



Business Case for
Natural Refrigerants

June 12-14, 2018 – Long Beach



CO2 Heat Pump Versatility Applied to Large Buildings

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COP21 - Paris Agreement

Canada's new goal for limiting global warming

December 2015 - Countries around the world committed to accelerate and intensify the actions and investments needed for a sustainable low-carbon future, to limit global average temperature rise to well below 2 °C above pre-industrial levels, and to pursue efforts to limit the increase to 1.5 °C. (2.7 °F)



Canada Ratified the Agreement on March 11, 2017

GHG Reduction – New Innovation Driver

30% GHG Emission Reductions by 2030 below 2005 GHG emission levels

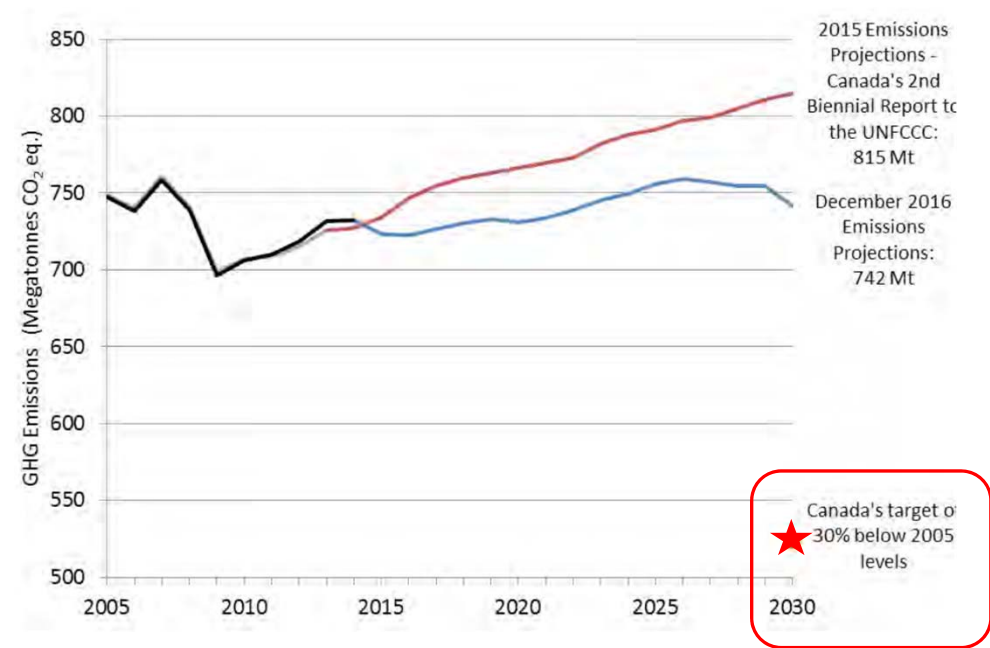
COP21: Canada's new goal for limiting global warming 'perhaps a dream'

Target ambitious but not impossible, scientists say

By Aleksandra Sagan, CBC News | Posted: Dec 10, 2015 11:16 AM ET | Last Updated: Dec 11, 2015 3:19 PM ET



Canada is currently committed to reducing emissions 30 per cent below 2005 levels by 2030, which is 'nowhere near strong enough' to stay below the country's new stated target, an environmental scientist says. (CBC)





GHG Reduction Driver also in USA

[Bloomberg the Company & Its Products](#) | [Bloomberg Anywhere Remote Login](#) | [Bloomberg Terminal Demo Request](#)

Bloomberg

Climate-Changed

New York City to Require Big Buildings to Cut Carbon Emissions

By [Chris Martin](#)

September 14, 2017, 2:40 PM EDT

NYC is leading by example with a goal to reduce emissions by **35% by 2025**
The Citywide Goal is a **80% GHG reduction by 2050**

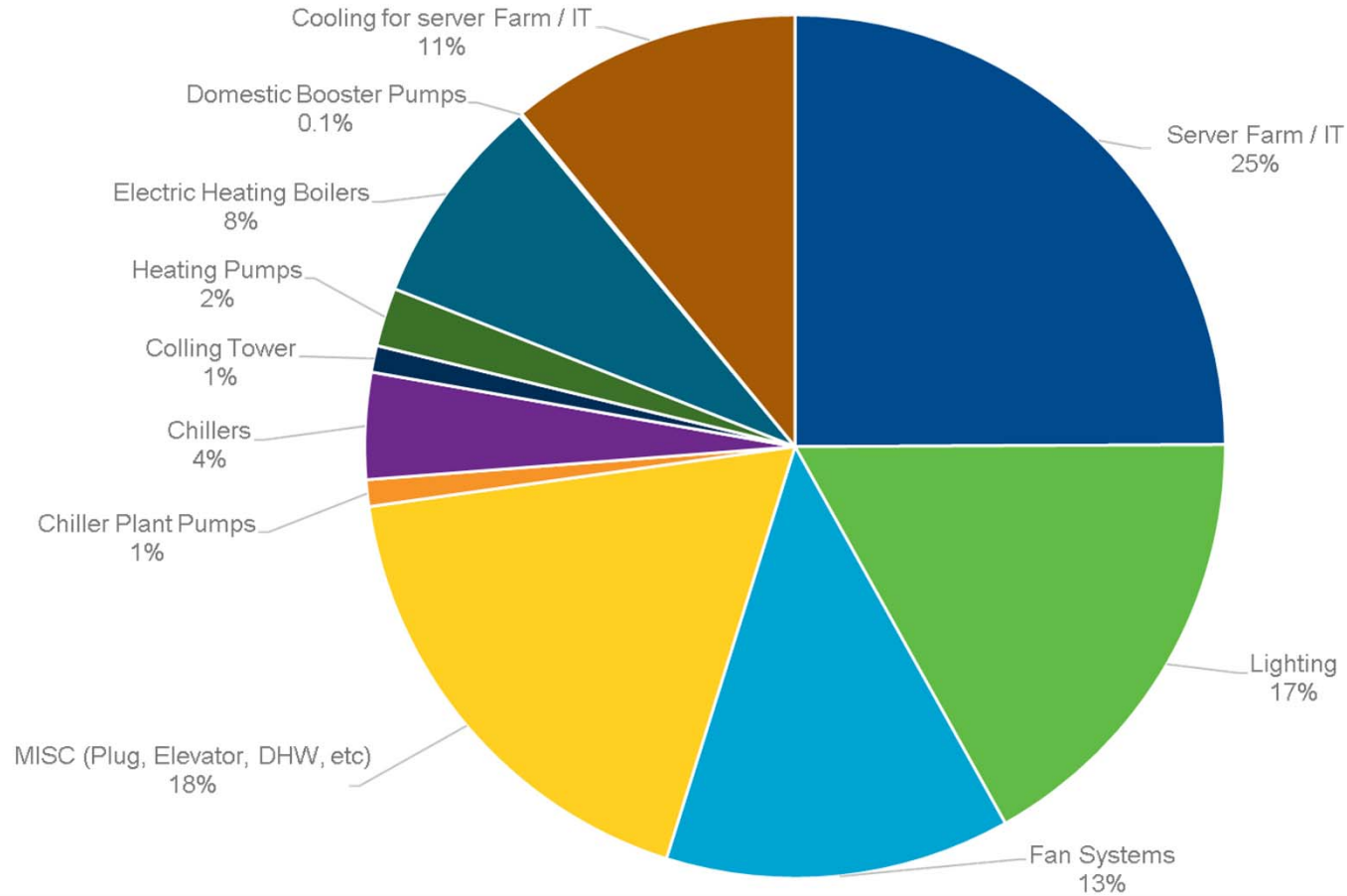
The mandate, which will **target 14,500 buildings above 25,000 square feet...**

The city will also authorize a **program to finance upgrades through low-interest property tax assessments**, a format that may reduce borrowing costs, according to the statement. For example, a 54-unit apartment building in the Bronx that recently replaced its boiler and invested in efficiency improvements could have saved \$8,000 a year in debt payments under that program, called Property Assessed Clean Energy. **PACE could finance \$100 million a year in upgrades in the city.**

From municipal offices to private businesses, hospitals, and apartments—must drastically curb their carbon emissions. Those who don't comply will face hefty **penalties amounting to as much as \$2 million a year for a 1 million-square-foot building.**

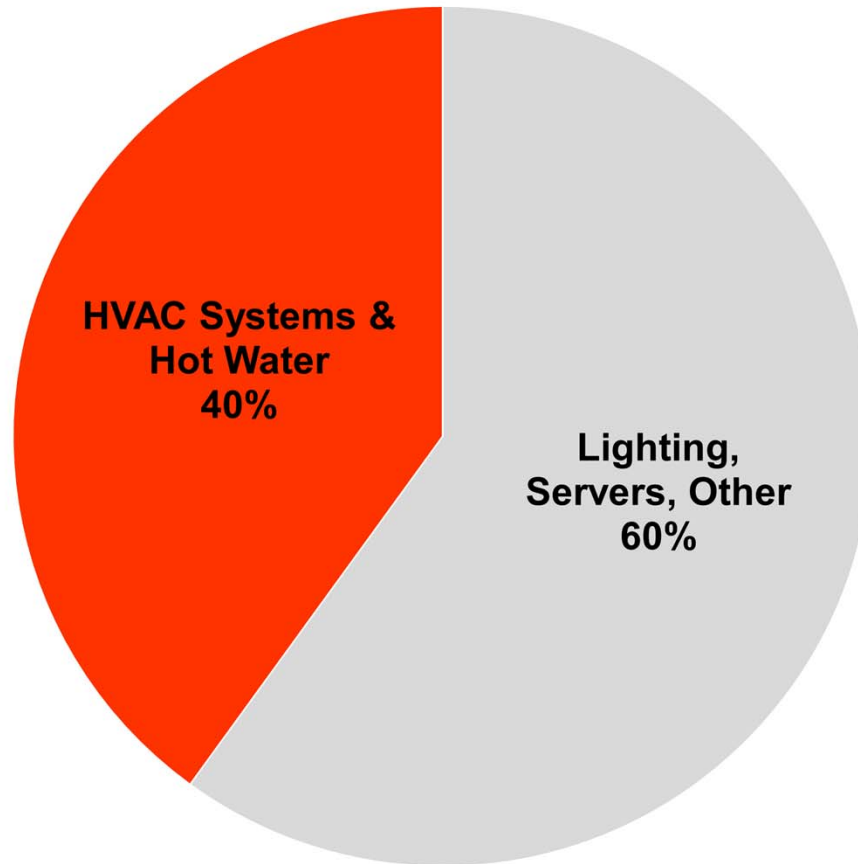


Energy Use Breakdown in a Large Commercial Building

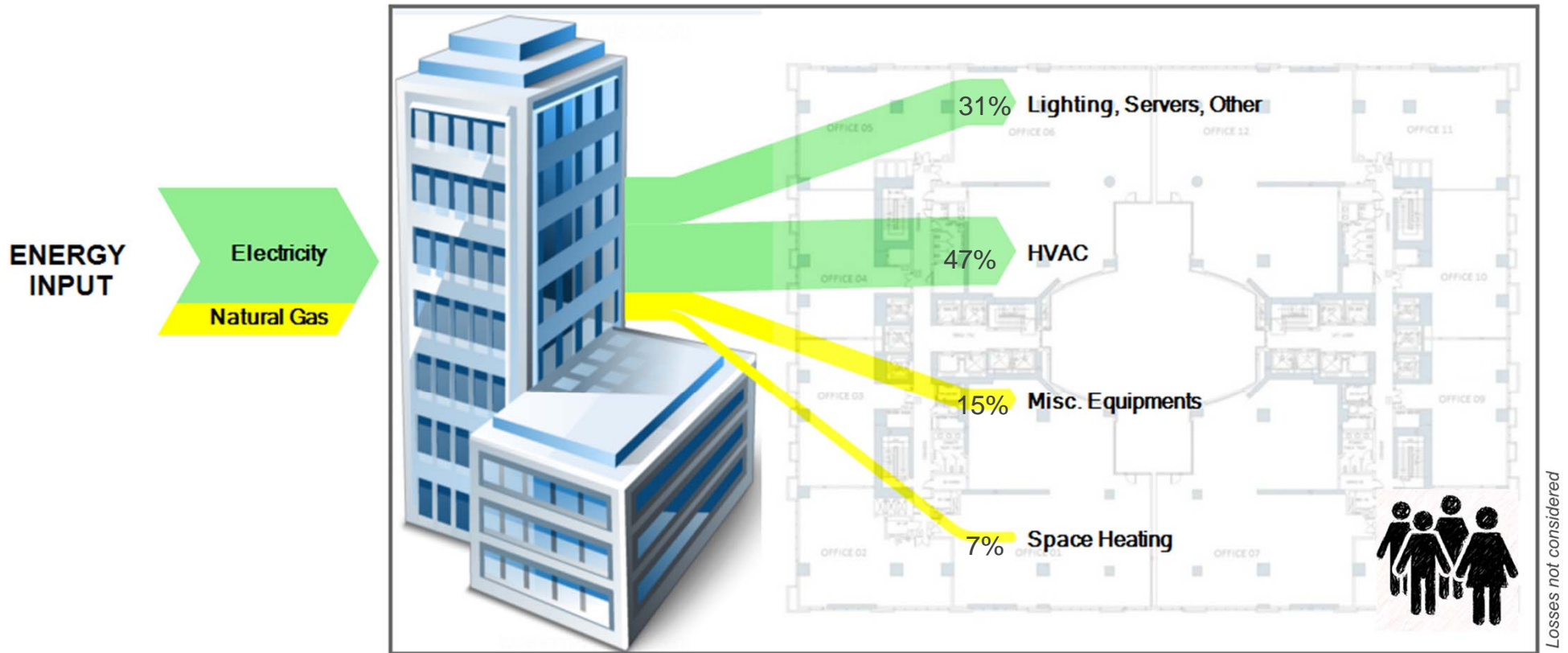




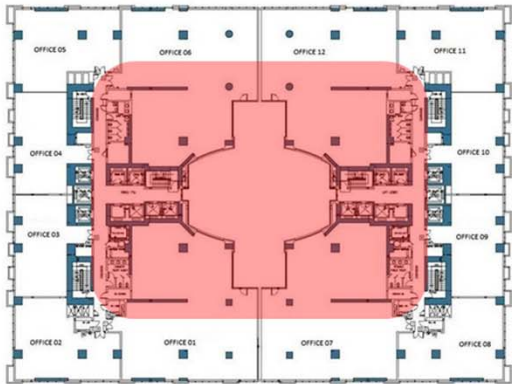
Energy Use Breakdown in a Large Commercial Building



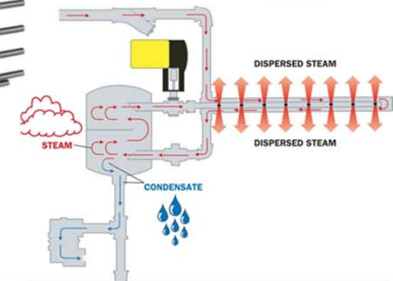
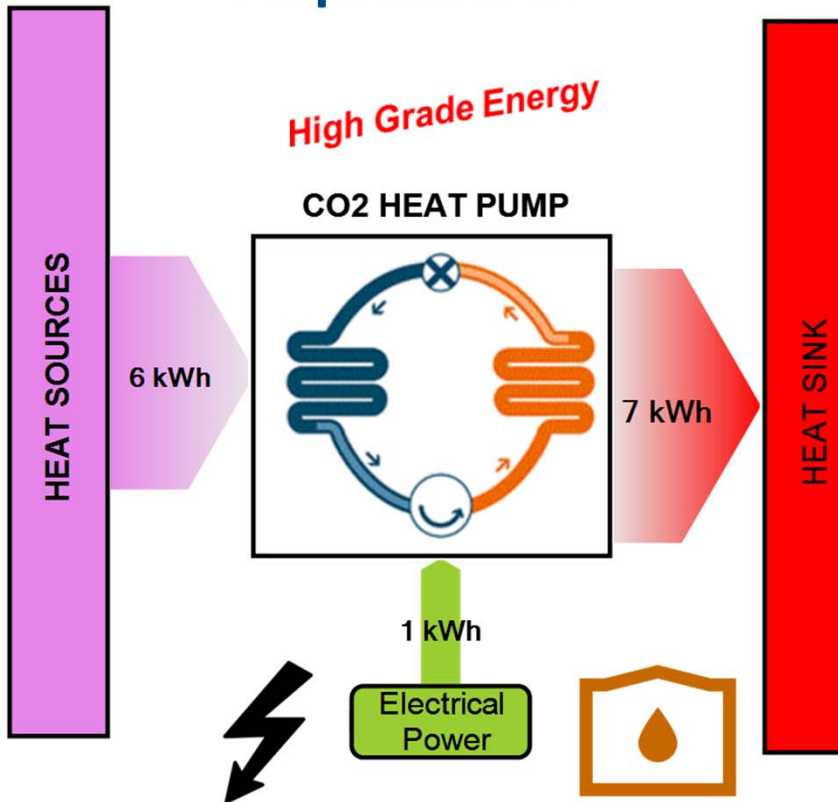
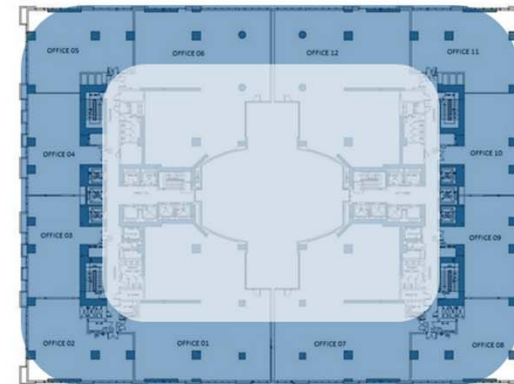
The Building is a Process



Heating • Cooling • Humidification • Dehumidification



Heat Upgrade Capabilities



Smart Energy



Typical Levels of Temperature Possible with a CO2 Heat Pump

Building's Applications



**Chilled
Water**
5-7°C
41-45°F



**Space
Heating**
25-60°C
77-140°F



**Domestic
Hot Water**
60°C
140°F

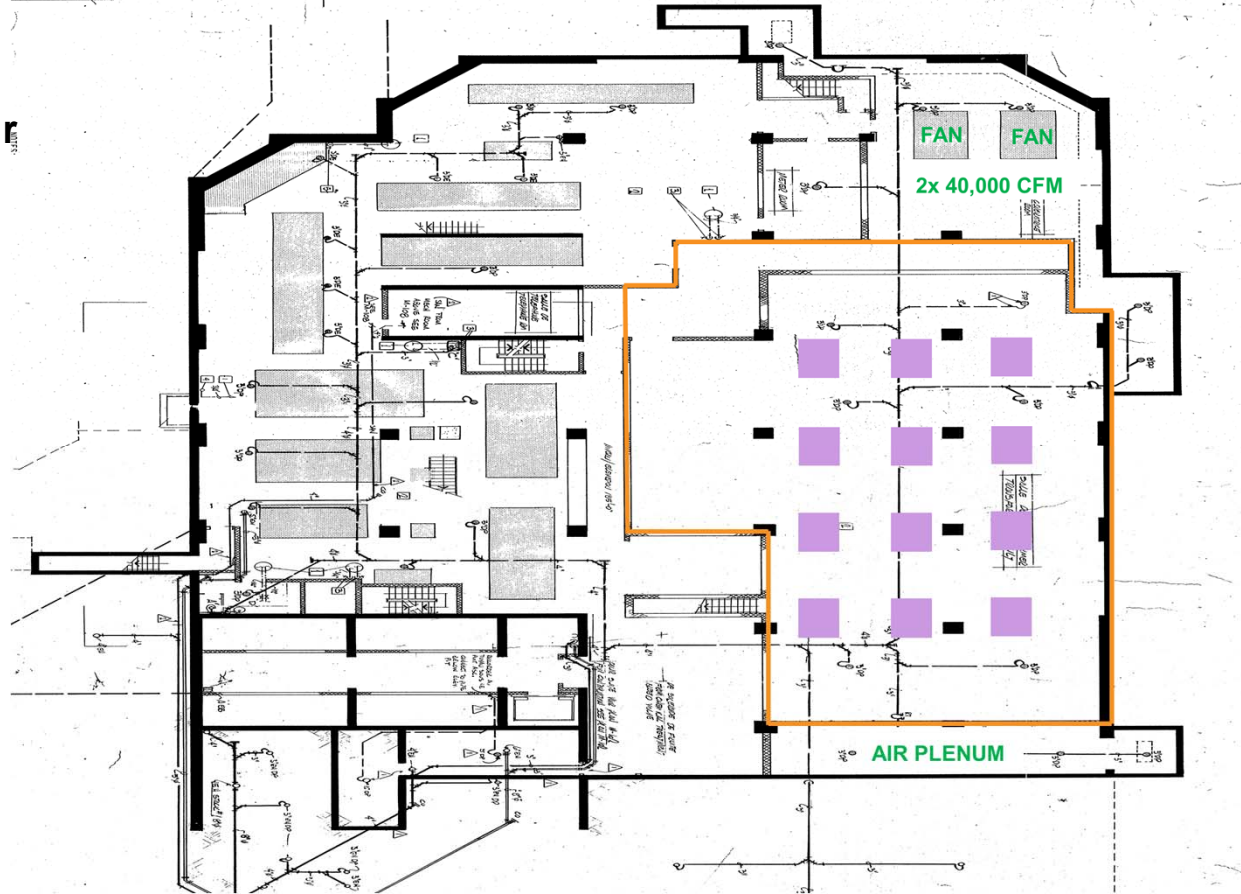


Steam
110-160°C
230-320°F
*Possible if connected
to a double stage cycle*



CO2 Heat Pump Project in a Transformer Room

**Current Design:
Cooling using the Outside Air
All Year Round**





CO2 Heat Pump Project in a Transformer Room

New Design:
Integration of a CO2 Heat Pump

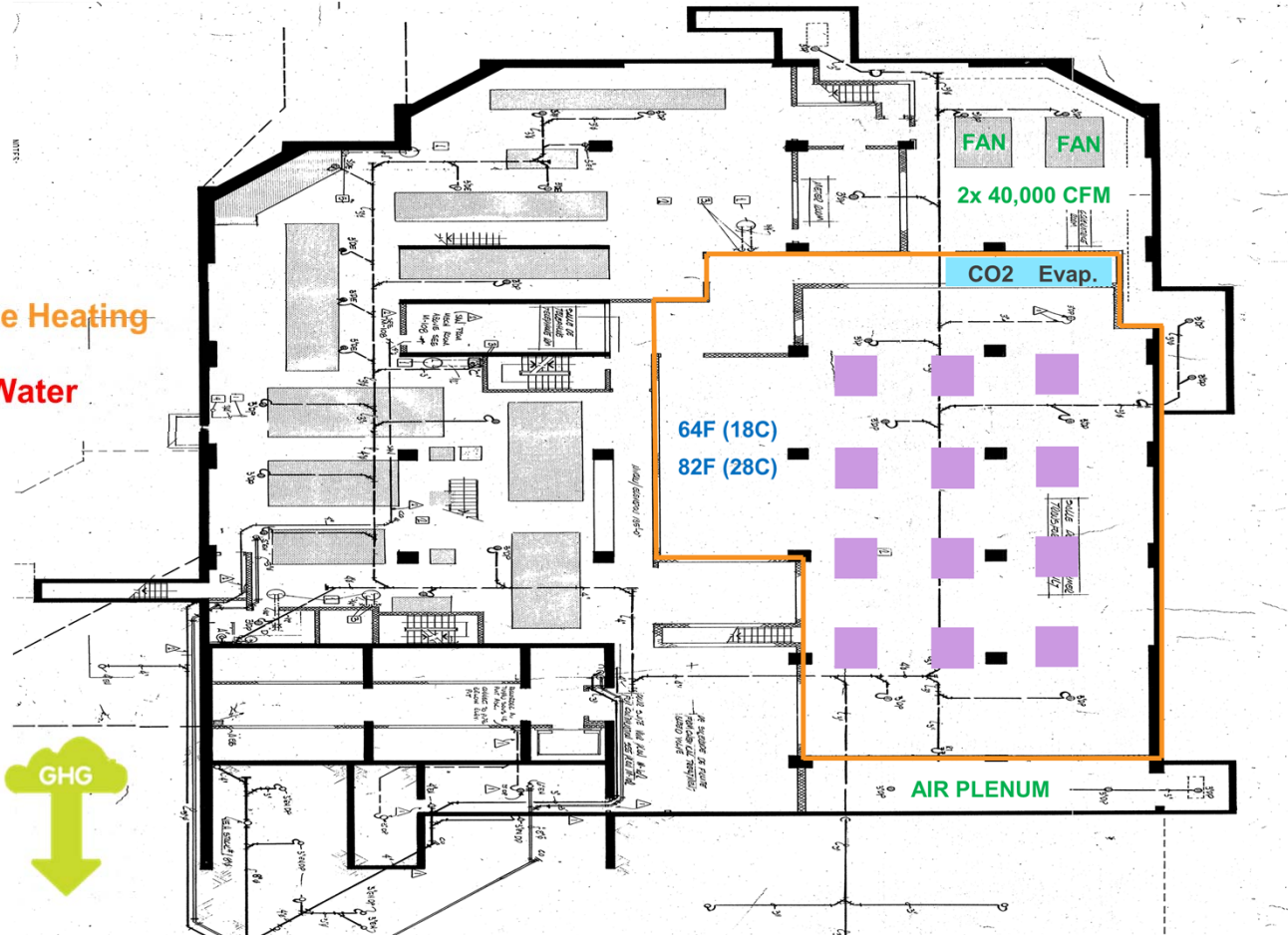
Heating Capacity	171 – 512 RT	0.6 - 1.8 MW
Cooling Capacity	28-85 RT	0.1 - 0.3 MW

- Space Heating
- Hot Water

COP between 5 & 6

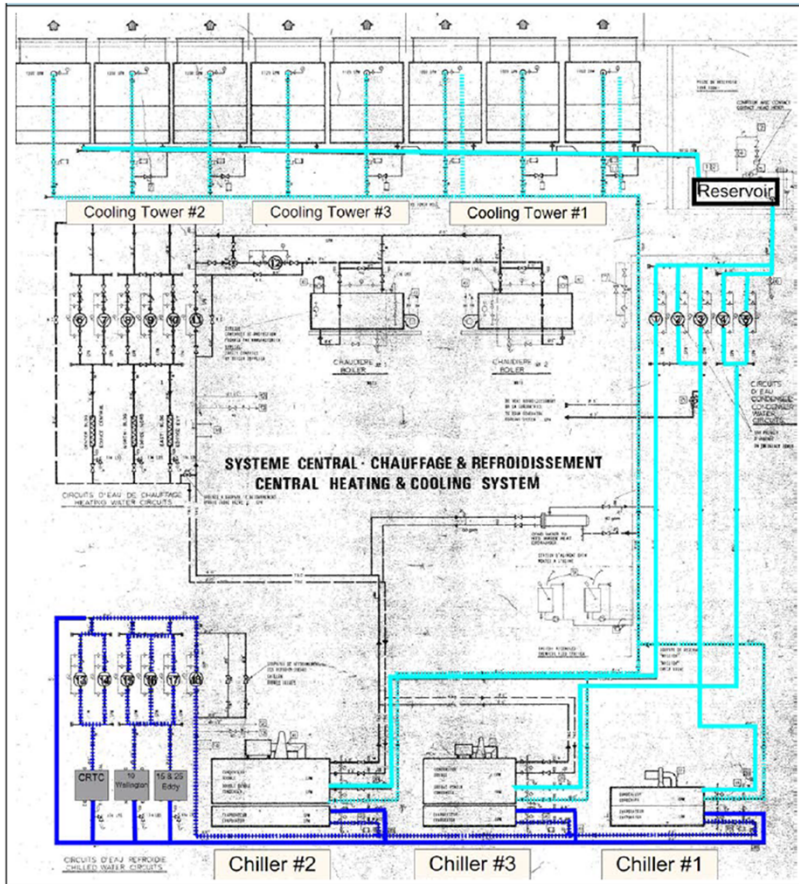
Significant GHG Reduction

vs Fossil Fuel and Natural Gas Boilers

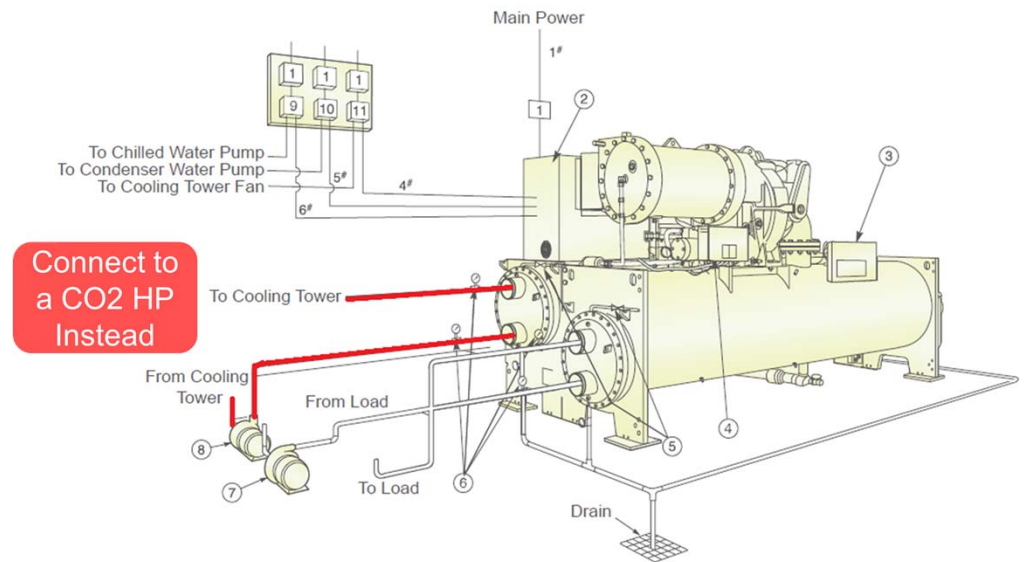


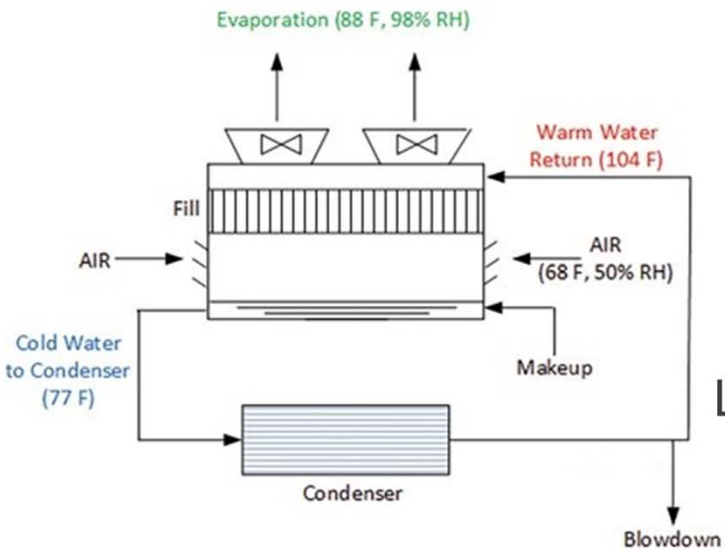


CO2 Heat Pump Integration in a Cooling Tower Loop



Condensing existing Chiller in Winter






**Legionella
 Risk**



**Significantly Reduce
 the Use of Cooling
 Towers**



**By Going DX and
 by Leveraging The
 Available Heat /
 Cold Sources in
 The Building**



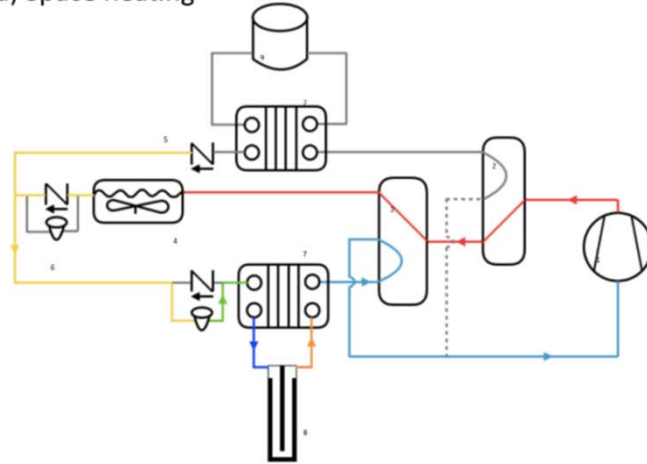
Combination Example with One Unit Rack

Source:

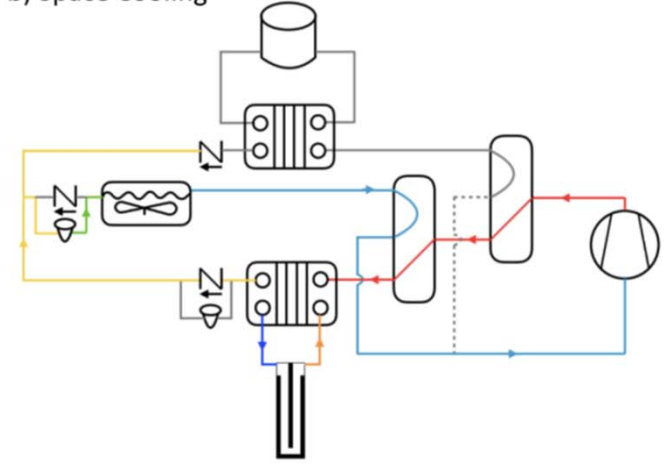
POLYTECHNIQUE MONTREAL



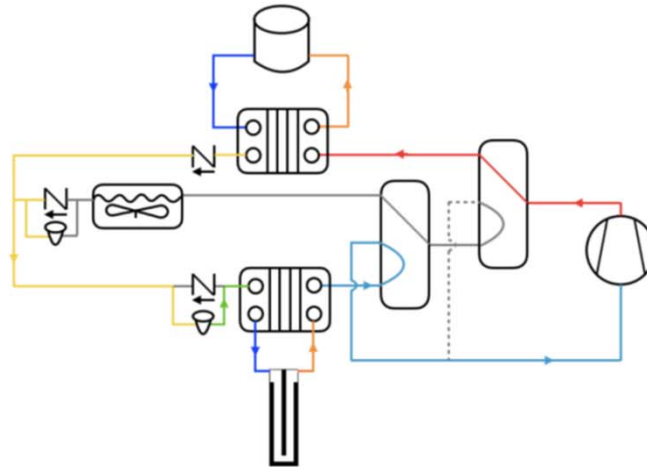
a) Space heating



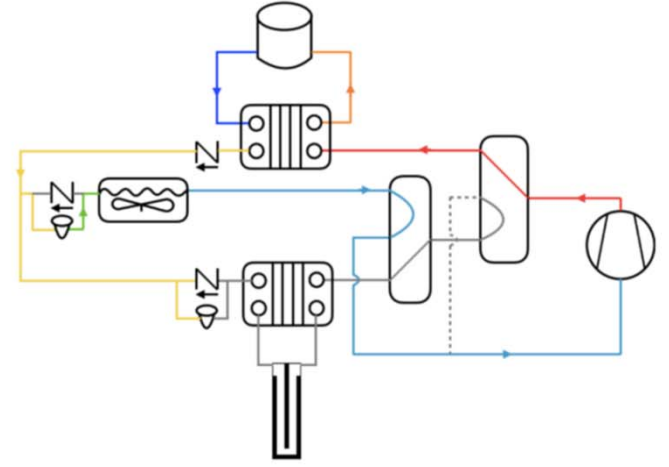
b) Space Cooling



c) Dedicated hot water

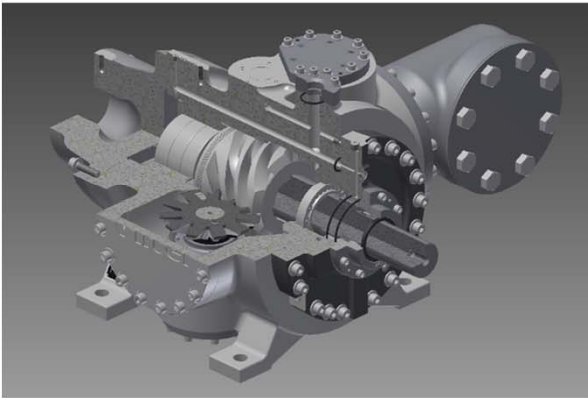


d) Simultaneous cooling and hot water





Worldwide First CO₂ Transcritical Single Screw Compressor HPLD – Under Performance Testing



Specifications

- Max Discharge Pressure: 1,600 PSIG
- 2,000 PSIG Being Developed for the 128 to 160 CFM
- 1,500 PSIG available for all the range
- Max Speed: 4,500 RPM
- Min Speed: 1,200 RPM (26%)
- Displacement: 128 to 243 CFM (7 Sizes)

Applications

- Transcritical CO₂
- Subcritical CO₂
- Heat Pumps
- Gas Compression
- District Heating

1MW HEAT PUMP CAPABILITY



ATMO
sphere

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Thank you very
much!

