“World’s Most Efficient”

Chiltrix

Air To Water Heat Pumps

(a/k/a Reverse Cycle Chillers or
Hydronic Heat Pumps)

AHRI CERTIFIED®

ENERGY STAR 2019
Emerging Technology Award

Chiltrix Air-To-Water Heat Pumps

Basic System Overview - Features

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- Ultra-High Efficiency IPLV EER 23 / COP 3.92
- Capacity 2 Tons Cooling, 2.7 Tons Heating
- Modular for "Stacking" up to Three Systems
- DC Inverter Variable Speed – Compressor, Fan, Pump
- Best of Breed Components
- Real Time Capacity Control
- Dynamic Humidity Control Option
- Dynamic Backup Heat Option
- Dynamic Outdoor Reset Control

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Suitable For Any Combination of:

- Cooling
- Heating
- Domestic Hot Water (DHW)

Install With Any Combination of:

- Radiant System (Heating and/or Cooling)
- Room Fan Coil Units (Up to 8 per CX34)
- Ducted Air Handlers
- Concealed Ceiling Fan Coil / Mini-Duct Units
- Indirect Water Heater Tank

Basic System Overview - Equipment

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1. Best-Of-Breed Component Selection – All Key Components are OTS (Off The Shelf). But only from the absolute "TOP" shelf.

2. Compressor: Variable Speed Mitsubishi DC Inverter
   Outdoor Fan: Variable Speed Panasonic DC Inverter
   Air Coil: MULTISTACK
   Water Coil: SWEP BPHE
   Valves: Emerson/Danfoss
   Pump: Variable Speed WILO

3. AHRI-Certified / CEC-Certified Title 24 / UL 60335-1-40 / UL 60335-2-40 / CSA 22.2

4. Unique High-Efficiency Capacity Controls

Chiltrix Capacity Control
Patent-Pending

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1. Manages capacity (compressor & pump speed) to match load based on ΔT between LWT (Leaving Water Temperature) and EWT (Entering Water Temperature) and GPM.

2. System targets ~2.4 - 2.8 GPM per ton and a ~10 °F ΔT

3. Real-Time BTU Calculation / BTU = 500 x GPM x ΔT

4. Does not "chase and overshoot" a set point.

5. 500 is the WF (Water Factor) of pure water:
   8.33 (lbs. per gallon) x 60 (minutes per hour) x 1.0 (specific heat of water) x 1.0 (specific gravity of water) = 499.8 (500)

   WF Adjustment for Propylene Glycol Mix:

10% Glycol, WF=494	40% Glycol, WF=463
20% Glycol, WF=488	50% Glycol, WF=442
30% Glycol, WF=480	60% Glycol, WF=421

Chiltrix Psychrologix™ Controller w/ Dynamic Humidity Control (DHC)

- DHC Manages Dehumidification (Latent Heat Rejection) & Disables Dehumidification When It's Not Needed.
- Can Provide >34% Additional Energy Savings Above The Official IPLV Rating When Dehumidification is Disabled.
- DHC sensor monitors indoor relative humidity
- Increased EER when running in >/= NPLV conditions
- Chiltrix Official IPLV is EER 23.02
- When DHC is active, NPLV is EER 30.7 or Higher
- When DHC is Active, efficiency can be as high as EER 35
- Patent Pending

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- In a standard AC/cooling system, the unit has no control over the coil temperature - "it is what it is".

- Only Chiltrix patent-pending DHC technology can proactively and dynamically control the coil temperature.

- When indoor humidity is in the "good" range (user defined), the Chiltrix w/ Psychrologix Controller runs at ~NPLV saving a large amount of energy, well above it's record-setting IPLV EER rating.

- If humidity enters the space (from a door opening, hot shower, etc.) the DHC controller immediately sees the increase in humidity and drops the coil temperature to its IPLV settings, well below the dew point, to get rid of the humidity.

Below, the top chart shows IPLV, the bottom chart shows NPLV. Both are results from the same official CX34 AHRI lab test and are based on identical ambient conditions.

The difference – IPLV shows cooling EER at loop (coil) temperature 44 °F (7 °C) w/ Strong Dehumidification Active. NPLV shows cooling EER at coil temperature 54 °F (13 °C) w/ Dehumidification Reduced or Disabled. Properly sized FCUs can still manage the sensible cooling load at NPLV (Dynamic Humidity Control Active) Conditions.

As you can see, running the loop 9 °F (5 °C) warmer has a profound effect on EER, increasing the rating from EER 23 to EER 30.72. A few more ^{o}F difference can raise it to EER 35.

Part Load Performance	LWT	% Load						
IPLV		100%		75%		50%		25%
Capacity, kW	7	7.654		5.735		4.109		4.403
Total Power, kW		2.364		1.149		0.507		0.403
Efficiency, EER (BTU/W)		11.048		17.030		27.653		37.278
Efficiency, COP (W/W)		3.238		4.991		8.105		10.926
IPLV EER:	23.02							

Part Load Performance	LWT	% Load						
NPLV		100%		75%		50%		25%
Capacity, kW	13	8.807		6.675		5.100		5.350
Total Power, kW		2.455		1.275		0.465		0.364
Efficiency, EER (BTU/W)		15.839		26.031		48.400		64.856
Efficiency, COP (W/W)		3.590		5.900		10.970		14.700
NPLV EER:	30.72							

Compare Air-To-Water Heat Pumps

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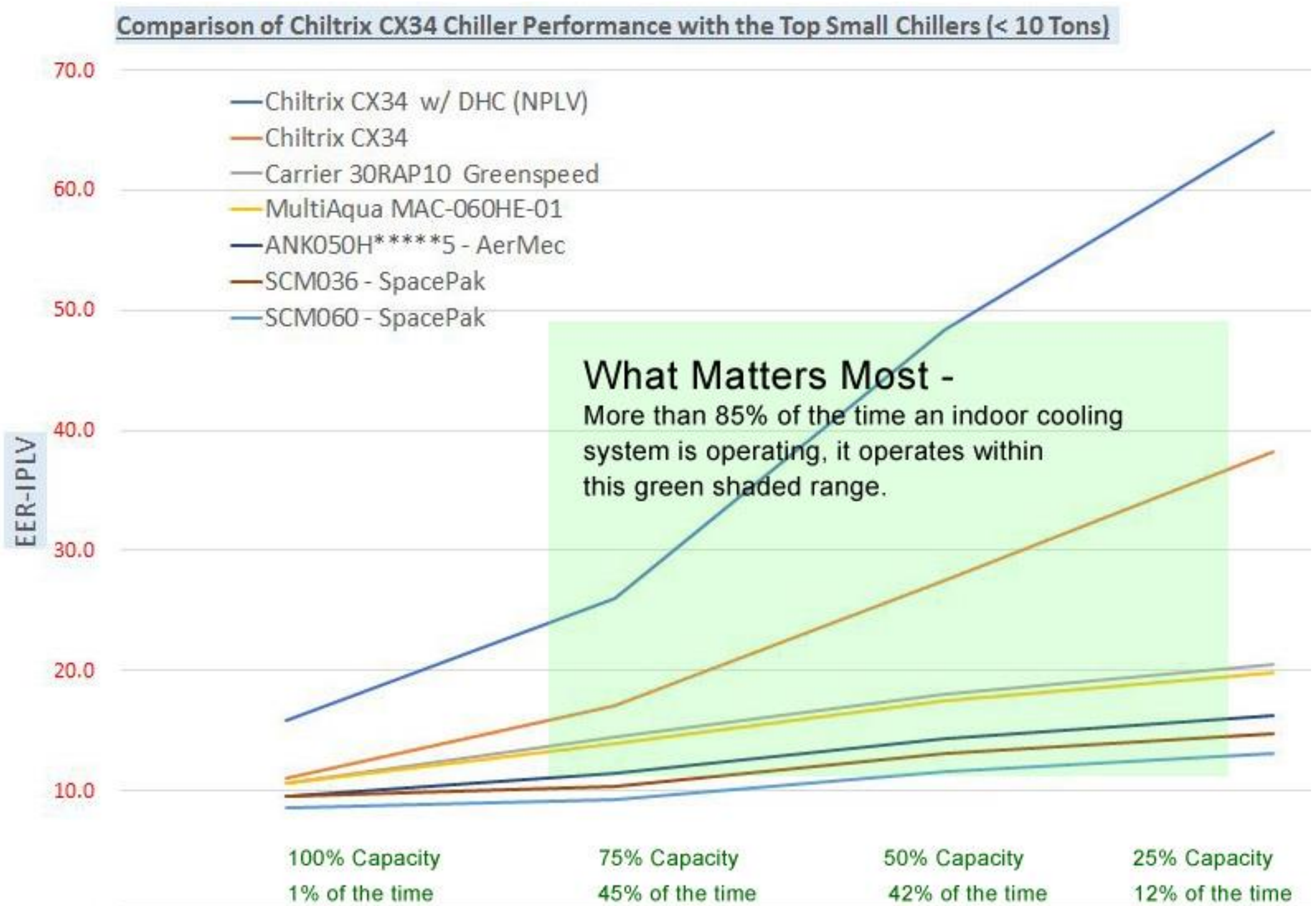
The cart below shows Chiltrix CX34 EER (Both IPLV and NPLV) compared to the top competitors.



The top blue line shows Chiltrix running w/ DHC at NPLV.

The orange line shows Chiltrix running at it's official IPLV.

These other lines show various competitors running at their official IPLV.

Only Chiltrix can dynamically shift between IPLV and NPLV.

Heating Operation

1. Heating control: As with cooling mode, capacity is controlled based on ΔT and GPM flow rate. Compressor and pump speed vary to match the load.

2. Typical running temperature of an air to water heat pump for radiant is 95 °F. Fan coil units should be sized for 104 °F entering water temp. Combo FCU-radiant design should be designed for 104 °F. Note that Chiltrix Fan Coil Units and Ducted Air Handlers are rated for 104 °F entering fluid temperature.

3. Radiant heating always requires a buffer tank. Fan coil-only installations can run without a buffer tank with 15-20 gallons minimum loop volume.

4. Optional integrated V18 dynamically variable power backup heater targets an exact match to any heating shortfall.

5. Onboard dynamic outdoor reset with user-customizable curve.

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Heating Operation
Proper Low-Temp Heating Design

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1. With All Heat Pumps, "Lift" Drives the COP. (Same as IPLV Vs.NPLV)

2. Lift = ΔT between Ambient and Supply Temp.

1. Carnot Efficiency: $W = \frac{Q_1}{COP_p} = \frac{Q_1(T_1 - T_2)}{\eta_{mech} T_1}$

2. Always Design For The Lowest Possible Heating Supply Temperature.

3. Example: at 0 ^{o}F outdoor temperature, an air to water heat pump such as the CX34 will have >20% higher capacity when used with an operating supply temperature of 95 ^{o}F compared to operating at 122 ^{o}F. And COP at 95 ^{o}F will be >30% higher at 95 ^{o}F than at 122 ^{o}F.

4. Help Your Customer Get The Highest COP: Use Closer PEX Spacing, add PEX in Walls, Ceiling if Needed.

5. Use Next-Size Larger FCUs to accommodate lower water temperatures.

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Heating Operation

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Capacity and COP of a heat pump varies as a function of both outdoor ambient temperature and leaving water temperature. See Chiltrix CX34 heating performance map below.

CX34 Fluid Outlet		Outdoor Air Temperature dB °F (wB)								
LWT °F		-4	5	17(15)	23	32	47(43)	59	68	77
86	Capacity (BTU)	15,968	18,561	22,371	25,556	29,719	35,178	43,332	48,689	53,568
	Power Input (kW)	2.03	2.10	2.22	2.29	2.37	2.50	2.60	2.73	2.86
	COP	2.31	2.59	2.95	3.27	3.67	4.12	4.89	5.23	5.49
95	Capacity (BTU)	14,365	16,992	20,575	24,396	28,660	33,813	41,661	46,779	51,456
	Power Input (kW)	2.14	2.19	2.27	2.37	2.45	2.53	2.63	2.75	2.89
	COP	1.97	2.27	2.66	3.02	3.43	3.92	4.65	4.98	5.22
104	Capacity (BTU)	13,375	15,559	18,891	22,622	26,818	31,868	39,272	44,151	48,553
	Power Input (kW)	2.14	2.17	2.26	2.40	2.53	2.65	2.74	2.88	3.01
	COP	1.83	2.12	2.45	2.76	3.11	3.53	4.20	4.49	4.72
113	Capacity (BTU)	12,147	14,126	17,178	20,847	24,942	29,889	36,815	41,388	45,516
	Power Input (kW)	2.14	2.17	2.25	2.45	2.63	2.80	2.90	3.05	3.19
	COP	1.66	1.91	2.23	2.49	2.78	3.13	3.72	3.98	4.18
122	Capacity (BTU)		12,727	15,494	19,073	23,099	27,944	34,427	38,692	42,548
	Power Input (kW)		2.14	2.23	2.51	2.75	2.99	3.10	3.25	3.41
	COP		1.74	2.03	2.23	2.46	2.74	3.26	3.49	3.66
131	Capacity (BTU)			14,091	17,367	21,018	25,419	31,322	35,178	38,692
	Power Input (kW)			2.26	2.53	2.79	3.82	3.13	3.28	3.44
	COP			1.82	2.01	2.21	2.47	2.93	3.14	3.30

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Dynamically Variable V18 Backup Heater

Patent Pending

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- Typical ATW heat pump backup is a water heater tank installed on the supply side of the loop.

- Typical tank backup element runs at full power to chase and overshoot a set point, stops, and a few moments later, repeats. Thermostat hysteresis results in temperature swings and wasted energy.

- The V18 is instead controlled by the CX34 to target a BTU shortfall, dynamically matching its variable output to match any heating capacity shortfall.

- V18 backup heat output is continuously adjusted in real time to avoid over-providing backup heat, allowing the compressor to always produce the highest possible % of total heat.

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V18 Dynamically Variable
Backup Heating
Patent Pending

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- V18 is a powerful small footprint wall mounted in-line backup heat solution.
- Practically No Pressure Drop:
  @ 7 GPM = 0.000427775 ft. / @ 14 GPM= 0.001438843 ft.
- Offered as a kit with all UL-Listed high voltage electrical components. Assembly required. Licensed electrician required for installation.
- 18,000 BTU (Variable 0-18,766 BTU) Per V18. Use up to three per CX34.
- Uses SSR Technology with 100 Power Level Steps, 0-100% Dynamic Power
- Each V18 requires 208v-240v, 30 amp GFCI breaker.

Heating Performance Modeling

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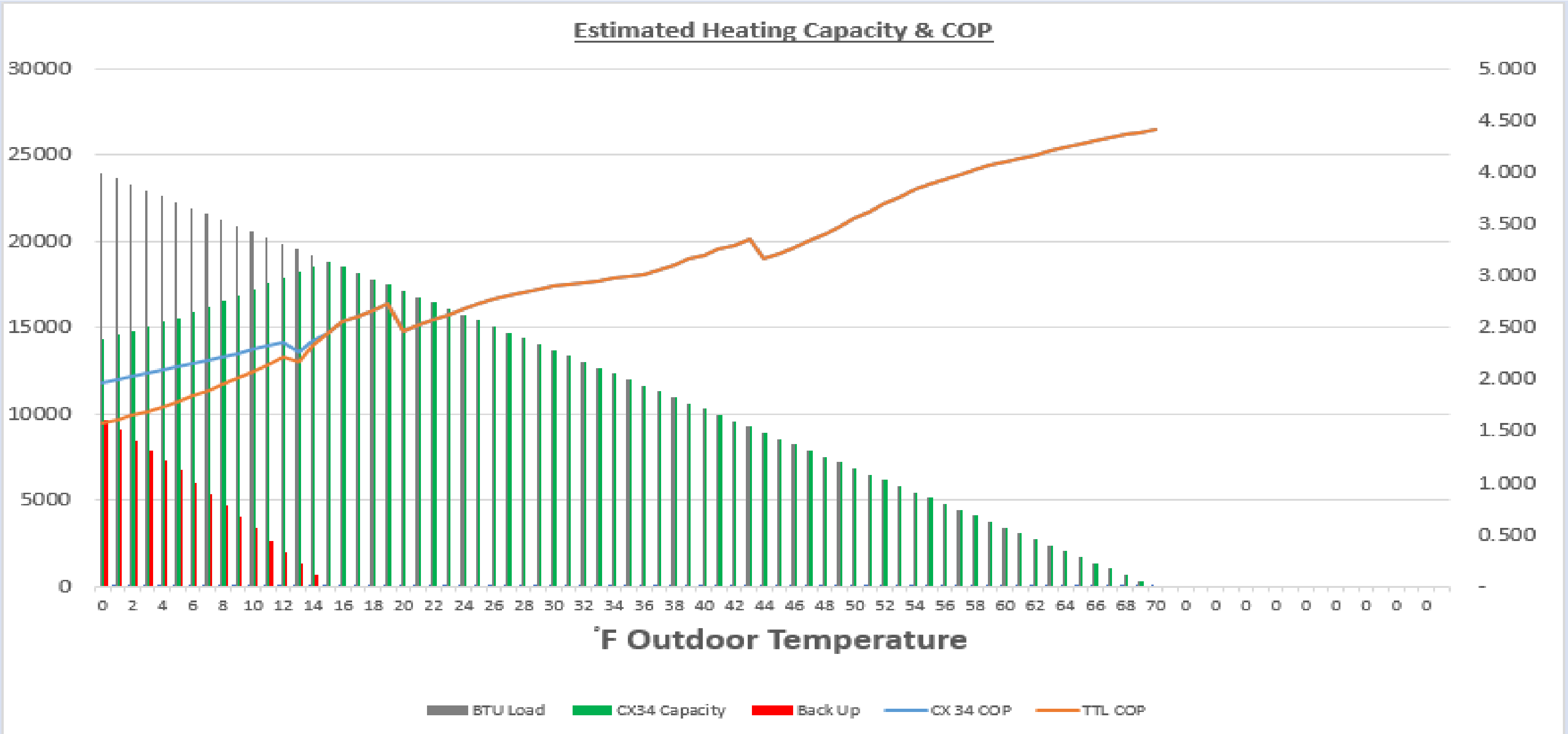
Chiltrix is able to provide heating performance projections that can help understand the estimated COP, annual energy costs, and backup heat requirements to help w/ system design & modeling, etc. Below, see example COP & Capacity Chart showing 1x CX34, Windsor, Ontario, Canada WMO 712980 w/ Manual J Heating Load 24,000 BTU @ Outdoor Design 0 ^{o}F / Radiant LWT105 / Per AHRI 550/590 Heating Test Data



Vertical grey lines are the load, vertical green lines are heat provided by compressor, vertical red lines are heat provided by backup. BTU load is down the left side, COP is down the right side, and across the chart the orange line is TTL COP (net including backup heat at COP 1), blue line is compressor-only COP, outdoor temps are across the bottom.

Heating Performance Modeling

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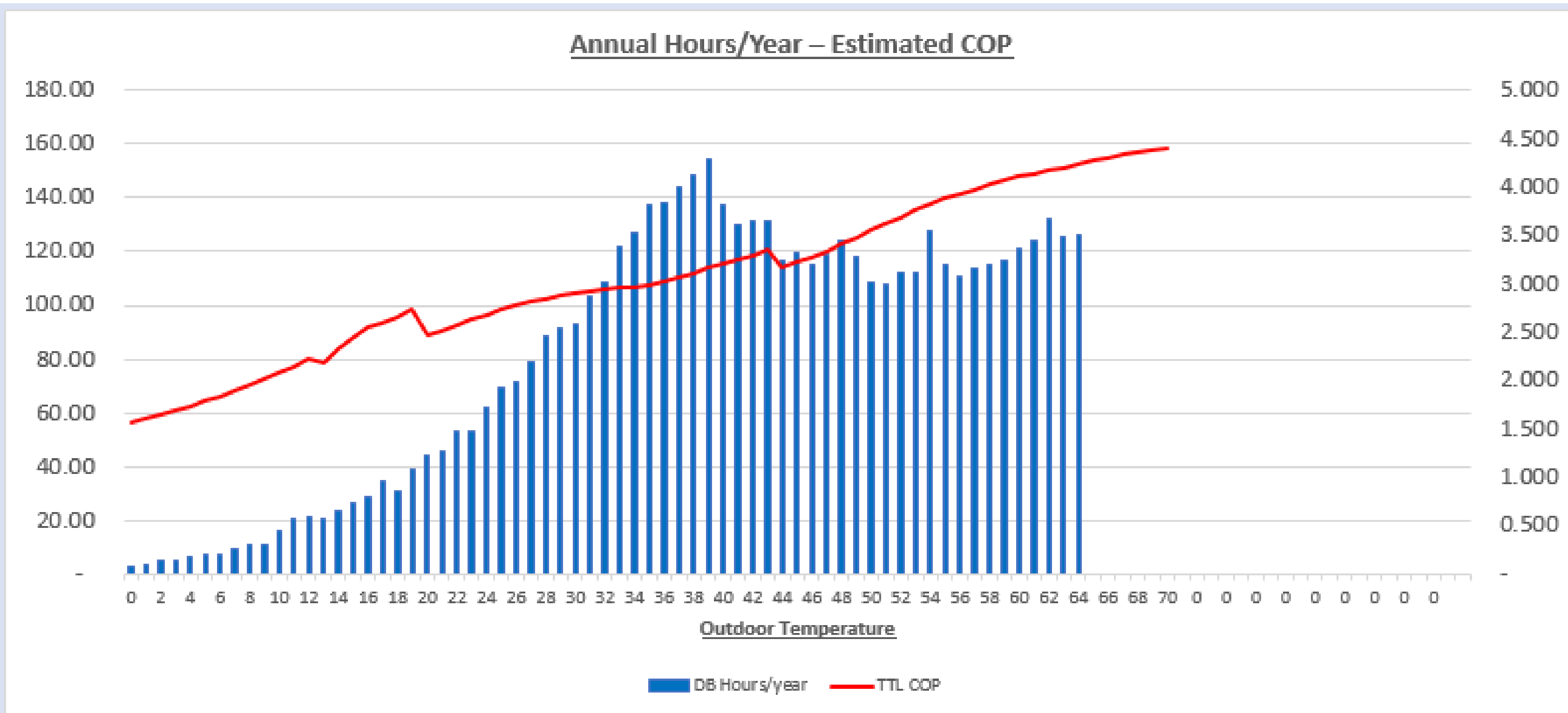
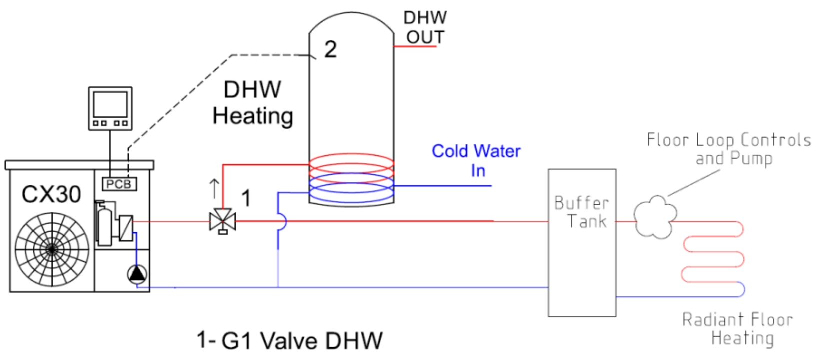
Example Annual Hours & COP Chart (1x CX34, Windsor, Ontario, Canada WMO 712980 w/ Manual J Heating Load 24,000 BTU @ Outdoor Design 0 °F / Radiant LWT105 / Per AHRI 550/590 Heating Test Data. Shows the COP at each temperature and the number of annual hours at each temperature. Data per ASHRAE Weather Data Viewer v6.0. ©ASHRAE 2018. Used under License.



Annual hours at each temperature are down the left side, COP is down the right side, outdoor temperatures are across the bottom. Orange line crossing the chart is TTL (net) COP including backup heat at COP 1.

Domestic Hot Water

- DHW Function requires a heat exchanger tank (indirect coil or solar type tank).
- Requires a G1 (DN25) 3-way valve, controlled by CX34.
- When the DHW tank needs heat, the CX34 switches to DHW mode (Full Speed Heating) and switches the G1 to the tank. Space heating/cooling are paused temporarily.
- Generally, the G1/tank should be close to the CX34. A booster pump may be needed depending on the pressure drop of the coil (if 3rd party tank used) and piping design to the tank.
- Max tank set point is 120 °F (Except when anti-legionella function is active).
- Domestic Water Heating may be disabled and tank heated by backup element when V18 is active.
- Automatic Anti-Legionella Function



1- G1 Valve DHW
2 - DHW Sensor

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DHW & Buffer Tanks

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DHW (Domestic Hot Water) Chiltrix DHW80:
70 Gallons Net / Well Insulated Poly 50mm
GIANT Coil: 72 ft. x 1.25" Convoluted Coil 32 ft^2 Surface Area
Inner Tank & Coil: Duplex 2205 Stainless Steel
Outer Tank: 304 Stainless Steel

VCT19 Buffer Tank: 304 Stainless Steel
19 Gallons Net / Well Insulated Poly 50mm
2x 1" NPT Ports Supply Side
2x 1" NPT Ports Load Side
Element-Ready For Emergency Heat

VCT37 Buffer Tank: 304 Stainless Steel
37 Gallons Net / Well Insulated Poly 50mm
6x 1" NPT Ports Side 1
4x 1.5" NPT Ports Side 2
Element-Ready For Emergency Heat
Designed For Either Vertical or Horizontal Installation

Use a VCT37 when combining 2 or 3 CX34 Units.

IMPORTANT: Read the DHW & Buffer Tank Manual:
https://www.chiltrix.com/heat-exchanger-tanks/chiltrix-tank-manual.pdf

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CX34 Air-To-Water Heat Pump
(Shown w/ DHW & Radiant System)

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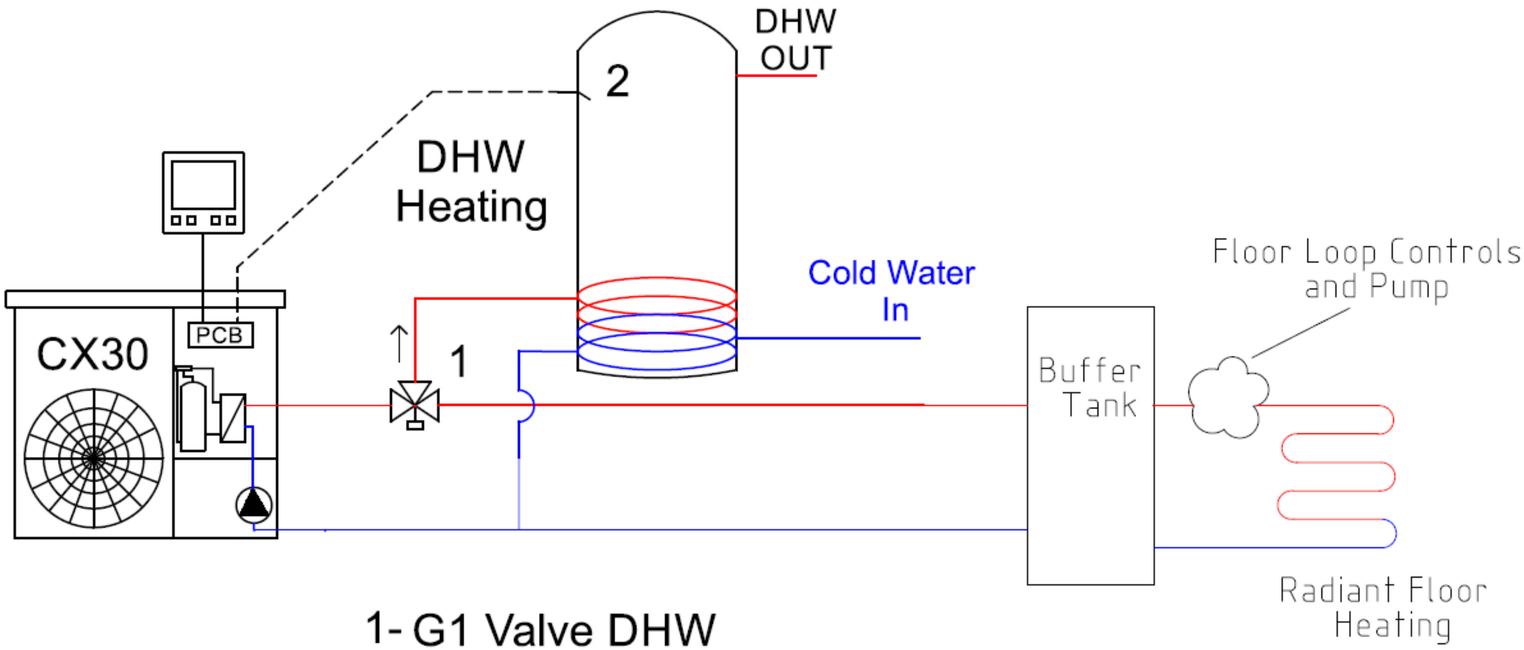

1- G1 Valve DHW

2 - DHW Sensor

Simplified concept drawing –
not all components shown

CX34 Air-To-Water Heat Pumps
(Shown w/ DHW & Fan Coil Units)

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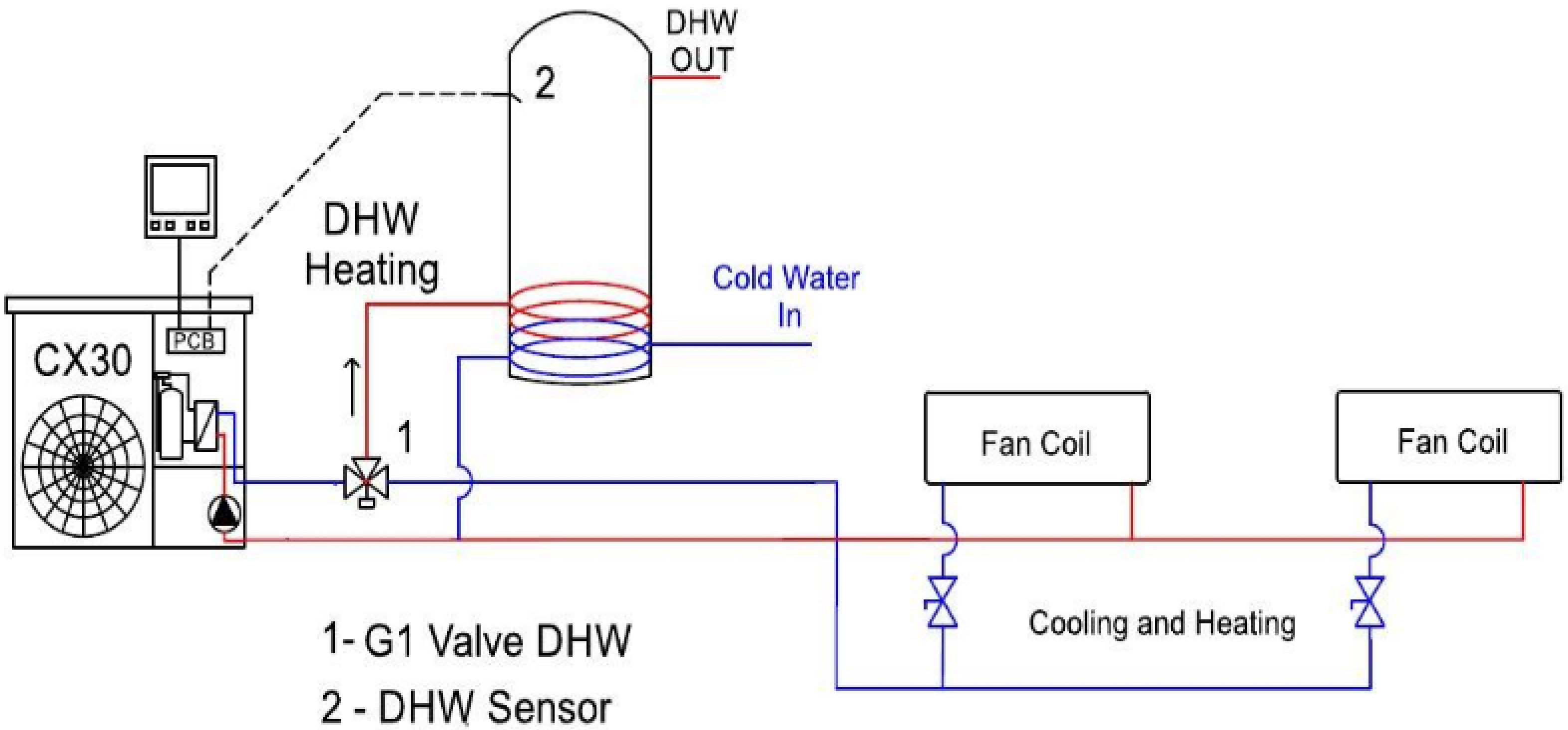

Simplified concept drawing – not all components shown

CX34 Air-To-Water Heat Pump
(Shown w/ Radiant, V18 & Fan Coils)

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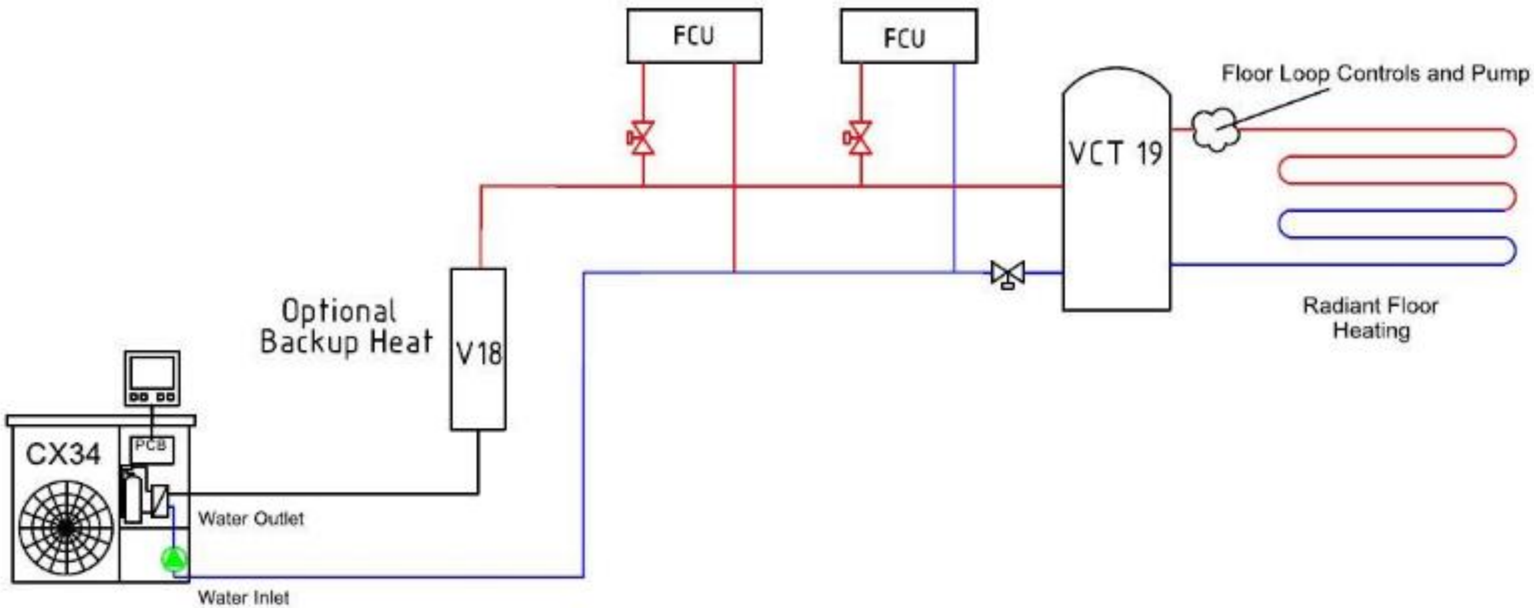
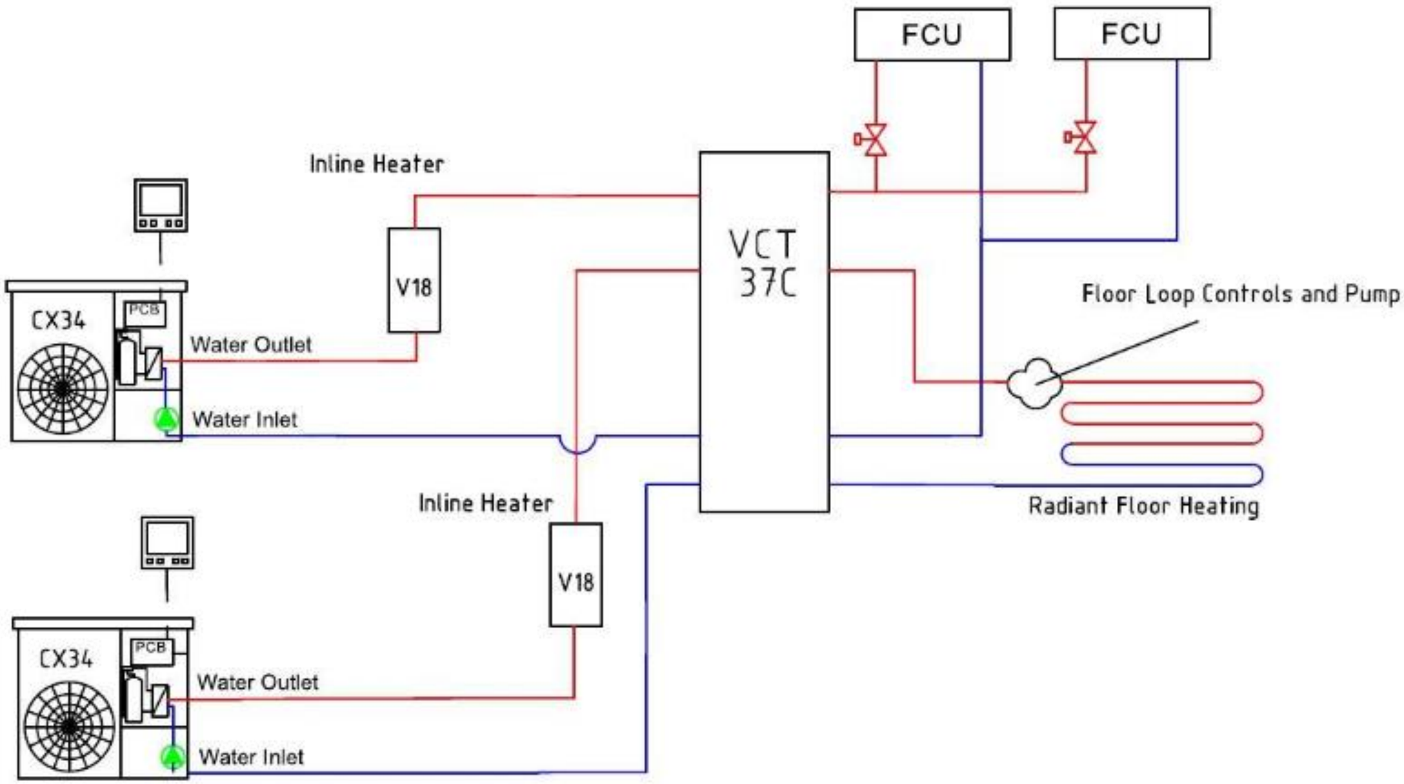


Simplified concept drawing – not all components shown

Hundreds or even thousands of designs are possible.

CX34 Air-To-Water Heat Pump
(Shown 2x CX34s w/ 2x V18s,
Radiant & Fan Coils)

"World's Most Efficient"



Simplified concept drawing – not all components shown

Hundreds or even thousands of designs are possible.

Design & Installation Notes

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If you understand boiler powered radiant systems you will be able to design and install Chiltrix air to water water heat pump systems but there are a few differences and some new things you will need to know. Chiltrix engineers are available to assist with designs & more. Please review the following items with Chiltrix in advance, as needed. We want to help! Let us be involved in your pre-sales, design, and commissioning!

- When a Buffer or Volume Tank is Needed
- Backup vs. Emergency Heat – What is the difference and how to use.
- Proper System Design - Operating Temperature vs. Capacity/Efficiency
- Using & Sizing 3rd Party Fan Coils/Air Handlers
- Don't Use Primary/Secondary or Closely Spaced Tees! If hydraulic separation is needed, use a buffer tank.
- Variable Speed Pump Inside/ Autonomous Control / Wild Coil Design
- CX34 Additional Control Options (Standard Thermostats, Relays, Modbus, WiFi/internet, BACnet, LonWorks, Metasys, and more…

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Thank You!

John Williams
Chiltrix Inc.

More Questions? Please call or email:
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And please visit https://www.chiltrix.com/

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