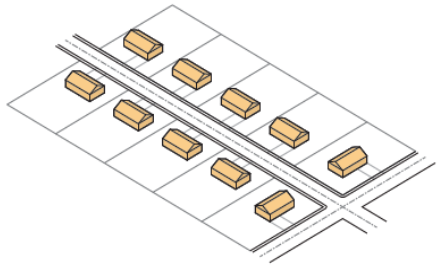
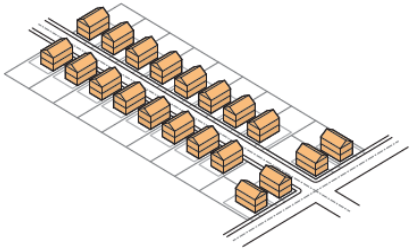
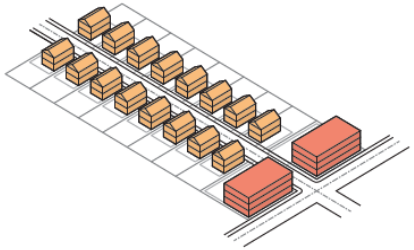
Energy *harvested*, *moved*, and *reused*



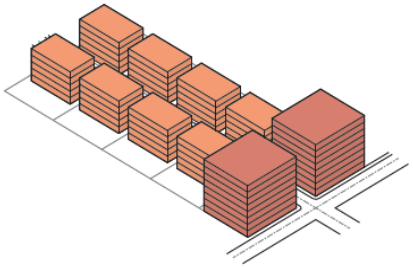
Low Density Residential



Medium Density Residential



Medium Density Mixed-Use



High Density Mixed-Use

Saving Energy and Money in Government and Commercial Buildings and Fleets

High Temperature Conversion And District Systems: How They Work

GreyEdge Group, LLC

Powered by R-718 Technology ©

Cary Smith csmith@greyedgegroup.com
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Meet the Presenters from the GreyEdge Group, LLC

- D. Cary Smith

CEM, CEA,
CGI, CGD

FELLOW

- Garen N. Ewbank

FELLOW

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What Do We Call The Process

Beneficial Electrification

Smart Electrification

Tactical Resource Efficient Electrification (TREE):
Strategic Energy Efficiency Resource Systems (SEERS)

The TREE method of building electrification uses strategic capital planning, an integrated design process, and an incrementalist, network-oriented approach to deliver building heating and cooling which requires little or no combustion, enables carbon neutrality, is highly efficient at low design temperatures and during extreme weather, is highly resilient and energy grid interactive, and reduces thermal waste by capturing as many on-site or nearby thermal flows as possible.

In the built environment, SEERS is the practical use of electricity and electric assets that enables a multiplication of the resulting work to a system coefficient of performance greater than one. The networking of thermal and electrical assets such that on-site combustion is minimized and typically wasted heat resources are recovered for re-use or storage. Use, Capture, and Re-use. Use of heat pumps and recovery of wasted energy from blackwater are two examples.

The Elusive "Negawatt" and GSHPs

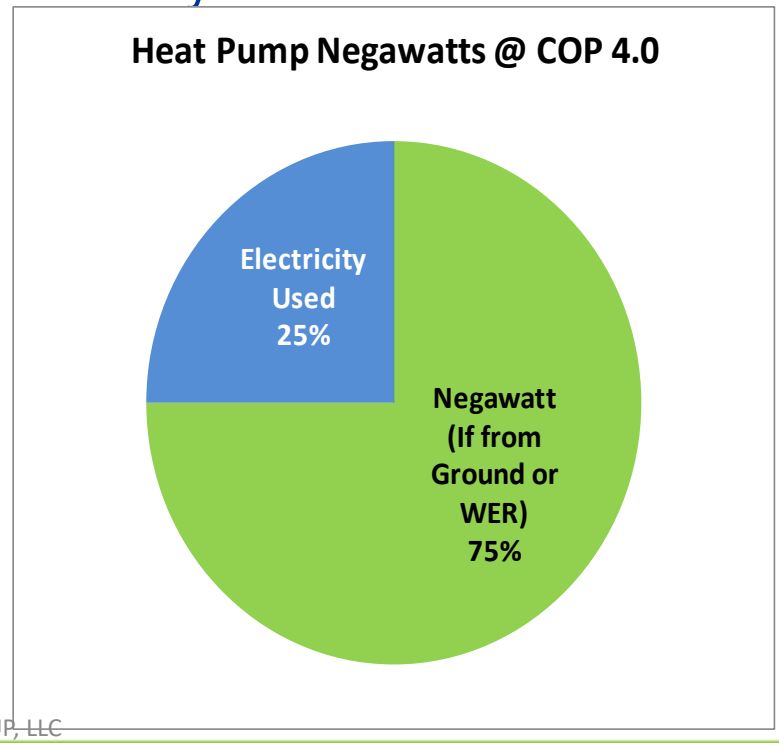
- Wasted Energy Recovery (WER):

  Energy recovered and reused in the process of heating and cooling buildings that the user would normally discard.

AVOIDED ENERGY CONSUMPTION

NEGAWATT MARKET

Negawatts could be traded as a commodity across time and space.

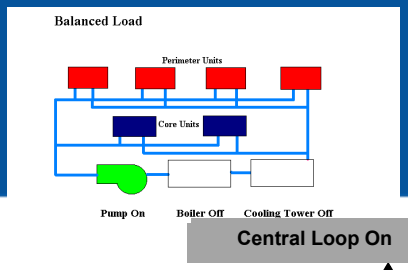


Low Temperature Geothermal Loop
Waste Energy Recovery (WER)

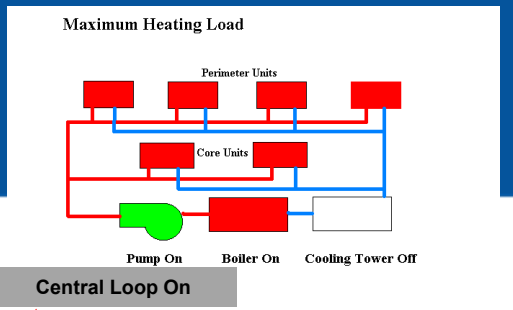
Now let's introduce a way to start to quantify the magnitude of the contribution of WER.

SYSTEM Coefficient of Performance (COP) is the most valid way to compare competing systems.

Consider two systems operating at their respective peaks.



55°F to 85°F
(12.78° C to 29.4° C)

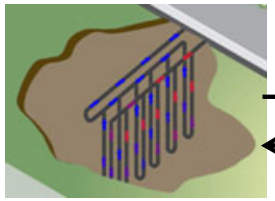


Stage 1 – building moves energy internally using building pumps.

Central Loop 50°F to 85°F
(12.78° C to 29.4° C)

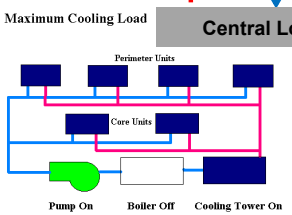
Stage 2 – building(s) move energy to or from the central loop.

Least Energy Path™



Stage 3 – Central Loop calls Borefield (hot or cold).

<50°F or >85°F
(10° C to 29.4° C)



Stage 4 – Central Loop calls Boiler or Fluid Cooler (hot or cold).

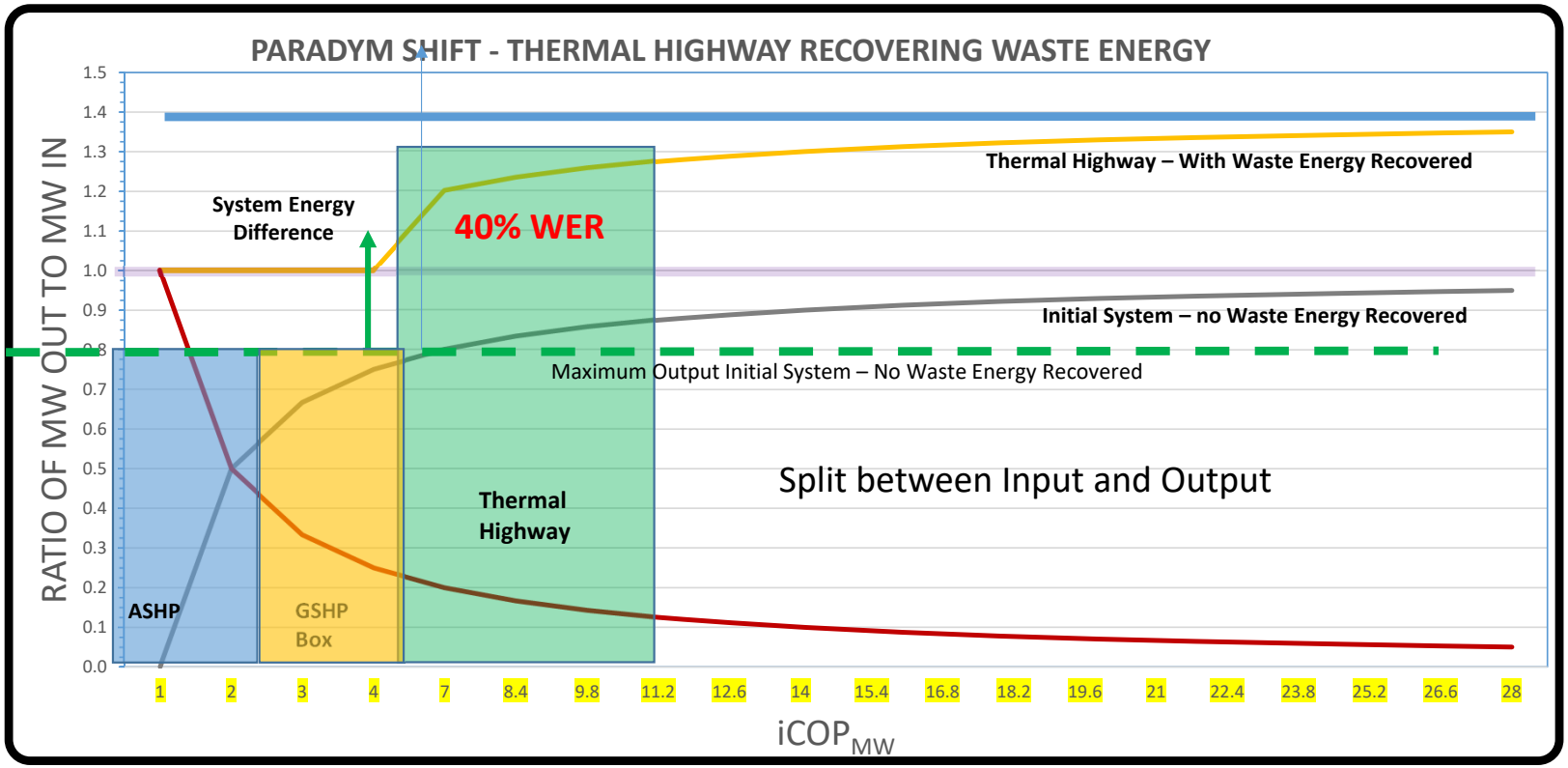
<40°F or >90°F
(4.4° C to 32.2° C)

What Can We Do With Ground Source and WER?

- Increase the system efficiency to 300% to 600%
- Heat and cool air
- Heat and Cool Water
- Move energy from one building or use to another
- Use the ground for thermal storage
- Store solar thermal energy (See http://www.dlsc.ca/animation.htm)
- Level energy loads on the system
- Shift system electrical demand peaks
- Shed excess energy at a time of day that is most advantageous

- Store energy to sell to other users – (micro grid applications)

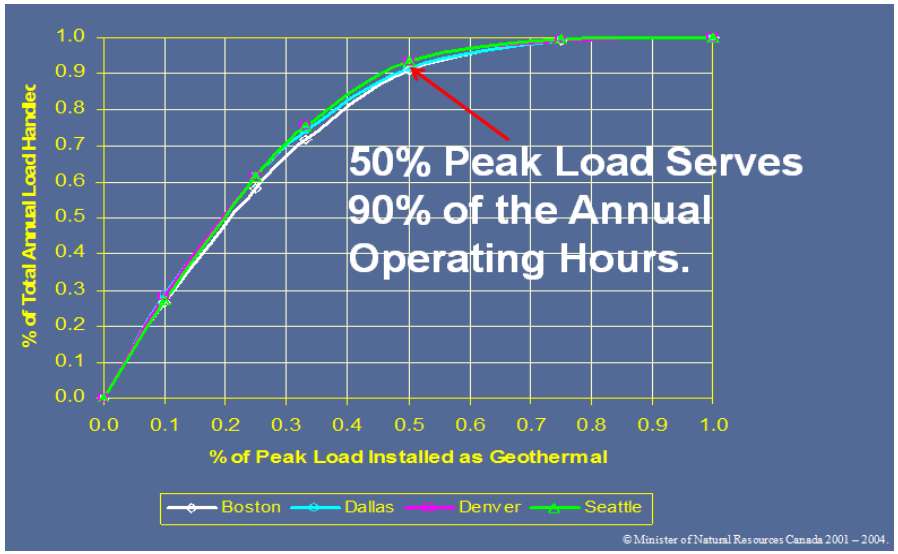
Thermal Highway– With WER, Maximum Output

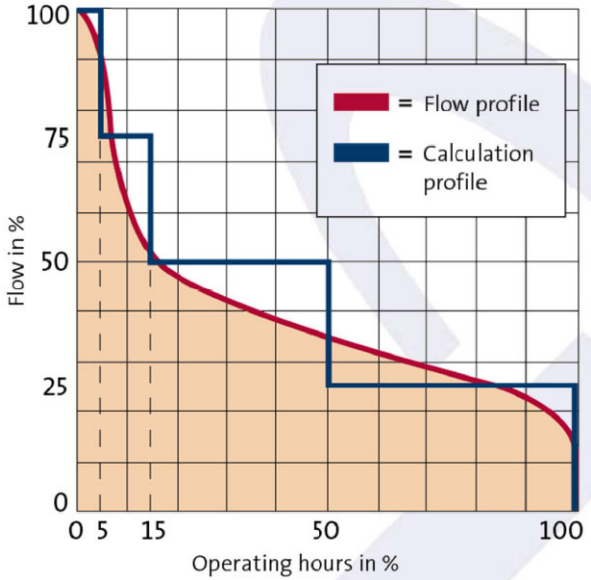


Harvest, Store, and Re-use Wasted Energy

Part Load Analysis, The core of DESIGN

% of Peak Load vs. % of Annual Hours

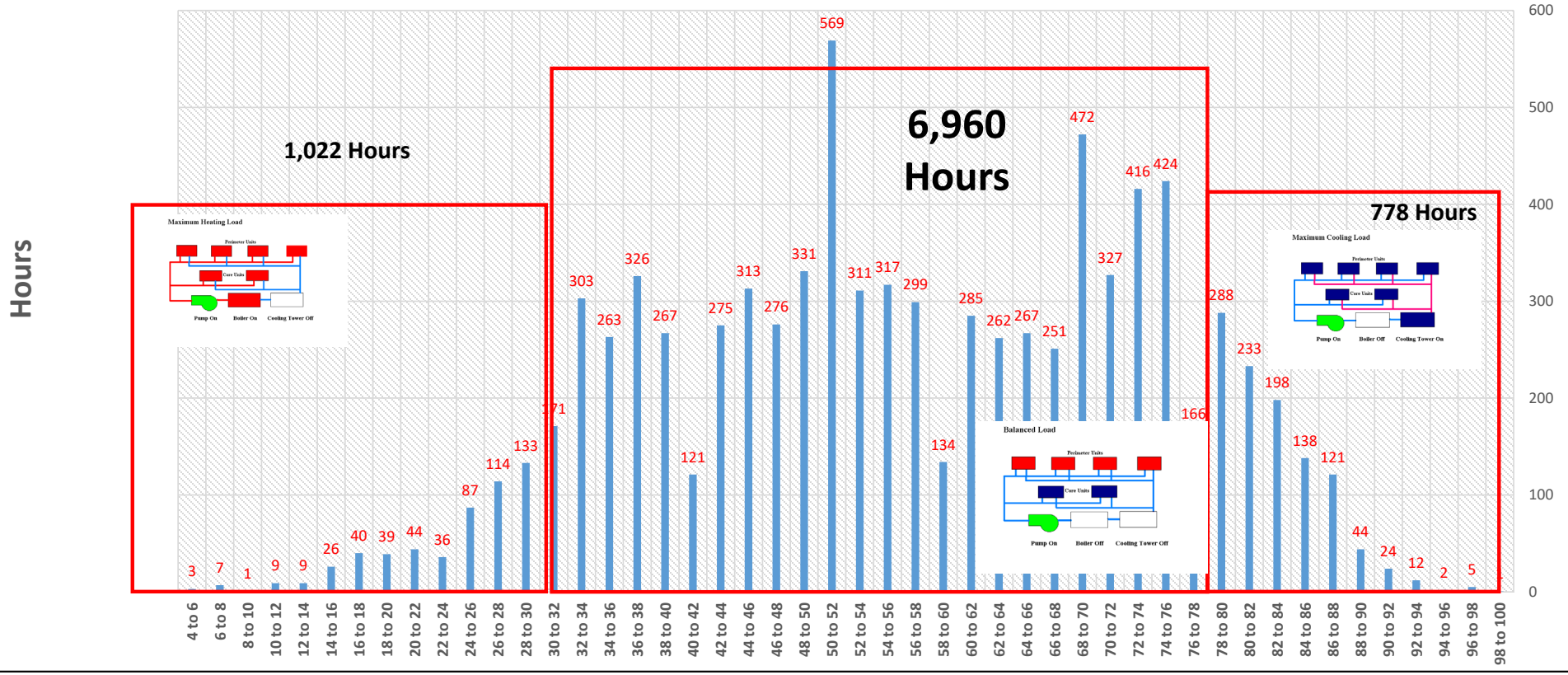




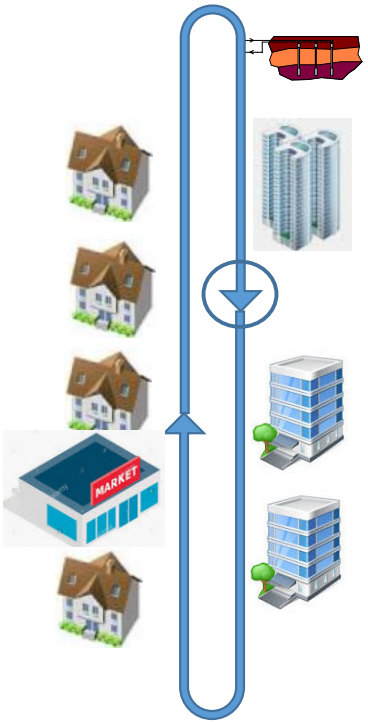
Flow in %	Hours in %
100	6
75	15
50	35
25	44

This profile is also applicable to the building load.

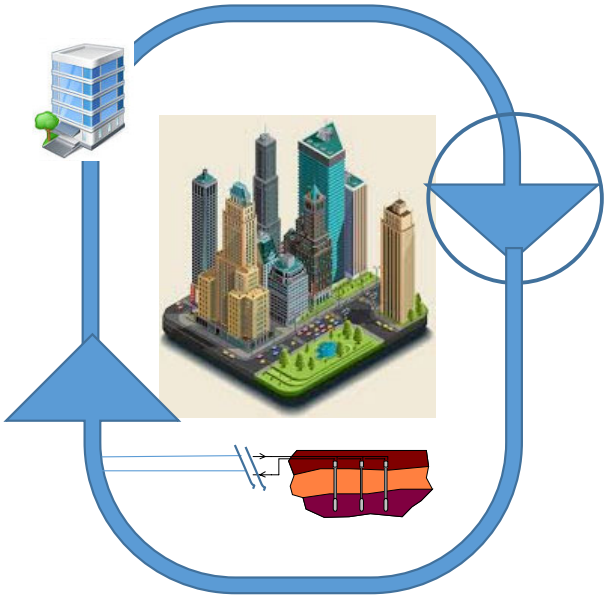
Conventional Bins for NEW YORK LAGUARDIA ARPT - Hours: 8760



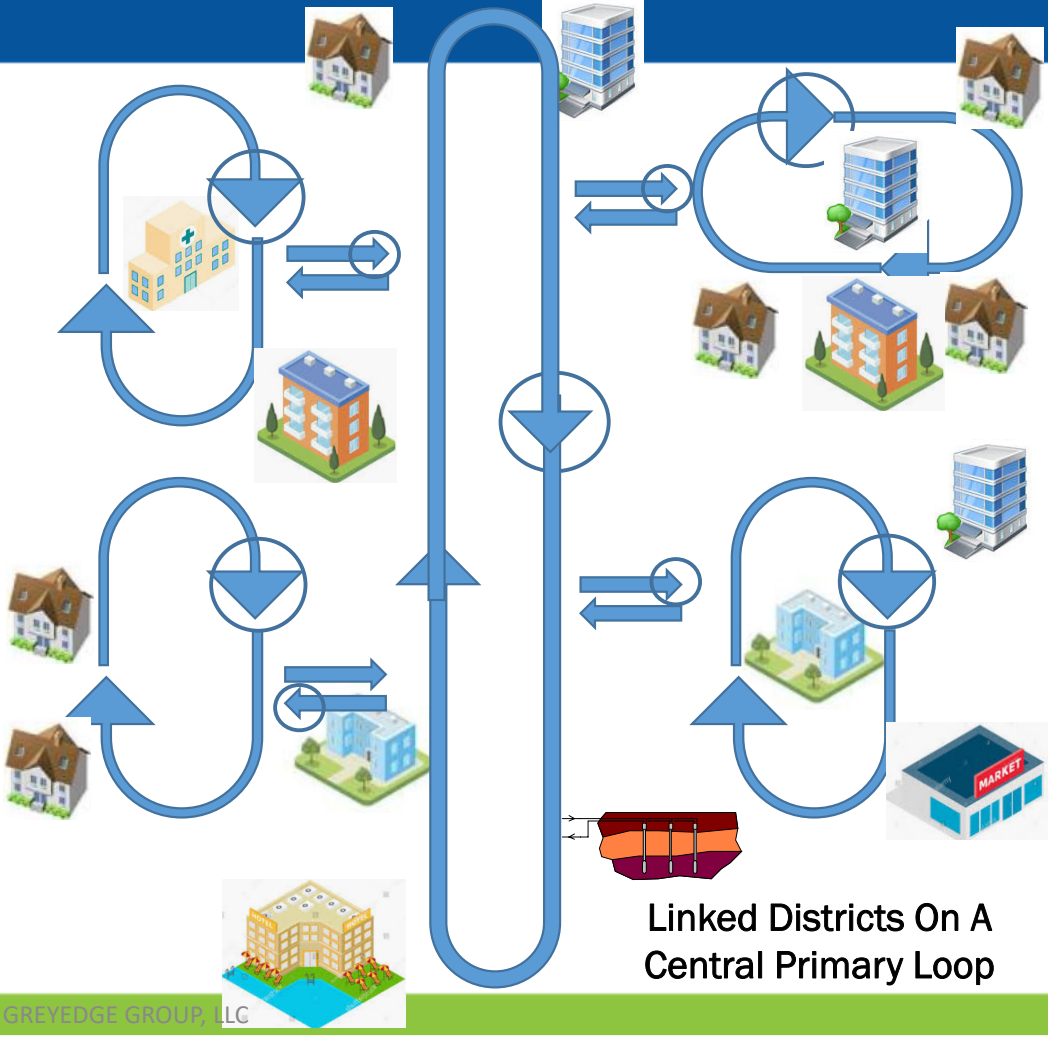
Primary / Secondary MicroDistrict Configurations



Hairpin



Perimeter Or
Run-around



Linked Districts On A
Central Primary Loop

Multip

Magic of contro
Floor to floor
temporary stor

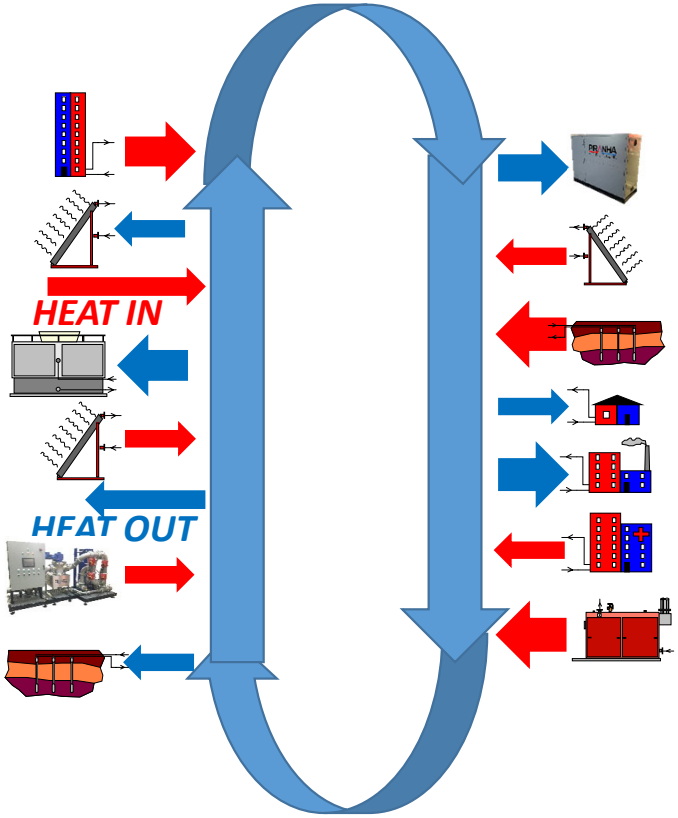
Phase Chang
thermal stora
stability

Thermal Highway© – Heat Sources & Sinks

- Buildings
  - **ADD** or **REMOVE** thermal energy
- Ground Loops
  - **ADD** or **REMOVE** thermal energy
- Cooling towers
  - Only **REMOVE** thermal energy
- Waste heat from power generators & CHP
  - Only **ADD** thermal energy

Today we will look at:

- *Wastewater Energy Recovery* (sanitary sewer, grey water, etc.)
  - **ADD** or **REMOVE** thermal energy
- *Solar PVT* (Solar Photovoltaics + Thermal)
  - **ADD** or **REMOVE** thermal energy



Colorado Mesa University
System Size ~ 3,500 Tons

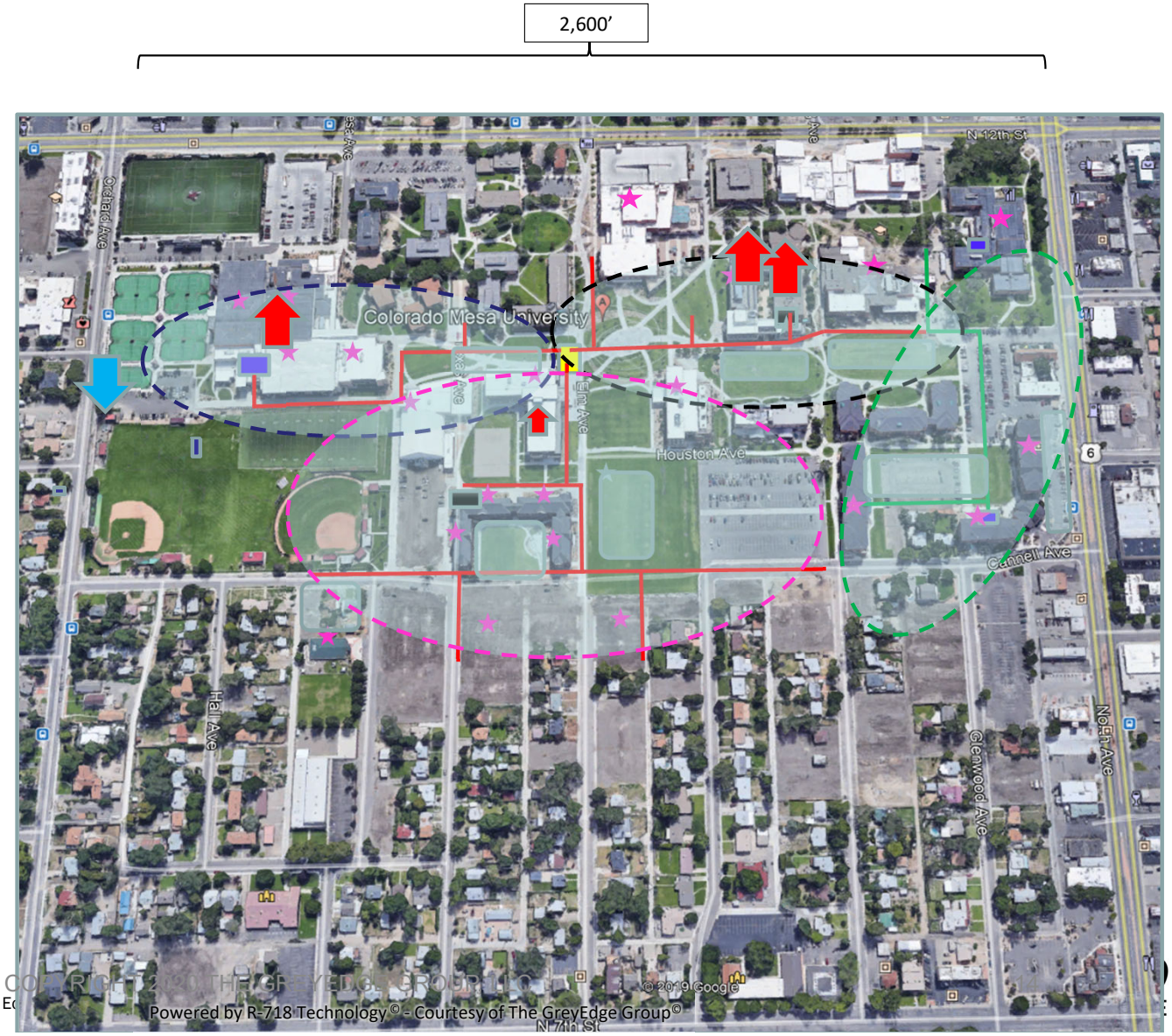
- Borefields – 121,000 feet
- Buildings

Thermal Highway

- 18” Pipes -
- 12” & 10” Pipes
- Vaults and Mechanical Rooms

GeoMicroDistrict

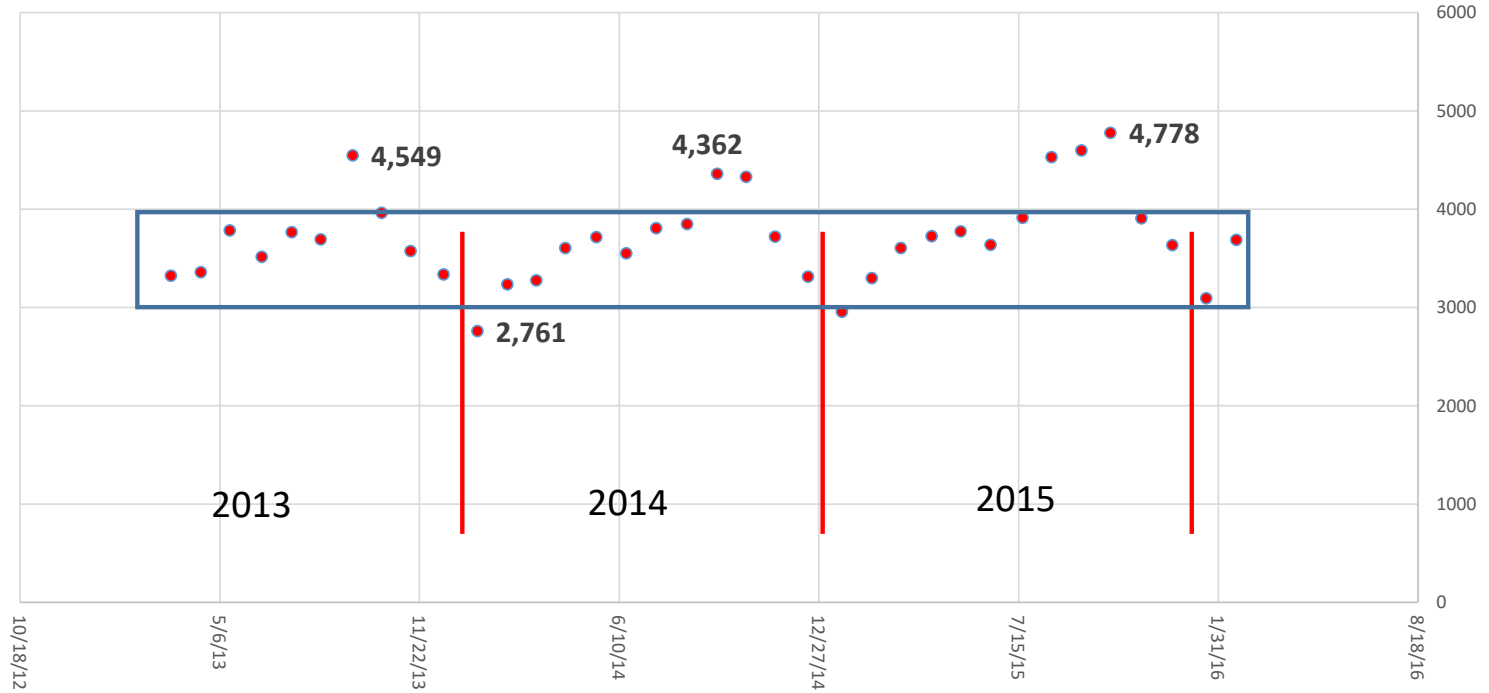
- Cooling Towers - 750 tons
- Future Irrigation (Heat and Cool)



Monthly Peak kW (Power) 2013 - 2016

800,000 Sq.Ft.
(74,322.4 m²)

1,200,000 Sq.Ft.
(111,484 m²)



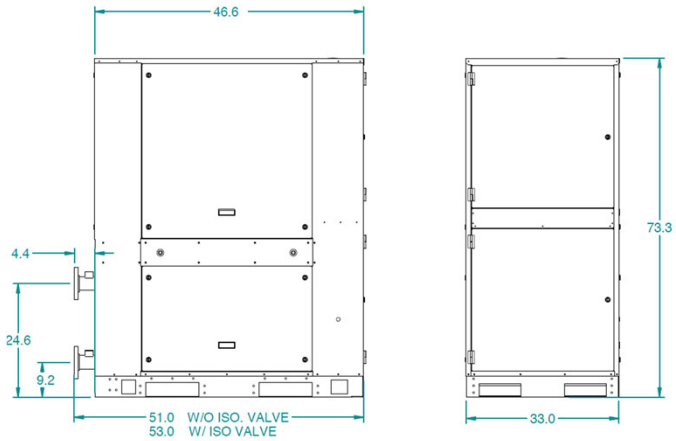
4 MW

3 MW

kW

Date

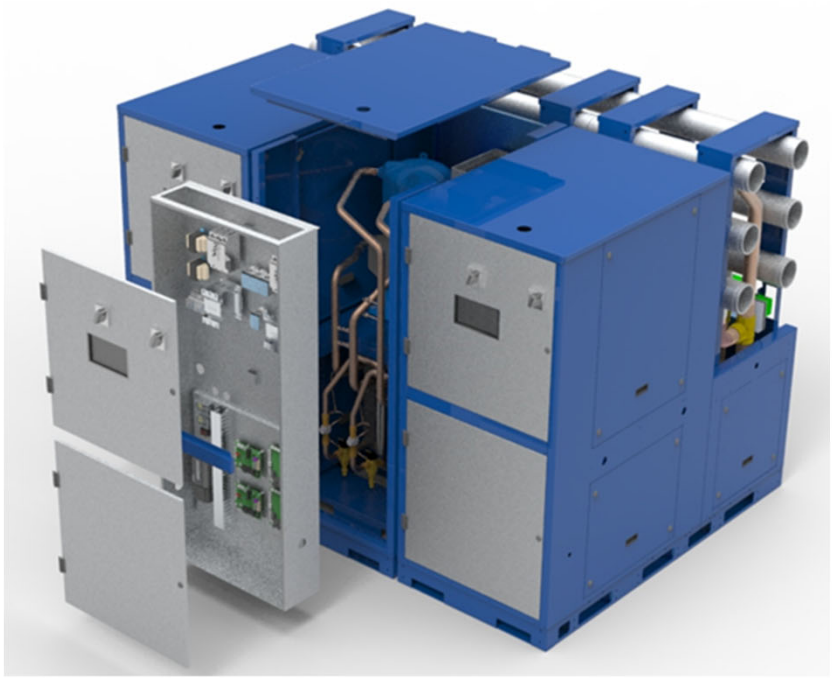
Larger Scale Solutions – 6 pipe heat recovery systems
Central Plant Solutions

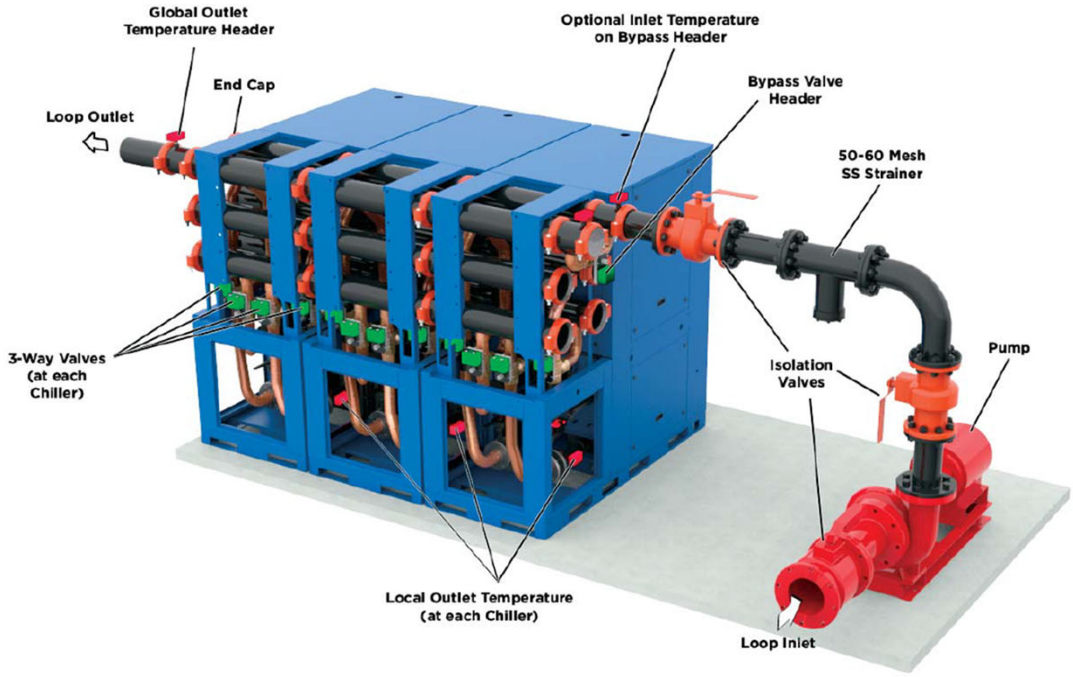


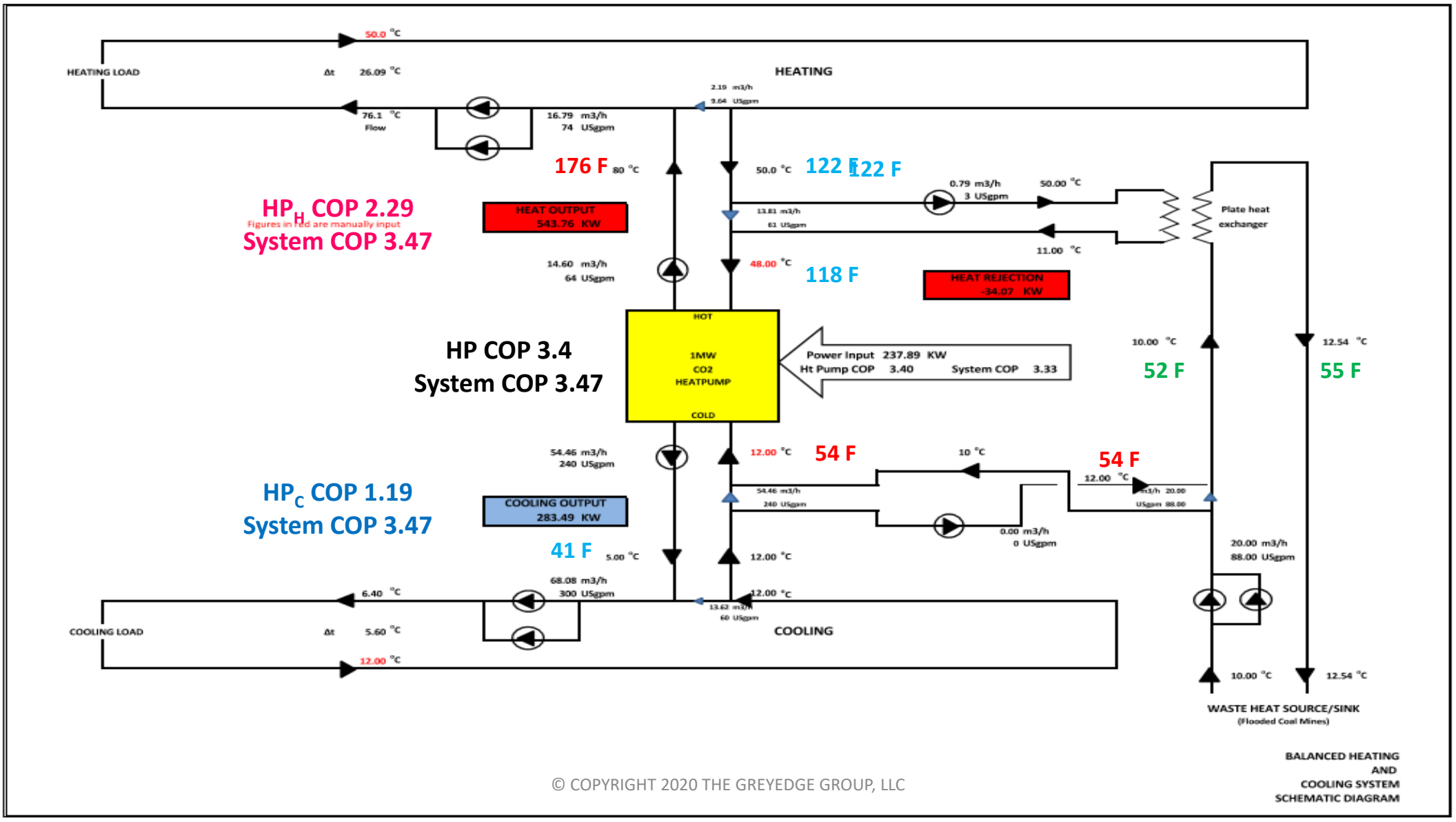
Modular Dual Scroll 20 – 80 Ton (each)

Modular Chillers

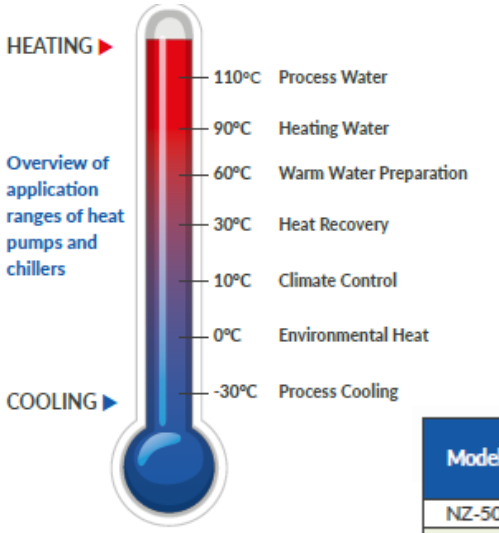
Individual Units Combined up to 300 tons (1055 kW)







BALANCED HEATING AND COOLING SYSTEM SCHEMATIC DIAGRAM



Overview of application ranges of heat pumps and chillers

Model	Heating capacity 20 -> 80 °C (kW)	Cooling capacity @ 7 °C (kW)	Power input (kW)	COP Heating (-)	COP Heating + Cooling (-)
NZ-50	50	35	11.4	4.39	7.46
NZ-100	100	70	22.48	4.45	7.56
NZ-200	200	140	46.1	4.34	7.38
NZ-300	300	210	66.8	4.49	7.63
NZ-400	400	282	84.2	4.75	8.10
NZ-500	500	350	110.9	4.51	7.66
NZ-600	600	425	127	4.72	8.07
NZ-700	700	495	148	4.73	8.07
NZ-800	800	565	169	4.73	8.08
NZ-900	900	635	188	4.79	8.16
NZ-1000	1000	710	219	4.57	7.81
NZ-1200	1200	830	271	4.43	7.49
NZ-1400	1400	980	314	4.46	7.58

Heat Recovery Generation

180LT CHARACTERISTICS

Electrical ratings	Maximum gross electric power	180 kWe
	Grid connection	400V, 3ph, 50-60 Hz
Heat source	Temperature range	158-248°F
	Thermal power input range	4.8 - 8.2 MMBTU/hr
	Hot source medium	Water, steam, oil
	Hydraulic connections	6 NB, PN 16 (232 psi)
Cold source	Temperature range	32-140 °F
	Working fluid	Water
	Cooling system	Dry cooler, cooling tower
	Hydraulic connections	8 NB, PN 16 (232 psi)
Main components	Working fluid	R1233zd
	Generator	Medium speed, permanent magnet
	Expander	Kinetic turbine
	Heat exchangers	Brazed plate
	Pump	Multi-stage magnetic coupling
	Controls	Industrial PLC
	Monitoring	Remote web support
Main ratings	Weight	15500 lbs
	Dimensions L x w x h	91 x 79 x 103 inch.
	Environmental	IP 20
	Noise level @33 ft.	60 dB
	Design lifetime	20 yrs
	Safety	Non flammable, non toxic, ODP=0
Norm compliance	Machine directive	2006/42/EG
	PED	2014/68/EU
	Electrical norms	2014/35/EG
	Grid codes	VDE-0126 (G59, VDE-ARN, UL,...)

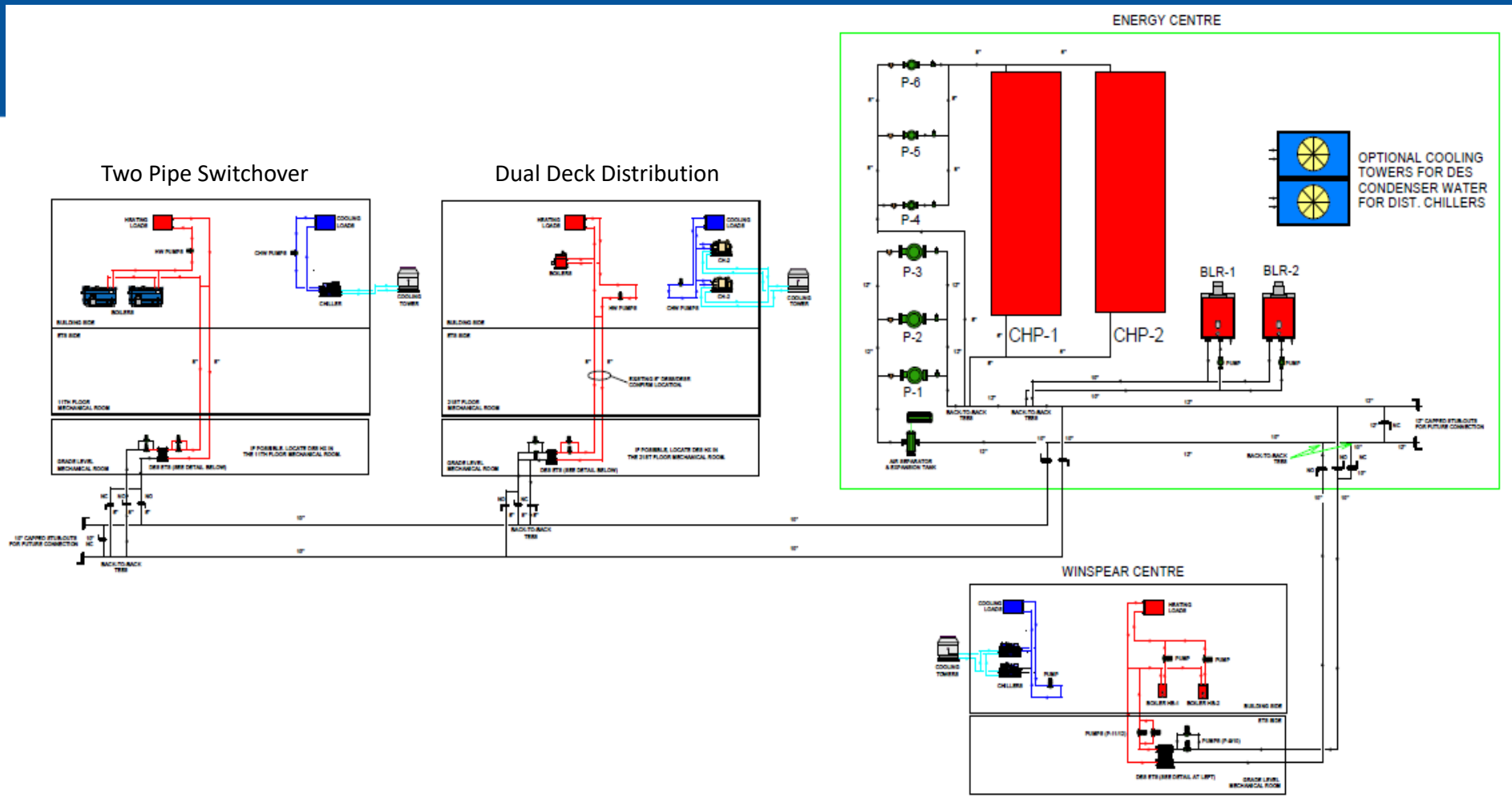
Alternative Refrigerant Hydronic Heat Pumps

	RE	P	S
Heating capacity EN 14511 0/35	210 - 420 kW	30 - 450 kW	180 - 2000 kW
Max. temperature of heat produced *	62 °C	120 °C	85 °C
Min. temperature of cooling produced *	-15 °C	-20 °C	-15 °C
ChillHeat product suitability for various applications			
Combined heating and cooling	●●●	●●●	●●●
Heat recovery at refrigeration plants	●	●●●	●●●
Heat recovery from waste water	●●	●●●	●●●
Ground source heating	●●●	●●●**	●●
Heat recovery from flue gases	●	●●●	●●●
Heat extraction from outdoor air	●●●	●●●	●●●
Heat recovery from industrial processes	●	●●●	●●●
Water chiller applications	●●●	●	●●
Refrigeration applications	●●	●●●	●●●

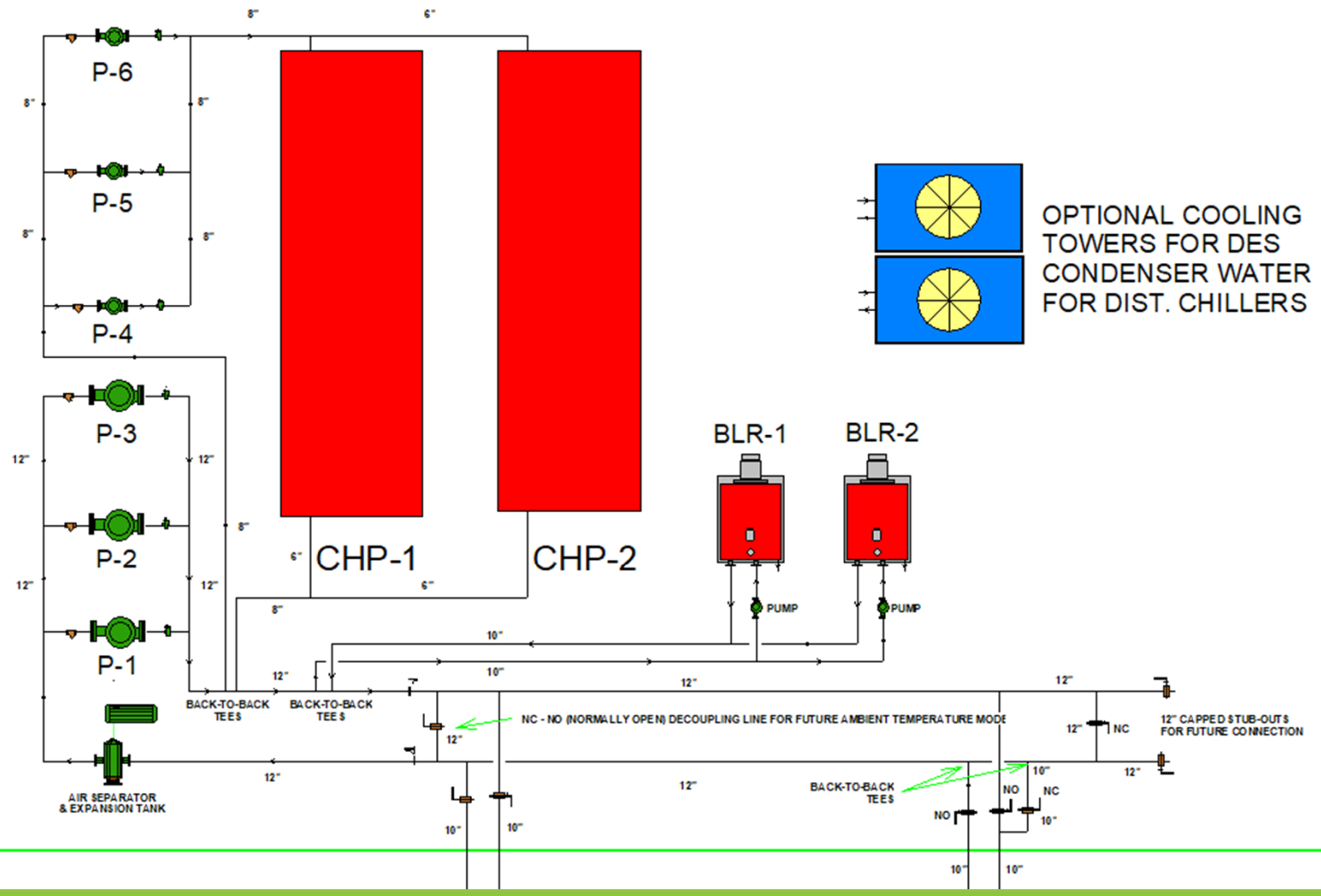
Changeover from High Temperature to Ambient

Process:

1. Identify driver zones and problem areas.
2. Identify areas for Co-gen and/or heat recovery.
3. Identify wasted energy recovery opportunities and part load opportunities.
4. Reduce delivery temperature in the shoulder months (hydronic reset) – nothing needed in building.
5. Supplement problem areas to further drive delivery temperatures towards optimal –(high or low).
6. Investigate twinning or replacing coils in delivery system
7. Investigate alternate heat pump refrigerants and heat recovery options for equipment replacement
8. Drive system to heat pumps and economizers
9. Drive supply loop to an ambient range (50 F to 85 F)

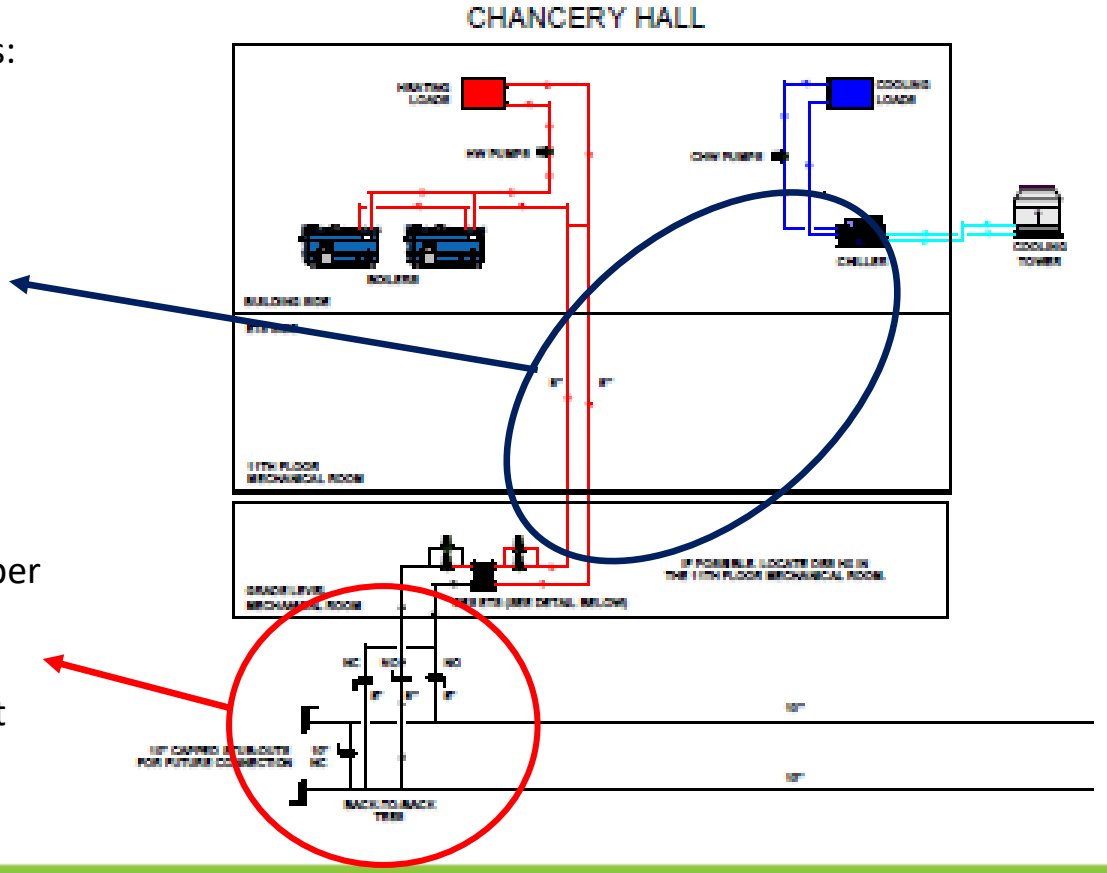


ENERGY CENTRE

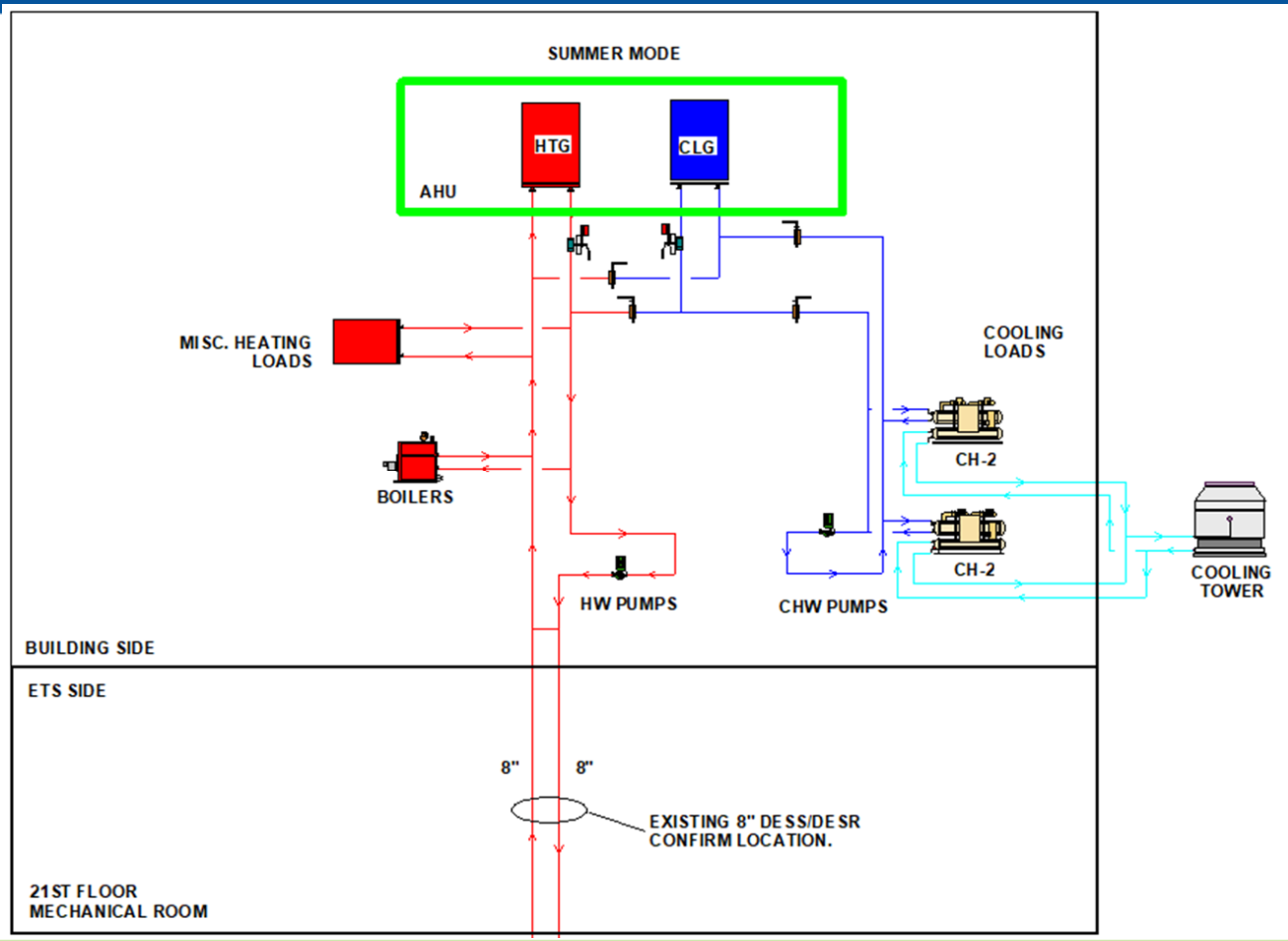


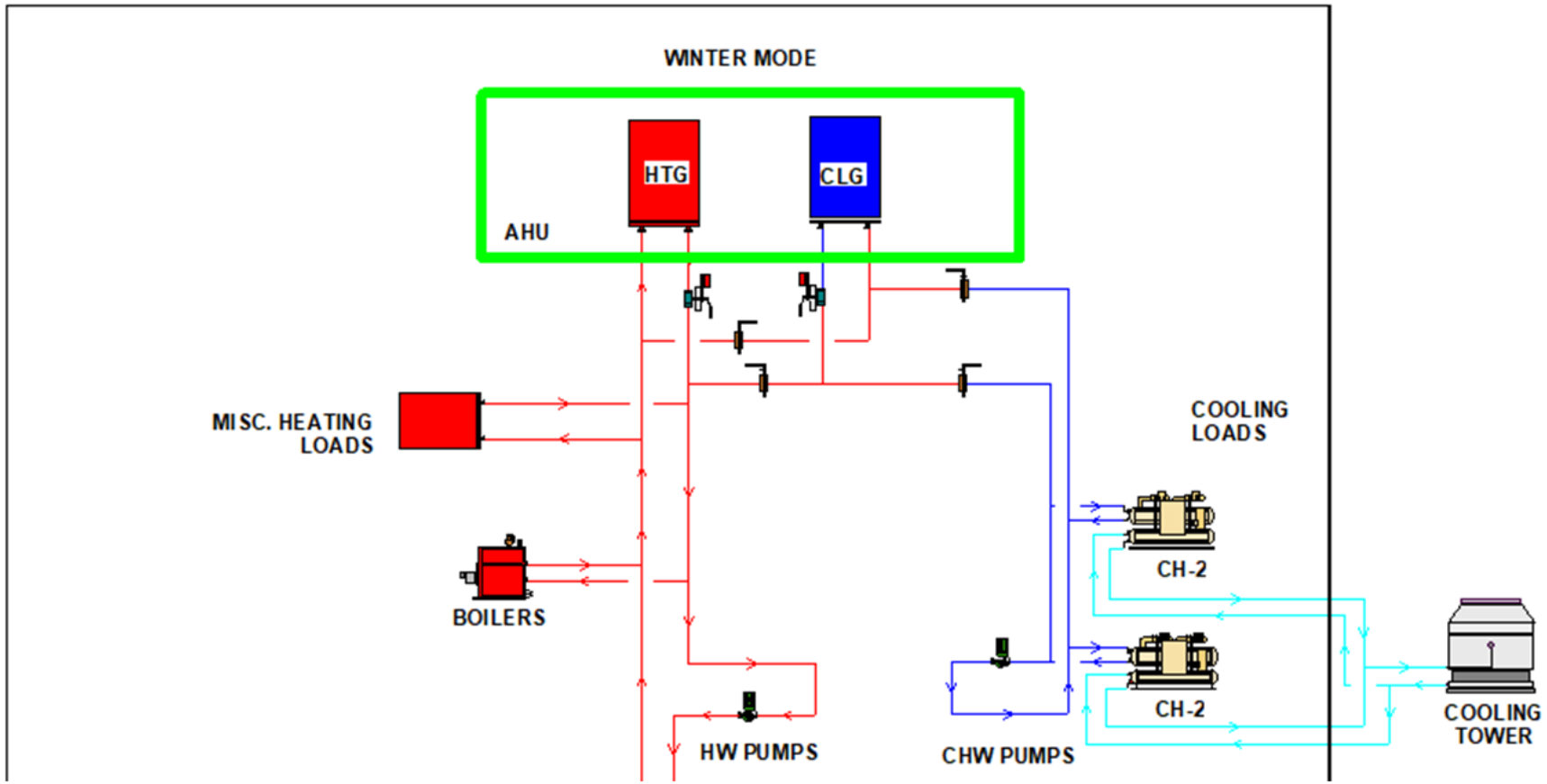
Adapting system for future move from hot/cold distribution to Ambient loop supply temperatures:

- Prime movers may move to the building
- Interconnect chilled water to use both coils – reduce deliver temperature
- Floor-to-floor retrofit may be possible with modular heat recovery driver heat pumps.



- Plumb Supply lines for current use with jumper for future primary-secondary one pipe loop.
- Plumb Energy Center primary-secondary to enable use as a “casual asset” on an ambient loop.





Other heat sources

High Temp Mitigation

Wastewater/black water – transition and/or original w. CO_2 or other
Solar thermal – transition and original source
Steam condensate – transition btu/h & and kwh

Ambient Temperature Plug & Play - Pivital Equipment – Heat Recovery Refrigerant Circuit (Simultaneous Heat/Cool)

Other buildings - ambient
Geothermal – capture, storage and time of use/ambient
- Standing column -
- In-foundation drilling - am
- Surface water - ambient

Energy *harvested*, *moved*, and *reused*

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High Temperature Conversion And District Systems: How They Work

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