SANDFORD FLEMING FORUM

Resilience of Commercial Property to Climate Change

BOMA Canada

RiskLogik

blackstone energy services

neelands Refrigeration Limited

Southern Harbour

crci | University of Toronto Faculty of Applied Science & Engineering

Introductions

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Refrigeration & Cooling Choices

A CO_2 Perspective

ENGINEERED FOR PERFORMANCE

How can one's choices – our choices - around refrigeration and cooling technology in commercial facilities, affect positive results for the sustainability of our planet, our business, our local and global communities, and planning for resilience?

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Decisions you make now with regards to refrigeration and cooling may not only improve the facility resilience, but also contribute to the stemming of global warming and extreme weather.

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Our goal in this brief overview twofold;

To raise your awareness and create curiosity about those facility refrigeration and cooling decisions that probably get made and how those decisions of today may play a role in sustainability and resilience.

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Elements Required For Making Informed Decisions Involving Emerging Technologies

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Knowledge

- Product awareness
- Product effectiveness
- Commercial feasibility

Culture

- Innovation?
- Entrepreneurial?
- What vs. Who?

- Supportive
- No credit in Team
- Engaged

Behavior

- Planning/ development
- Engineering
- Procurement

Process

Knowledge

- Product awareness
- Product effectiveness
- Commercial feasibility

So………… What About Carbon Dioxide

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History of CO_2

- Technology that originally emerged in the mid-19th century
- 1850 : First CO_2 refrigeration patent by Alexander Twining (England)
- 1890 : CO_2 is seen as the only “safe” refrigerant
- Golden age from 1920 to 1930 with system up to 350T, to be phased out in favor of synthetic refrigerants (R-12)

History of CO_2

In the latter part of the 20th century, scientists began to understand the relationship between synthetic refrigerant usage and the impact to the ozone layer and global warming.

With the signing of the Montreal Protocol, the world's developed economies focused on restrictions and a planned course of action towards elimination of the **Ozone Depletion** (ODP) CFC and HCFC synthetics

History of CO_2

- As a result, CO_2 resurfaced in the 1990s
- 1991 : "Transcritical" patent by Gustav Lorentzen (Norway)
- 2009 : First appearance of CO_2 systems in grocery stores in Americas
- 2010 : First CO_2/NH_3 cascade system for distribution centers in Canada (Carnot)
- 2010 : First Ice rink with (in slab) recirculated CO_2 system in North America

History of CO_2

- 2012 : First Ice rink with direct heat recovery CO_2 system in North America (Carnot)
- >2013: Transfer of technology to other refrigeration applications
- 2013 : First Data center to run a CO_2 cooling unit (Carnot AQUILON ™ unit)
- Reliable and proven systems
  - Presence in Europe for over 20 years
  - Presence in Canada and United States for ten years

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Basics of CO_2

- Toxicity is very low
- Non flammable
- ODP = 0
- GWP = 1 (407c-1600; 410A-1725; 134a-1430)
- High refrigeration volumetric capacity

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Basics of CO_2

- High convective heat transfer coefficient
- Low critical points
- Higher operating pressure
- Higher discharge temperatures

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Technologies Unique to CO_2

High Grade Heat Recovery

CO_2 refrigeration systems have generally higher working pressures than traditional synthetic, but this is safely engineered at reasonable costs.

A benefit of these higher pressures is that it produces heat.

This heat can then be easily captured to pre-heat your hot water requirements or for other building purposes such as dehumidification.

For example, a typical chiller design which required 100 TR can yield up to 2.2M btu's of heat recovery for hot water supply.

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New Patented Technologies

“Free cooling” Mode

- Outstanding free cooling capabilities
- Free cooling enabled to within 4-5 C of refrigeration/ cooling set point
- Typical data room can see free cooling enabled as high as 18 C
- Typical distribution centre along 41st parallel can see over 4,000 hours annually of free cooling
- All compressors stopped and no need for pumped refrigeration
- Fewer points of failure and very low power consumption per TR.

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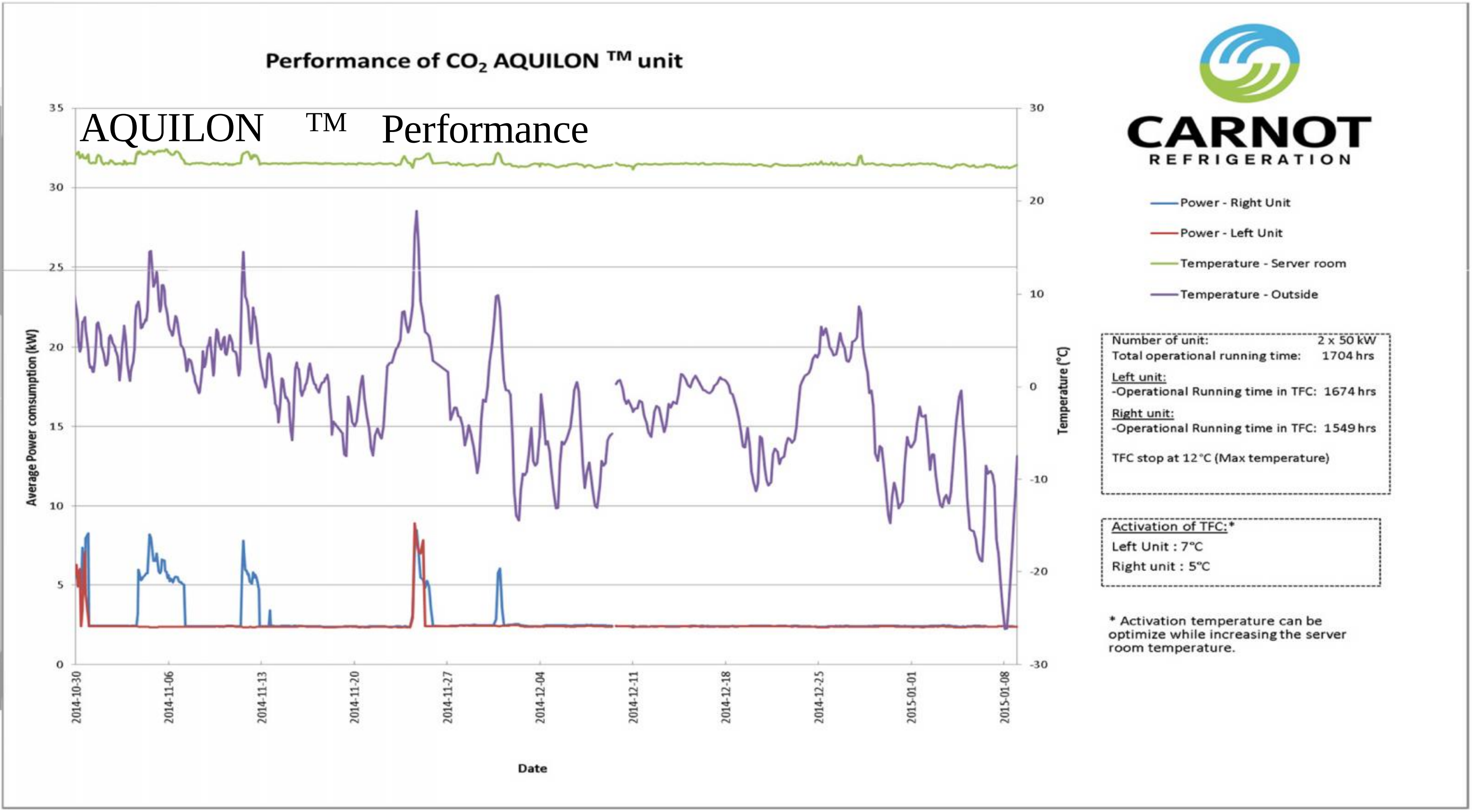
AQUILON TM Performance



Can These CO_2 Properties Assist Resilience?

Heat Reclaim

- Supply of essential services during gas supply disruption
- Heating
- Dehumidification
- Domestic hot water
- Sterilization/ wash down
- Food services
- Any other heating application

Free Cooling

- Possible supply of all air conditioning needs with minimal power requirement
- Fewer points of failure
- No moving parts
- Ability to re direct power to other services

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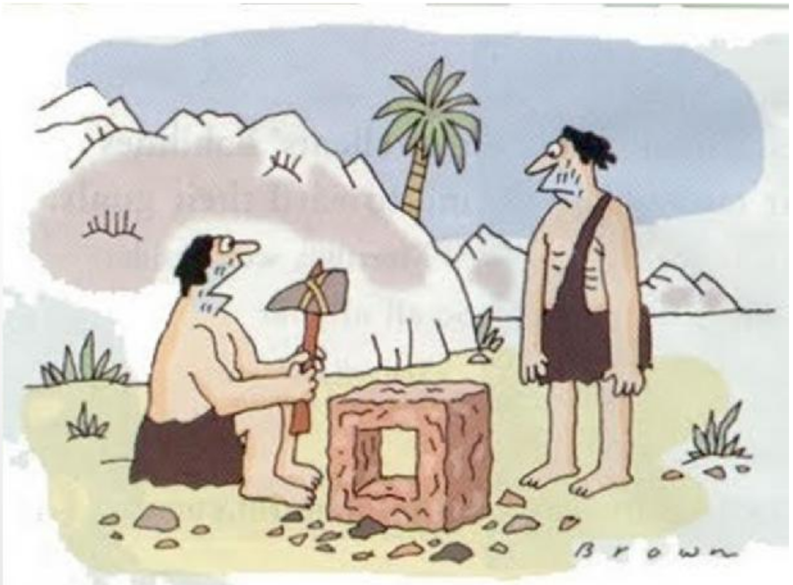
Can These CO_2 Properties Assist Resilience?

H,S & E

- Non corrosive
- Non flammable
- Site and emergency services far less impacted with CO2 – especially versus ammonia
- Leak of CO2 to atmosphere has no impact to planet or community
- No need for community evacuation plans

Demonstration of Versatility & Feasibility



"I call my invention 'The Wheel,' but so far I've been unable to attract any venture capital."

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Distribution Centers and Supermarkets

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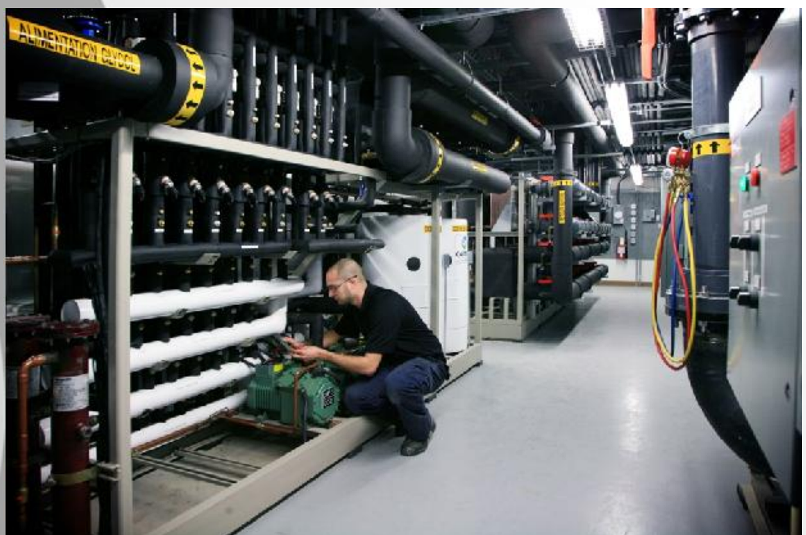
NH_3 / CO_2 Hybrid Refrigeration System

Supermarkets & Multi Zone Cooling



» Benefits

- Divides by 3 900 the GHG emissions compared to R22
- Refrigerates food and keeps its freshness for a long period of time which helps reducing product loss
- Recovers the heat generated by the compressors, which becomes a free energy able to warm up the store's potable water and ambient air

» Awards

- Best of the Best, GreenChill Awards, US Protection Environmental Agency
- Certification, EPA GreenChill platine
- "Cleantech Next10" 2012 Award, Corporate Knights

Carnot's solution

	QTY	kBtu /h
Compressors	12	1289

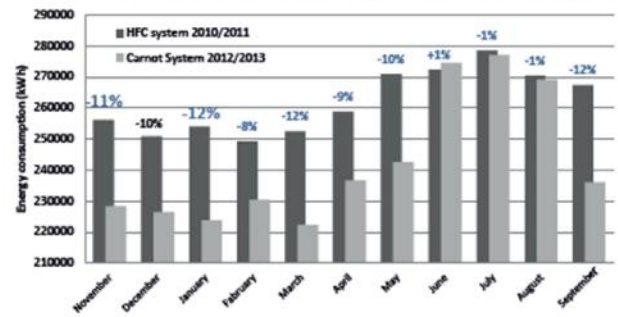
HEAT RECOVERY SYSTEM	
Total heat recovery	1 915 kBtu/h
Two stages sales area	540 kBtu/h
Vestibule and cash register	460 kBtu/h
Receiving Dock	265 kBtu/h
Right and left Warehouses	530 kBtu/h
Domestic water	120 kBtu/h

Carnot's coordination
In order to provide a continuous service to the customers, the start-up of the CO_2 refrigeration system has been spread over 16 phases.

"Excellent service, great staff attitude, professional"

André Perreault
Director

After the start-up of the CO2 refrigeration system, we noticed a 22% reduction in energy consumption of the refrigeration process. This equals to a reduction of 11% of the energy consumption of the entire building. It should also be noted that we brought improvements to the system in March 2013, and that these improvements have increased the efficiency of the system.



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Arenas

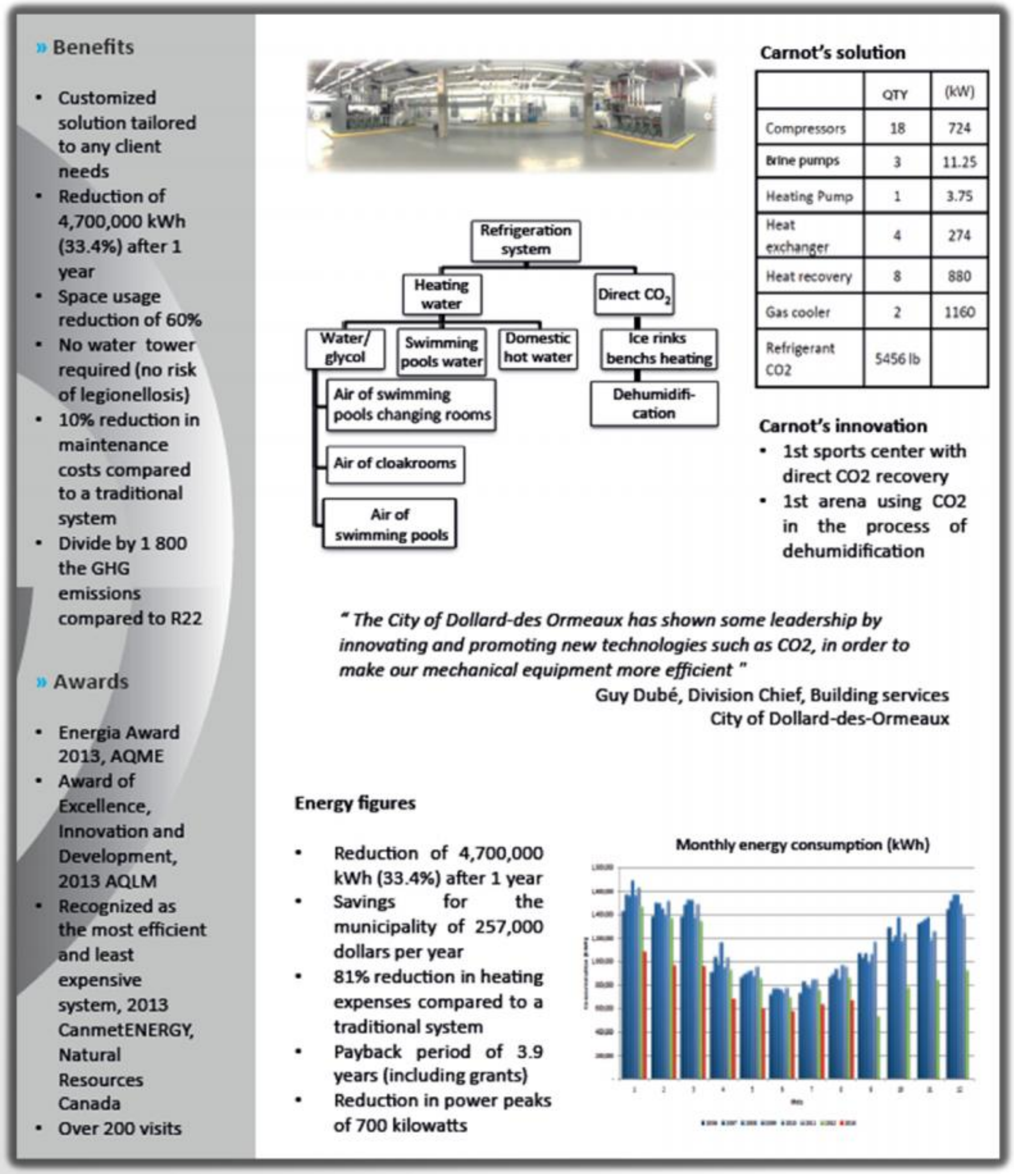
Municipal Multi Purpose Case Study

Original HCFC System

- ✗ 18 Compressors, 25hp
- ✗ 9 Air Cooled Condensers
- ✗ 4 Brine Pumps, 38 kW
- ✗ Heat Recovery, 50 kW

Retrofitted
Carnot CO2 System

- ✓ 4,700,000 kWh reduction
- ✓ Power Peak reduced by 700 Kw
- ✓ Heat Recovery of 880 kW
- ✓ 81% reduction in heating expense
- ✓ $257,000 / year energy reduction



» Benefits

- Customized solution tailored to any client needs
- Reduction of 4,700,000 kWh (33.4%) after 1 year
- Space usage reduction of 60%
- No water tower required (no risk of legionellosis)
- 10% reduction in maintenance costs compared to a traditional system
- Divide by 1 800 the GHG emissions compared to R22

» Awards

- Energia Award 2013, AQME
- Award of Excellence, Innovation and Development, 2013 AQLM
- Recognized as the most efficient and least expensive system, 2013 CanmetENERGY, Natural Resources Canada
- Over 200 visits

Refrigeration system
Heating water
Direct CO_2
Water/glycol
Swimming pools water
Domestic hot water
Ice rinks benchs heating
Air of swimming pools changing rooms
Dehumidification
Air of cloakrooms
Air of swimming pools

Carnot's solution

	QTY	(kW)
Compressors	18	724
Brine pumps	3	11.25
Heating Pump	1	3.75
Heat exchanger	4	274
Heat recovery	8	880
Gas cooler	2	1160
Refrigerant CO2	5456 lb	

Carnot's innovation

- 1st sports center with direct CO2 recovery
- 1st arena using CO2 in the process of dehumidification

" The City of Dollard-des Ormeaux has shown some leadership by innovating and promoting new technologies such as CO2, in order to make our mechanical equipment more efficient "

Guy Dubé, Division Chief, Building services
City of Dollard-des-Ormeaux

Energy figures

- Reduction of 4,700,000 kWh (33.4%) after 1 year
- Savings for the municipality of 257,000 dollars per year
- 81% reduction in heating expenses compared to a traditional system
- Payback period of 3.9 years (including grants)
- Reduction in power peaks of 700 kilowatts

Monthly energy consumption (kWh)

Cold Storage - Cranberry Facility

- Warehouse
  - Products Cranberry
  - Volume 544 310 kg (1 200 000 lbs)
  - Area 4 180 sq. m (45 000 sq. ft.)
  - Height 12 m (40 ft)
  - Loading dock 4 doors

- System
  - Refrigerant R744 only (CO_2)
  - Capacity 644 kW (183 TR)
  - Temperature - 18˚C (0˚F)
  - Refrigerant charge 1 500 kg (3 300 lbs)
  - Heat recovery Sub-floor
  - Defrost Hot gas

CO_2 Transcritical Refrigeration System

- Benefits
  - No HFCs
  - No NH_3
  - Non-toxic refrigerant
  - Reduced H&S costs and risks
  - No cooling tower : Eliminate water consumption and chemical treatment
  - Reduces piping and insulation sizes by 50%
  - Full heat recovery for building
  - Free cooling mode (thermosyphon)

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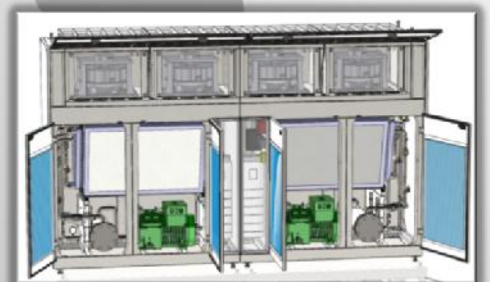
Data/ Communication/ Critical Cooling

Benoit Sicotte, Senior Manager, Corporate Responsibility, Bell :

"Bell is currently working with Carnot, a Pioneer in the development of CO2 refrigeration technologies on an innovative solution that have not yet been introduced in any data center in Canada and have the potential to reduce significantly Bell's environmental footprint."



From concept to exceeding performance criteria.

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Process

- Planning/ development
- Engineering
- Procurement

Integration of The Business Solution

ASSESSING CARBON DIOXIDE AS A SOLUTION

ROI Threshold:________Years	Level of Importance To You			
	Not at all	>>>>>>>>		Very
	1	2	3	4
Lowest Initial Cost				
ROI Threshold				
Technology Peace of mind				
Support and Ongoing Service				
Engineering Issues				
Health & Safety Risk Reduction				
Elimination of HFC's/ HCFC				
Public Perception/Marketing				

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CO_2

provides owners with a solution that is

Flexible

Reliable

Cost Effective

Safe …..and

Environmentally

Responsible!

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Thank you