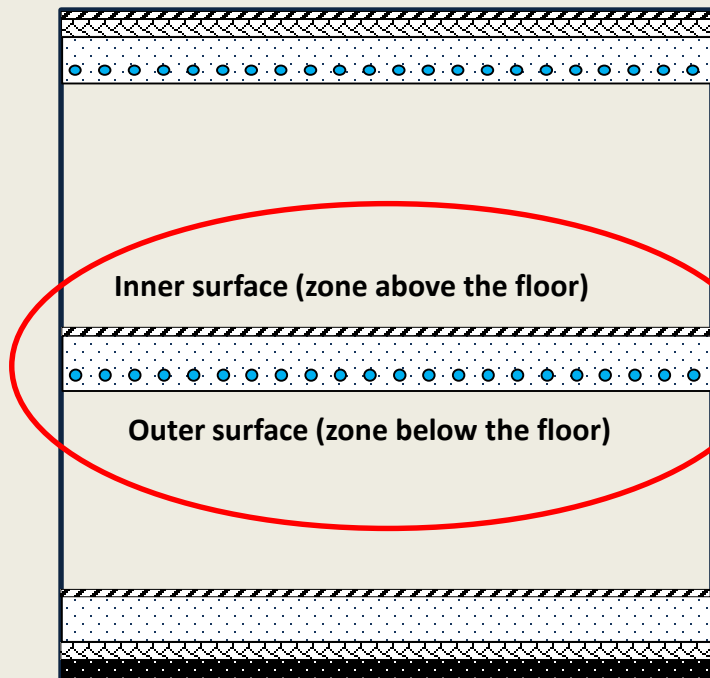
☒ Internal source

Layer after which the internal source... 3

Dimensions 2-D

Tube spacing (m) 0.300

DESIGN BUILDER – INTERNAL FLOOR SLAB CONSTRUCTION



Constructions Data

Layers Surface properties Image Calculated Cost Internal source

Cross Section

Inner surface

13.00mm Ceramic/porcelain_Hyd

12.00mm Floor/Root Screed

125.00mm RCC_Nayak

25.00mm RCC_Nayak

Outer surface

- Construction is defined layer by layer
- Layer numbering always starts from outer surface
- Insert the cooling pipes (internal source) above the outer surface, implies more cooling effect to the zone below

DESIGN BUILDER – INTERNAL FLOOR SLAB CONSTRUCTION

Constructions Data

Condensation analysis

Layers Surface properties Image Calculated Cost Internal source

General

Name training module - chilled internal floor

Source

Category

Floors (internal)

Region

England and Wales

Definition

Definition method

1-Layers

Calculation Settings

Layers

Number of layers

4

Outermost layer

Material

RCC_Nayak

Thickness (m)

0.0250

☐ Bridged?

Layer 2

Material

RCC_Nayak

Thickness (m)

0.1250

☐ Bridged?

Layer 3

Material

Floor/Roof Screed

Thickness (m)

0.0120

☐ Bridged?

Innermost layer

Material

Ceramic/porcelain_Hyd

Thickness (m)

0.0130

☐ Bridged?

Condensation analysis

Layers Surface properties Image Calculated Cost Internal source

Internal source

☒ Internal source

Layer after which the internal source is ...

1

Dimensions

2-D

Tube spacing (m)

0.300

MODEL READY FOR SIMULATION

Calculation Options Data

General Options Output Simulation Manager

Calculation Options

Simulation method 1-EnergyPlus

Time steps per hour 4

Temperature control 2-Operative temperature

Solar

☐ Include all buildings in shading calcs

☐ Model reflections and shading of ground reflected solar

Solar distribution 2-Full exterior

Shadowing interval (days) 20

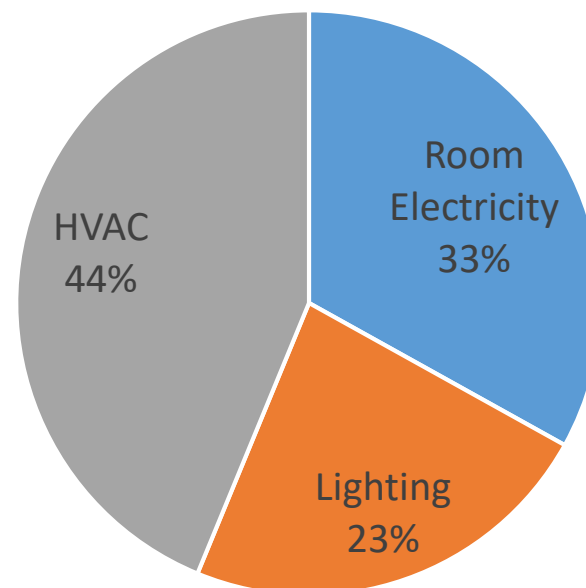
Detailed HVAC Autosizing >>

Advanced >>

SLAB COOLING - SIMULATION RESULTS



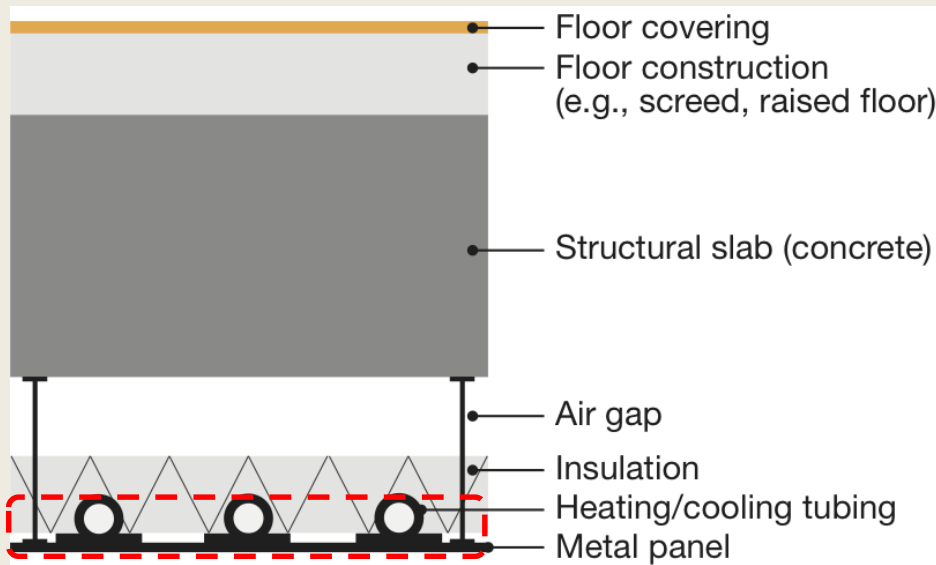
No	End use	Energy Consumption (kWh/year)
1	Lighting	46500
2	Equipment	32550
3	HVAC	61551
4	Total	140602
5	EPI (total)	79
6	EPI (HVAC)	34.5



No	Chiller	Load share
1	DOAS	37%
2	Radiant	63%

INPUTS FOR RADIANT PANEL

RADIANT PANELS MODELLING

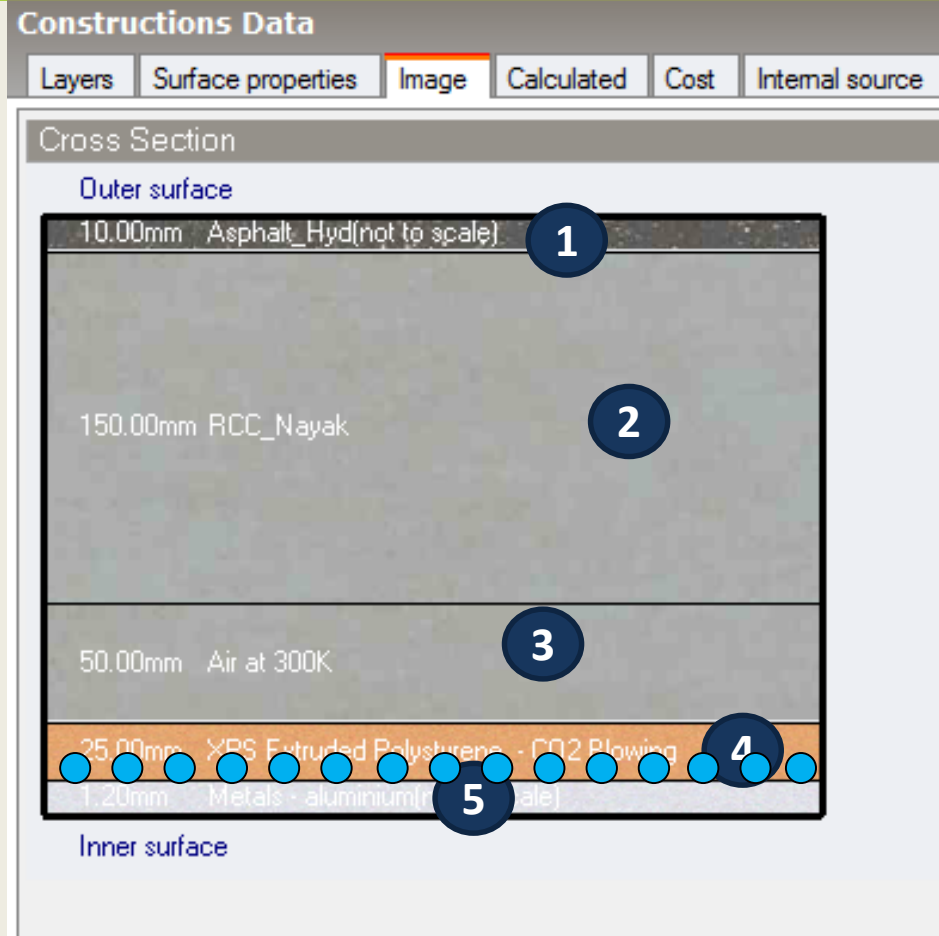
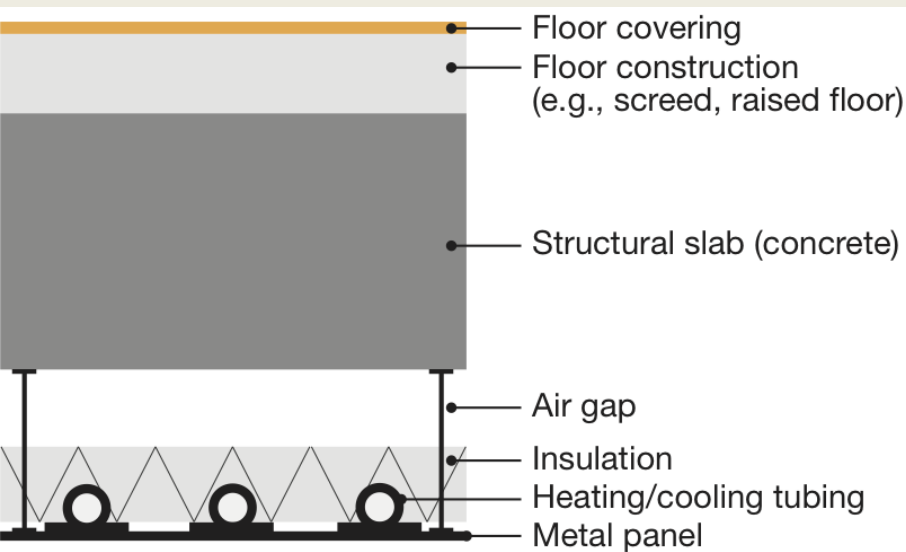


Panel cooling systems



Source: Jingjuan Feng, PhD Thesis, "Design and Control of Hydronic Radiant Cooling Systems", University of California, Berkeley

DESIGN BUILDER – ROOF PANEL CONSTRUCTION



- Insert the cooling pipes (internal source) above the aluminum panel

DESIGN BUILDER – ROOF PANEL CONSTRUCTION

Constructions Data

Layers | Surface properties | Image | Calculated | Cost | Internal source | Condensation analysis

General

Name Training module - panel + air gap chilled flat roof

Source

Category Roofs

Region England and Wales

Definition

Definition method 1-Layers

Calculation Settings

Layers

Number of layers 5

Outermost layer

Material Asphalt_Hyd

Thickness (m) 0.0100

☐ Bridged?

Layer 2

Material RCC_Nayak

Thickness (m) 0.1500

☐ Bridged?

Layer 3

Material Air at 300K

Thickness (m) 0.0500

☐ Bridged?

Layer 4

Material XPS Extruded Polystyrene - CO2 Blowin

Thickness (m) 0.0250

☐ Bridged?

Innermost layer

Material Metals - aluminium

Thickness (m) 0.0012

☐ Bridged?

Constructions Data

Layers | Surface properties | Image | Calculated | Cost

Internal source | Condensation analysis

Internal source

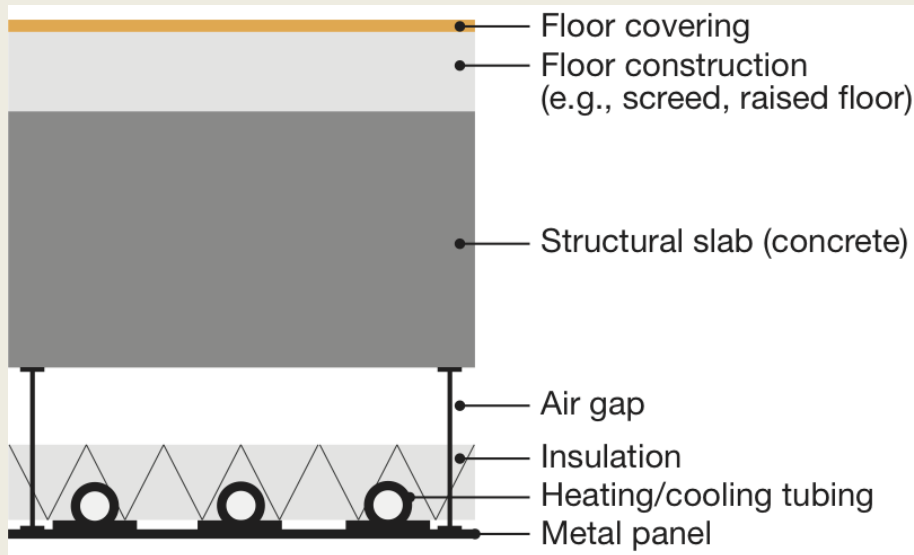
☒ Internal source

Layer after which the internal s... 4

Dimensions 2-D

Tube spacing (m) 0.300

DESIGN BUILDER – INTERNAL FLOOR PANEL CONSTRUCTION

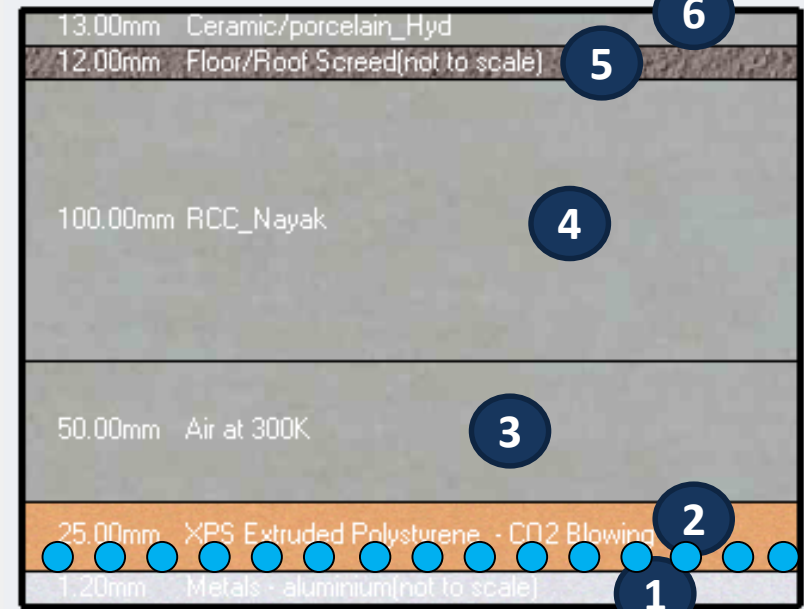


Constructions Data

Layers Surface properties Image Calculated Cost Internal source

Cross Section

Inner surface



Outer surface

- Insert the cooling pipes (internal source) above the aluminum panel

DESIGN BUILDER – INTERNAL FLOOR PANEL CONSTRUCTION

Condensation analysis

Layers Surface properties Image Calculated Cost **Internal source**

Source
Category Floors (internal)
Region England and Wales

Definition
Definition method 1-Layers

Calculation Settings

Layers

Number of layers 6

Outermost layer
Material Metals - aluminium
Thickness (m) 0.0012
☐ Bridged?

Layer 2
Material XPS Extruded Polystyrene -
Thickness (m) 0.0250
☐ Bridged?

Layer 3
Material Air at 300K
Thickness (m) 0.0500
☐ Bridged?

Layer 4
Material RCC_Nayak
Thickness (m) 0.1000
☐ Bridged?

Layer 5
Material Floor/Roof Screed
Thickness (m) 0.0120
☐ Bridged?

Innermost layer
Material Ceramic/porcelain_Hyd
Thickness (m) 0.0130
☐ Bridged?

Constructions Data

Condensation analysis

Layers Surface properties Image Calculated Cost **Internal source**

Internal source

☒ Internal source

Layer after which the internal source is p...

1

Dimensions

2-D

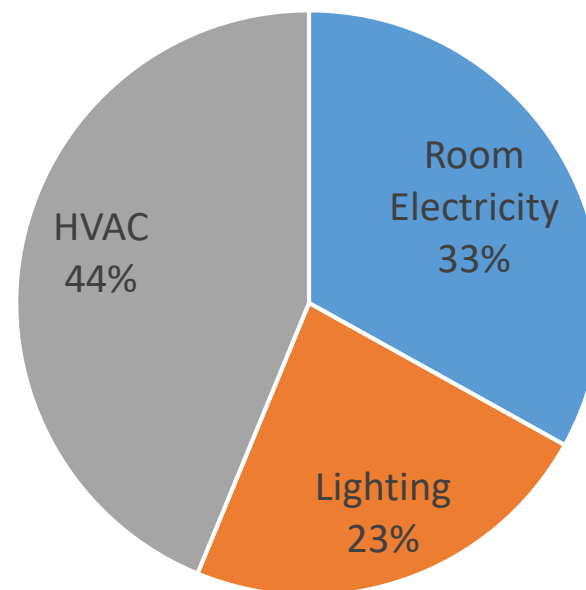
Tube spacing (m)

0.300

PANEL COOLING - SIMULATION RESULTS



No	End use	Energy Consumption (kWh/year)
1	Lighting	46500
2	Equipment	32550
3	HVAC	58880
4	Total	137930
5	EPI (total)	77
6	EPI (HVAC)	33



No	Chiller	Load share
1	DOAS	37%
2	Radiant	63%

THANK YOU