Variable Refrigerant Flow Heat Pump Technology

LEED Platinum A GRANDER VIEW Office Building
Heat Pump Technology
– Hydronic vs Variable Refrigerant Flow (VRF)

- Both provide heating and cooling
- Both use compressors – self contained or central
- Both are low carbon
- Both rely on an external energy source (water, air)
- Both use electricity to operate

**Hydronic**
- Water-source only (W/W, W/A)
- Each HP contains a compressor, usually local to serviced space
- Each local HP requires supply and return water pipes
- Water carries heat directly to and from fan coils
- Produces water temperatures up to 120°F, not high enough for DHW

**VRF**
- Water-source or Air-source (W/A, W/W, A/A, A/W)
- Each VRF HP (condenser) contains compressor, remote to serviced space
- Each remote HP requires supply and return water pipes or air supply
- Water or air exchanges heat to refrigerant, which carries heat to fan coils
- Produces water temperatures to 170°F, suitable for DHW
Thermal Energy Mediums

- **AIR**
  - 18" round duct
  - 0.47 Btu/hr per lb

- **WATER**
  - 1.25" water lines (2)
  - 1.5" with 30% glycol
  - 8.87 Btu/hr per lb

- **REFRIGERANT**
  - 3/8" and 5/8" 410A refrigerant lines (2)
  - 85.30 Btu/hr per lb

Refrigerant uses 80% less energy to move heat, than air or water!
Hydronic Heat Pumps – stacked

- Multiple local compressors
- Multiple hydronic risers
Variable Refrigerant Flow (VRF) – floor by floor

- Central remote compressors
- One central riser
Attributes—of Variable Refrigerant Flow

- Air and Water Source
- Use of inverter driven compressor(s)
- Multiple indoor units with single outdoor unit
- Variable Refrigerant Flow (410A)
- Heat Pump & Heat Recovery
- Direct Expansion
Water Side
Heat recovery
Continuously rebalances load among condensers, before drawing from Boiler/Geo system.

2: BC Controller Side
Heat Recovery
Continuously rebalances heat among up to 16 zones, before drawing from condensers.

Water-Source VRF Double Heat Recovery

- Ultimate zone control
- Simultaneous Heating and cooling from one condenser
Refrigerant – R410A

- A Hydrofluorocarbon (HFC) – Zero ozone depletion (50:50 blend of R22 and R407c)
- Phase change from liquid to gas and back is at almost constant temperature – almost no energy required, occurs with pressure change
- High energy effect per volume (6725 KJ/m³)
- High density and high efficiency means smaller equipment and piping components
- Low volatility means it is the ONLY refrigerant today, that meets high Canadian Standards for combustibility in buildings.
- Essential quality installation, licensed refrigerant installer, specified thickness copper piping, few carefully brazed joints, special tools and gauges.
- High Global Warming Potential, mitigated by containment and reuse, no discharge or disposal.
- Higher equipment operating efficiency reduces refrigerant required; new refrigerants being developed by the industry.
Building: Three-story, LEED Platinum 22,000 ft² Office Building
Location: Kitchener, Ontario, Canada
Design Data: Winter/Summer –18°C/+35°C
Completed: 2009
PROJECT GOALS

- Be the first “triple LEED Platinum” building (NC, CI and EBOM)
- Create the most energy-efficient office in Canada
- Demonstrate that high-performance green buildings are possible at minimal extra cost using available technology
- Provide an attractive, productive and healthy workplace
DESIGN

- 22,000 ft²
- Three Storeys
- 90 Employees
Building Structure

- Narrow footprint building
- Each occupant has access to natural light
- Precast concrete slabs span wall to wall
- No interior columns
• Walls: ICF (R25)
• WWR: 40%
• Windows: Triple-Glazed, Low-e, Fibreglass
• Curtain-wall: 50 mm thermally broken aluminium
• Roof: R24
A GRANDER VIEW

Innovative Technologies and Strategies

- Automated exterior shading controls solar heat gain
- Operable windows
- Passive ventilation
- Photovoltaic system
Innovative Technologies and Strategies

- Rainwater collection
- Heat Recovery by using Heat Pump to cool server rooms and preheat
A GRANDER VIEW

Innovative Technologies and Strategies

- Air-source VRF Heat Pump system for superior thermal comfort and higher efficiency
A Grander View

Innovative Technologies and Strategies

- Individual zone control
- Variable Refrigerant Flow Heat Pump piping layout
Innovative Technologies and Strategies

- Ventilation Earth Tube
- Preheats Inlet Air / Outside Air
- Delivered to Fixed Plate HX
Outcome:

- Comfort for the occupants
- Smaller footprint
- Minimum maintenance needed
- Inherent system redundancy lever
- Superior part-load performance; because systems are operating at part load over 90% of the time
- Low sound levels
- Energy savings of 30% to 40% over traditional systems have been confirmed in numerous studies
- Plug-and-play commissioning and easy start-ups
- System intelligence
- Factory packaged controls including zone and central controllers
- Integration with BMS or remote diagnostic capabilities
First Year Energy Consumption

Field measurements indicate annual energy usage = 61.6 kWh/m²/year

HVAC System = 26–28 kWh/m²/yr
Energy Consumption Monitored Over 10 Years

A Grander View - Electricity Consumption

![Bar chart showing monthly electricity consumption over 10 years]
Energy Consumption Monitored Over 10 Years

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Ten Year Energy Consumption Comparison

Energy Consumption Comparison of A Grander View and Typical Office Building in Canada

- Whole Building Energy Consumption:
  - A Grander View: 81.9
  - Typical Office Building in Canada: 333

- Only HVAC System Energy Consumption:
  - A Grander View: 32.76
  - Typical Office Building in Canada: 133.2
Thank you