Primary School Emulator

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Overview

- **Main Target**

Model a typical primary school in Quebec for inclusion in the BOPTEST repository

- **Building Plan and Geometry**

Adopted the plan of the reference building from the U.S. Department of Energy (DOE) for the primary school

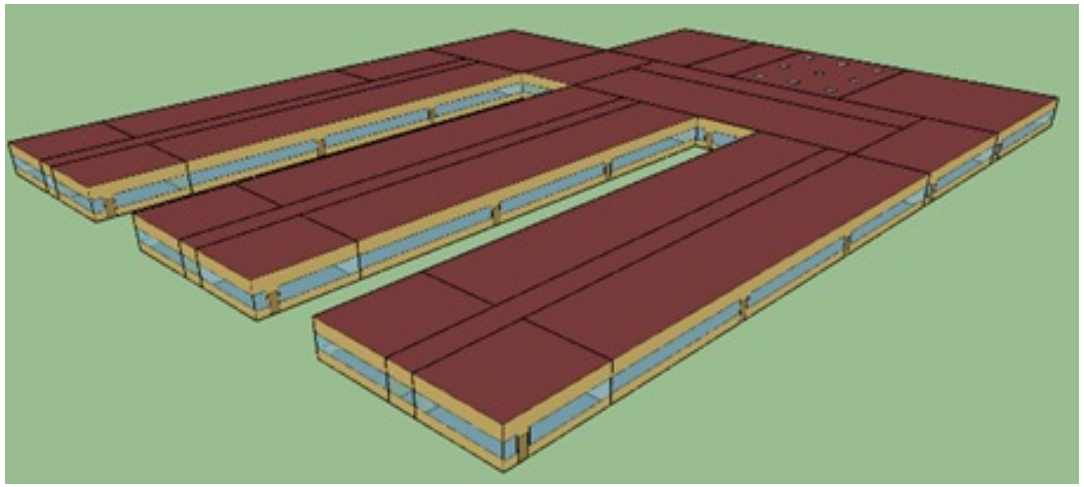
- **Climate Zone**

Climate Zone 6A (cold and humid) selected; Montreal as a representative city

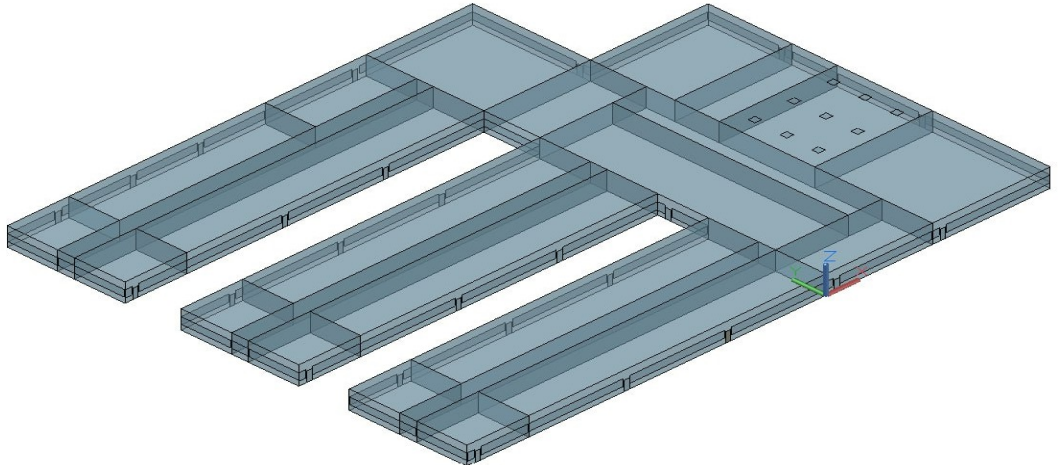
- **HVAC System**

Configuration of primary and secondary HVAC system based on a previous study for schools in Quebec

Building geometry



U.S. Department of Energy. (n.d.). *Prototype Building Models*. Retrieved from https://www.energycodes.gov/prototype-building-models.



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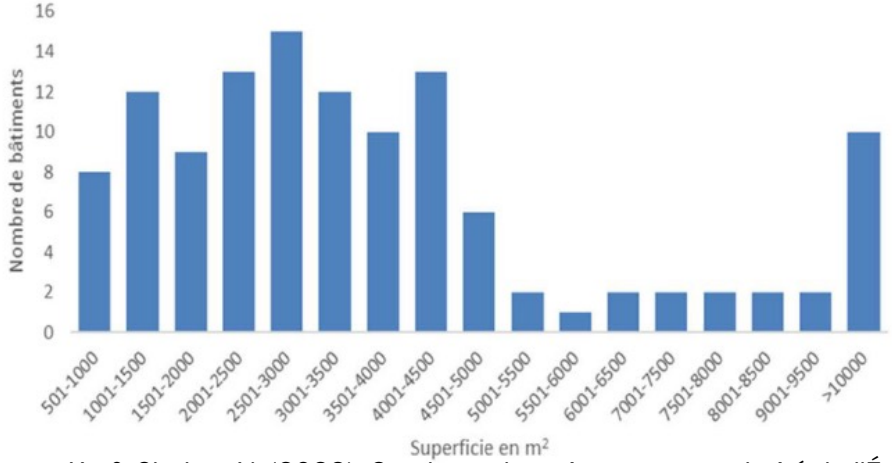
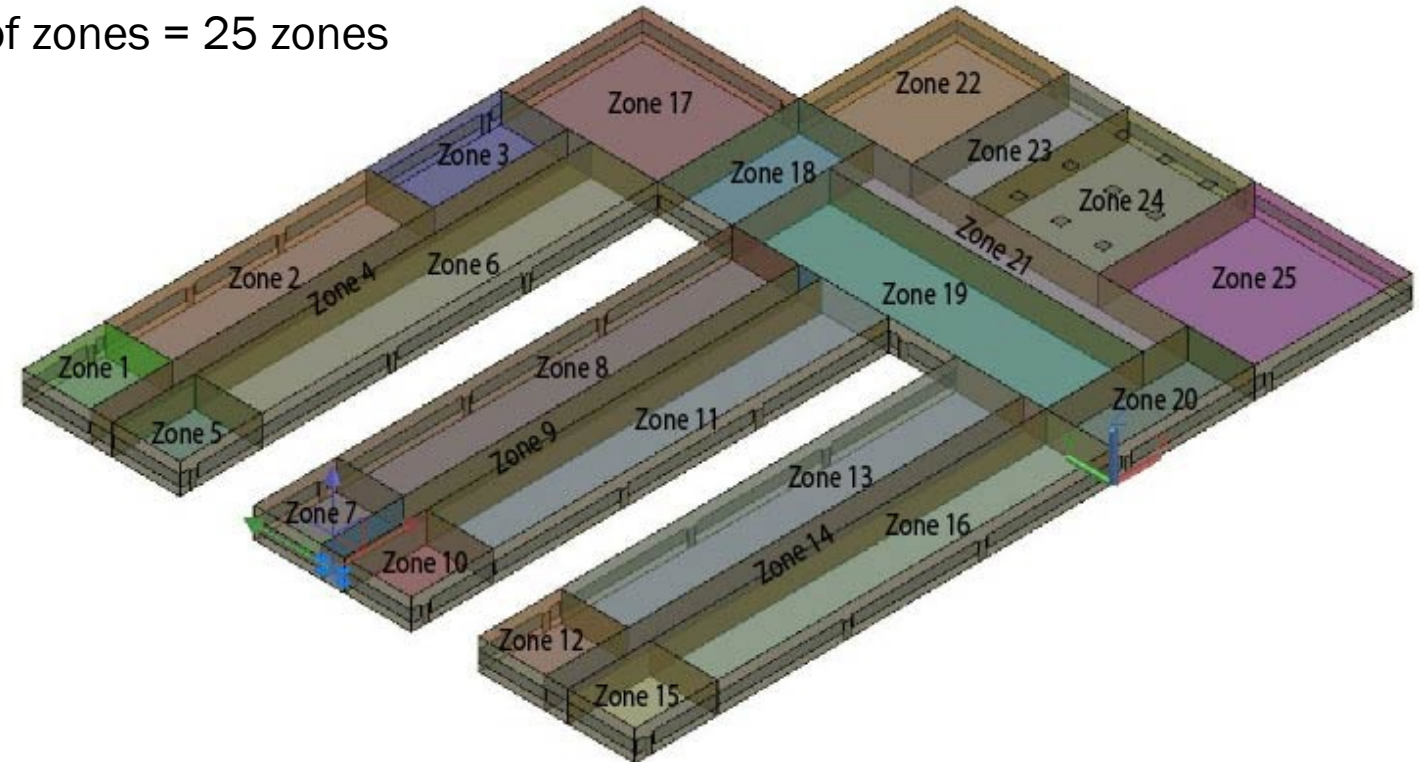


D'Avignon, K., & Chabot, V. (2022). *Stockage thermique et exemplarité de l'État*. École de technologie supérieure.

Case Study	Primary School
Floor area	2750 (m^2)
Number of floors	1
Window to wall ratio	35%

Zoning

Total number of zones = 25 zones



U.S. Department of Energy. (n.d.). *Prototype Building Models*. Retrieved from https://www.energycodes.gov/prototype-building-models.

Groups	Zones
A	5,10,15
B	1,7,12
C	6,11,16
D	8,13
E	2,3
F	17,22
G	4,9,14,21
H	18,19
I	20
J	23,24
K	25

Envelope (ASHRAE Standard 90.1-2022)

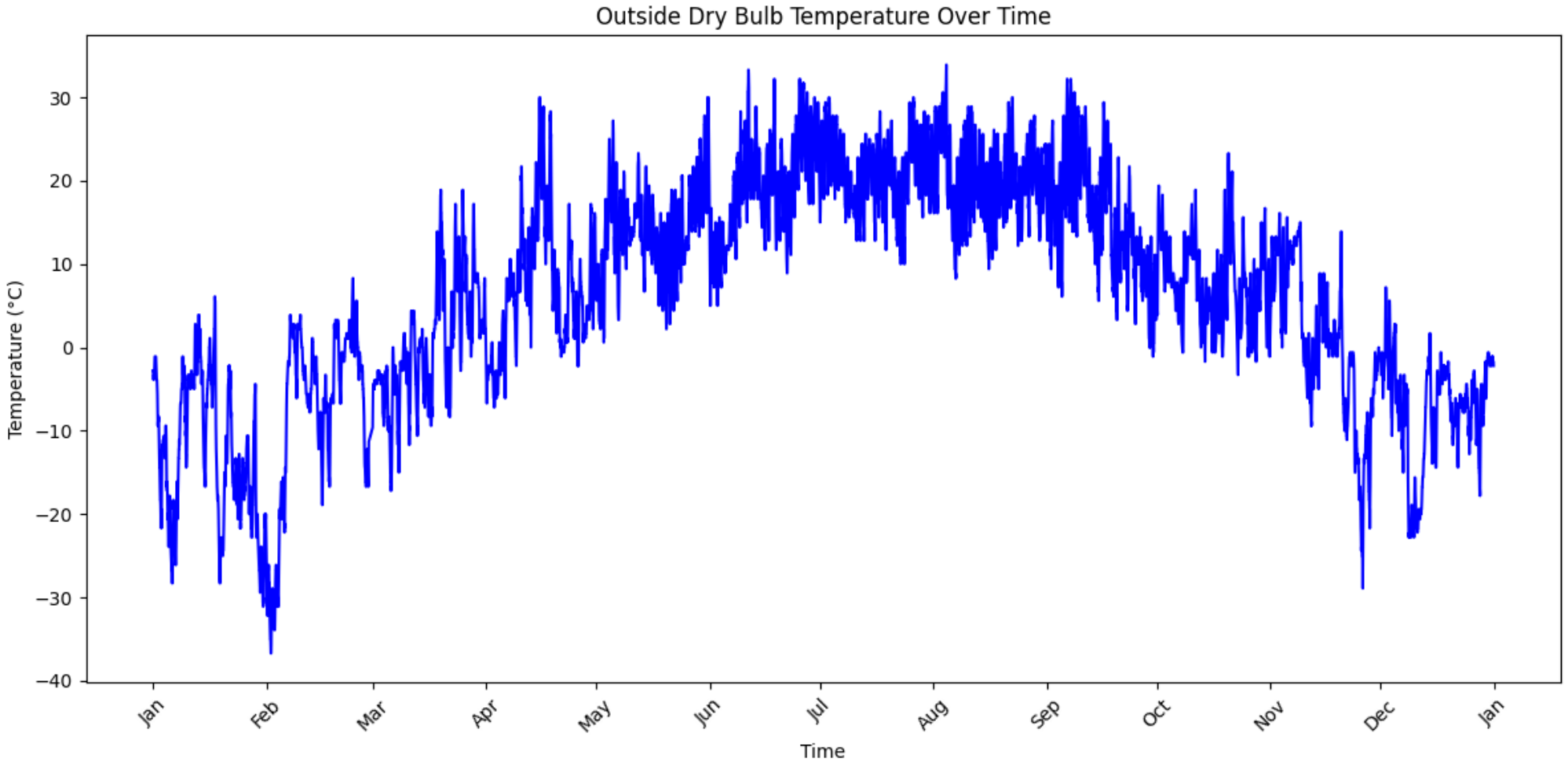
Opaque

Location	U-Factor with Film [W/m2-K]	U-Factor no Film [W/m2-K]	Gross Area [m2]	Net Area [m2]
Wall	0.545	0.593	2488	1584
Floor_type 1	0.178	0.183	594	594
Floor_type 2	0.098	0.1	3540	3540
Floor_type 3	0.014	0.014	1122	1122
Floor_type 4	0.042	0.042	715	715
Ceilling	0.182	0.186	6870	6870

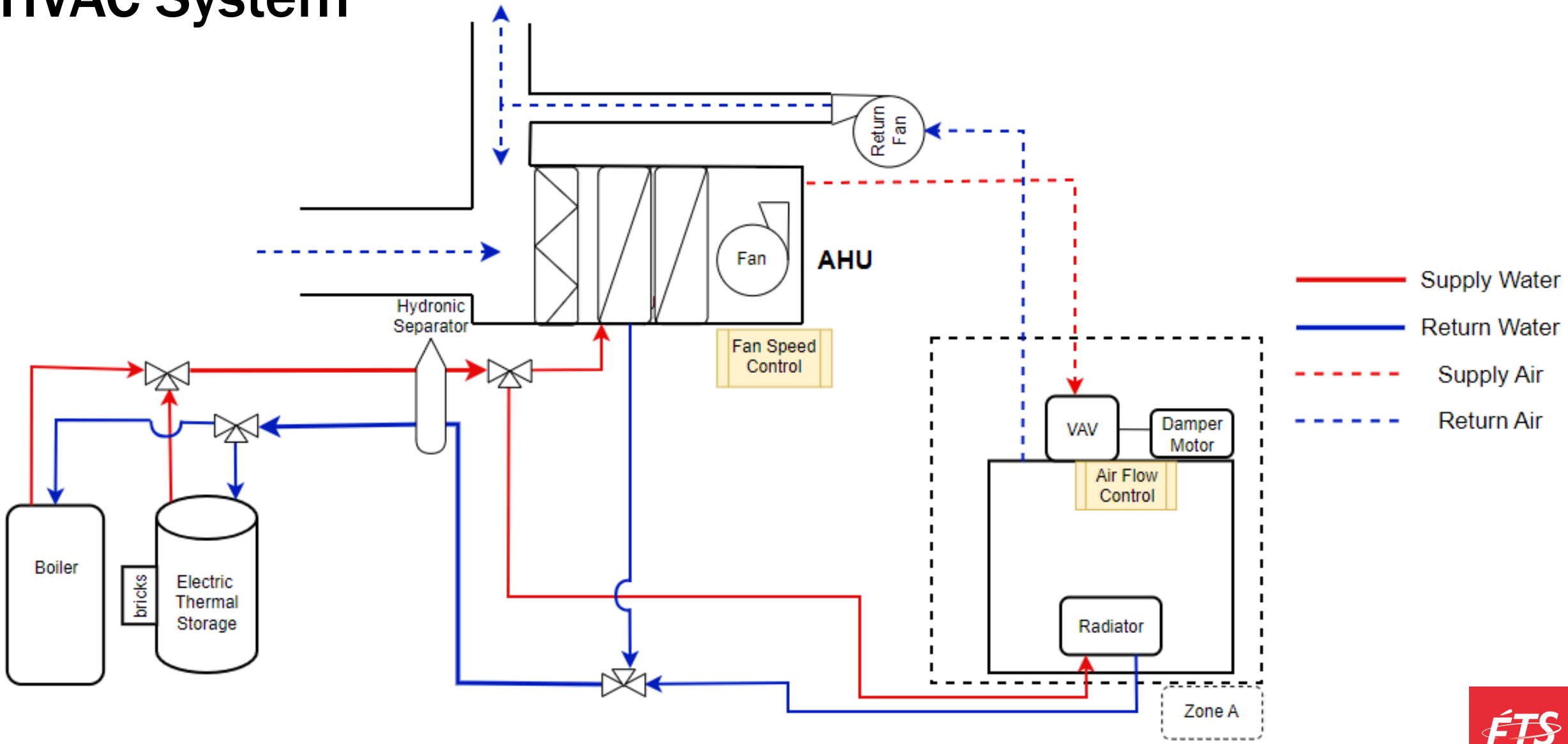
Transparent

Type	Glass Area [m2]	Glass U-Factor [W/m2-K]
Window_Wall	879.09	1.977
Skylight	13.41	2.672

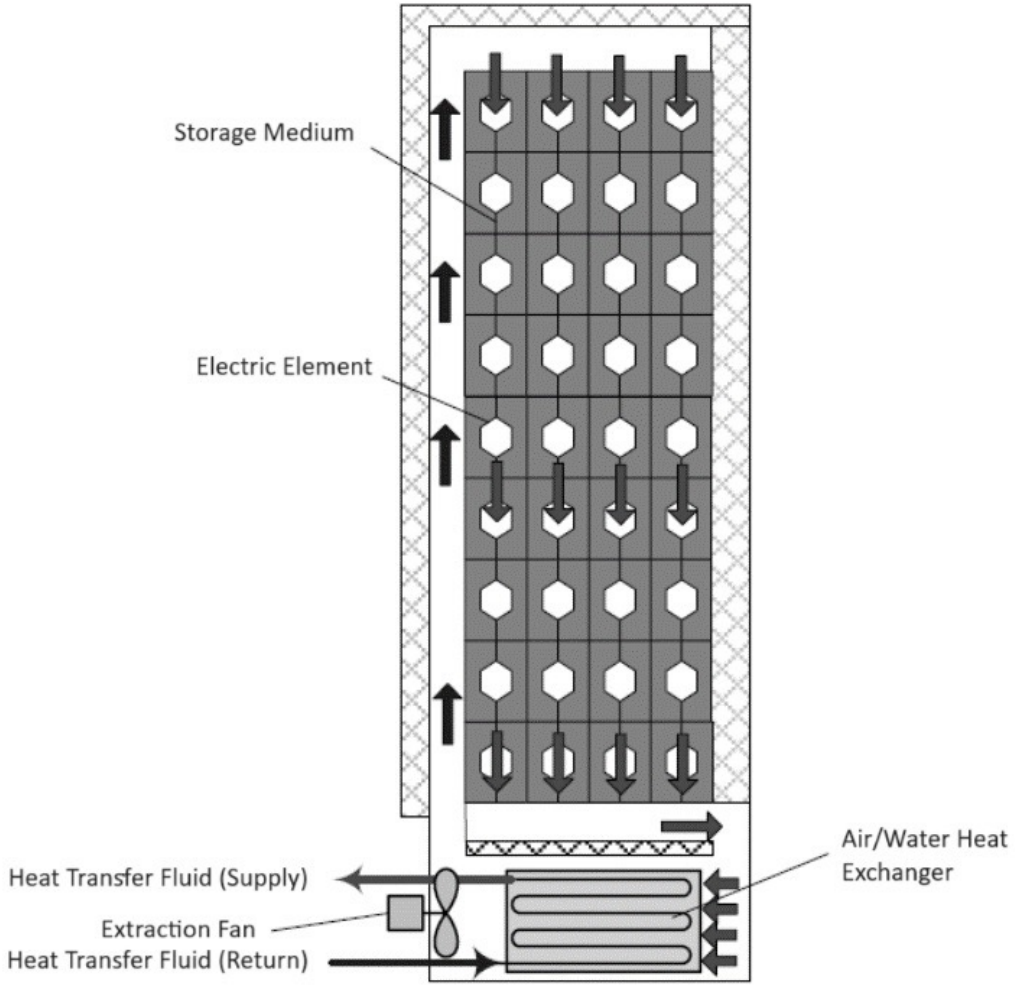
Climate Zone 6A (cold and humid), Montreal



HVAC System


Return Fan
Fan
AHU
Hydronic Separator
Fan Speed Control
VAV
Damper Motor
Air Flow Control
Radiator
Zone A
Boiler
bricks
Electric Thermal Storage
Supply Water
Return Water
Supply Air
Return Air

Electric thermal storage (ETS)



- ETS systems store heat in a mass of high-density ceramic bricks with a high storage capacity (15 times that of water at 100°C). Electric elements can heat the bricks up to 900°C during off-peak hours.
- The system is BACnet-compatible, allowing remote control via the building automation network.
- Advantages

✓ Lower billing demand and stable, predictable heating costs.

✓ Easy interfacing with existing heating systems.

✓ Compact design with low maintenance costs.

✓ Short payback period (generally less than five years).

Modeling

- **Modeling Approach**

Spawn: Adopted for the modeling of this case study.

- **Building Plan**

EnergyPlus IDF File Based on the DOE archetype, with modifications for area and version compatibility.

- **HVAC System Design**

Modelica Buildings Library utilized for modeling the HVAC system in the Spawn model.

Thanks!

Do you have any questions?

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