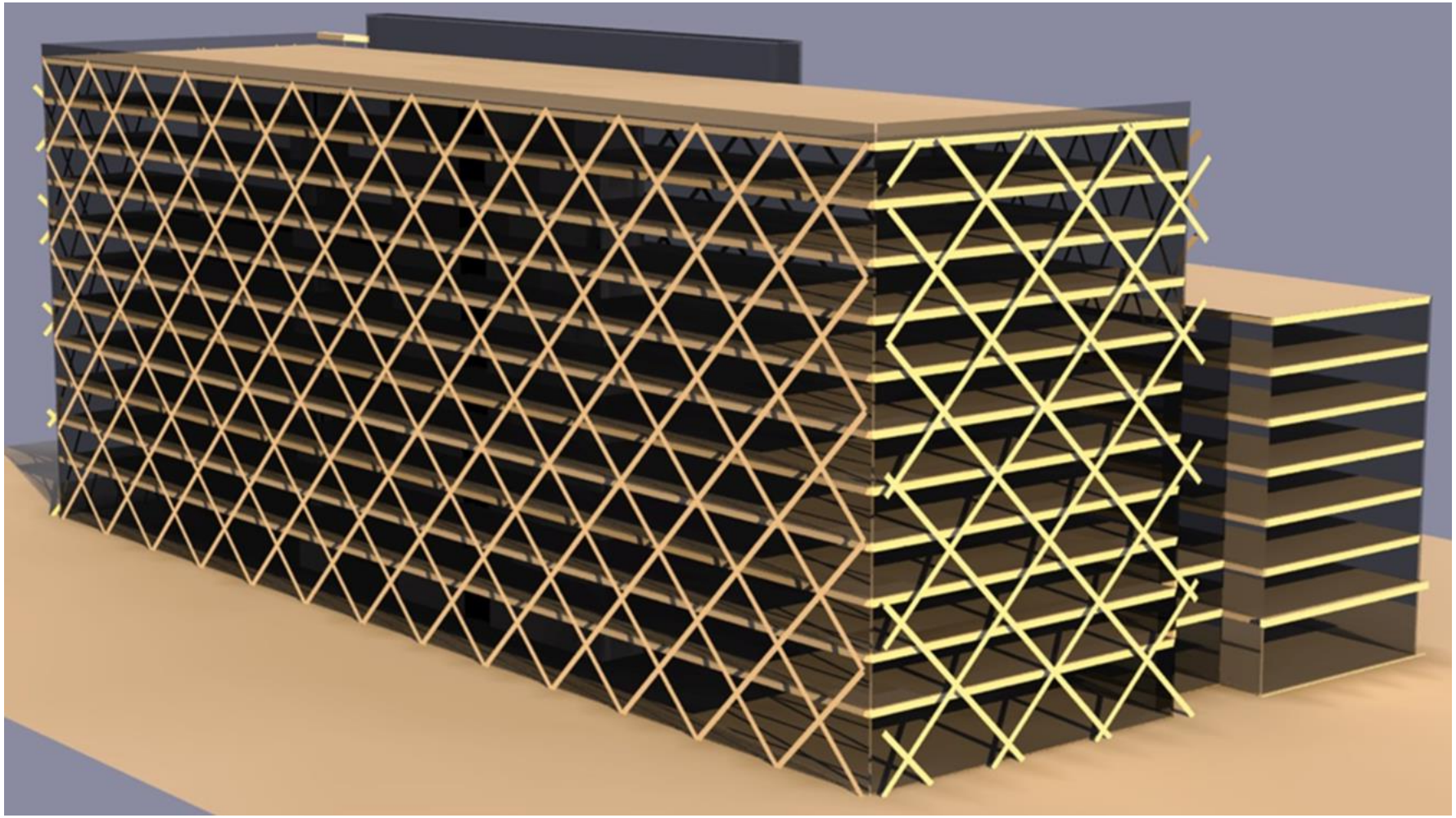
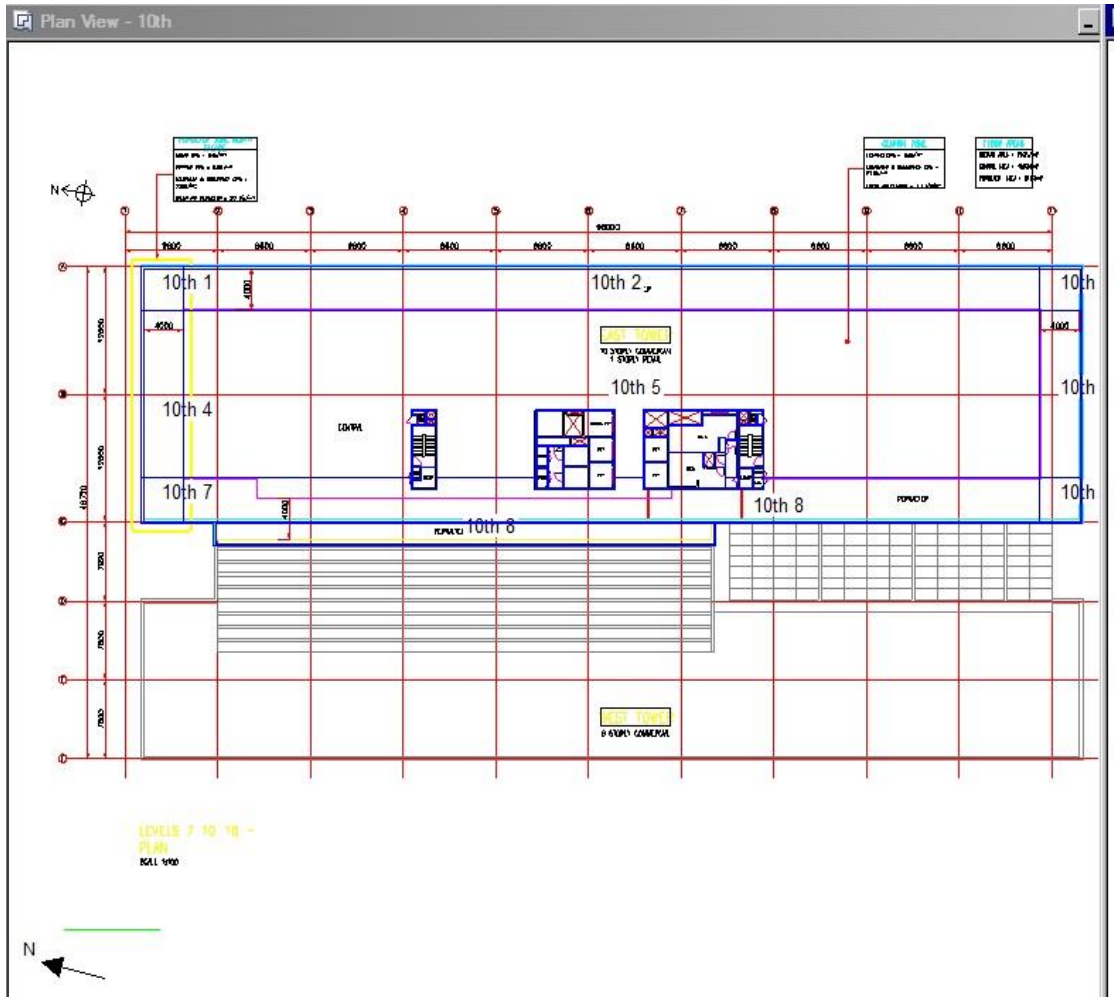
FAST AND ROBUST BUILDING SIMULATION SOFTWARE

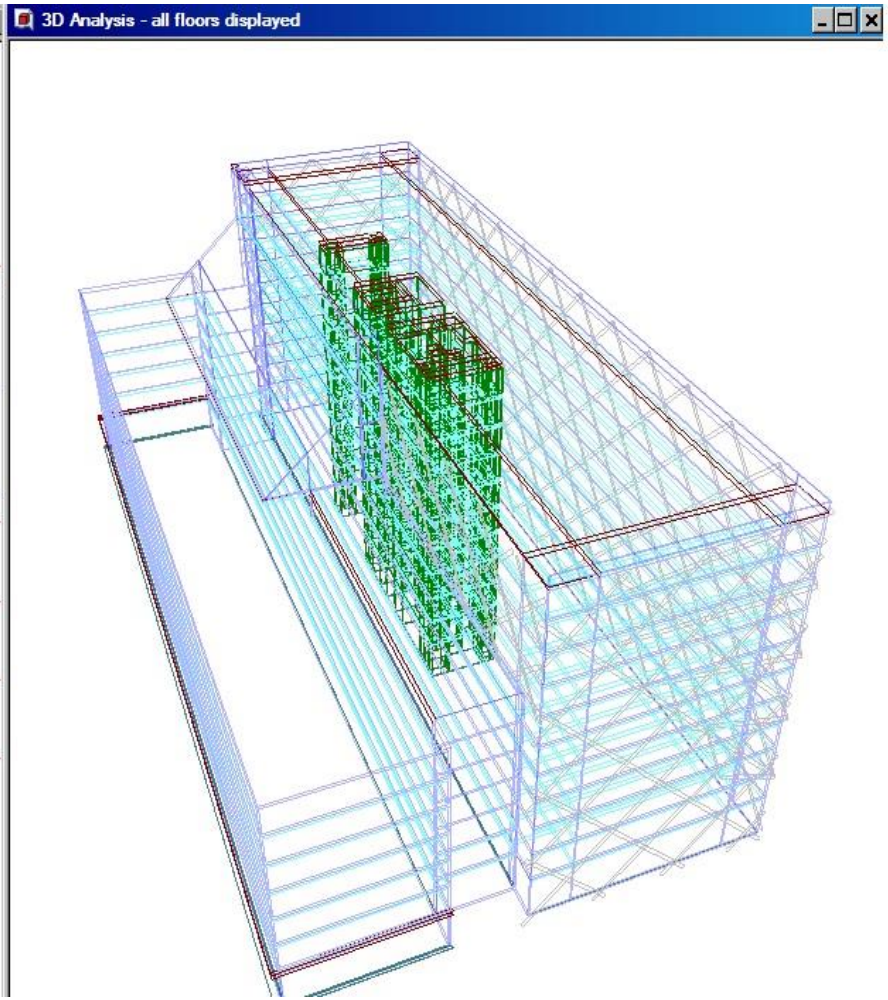
Chilled Beam Performance:
1 Shelly Street, Sydney

3D Model Creation

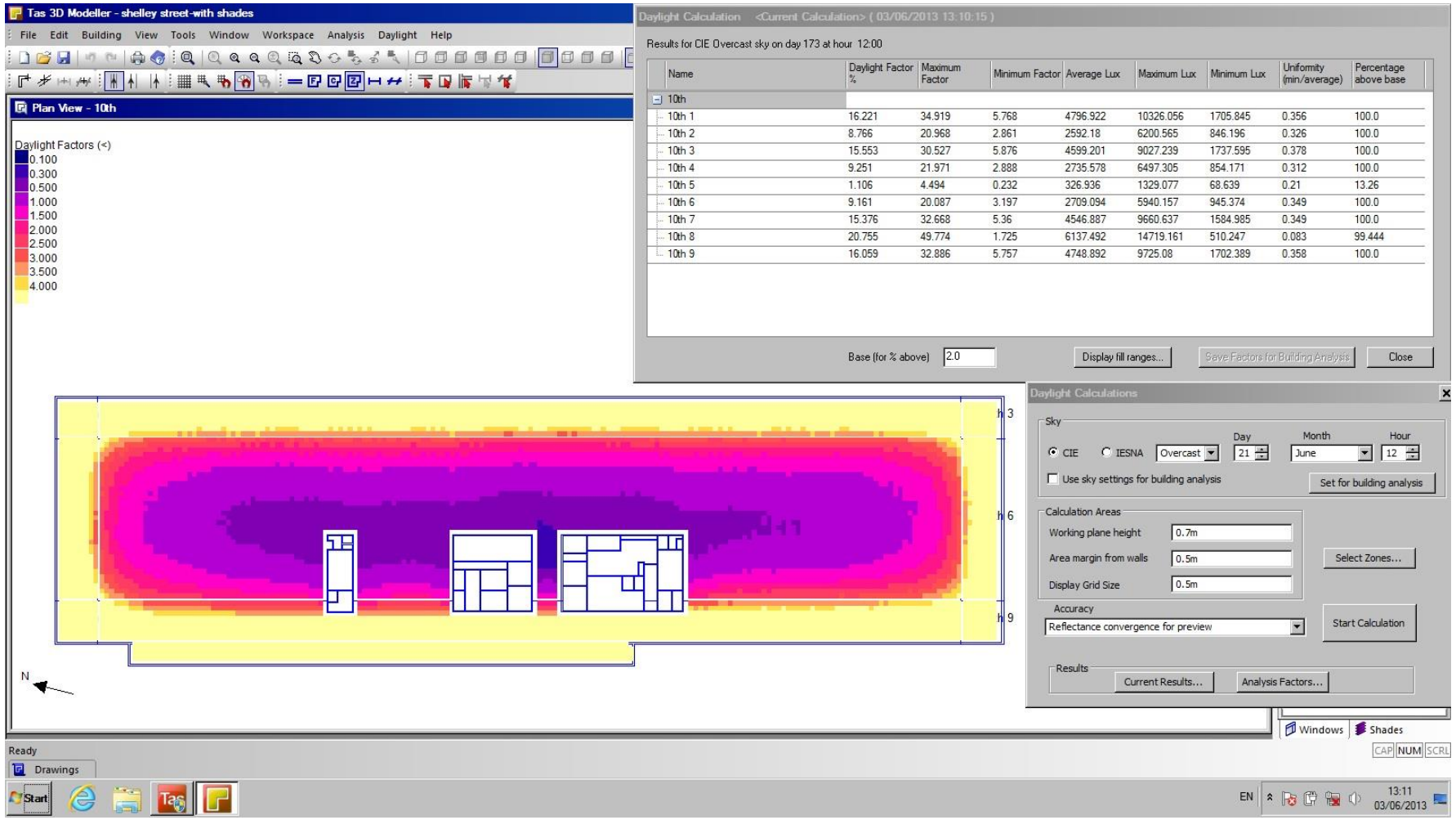


3D Model Creation





Daylight Analysis



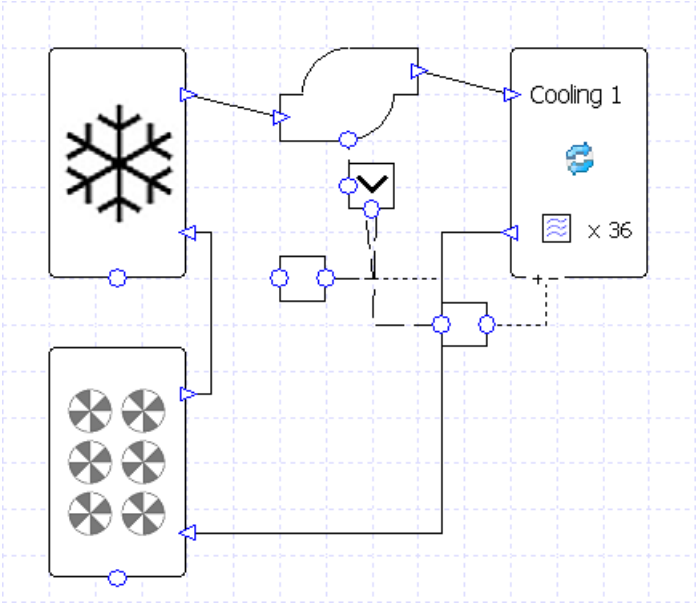
FRENGER systems

HVAC Systems: Performance Comparison

- VAV fancoil
- Active chilled beam
- Passive chilled beam (95% convective / 5% radiant absorption)
- Passive “Radiant” chilled beam (65% convective / 35% radiant absorption)
- Traditional VAV
- Modern VAV (temperature and CO2 control with “static reset”)

Cooling circuit (common to all air side systems)

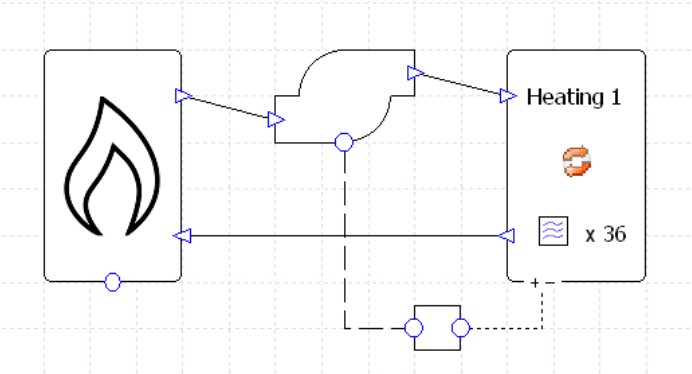
Chiller has a COP of 4 (typical chiller performance based on flow of 6°C and return temp of 12°C).
Addition of Dry Air Cooler for free cooling when available. DAC efficiency = 67%, SFP of fans = 0.4W/l/s



Heating circuit (common to all air side systems)

Boiler has an efficiency of 90% and a flow set point of 65°C.

DHWS also fed from this circuit.

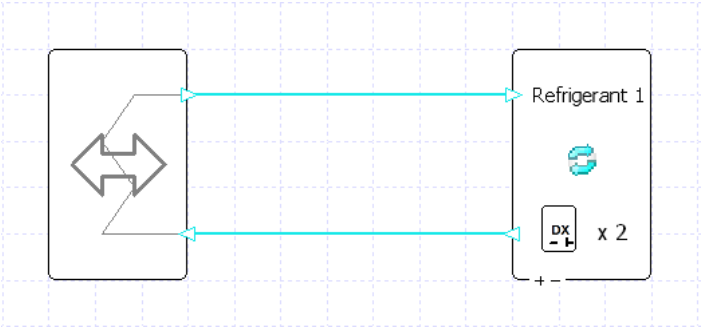


DX circuit - common to all air side systems

Nominal heating energy input ratio 0.261 (COP = 3.83)

Nominal cooling energy input ratio 0.307 (COP = 3.26)

(Performance taken from typical Mitsubishi VRF heat recovery unit)



VAV fancoil

A high efficiency chiller supplies chilled water at 6°C to the fan coils with a nominal return temperature of 12°C.

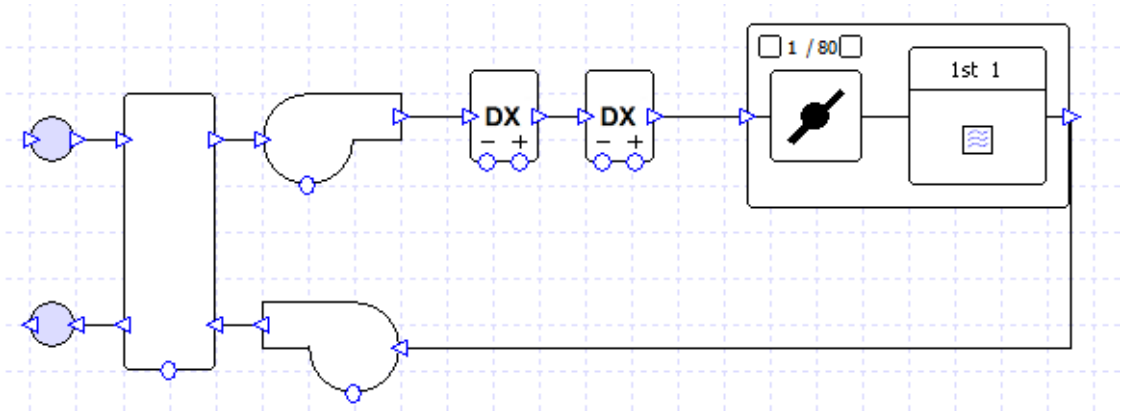
An air source heat pump supplies heating and cooling to the DX coils in the AHU

AHU based on total SFP of 1.8 W/l/s, includes heat recovery at 75% efficiency, provides air to the fan coil units at 14°C.

The fresh air flow rate is 2.2 l/s/m^2 for perimeter zones and 1.1 l/s/m^2 for core zones.

The fan coil units include EC motors and VAV control and have an SFP of 0.25 W/l/s.

The fan coil units have a minimum flow turndown to 60% of the maximum flow rate.



Active Chilled Beam

Dedicated high efficiency chiller supplies 14°C water to chilled beams

Incorporates “Free Cooling” circuit

- When outdoor conditions permit, chiller can turn off.
- During other times, free cooling runs in conjunction with chiller to further reduce energy usage.

Variable pump speed to ensure chilled water return is 3K higher than the supply.

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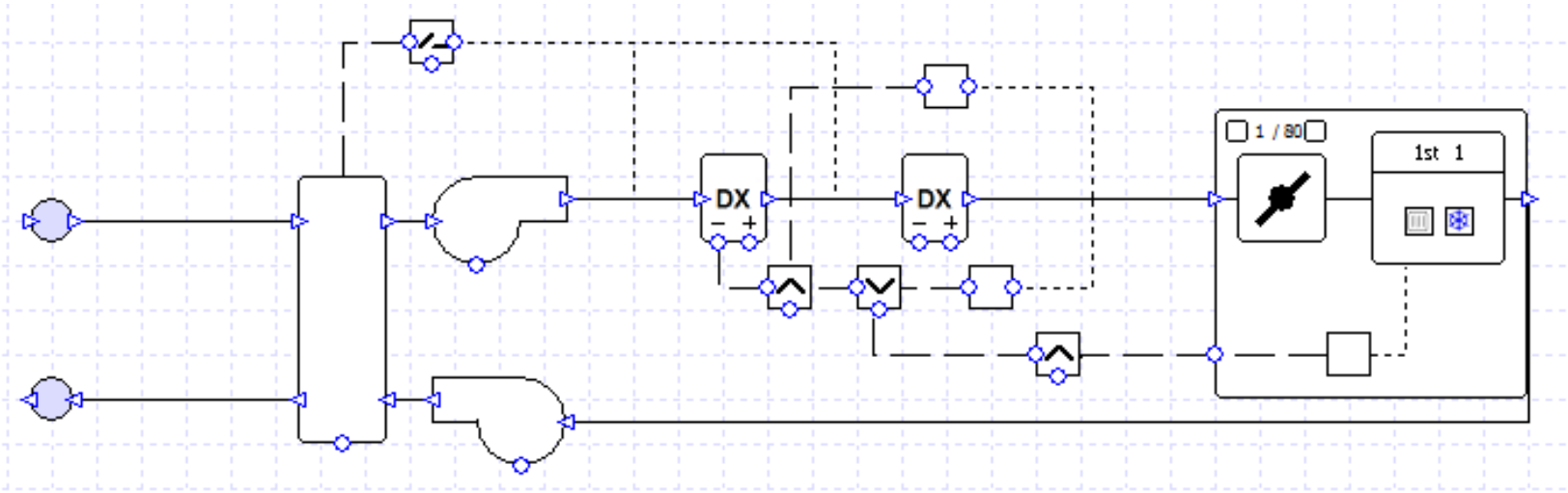

Active Chilled Beam

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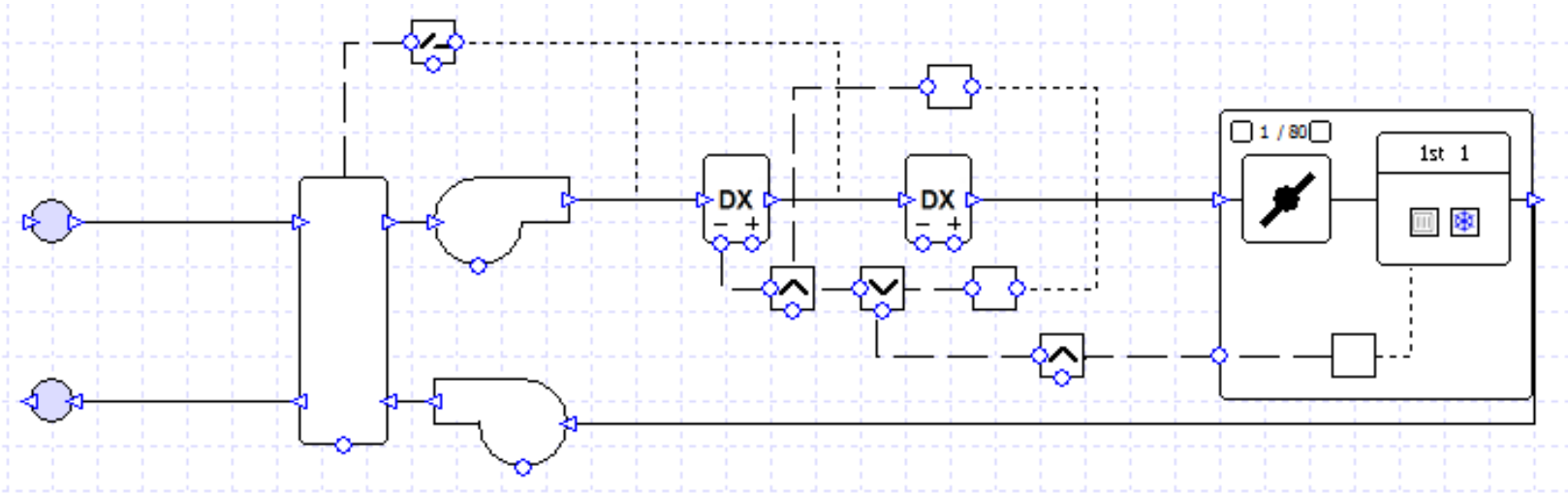
DX cooling coil provides conditioned air at 16°C

- Dehumidifies supply air to control latent gains within the space
- Maintains dew point at 1.0°C lower than chilled water flow temperature onto beams.

DX heating coil provides the conditioned air at 13°C, supplies reheat during dehumidification.

AHU based on a total SFP of 1.8 W/l/s, includes heat recovery at 75% efficiency.

Fresh air flow rate = 2.2 l/s/m^2 for perimeter zones & 1.1 l/s/m^2 for core zones.



Passive Chilled Beam (common to both radiant & convective)

Two passive chilled beam systems modelled: 5% radiant proportion, 35% radiant proportion.

To compensate for lower resultant temperatures, room thermostat cooling setpoint increased by 1°C for the 35% system.

Dedicated high efficiency chiller supplies 15°C water to chilled beams

Incorporates “Free Cooling” circuit

- When outdoor conditions permit, chiller can turn off.
- During other times, free cooling runs in conjunction with chiller to further reduce energy usage.

Variable pump speed to ensure chilled water return is 3K higher than the supply.

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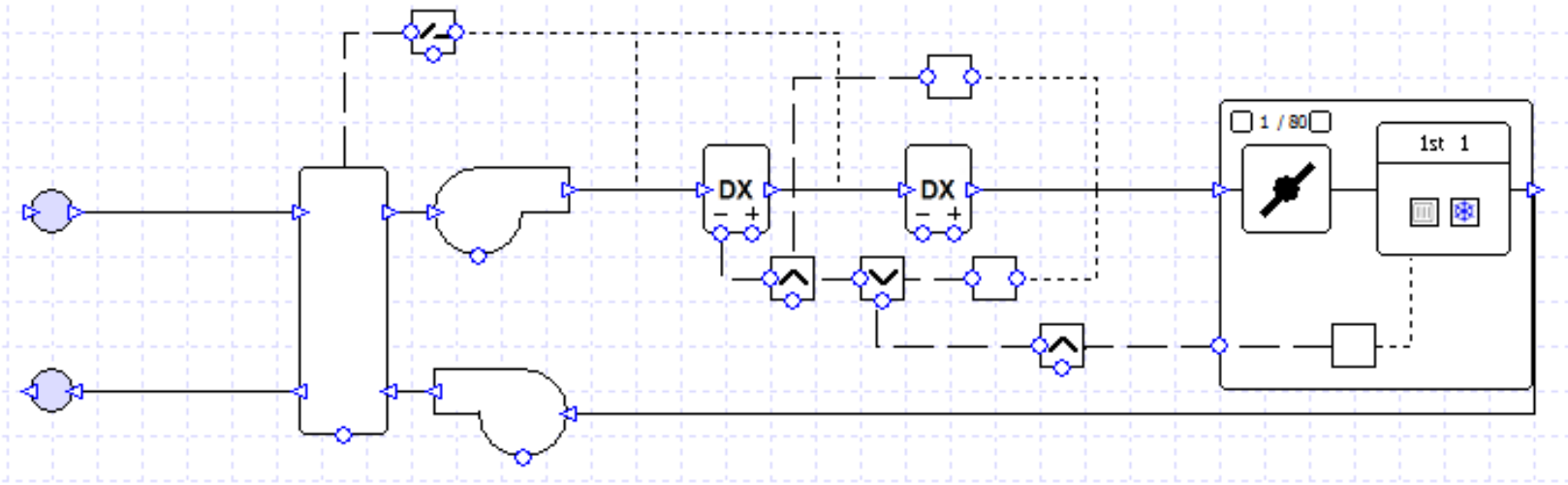

Passive Chilled Beam (common to both radiant & convective)

(continued from previous slide)

DX cooling coil provides conditioned air at 16°C

- Dehumidifies supply air to control latent gains within the space
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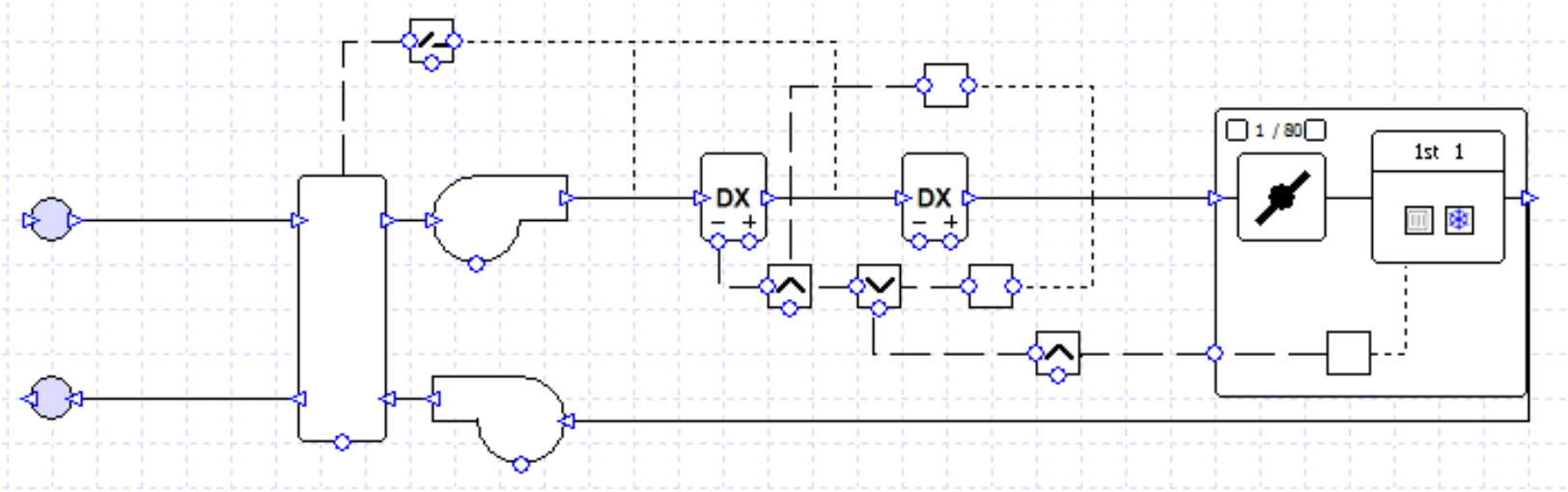
DX heating coil provides the conditioned air at 16°C, supplies reheat during dehumidification.

AHU based on a total SFP of 1.8 W/l/s, includes heat recovery at 75% efficiency.

Fresh air flow rate = 2.2 l/s/m^2 for perimeter zones & 1.1 l/s/m^2 for core zones.



Traditional VAV

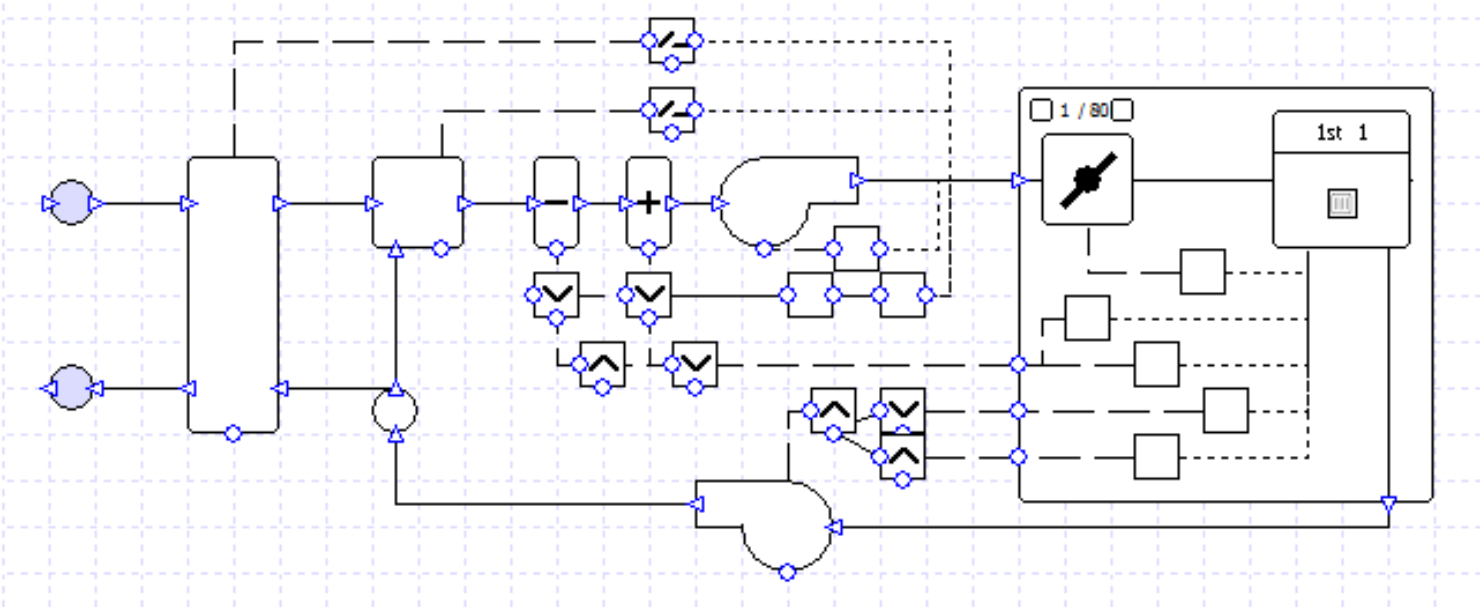
High efficiency chiller supplies chilled water at 6°C to cooling coil with nominal return temperature of 12°C.

VAV system based on a total SFP of 1.8 W/l/s, heat recovery at 75% efficiency, provides air to zones to meet heating & cooling demands.

Fresh air flow rates: 2.2 l/s/m^2 for perimeter zones, 1.1 l/s/m^2 for core zones.

Zone dampers configured to control air flow based on zone temperature requirements.

Supply fan controlled to maintain a constant static pressure.



Modern VAV

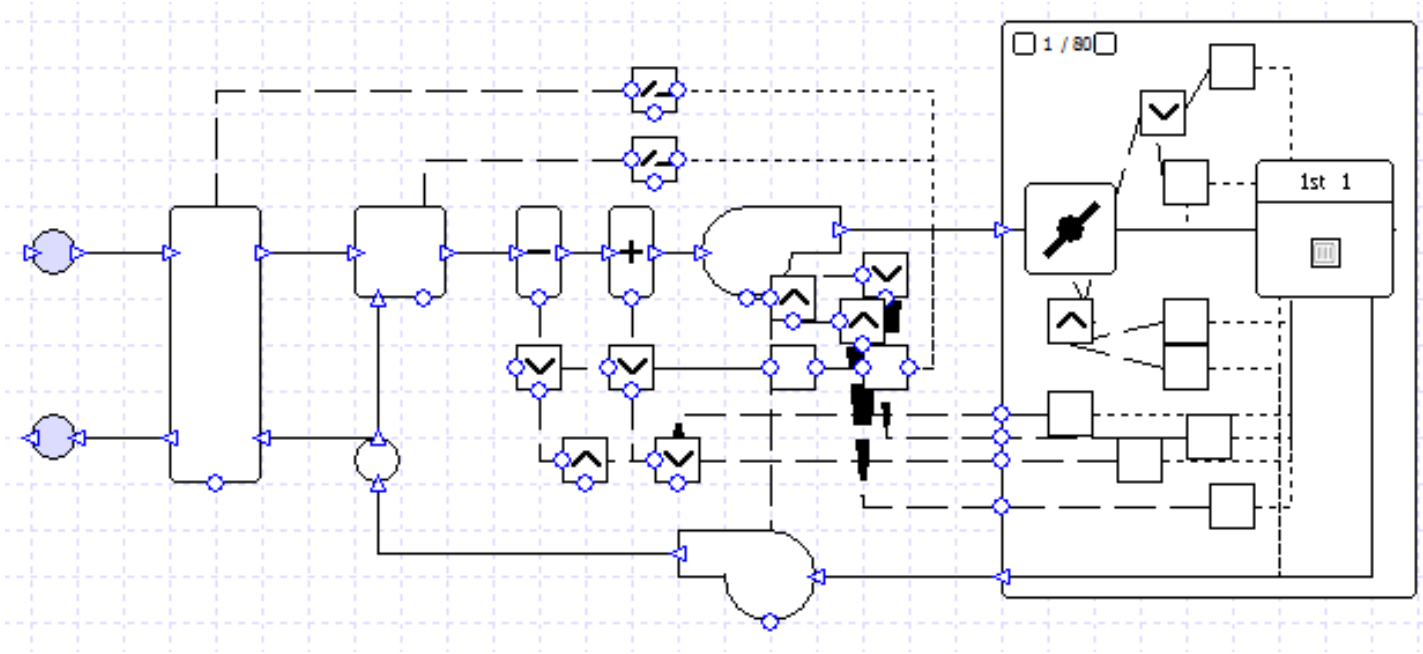
High efficiency chiller supplies chilled water at 6°C to cooling coils with nominal return temperature of 12°C.

VAV system based on a total SFP of 1.8 W/l/s, heat recovery at 75% efficiency, provides air to zones based on heating & cooling demand.

Fresh air flow rates: 2.2 l/s/m^2 for perimeter zones, 1.1 l/s/m^2 for core zones.

Zone dampers configured to control air flow based on zone temperature requirements and CO_2 levels.

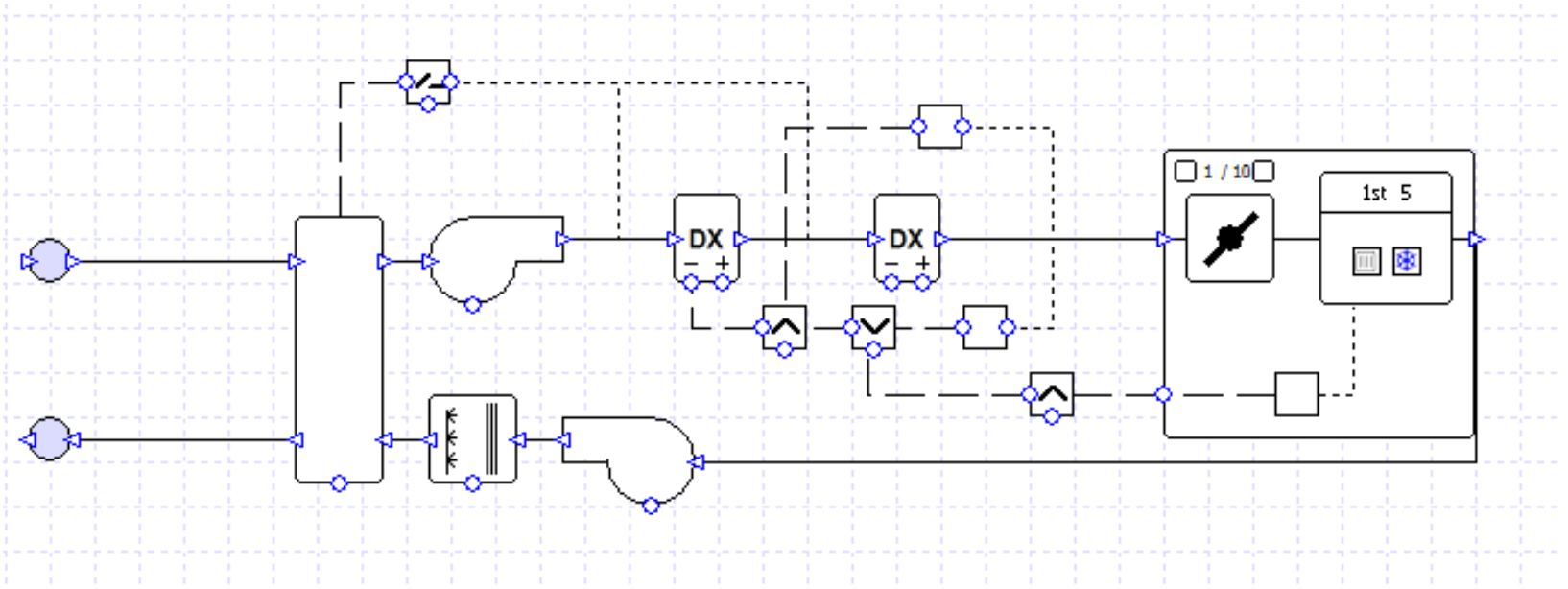
Supply & return fans controlled to give “static pressure reset” as described in ASHRAE 90.1.



Frenger Radiant Chilled Beam (A)

Passive chilled (65% convective / 35% radiant absorption) beam air side

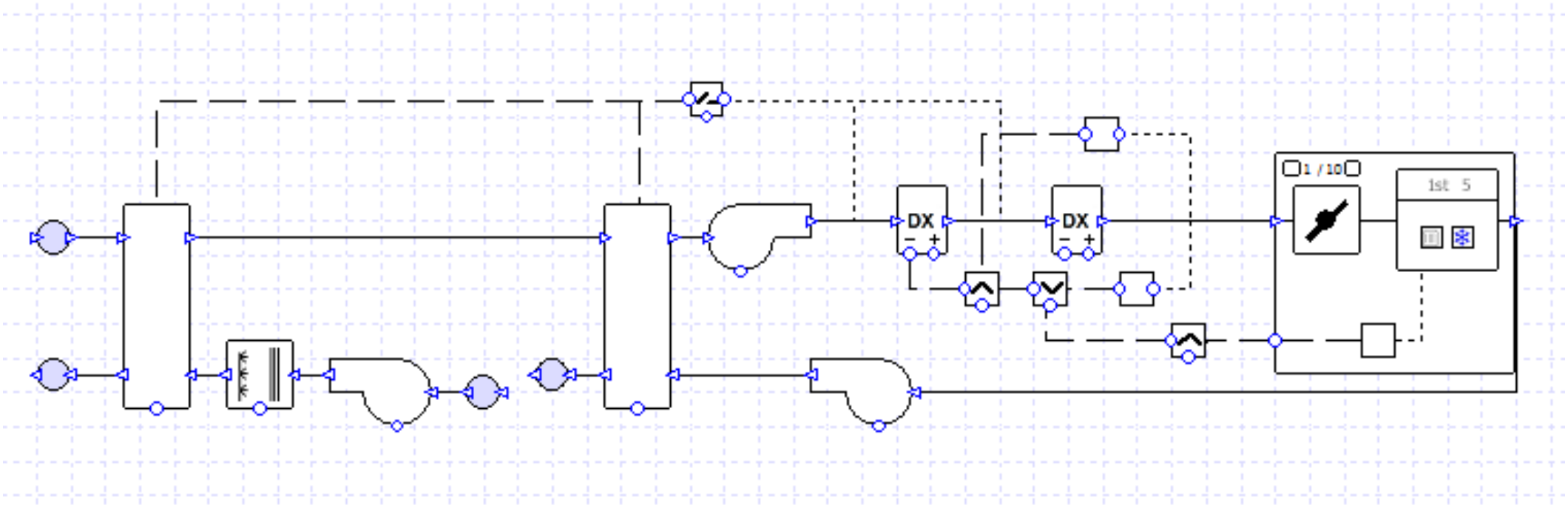
Evaporative cooling of exhaust air before heat recovery.



Frenger Radiant Chilled Beam (B)

Passive chilled (65% convective / 35% radiant absorption) beam air side

Evaporative cooling and sensible heat recovery on fresh air.



Results Analysis

	Heating (kWh)	Cooling (kWh)	Auxiliary (kWh)	Total (kWh)
VAV fancoil	84,504.39	541,862.09	252,238.47	878,604.95
Active beam	84,468.56	529,660.69	203,059.41	817,188.66
Passive Beam (95% Convective / 5% Radiant absorption)	87,021.97	509,811.69	206,553.40	803,387.06
Frenger "Radiant" Passive Beam (65% Convective / 35% Radiant absorption)	86,836.56	454,034.25	203,257.08	**744,127.89**
Traditional VAV	365,106.69	663,804.59	389,736.06	1,418,647.34
Modern VAV	86,167.17	609,406.33	276,391.29	971,964.79

From the above results the Frenger Radiant passive beam system consumes the least energy.

Frenger "Radiant" Passive Beam (65% Convective / 35% Radiant absorption)	86,836.56	454,034.25	203,257.08	**744,127.89**

By applying evaporative cooling on the exhaust air further energy savings can be achieved, however when applied to the fresh air system additional energy would be consumed.

Radiant Chilled Beam (A): Evaporative cooling on exhaust air	88,454.71	411,994.34	209,178.74	709,178.93
Radiant Chilled Beam (B): Evaporative cooling on fresh air	88,319.67	383,777.83	282,394.64	754,491.95

FRENGER® systems