Hybrid Heat Pump System
Energy Efficient Comfort Solutions

CGC
HYBRID HEAT PUMP SYSTEM

Energy in Motion
The CGC Group Hybrid Heat Pump System is a novel combination of two traditional commercial HVAC building technologies. The system combines conventional water cooled air conditioning and hydronic space heating, all in one package. A CGC Hybrid unit operates as a fan coil in heating and a water cooled DX unit in cooling. The compressors do not operate in the heating mode. They can cool or heat any space at any time of the year. Instead of a refrigerant reversing valve for heating, the CGC Hybrid unit diverts the loop fluid to a hydronic heating coil located inside the unit. This loop fluid varies in temperature depending on outdoor ambient conditions. As the ambient temperature gets colder, the fluid temperature is increased.
The CGC Group Hybrid Heat Pump System conserves heat within the fluid loop instead of rejecting it to the atmosphere through a fluid cooler. This FreeHeat™ can then be used for various building heating requirements. Even with elevated fluid temperatures (maximum 125º F), the CGC Hybrid Heat Pumps are still able to perform mechanical cooling while maintaining high EER’s (Energy Efficiency Ratio).

An example of how the CGC Hybrid design can take advantage of FreeHeat™ is for treating the ventilation air. The cost to treat make up air constitutes a significant portion of the building’s total annual energy budget. Many buildings operate gas fired Make Up Air units while simultaneously rejecting condenser heat to a fluid cooler. The energy consumed by the fluid cooler can be significant. With the CGC Hybrid system, FreeHeat™ is used to treat the fresh air instead of wasting the heat to a fluid cooler. This eliminates the consumption of a fuel source to heat the fresh air during shoulder seasons.

FreeHeat™ is defined as... the process of reclaiming the heat generated within a building to directly satisfy the heating needs of the building, without additional energy input.
The fundamental driving force behind the development of the CGC Hybrid Heat Pump System was to maximize the benefits of the traditional Water Source Heat Pump (WSHP) system while eliminating the disadvantages.

- A major improvement with the CGC design is to not operate compressors to extract heat from the fluid loop.
- Another is to minimize fluid cooler operation by conserving the heat within the fluid loop. This heat is then available for building heating requirements. This eliminates the wasteful rejection of useful energy.
- Turning compressors off delivers whisper quiet operation in the heating mode.
- Isolate and dampen all mechanical components for quiet operation in all modes.
- Design units that are ultra efficient (EER’s of 15+).

Traditional System Design Facts

Traditional reversing Water Source Heat Pumps (WSHP).

- 25% to 30% of the energy required for heating is from the operation of electrically operated compressors.
- The cost for this electrically generated heat can be 40% to 60% of the heating energy costs depending on the local cost of electricity.
- Fluid coolers waste heat.
- Fluid coolers consume a significant amount of electrical energy.
- Compressor noise is more objectional in the heating mode.

CGC Group Hybrid Heat Pump System

- Allows the choice of fuel source for boiler operation (electricity, natural gas, or other).
- Since the compressors do not operate in heating, electrical consumption is significantly diminished.
- Naturally conserves energy by not rejecting it to fluid coolers.
- Naturally recovers energy and uses it as FreeHeat™ for building heating.
- Pumping energy costs are reduced by up to 30% due to lower flow rates.
- Very quiet sound levels in ALL modes of operation and especially in the heating mode with no compressor operation.
- Very efficient design due to the elimination of the reversing valve, unidirectional refrigerant flow, and high performance condenser.
Benefits of the CGC Hybrid Heat Pump System

Energy
- NO electric heating. Compressors do not operate in heating.
- Ultra high Energy Efficiency Ratio, EER’s 15% to 20% higher.
- Heat recovery & conservation are inherent to the Hybrid design utilizing FreeHeat™.
- Lower flow rates reduces pumping energy costs.
- Winter peak demand savings.

Sound Levels
- No compressor operation in the heating mode results in fan-coil sound levels.
- Dry wall mounted directly on casing reduces sound transmission.
- Inherent quiet design with a separate insulated compressor section and tuned sound trombones.
- Only the quietest rotary and scroll compressors are used.
- CGC commonly gets awarded jobs based on sound comparison.

Maintenance
- No compressor operation in heating and reduced cycling extends compressor life.
- Microprocessor control with LED diagnostic and safeties to protect the refrigeration circuit.
- 100% self contained chassis allows for quick replacement.

Installation Savings
- Lower flow rates results in smaller pipes.
- Can eliminate separate high temperature water loop.
- Risers and cabinets installation for Vertical Stack units can be done by one person.
- Smaller pumps.
- Smaller fluid cooler.
- Lower connected electrical load can result in smaller building electrical system.

Heating Comfort
- Better heating gradient with fan-coil load matching as opposed to full compressor operation.
- Low fan speed control algorithm reduces sound and energy.
- Heating capacities increase as ambient temperature decreases.

Retrofit Friendly
- Designed for retrofit applications.
- Risers shipped loose simplifies installation.
- Some Horizontal & Vertical models have 100% completely removable chassis (including fans & controls).
- The KlassKeeper and Teachers PET (geothermal) are designed for retro-fitting existing schools.
CGC Group Product Offering

Vertical Units

Vertical Stack

InnKeeper (IK)*
HomeKeeper (HK)*

- 100% Completely removable chassis.
- Sheet metal cabinets available for immediate shipment.
- Very low sound levels.
- Multiple supply and return air knock outs (left, right, rear).
- Small footprint increases floor space.
- Drywall mounts directly on cabinet.

| **InnKeeper** | ¾ - 1½ tons | 21”W x 14”D x 88”H |
| **HomeKeeper** | 1¼ - 3½ tons | 21”W x 20”D x 88”H |

*Width of 21 inches includes risers.

SpaceKeeper Vertical (SKV)*

- Small footprint increase mechanical room space.
- EC motors available.

Small SpaceKeeper Vertical (SKV)*

| SKV 008-018 | ¾ - 1½ tons | 17”W x 17”L x 48”H |
| SKV 020-036 | 1¼ - 3 tons | 20”W x 20”L x 57”H |
| SKV 042-060 | 3½ -5 tons | 24”W x 24”L x 59”H |

Large SpaceKeeper Vertical (SKV)*

| SKV 070-100 | 6 - 8 tons | 32”W x 32”L x 72”H |
| SKV 120-150 | 5¼ - 12½ tons | 32”W x 44”L x 72”H |
| SKV 180-240 | 15 - 20 tons | 32”W x 70”L x 72”H |
| SKV 280-320 | 23 - 26½ tons | 32”W x 82”L x 72”H |

*All equipment available in R410A.
Horizontal Units

SpaceKeeper Horizontal (SKH)*

- EC motors available.

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<thead>
<tr>
<th>Model</th>
<th>Tons</th>
<th>Dimensions</th>
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</thead>
<tbody>
<tr>
<td>SKH 008-018</td>
<td>¾ - 1½   tons</td>
<td>15”H x 22”W x 29”L</td>
</tr>
<tr>
<td>SKH 020-036</td>
<td>1¼ - 3   tons</td>
<td>18”H x 22”W x 38”L</td>
</tr>
<tr>
<td>SKH 042-060</td>
<td>3½ - 5   tons</td>
<td>20”H x 32”W x 46”L</td>
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SlimKeeper (SLK)*

- Only 11” high for shallow ceiling heights.
- Positive pressure condensate drainage (no traps required).

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<thead>
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<th>Model</th>
<th>Tons</th>
<th>Dimensions</th>
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</thead>
<tbody>
<tr>
<td>SlimKeeper</td>
<td>¾ - 1¼   tons</td>
<td>11”W x 30”W x 24”L</td>
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</table>
Specific Hybrid Applications

Geothermal System Advantages

• Heating the building with excess heat (FREEHEAT™) during balanced operation minimizes the amount of heat rejected to the earth loop. This results in less stress on the earth’s thermal mass and can provide 38%+ reduction in heating energy requirements.
• Air to Water Heat Pump units are sized for standard operation, not oversized for geothermal operation.
• Pipe insulation is not required on heat pump loop.
• Recharging of the earth’s energy mass can take place during off peak hours.

SideWinder - REMOVABLE Horizontal Chassis

• Ideal for hotels and assisted living.
• Both new installations and retrofits.
• Installed in unused space above closet, freeing up valuable floor space.
• Removable chassis allows quick and easy maintenance.
• Mounting assembly can be installed before chassis, ensuring short system lead time.
• Positive pressure condensate drainage (no traps required).
• ¾ - 1¼ tons.
• 15”H x 20”W x 38”L.
KlassKeeper - Classroom Heat Recovery Unit Ventilator

• Provides all of the fresh air requirements for classrooms.
• Very low sound levels.
• Aluminum plate air-to-air heat exchanger.
• 410A refrigerant.
• EC Motor (Standard).
• Ducted or free discharge.
• Optional UV Sanitizer.
• Up to 500 CFM outside air.
• Up to 450 CFM exhaust air.

KKV 030 to 060
2½ - 5 tons, 800 to 1600 CFM
24”W x 22”D x 60”H
VariZone - Commercial Zoning System

One unit can provide simultaneous Heating and Cooling for different zones by using heat of compression for Heat Recovery.

- Zone 1 calls for cooling. LAT=55º F.
- Zone 2 calls for heating, using FreeHeat™. LAT=80º F.
- Zone 3 calls for heating, using FreeHeat™. LAT=80º F.
- An economic, energy efficient and simple solution for zoning and sub-zoning spaces.
- Zones from 100 ft² to 1,500 ft².
- Ideal for commercial offices or anywhere zone control is required.
- Ease of maintenance in mechanical rooms.
- Relegation of mechanical noise to mechanical rooms.
- Tenant fit-out is simple and inexpensive.

Hollandview Trail Medical Office, Aurora, Ontario
ComfortZone - Cold Wall Barrier Utilizing **FreeHeat™**

- **1st Stage Heating** - In Floor Perimeter radiant heating.
- **2nd Stage Heating** - Hybrid Heat Pump hydronic coil.
- Eliminates cold wall effect due to large glass areas.
- Valves and controls built into the vertical stack Hybrid Heat Pump.

The Challenge

Modern buildings are often constructed with large glass areas and spectacular views but come with comfort challenges. Heating the space near the full height windows becomes expensive and difficult. Often, the result is an almost uninhabitable cold space at the perimeter with cold drafts commonly referred to as “the cold wall effect”.

The Solution

ComfortZone by the CGC Group utilizes the warm heat pump fluid loop for radiant in-floor heating as the first stage of heat. Treating the problem at the source with radiant heat, eliminates cold spots and downdrafts and provides greater comfort.
CGC’s Featured Projects

Broad Street Bank, Trenton, N.J.

Springdale Professional Building, Brampton, Ontario

Ontario Power Generation, Pickering, Ontario

BELL Canada Campus, Montreal, Quebec
**Office Building**

Ontario Power Generation, Pickering, Ontario
Voortman Cookies, Hamilton, Ontario
Hollandview Trail Professional Bldg., Aurora, Ontario
Springdale Professional Bldg., Brampton, Ontario
Bell Canada, Montreal, Quebec
Miami Valley Research, Dayton, OH
First Canadian Title, Oakville, Ontario
Bell Mobility, Mississauga, Ontario
The Ellis Building, Toronto, Ontario
Heritage Centre, Buffalo, N.Y.
St. Ilija Church, Mississauga, Ontario
Local 46 Training Centre, Toronto, Ontario
Kingsway Financial, Montreal, Quebec
St. Catharines Courthouse, St. Catharines, Ontario
Yonge and Ashfield, Markham, Ontario
Oshawa City Hall, Oshawa, Ontario
Peel Heritage Museum, Brampton, Ontario
Michaelangelo Market Place, Markham, Ontario
Dollarama Headquarters, Montreal, Quebec

**Condominium & Residential**

River House, Manhattan, N.Y.
Broad Street Bank, Trenton, N.J.
Horizon House, Seattle, WA
909-5th Ave, Seattle, WA
18 Yorkville, Toronto, Ontario
Le Vistal, Montreal, Quebec
The Star of Downtown, Toronto, Ontario
60 Lofts, Toronto, Ontario
Trebeca Green, N.Y. city, N.Y.
Chateau Royal, Toronto, Ontario
Greavette, Gravenhurst, Ontario
London, Toronto, Ontario
Harbour Walk Phase 1 & 2 & 3, Cobourg, Ontario
Bella Vista, Mississauga, Ontario
ONE SIX NINE, Toronto, Ontario
Zen Lofts, Toronto, Ontario
Stewart Lofts, Toronto, Ontario
South Common Court, Mississauga, Ontario
Amstad Apartments, Toronto, Ontario
Gilda’s House, Buffalo, N.Y.
Radiance at Minto Gardens, Toronto, Ontario
Chelsea Lofts, Toronto, Ontario
360 On Pearl, Burlington, Ontario
400 Sherbrooke Ouest, Montreal, Quebec
Universal Condo Recreation Centre, Toronto, Ontario
Port Elaine, Oakville, Ontario
Bleury Viger, Montreal, Quebec
Hotel & Hospitality

Marriott, Brooklyn Bridge, N.Y.
Trump National Golf Club, Westchester, N.Y.
Holiday Inn Cheektowaga, Buffalo, N.Y.
Holiday Inn Buffalo Airport, Buffalo, N.Y.
Holiday Inn Amherst, Buffalo, N.Y.
Westin Trillium, Collingwood, Ontario
Delta Vancouver Hotel, Vancouver, B.C.
Nelligan Hotel, Montreal, Quebec
Hotel Frederick, Boonsville, MS
Touchstone Resort, Muskoka, Ontario
Suncadia Resort and Spa, Cle Elum, WA
Tulalip Hotel and Casino, WA
Holiday Inn SEATAC, Seattle, WA
Place D’Armes, Montreal, Quebec
Seasons at Blue, Collingwood, Ontario
Courtyard by Marriott, Bellevue, WA
Sheraton Parkway Hotel, Richmond Hill, Ontario
Gladstone Hotel, Toronto, Ontario
Hilton Garden Inn, Markham, Ontario
Holiday Inn Select, Mississauga, Ontario
Madison Avenue Boutique Hotel, Toronto, Ontario
Eganridge Inn & Country Club, Peterborough, Ontario
Hilton Garden Inn, Montreal, Quebec

Retirement & Assisted Living

Cliffs at Eagle Rock, Freehold, N.J.
Fairhaven Assisted Living, Sykesville, MD
Timber Ridge, Issaquah, WA
Amica at Dundas, Dundas, Ontario
Lynde Creek Village, Peterborough, Ontario
Sunrise Assisted Living, Oakville, Ontario
Empire Living, North Bay, Ontario
Luther Village, Waterlo, Ontario
Sumac Lodge, Sarnia, Ontario
Shalom Village, Hamilton, Ontario
Residences on Augusta, Hamilton, Ontario
Duke of Devonshire, Ottawa, Ontario
Blue Heron Apartments, Ottawa, Ontario
Palisade Gardens, Cobourg, Ontario

School Board

Rockyview School Board, Calgary, Alberta
Grand Erie District School Board, Brantford, Ontario
Thames Valley District School Board, London, Ontario
Upper Grand District School Board, Guelf, Ontario
Ottawa Carlton District School Board, Ontario
Wolf Creek School Division 72, Alberta
Chinooks Edge School Division 39, Alberta
Red Deer Public School District 104, Alberta
Red River Valley School Division, Alberta
Federation of Independent School Assoc., B.C.
Hastings and Prince Edward District School Board, Ontario
Greater Essex County District School Board, Ontario
HVAC Strategies
For Saving Energy
What is the main advantage of the CGC Hybrid Heat Pump System?

The answer is quite simple: **Energy Savings.**

The CGC Hybrid Heat Pump System is designed to use considerably less electricity than traditional reversing WSHP systems, since the compressors only operate in the cooling mode and NOT in the heating mode. The rejected energy from the cooling units is transferred directly to a hydronic heating coil located in the unit similar in operation to a simple fan coil. There are no reversing valves in the CGC Hybrid Heat Pump units. In order to determine how much electrical energy can be saved by not operating the compressors for heating, consideration must be given to the amount of annual operating hours in both the heating & cooling modes.

**Figure 1:** Electrical consumption, kw-hr (100 - 1 ton heat pumps operating for 1 hr.)

![Figure 1: Electrical consumption, kw-hr](image)

**Total Energy Consumption**

**Figure 2:** BTUH consumption (Electricity & Natural Gas) (100 - 1 ton heat pumps operating for 1 hr.)

![Figure 2: BTUH consumption](image)

Figure 2 depicts total energy consumption measured in BTUH. Taking into account electricity and natural gas consumption, the CGC Hybrid system shows a net reduction in total energy usage.
Energy costs – CGC vs traditional WSHP

When the costs of energy (electricity and natural gas) as well as the quantity of energy consumed are factored in, the CGC Hybrid Heat Pump System consumes less energy and shows a net reduction in operating costs over traditional reversing Water Source Heat Pumps (WSHP).

Figure 3: Energy Costs (Gas & Electricity combined) (100 - 1 ton heat pumps operating for 1 hr.)

![Energy Costs Graph](image)

(Electricity @ $0.08/kw-hr, Gas $ 1.28 therm, $ 0.0127/cu.ft., $ 0.45/cu.m)

Geothermal savings

An independent analysis by Caneta Energy confirms that a CGC Geothermal system installed in a Toronto area office building will result in 23.8% energy savings over a conventional GSHP system.

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<thead>
<tr>
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<th>HVAC Only (Annually)</th>
<th>ENTIRE Building (Annually)</th>
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<tbody>
<tr>
<td>System type</td>
<td>Energy Use (KWh)</td>
<td>Operating costs ($)</td>
</tr>
<tr>
<td>Conventional GSHP</td>
<td>619,963</td>
<td>$ 55,169</td>
</tr>
<tr>
<td>CGC Hybrid</td>
<td>472,309</td>
<td>$43,311</td>
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<tr>
<td>Savings</td>
<td>147,654 (23.8%)</td>
<td>$ 11,858 (21.5%)</td>
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“Caneta Energy has modeled heat pump systems in a significant number of buildings over the past number of years. We have seldom seen a concept as promising as the CGC Group hybrid system particularly when used in a ground coupled system with water-to-water heat pumps between the building loop and ground heat exchanger. When the building is balanced thermally, the ground heat exchanger can be by-passed, to maximize heat recovery and minimize pumping. This provides the benefits of conventional water-loop and ground source concepts in one system.”

Caneta Research Inc
R.L. Douglas Cane, P.Eng, Principal
April 24, 2007
The CGC design utilizes the building’s rejected energy from cooling units to directly satisfy various building heating loads.

This process eliminates the wasteful rejection of heat to a fluid cooler or geo-thermal loop. This benefit is realized whenever there is an excess amount of heat from the cooling units (typically shoulder seasons). In a traditional reversing WSHP system operating in the heating mode, the fluid loop is used as evaporator water and must be maintained to less than 90°F. In such cases, fluid coolers may be required to maintain this temperature which is a needless waste of energy.

With the CGC Hybrid design operating in heating, the warmer the water the better since the water is used directly for building heating purposes. Heat rejection to a fluid cooler or ground loop is the very last resort.

Rejected heat from the cooling units used as a direct heating source is referred to as FreeHeat™.

FreeHeat™ is defined as...

“The process of reclaiming the heat generated within a building to directly satisfy the heating needs of the building, without additional energy input.”

FreeHeat™ is a Registered Trademark of the CGC Group of Companies.

In some cases FreeHeat™ can eliminate the requirement for a separate high temperature water loop and can be used in the following applications:

- Fresh Air pre-heating
- In-floor radiant heating
- Zone heating
- Snow melting
- Pool heating
- Low grade heat for unit heaters

The CGC Hybrid make up air unit (Varipak) is a hybrid heat pump with heating and cooling capabilities that does not use natural gas as the heating source.

Whenever there is excess rejected heat in the fluid loop, the Varipak unit pre-treats the fresh air with this FreeHeat™. With a traditional reversing WSHP, it is not uncommon to have heat injection and heat rejection operating simultaneously. Gas-fired make up air units regularly operate while fluid coolers reject unusable heat.

With the CGC design the simultaneous operation of a gas-fired make up air unit and a fluid cooler is eliminated.

As the outdoor ambient temperature falls, the water loop temperature is scheduled with boiler operation to meet the heating requirements.
Thermal balanced comparison for a commercial Heat Pump application

Traditional Reversing WSHP System

- 40°F Ambient
- Typical Shoulder Season
- 336,000 BTU/h Excess heat rejected
- 5,000 CFM @ 70°F
- Gas Fired MUA
- 204,000 BTU/h INPUT

Energy Bills
- Electricity
  - Cooling: 30 compressors @ 1kW = 30 kW
  - Heating: 10 compressors @ 1kW = 10 kW
- Natural Gas
  - 204,000 BTU/h

CGC Hybrid Heat Pump System

- 40°F Ambient
- Typical Shoulder Season
- 162,750 BTU/h
- YARI-PACK MUA
- 5,000 CFM @ 70°F
- FreeHeat™ 137 MBH Available

Energy Bills
- Electricity
  - Cooling: 30 compressors @ 1kW = 30 kW
  - Heating: 10 compressors @ 1kW = 10 kW
  - Heating: 0 compressors
- Natural Gas
  - 0 BTU/h

Energy in Motion
What about heat injection?

In either system (traditional reversing WSHP & CGC Hybrid), heat injection will be required whenever there is insufficient heat in the fluid loop to satisfy the heating load. This will typically occur when there is greater than 50% of the units calling for heat. Therefore, a boiler is always required.

Since the traditional reversing WSHP system generates some heat from the compressors, it may require less input from the fluid loop. The CGC Hybrid design may require more boiler load since it does not generate heat from the compressors. When a CGC Hybrid make up air unit (Varipak) is used to pre-treat the fresh air with FreeHeat™, the total building annual natural gas consumption should be less than if gas-fired make up air units were used.

An important consideration to take into account is that both systems will require boiler operation at some point in order to introduce heat into the water loop.

Figure 4: Boiler energy consumption, BTUH (100 - 1 ton heat pumps operating for 1 hr.)

Energy Efficiency Ratio

The CGC refrigeration system is optimized for cooling operation only and NOT for heating. The results are considerably higher EER’s when compared with a reversing WSHP that has to operate in both heating and cooling modes. Furthermore, there are no reversing valves in the CGC design which further improves the efficiency. The shell and tube condenser is much more effective and efficient at removing heat than coaxial condensers. Strictly from an EER perspective, the CGC unit is significantly more efficient. Typical EER’s for the CGC product line are 15 and higher, while standard reversing WSHP have EER’s in the 12 to 14 range.

Most manufacturers do have optimal high efficient models, but appear to be seldom provided due to their significant higher premiums.
Does the cost of natural gas affect the CGC advantages?

The answer is **NO.** It would not affect the advantages of the CGC Hybrid System.

The CGC Hybrid system actually reduces the amount of energy consumed.
The costs of the energy source can affect the operating costs but it will have no impact on the amount of energy required for either system.

An important point to consider is that the cost to generate heat with electricity is typically higher than the costs to generate heat with natural gas. The CGC system reduces the amount of electricity consumed which is the most expensive source of energy.

CGC compared the energy costs to generate a million BTUH with electricity and with natural gas.

Electricity was assumed to have a somewhat modest cost of $0.07/kw-hr, while natural gas was assumed to have a cost of $1.25/ therm. Still, the cost to generate heat with natural gas is lower than with electricity.

![Graph showing cost comparison between electricity and natural gas](image)

**Boiler efficiency=85%**

The CGC Hybrid Heat Pump design has many inherent design benefits:

- High EER’s, due to unidirectional refrigerant flow.
- Maintain ASHRAE 90.1 minimum EER level with a low flow rate of 2 gpm/ton and high water loop temperatures.
- Low flow rate of 2 gpm/ton vs 3 gpm/ton will result in lower pumping energy as well as smaller pipe sizes and possibly smaller pumps.
- Lower flow rates and higher operating temperatures can reduce the fluid cooler size.
- Better heating comfort. The heating requirements are satisfied by scheduling the water loop temperature (heat injection) with the ambient conditions. The CGC heating algorithm calls for low fan speed operation for the first 10 minutes. A traditional reversing WSHP has full compressor operation.
- Less compressor cycling = less maintenance + longer compressor life.
- Very quiet operation even with compressor operation (cooling), fan coil sound levels on heating.
- Significantly lower MCA is some cases may warrant a smaller electrical infrastructure.
- A separate high temperature water heating loop is regularly eliminated with the CGC design.
- Gas-fired make up air units are not required if the CGC design incorporates a Hybrid Heat Pump make up air Unit (Varipak).