De-Carbonizing the Campus: Planning, Tools & Technologies

CampusEnergy2023

February 27 – March 2, 2023

Gaylord Texan Resort & Convention Center | Grapevine, Texas

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Campus Upgrades: Geothermal Energy Networks

36th Annual Campus Energy Conference, Workshops & Trade Show

CampusEnergy2023

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Gaylord Texan Resort & Convention Center, Grapevine, Texas

IDEA CampusEnergy2023

March 01, 2023

egg geo

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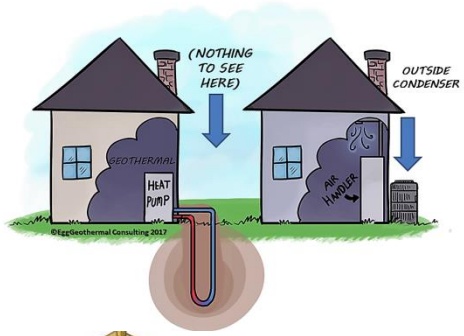
Defining the Future of Geothermal

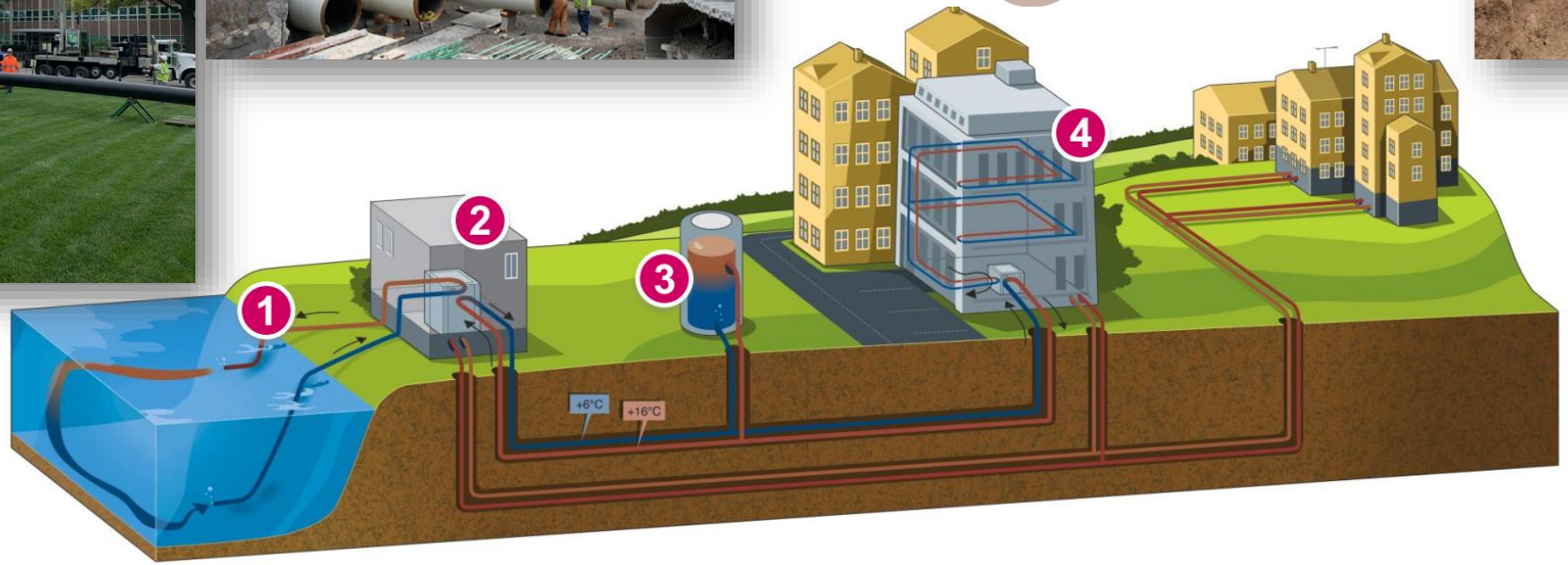
A Geothermal Energy Network involves thermal infrastructure

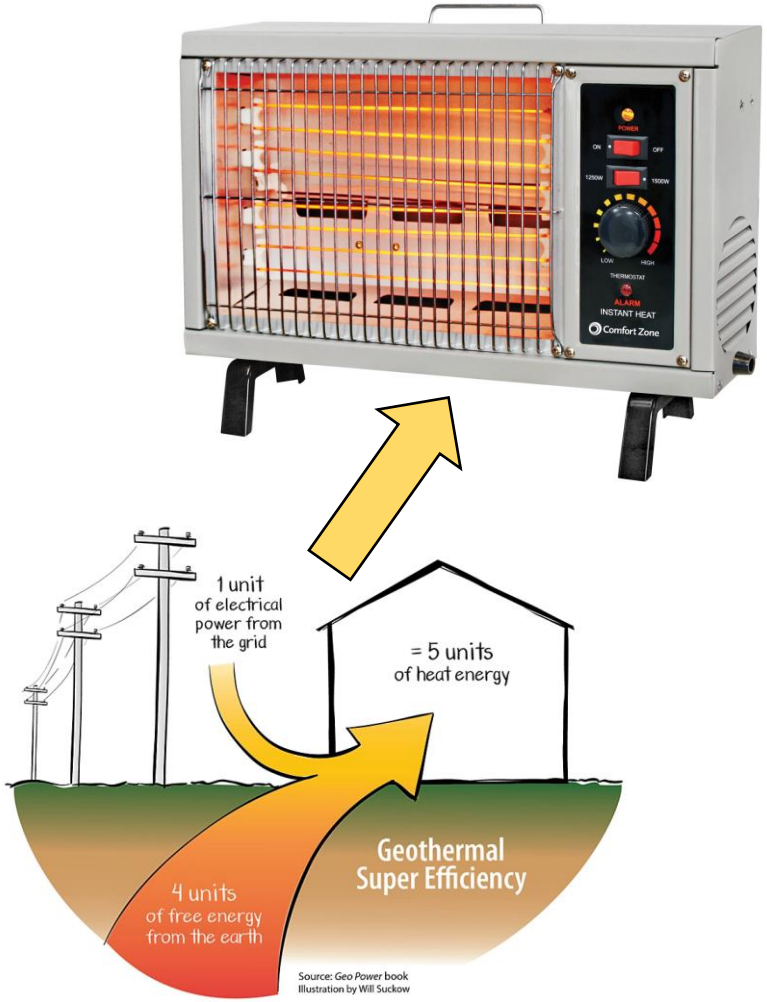
Convert Natural Gas to Geothermal Energy Networks

Energy Input	Infrastructure	Utilization Technology	Functional Output	
Thermal Energy (Earth Exchange)	Pipe in the Ground	Heat Pump (Compression) 300%+ Efficiency	Heating & Cooling	Geothermal
Natural Gas (Consumed)	Pipe in the Ground	Furnace/Boiler (Combustion) ~95% Efficiency	Heating (only)	Natural Gas

Thermal Energy Networks share energy between structures using pipes between buildings and their Geothermal Heat Pumps







1 kW of Electricity = 3412 BTUs = 3,412 BTUs of heat (Space Heater)

= 17,060 BTUs of heat* (Thermal Loop Heat Pump)

- ***It takes 20% the kW to do the same heating with a thermal loop heat pump***

*@ 5.0 COP

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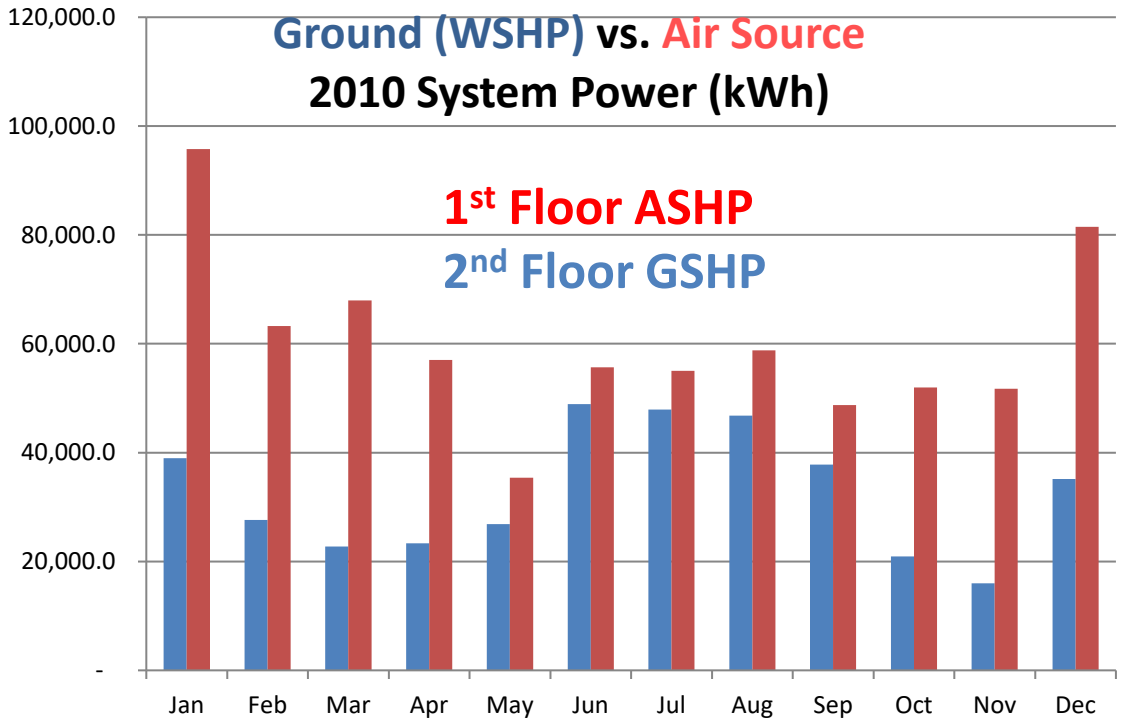
Understanding efficiency; the ASHRAE Building in Atlanta

Thermal Energy Heat Pumps consume less energy than air-source heat pumps



Power Consumption at ASHRAE Bldg., Atlanta

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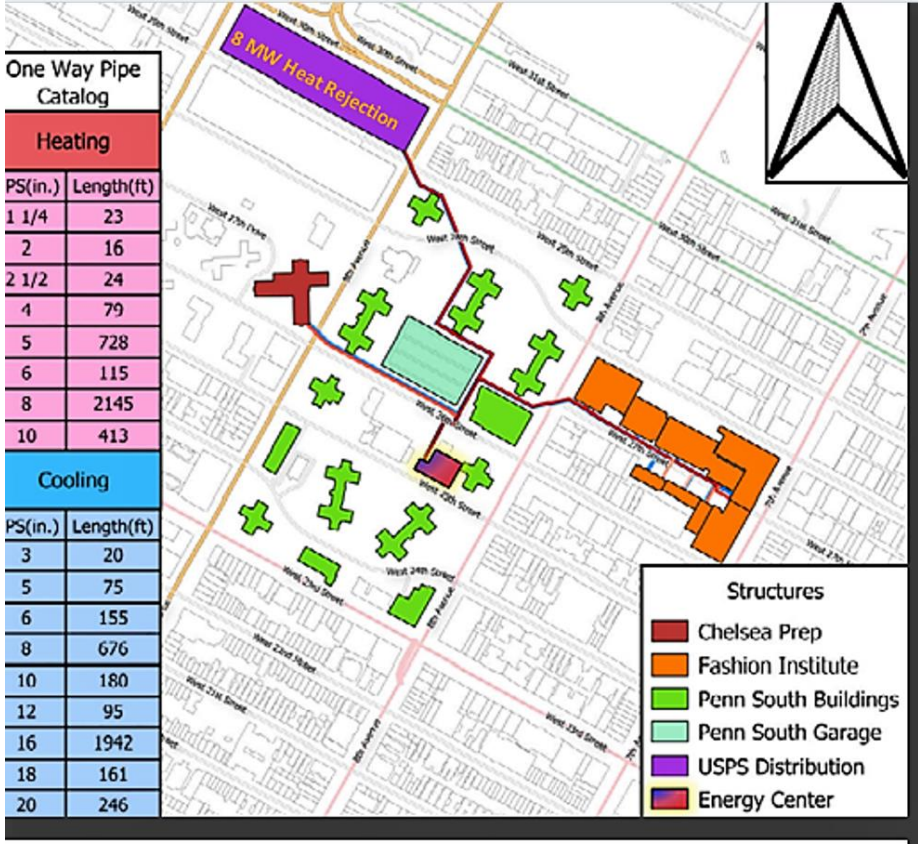
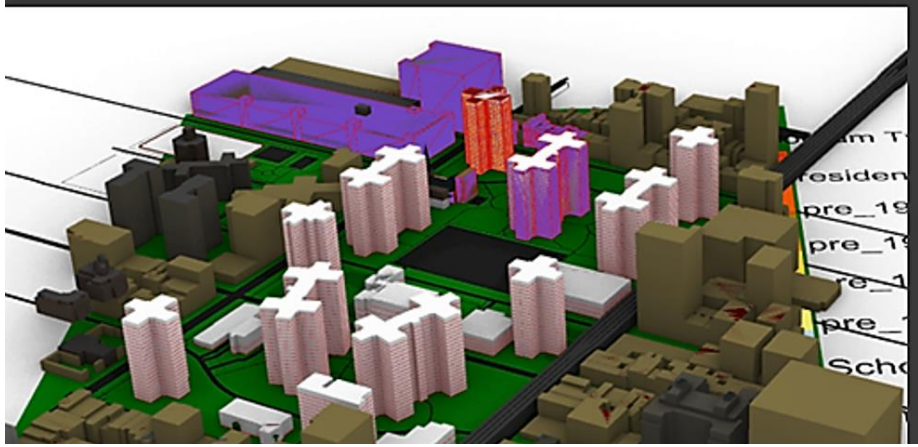
One Way Pipe Catalog	
Heating	
PS(in.)	Length(ft)
1 1/4	23
2	16
2 1/2	24
4	79
5	728
6	115
8	2145
10	413
Cooling	
PS(in.)	Length(ft)
3	20
5	75
6	155
8	676
10	180
12	95
16	1942
18	161
20	246





Thermal Energy Network Modeling

Penn South Campus and Adjoining Properties

EGG GEO

TASK 3

FLOW DIAGRAM

WELL DATA TO BE VERFIED BY HYDRGEOLOGICAL TESTING

-

WELL CONFIGURATION SUBJECT TO CHANGE

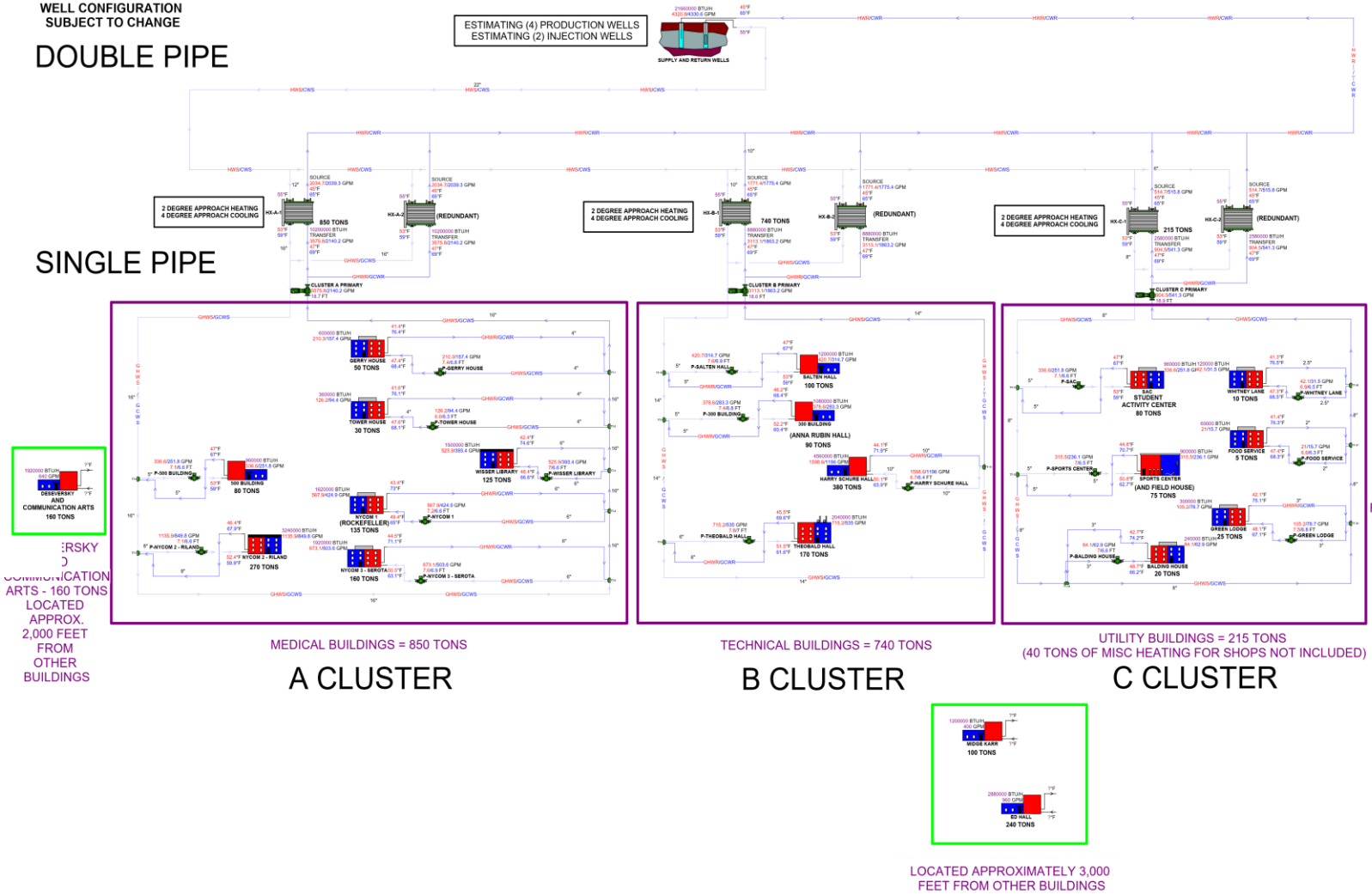
DOUBLE PIPE

SINGLE PIPE

2,580 TOTAL TONS

1,805 CONNECTED TONS

4,330 GPM



ERSKY
COMMUNICATION ARTS - 160 TONS LOCATED APPROX. 2,000 FEET FROM OTHER BUILDINGS

MEDICAL BUILDINGS = 850 TONS

A CLUSTER

TECHNICAL BUILDINGS = 740 TONS

B CLUSTER

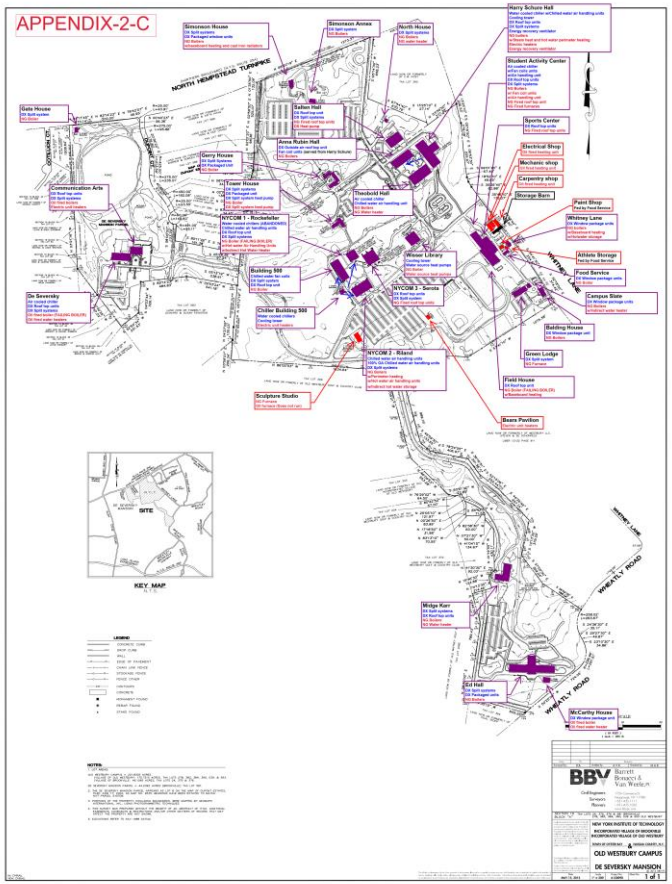
UTILITY BUILDINGS = 215 TONS
(40 TONS OF MISC HEATING FOR SHOPS NOT INCLUDED)

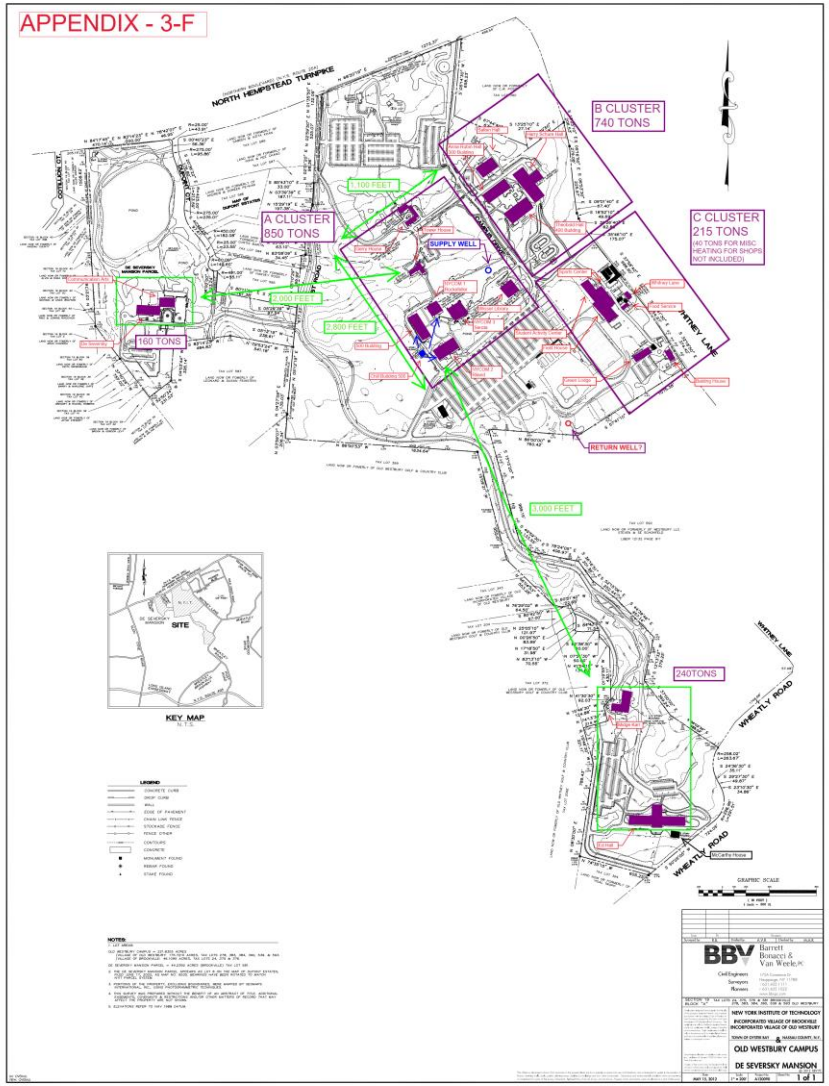
C CLUSTER

FUTURE DORM - 275 TONS

LOCATED APPROXIMATELY 3,000 FEET FROM OTHER BUILDINGS

Modeling and Inventory of Data for Heating and Cooling a Campus





Building Electrification Promotes Load Sharing / Diversification of Energy Resources

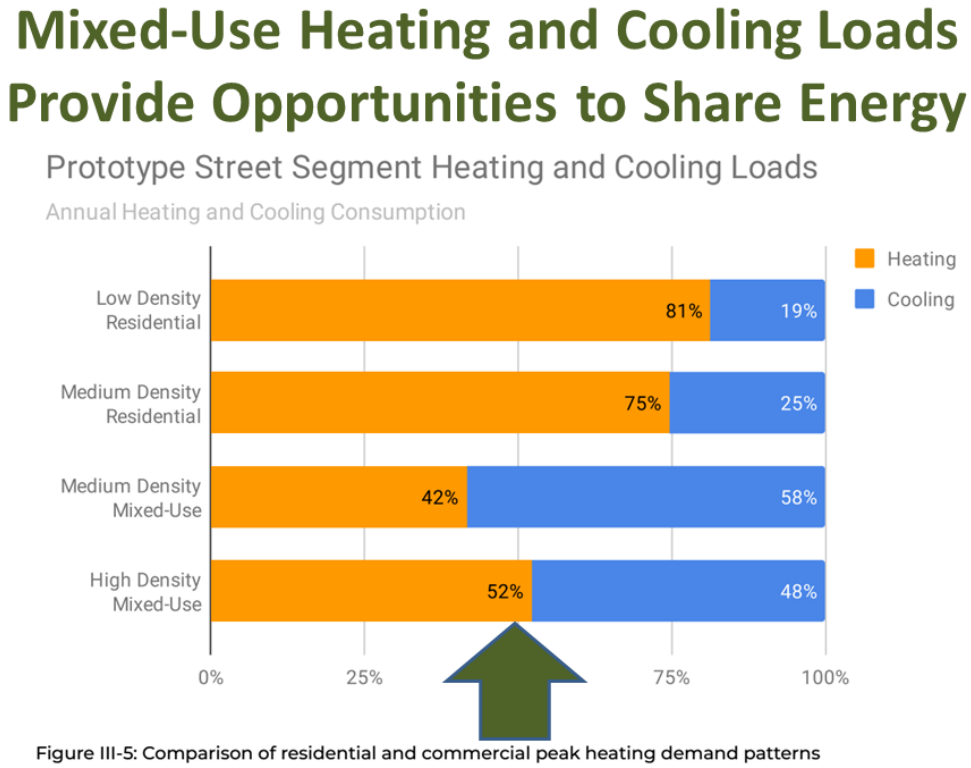


Figure III-5: Comparison of residential and commercial peak heating demand patterns

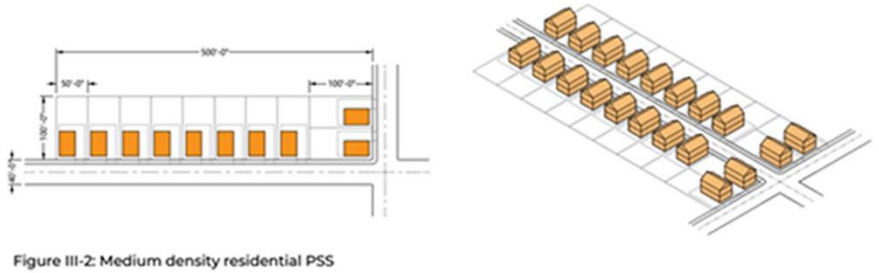


Figure III-2: Medium density residential PSS

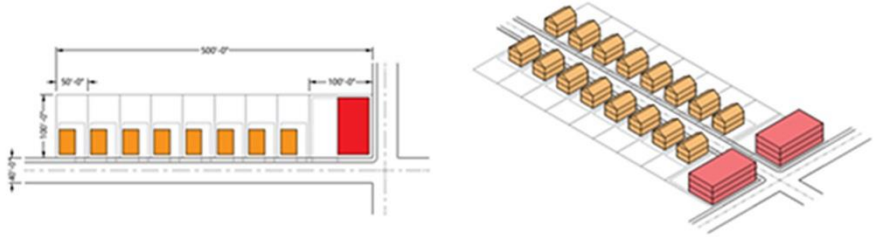


Figure III-3: Medium density mixed-use PSS

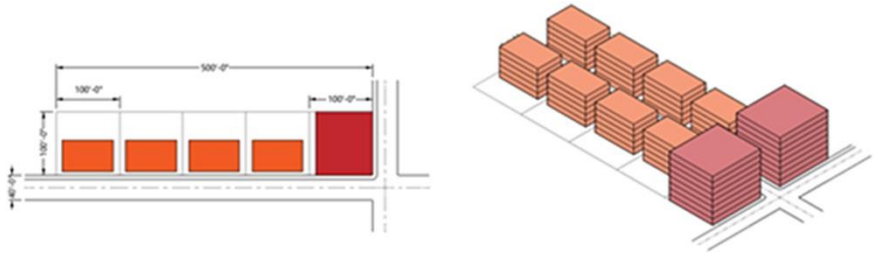
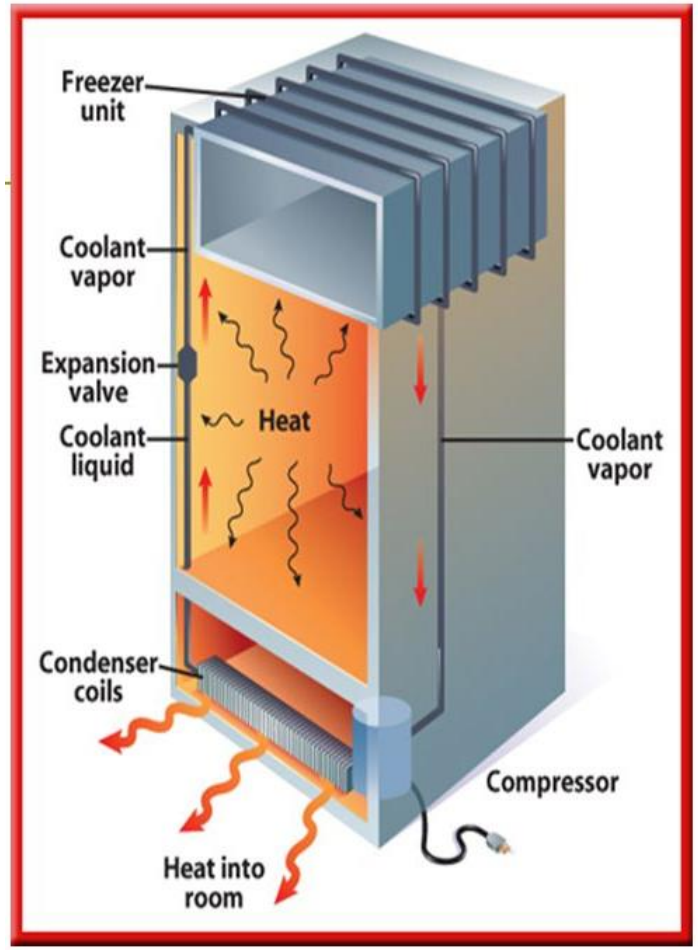
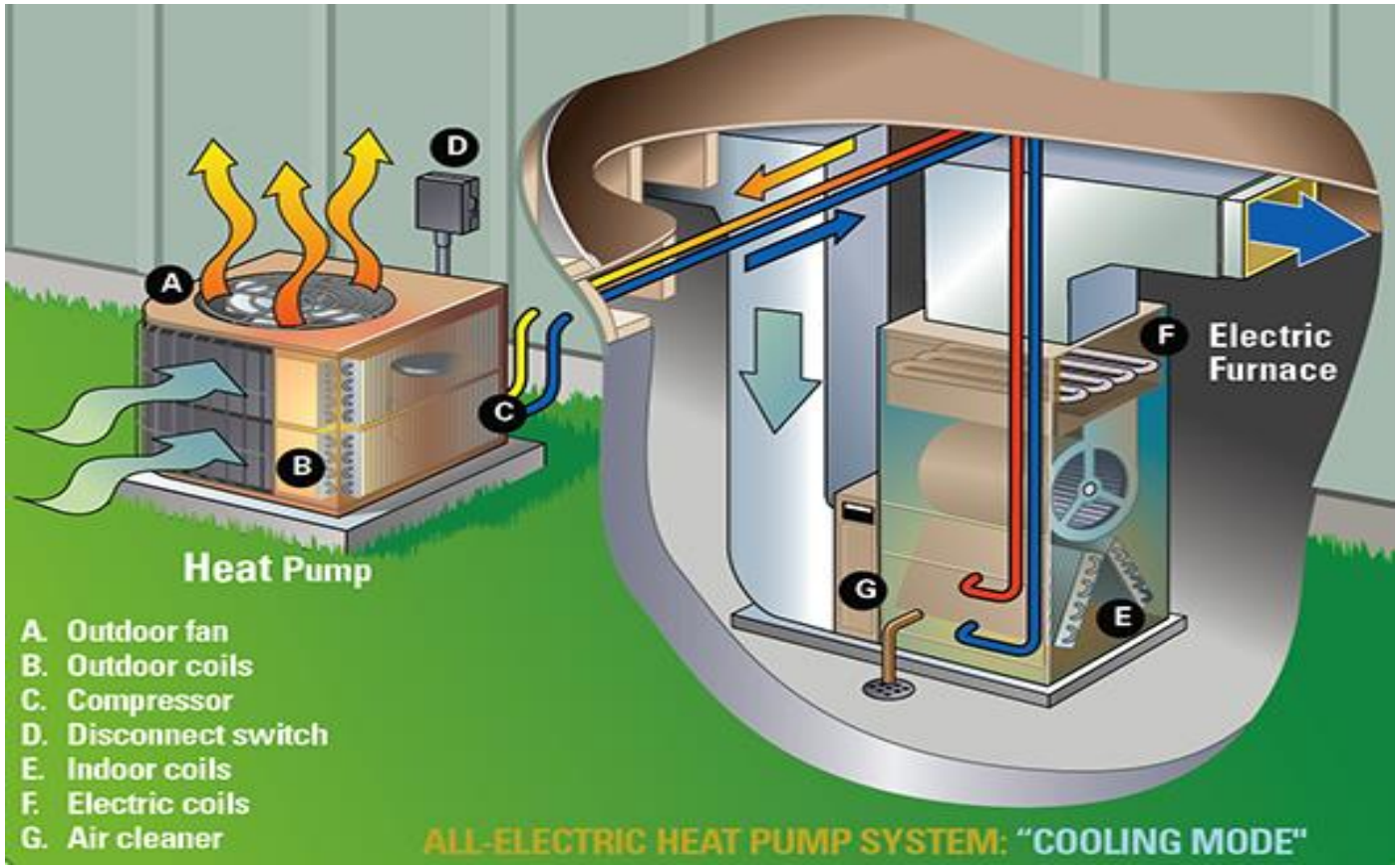


Figure III-4: High density mixed-use PSS

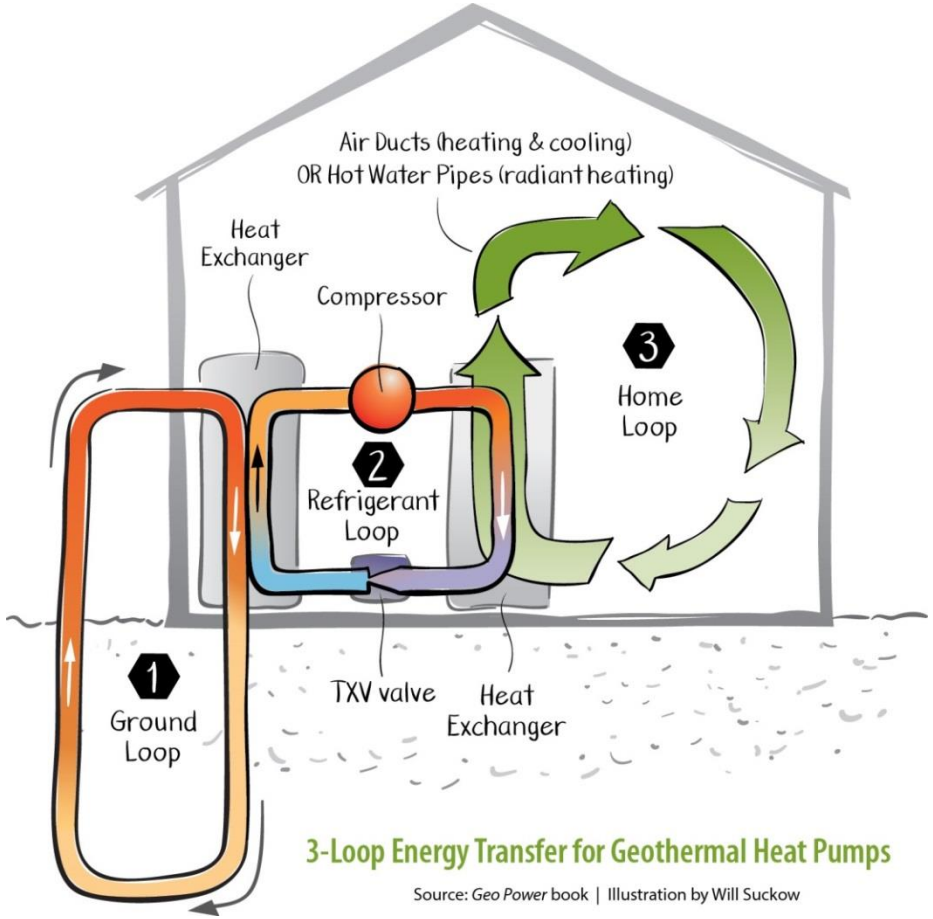
Heat Pumps: How to cool & heat spaces by "pumping heat"- exactly like a refrigerator

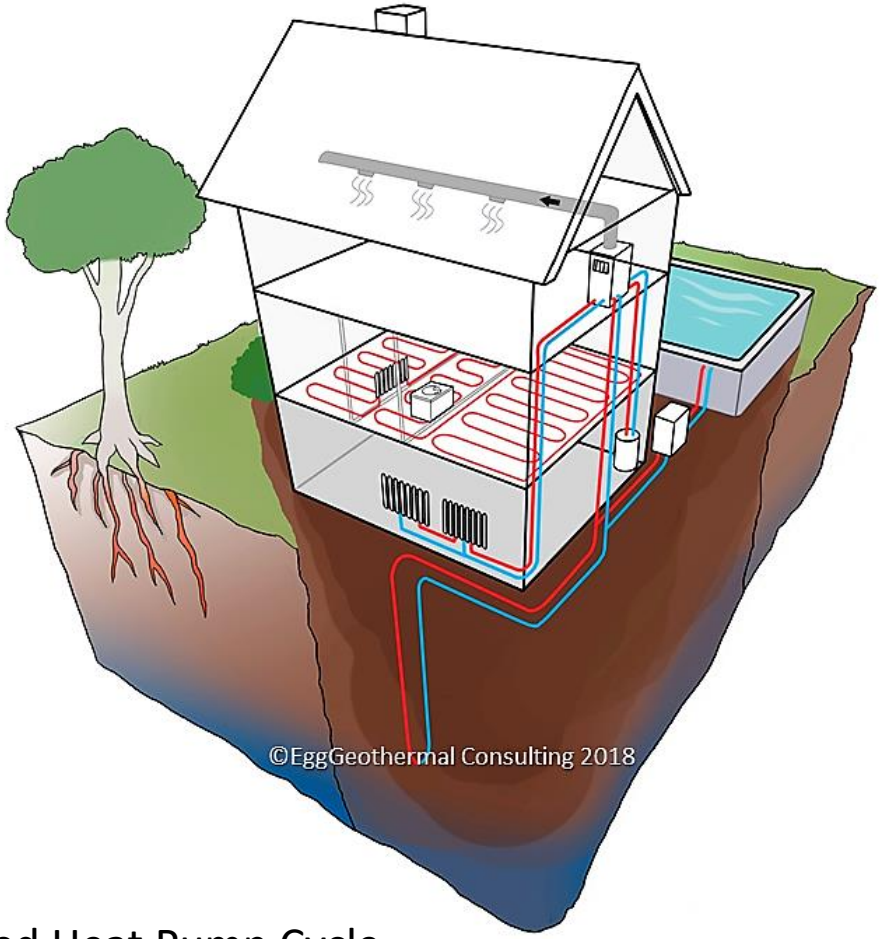




Heat Pump = about 3.0 to 5.0 + COP

Understanding the refrigeration cycle in a water source, or Geothermal Heat Pump (GHP)





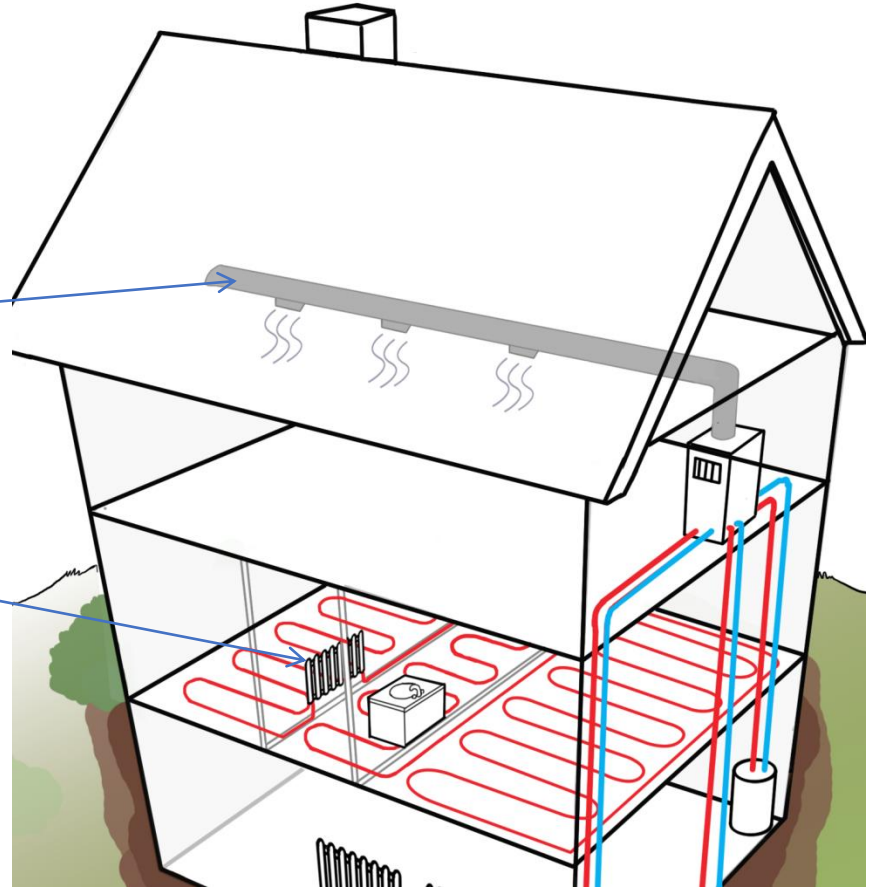
Animated Heat Pump Cycle
https://youtu.be/cGyEUZVGpxw

Forced Air & Hydronic Distribution

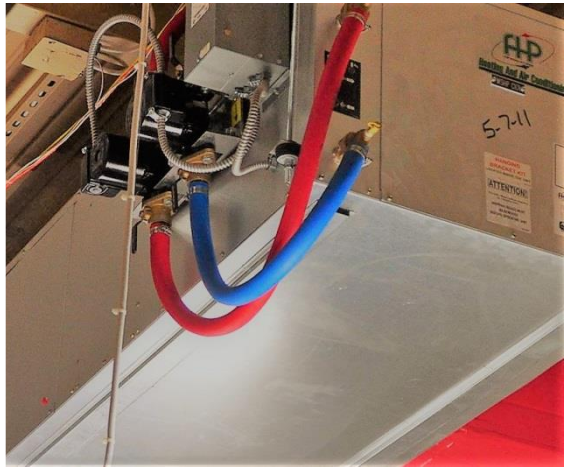
There are generally two ways to get the heating and cooling to the areas served

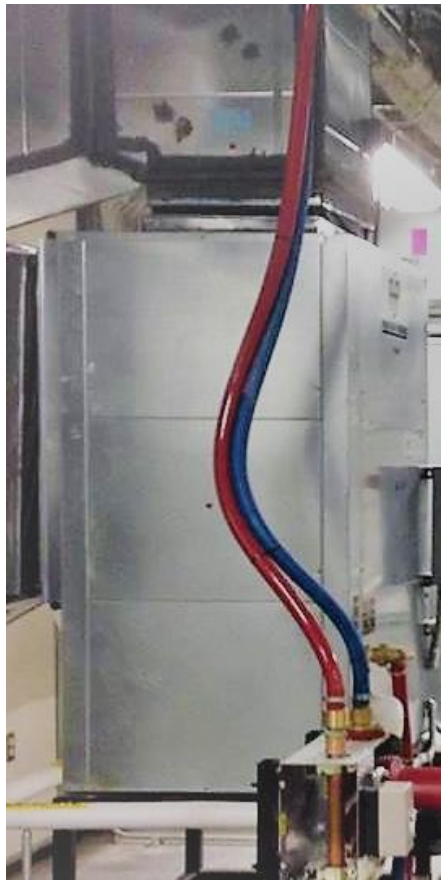
- Forced air: usually through ducted systems
- Hydronic distribution: usually through water based heat transfer fluids*

*refrigerant based distribution circuits are also used



Like ASHPs GSHPs are also designed to fit every type of structure



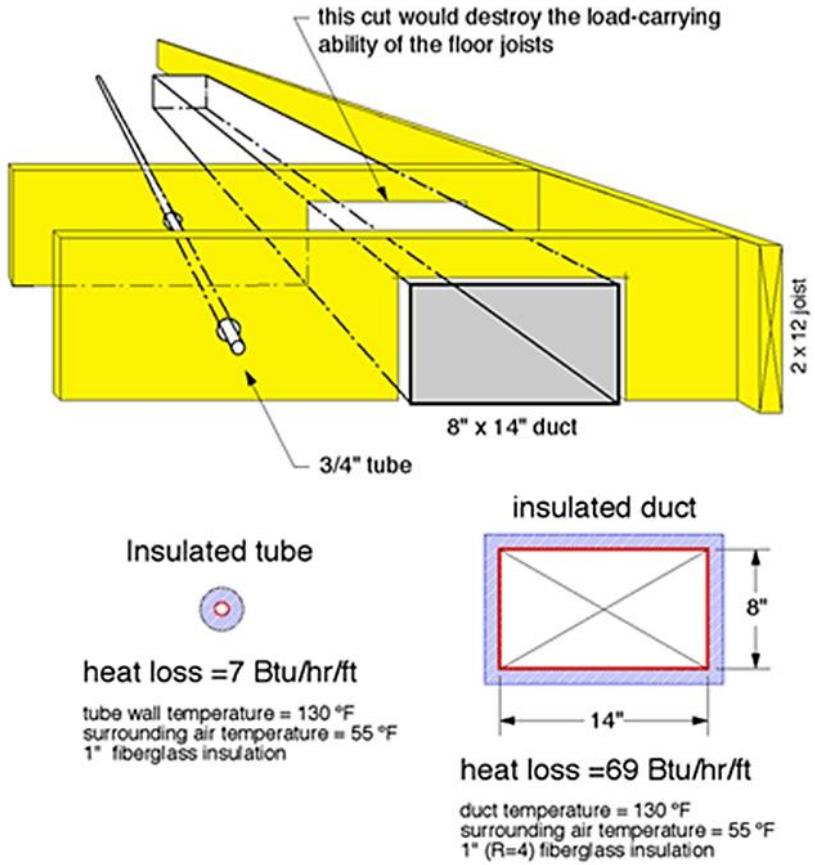


GHPs to fit every type of building, even roof tops

Replacement Roof Top GHPs

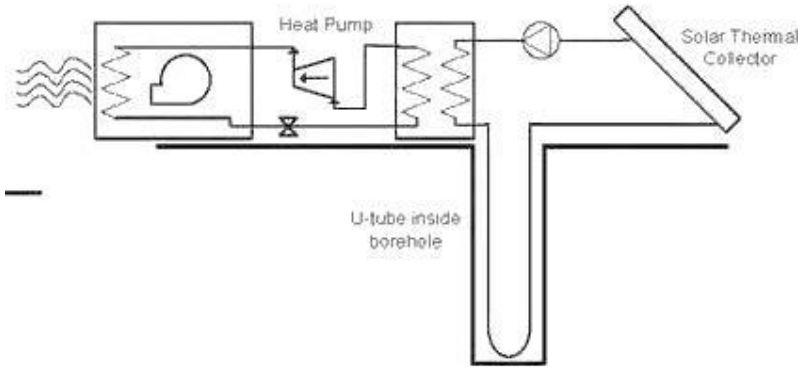
All Inside 100% Fresh Air (DOAS)

Less Energy is required to move BTUs in Water/Fluid compared to Forced Air



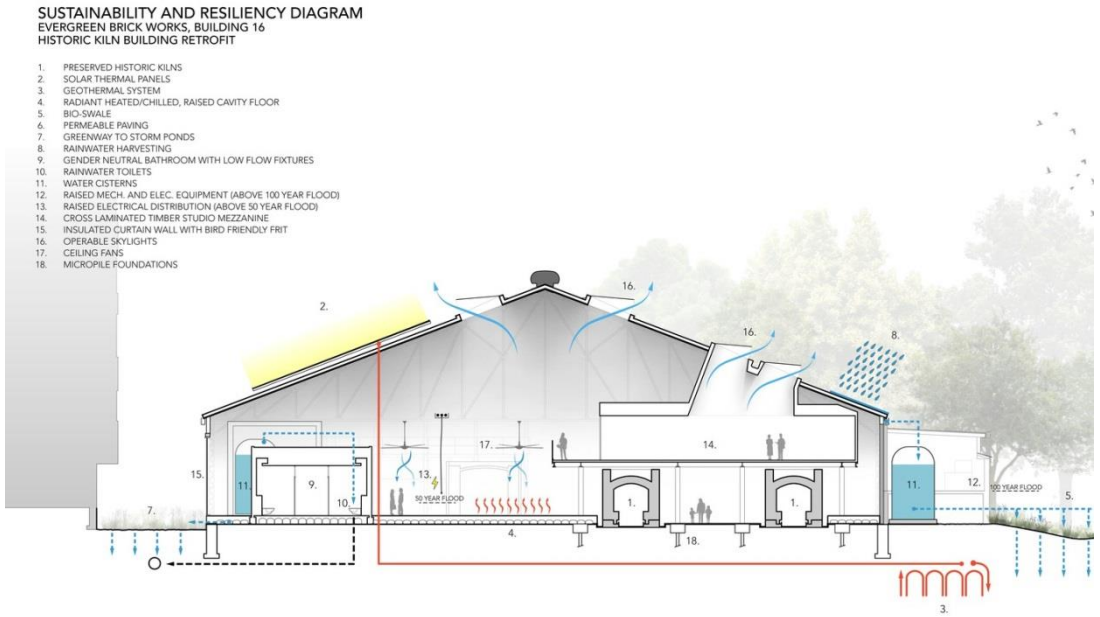
- A ¾” pipe can effectively carry the same cooling and heating energy as an 8” X 14” air duct
- Construction is simplified and space is optimized
- Energy is saved in pumping vs. fan power
- Almost 10x more energy is lost through the walls of the duct

Hybrid System Configurations

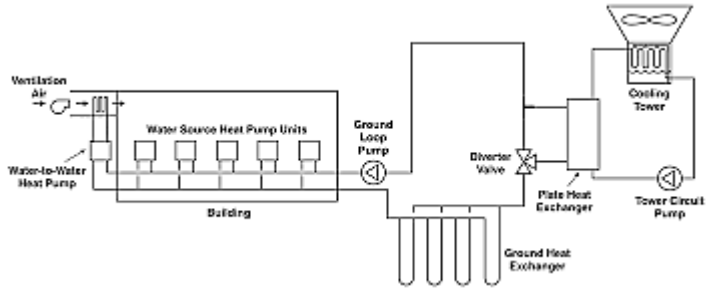


Solar Thermal Hybrid

- Like the hybrid dry cooler, predictive logic off-peak a solar thermal systems will amplify the heating capacity of the GSHP system.
- Gas Boiler can handle peak heating needs in these situations.

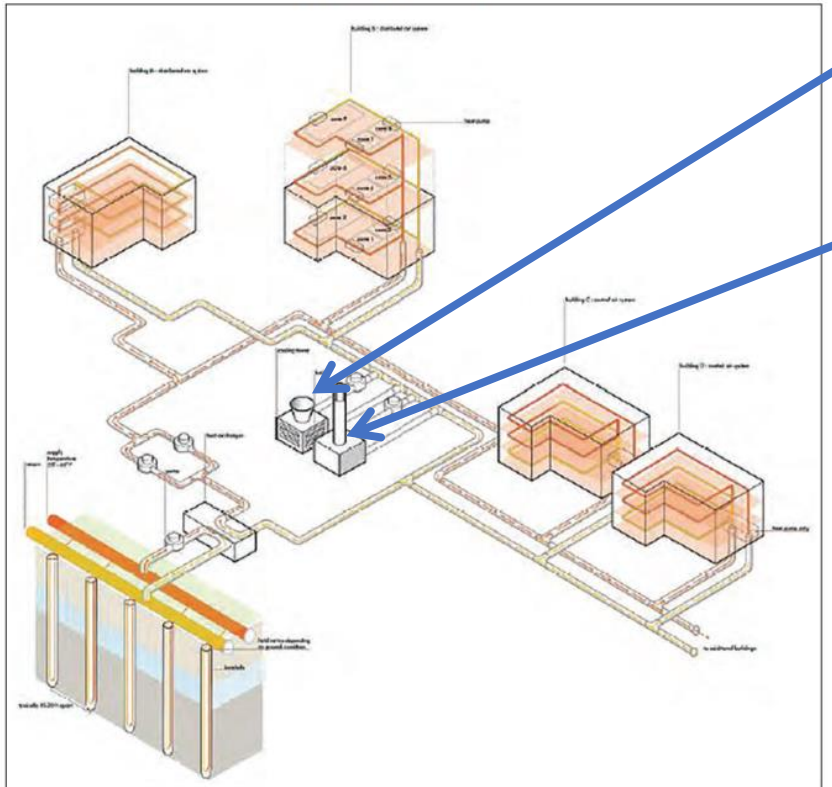


Hybrid System Configurations



- The most significant advantage of a hybrid systems is the ability to economically meet a building load that, if designed with a ground loop alone, would be more costly.
- For this reason, a hybrid system is sometimes the better choice for a short-term investment ROI

Figure 2.2d Hybrid GHX



Heat exchanged through one of the GHX options above (Tables 3.2a-c) in concert with other heat sources and sinks that are not ground-coupled, e.g., boiler, cooling tower, boiler or solar collector; can serve unbalanced seasonal loads, reduce land area and cost of GHX, and take advantage of other available heat sources and sinks.

Hybrid Configuration

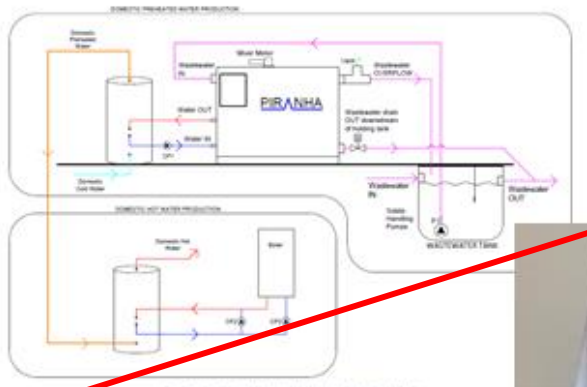
With all of these building types, peak loads can be managed with “Peaker” plants

- These could be Hydrogen Fired End Use Facilities
- Designed to provide Needs +1
- Could provide a boost of needed heat on extended cold snaps
- Provides a heat source when other heat sources and sinks are out of commission for any reason

Other great resources include Wastewater Energy Recovery; can reduce loads by 40% to 60%

Sharing Knowledge Curriculum and Education

Wastewater Energy Recovery: Sharc Piranha



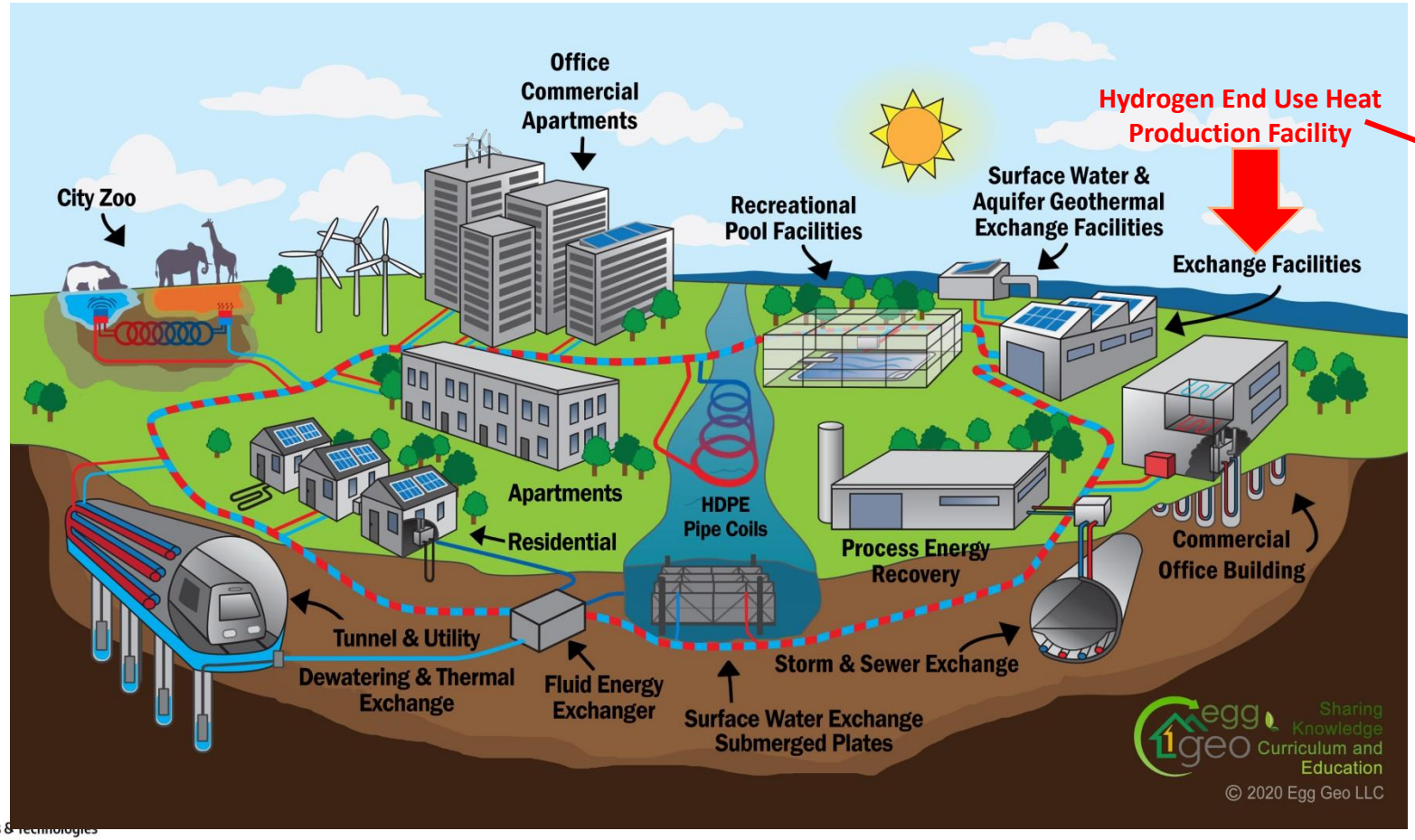
EPRI ELECTRIC POWER RESEARCH INSTITUTE

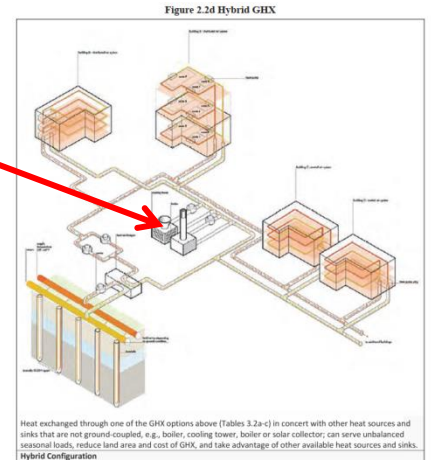
Ameren ACCELERATOR

As Geothermal Energy Networks are built up, there will be a need to supplement heat periodically, and as back-up for unforeseen weather events and load conditions

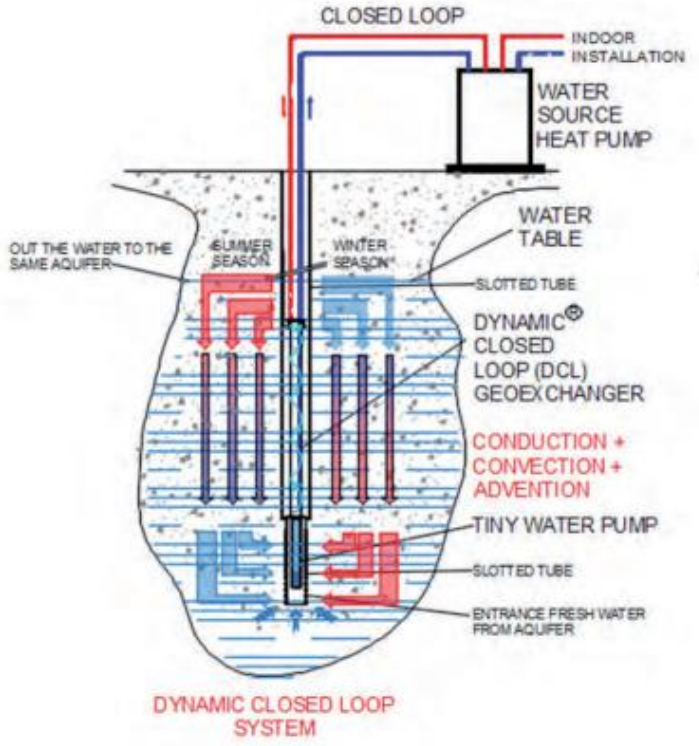
CEATI INTERNATIONAL DEMAND SIDE ENERGY MANAGEMENT PROGRAM

Homes and buildings will come off of individual loops, and onto the 'Geo-Thermal Energy Grid"





The Dynamic Closed Loop (DCL) Concept (Spain)



ENVIRONMENTAL SUSTAINABILITY

- HEAT-EXCHANGE INSIDE THE WELL:
- LESS PUMP ENERGUY NEEDED
- ZERO WATER EXTRACTION FROM THE WELL
- ZERO GROUND THERMAL AFFECTION

Aquifer Based Thermal Exchange: Dynamic Closed Loop & Open Exchange Wells

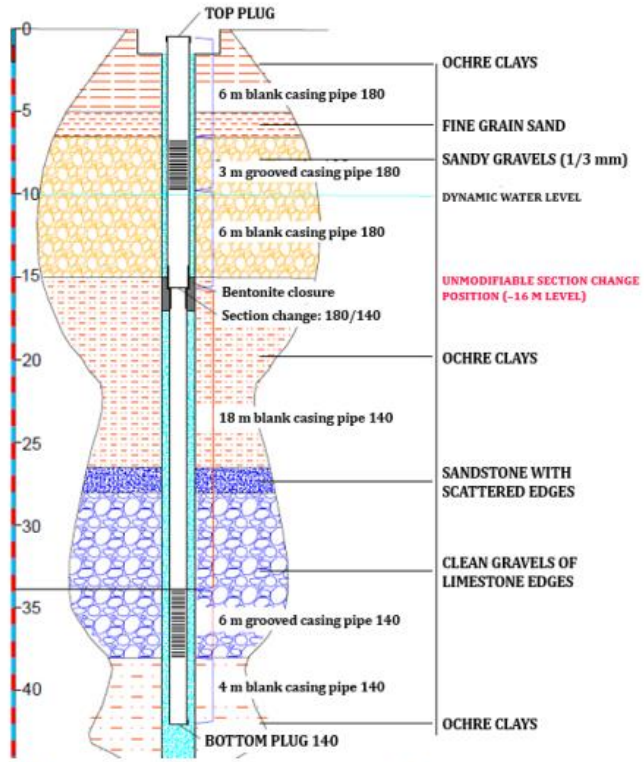
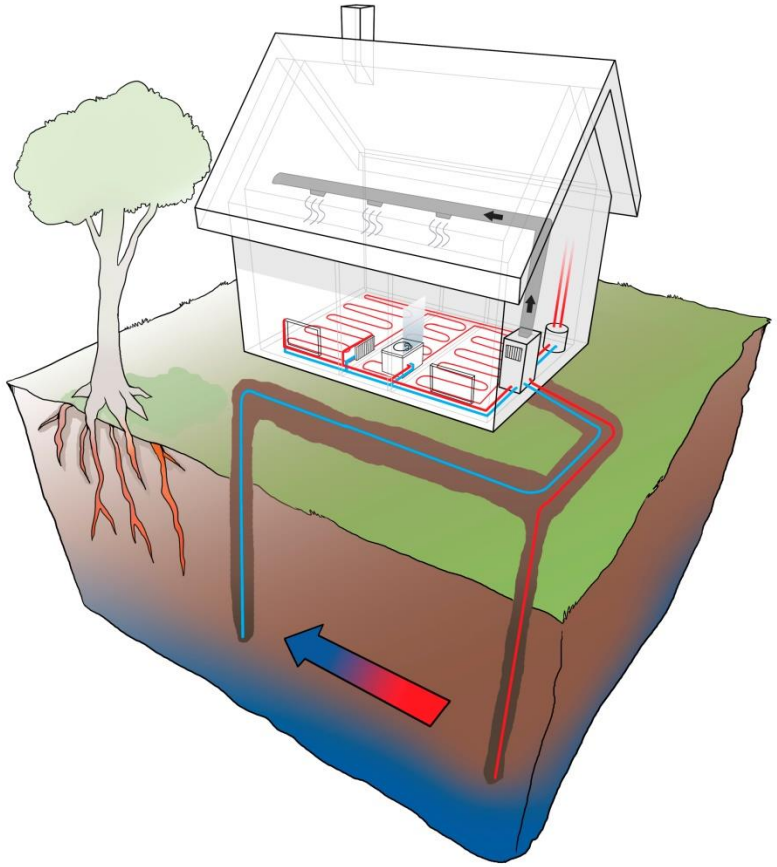
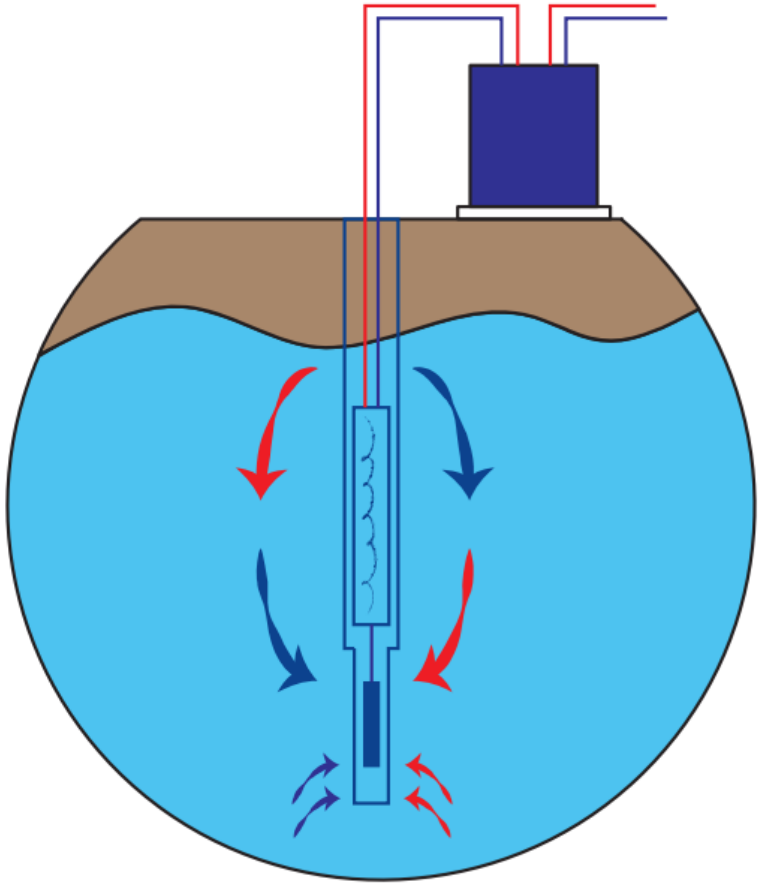
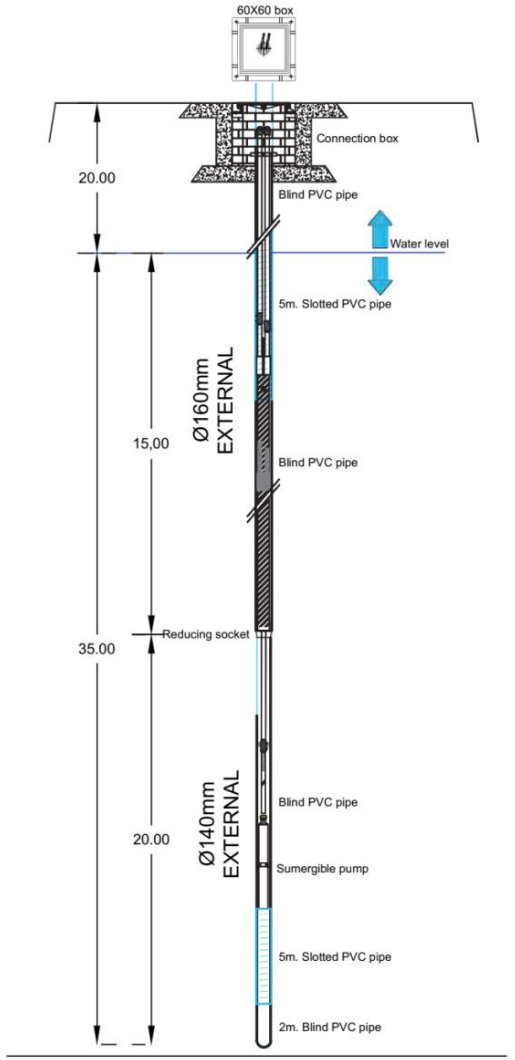


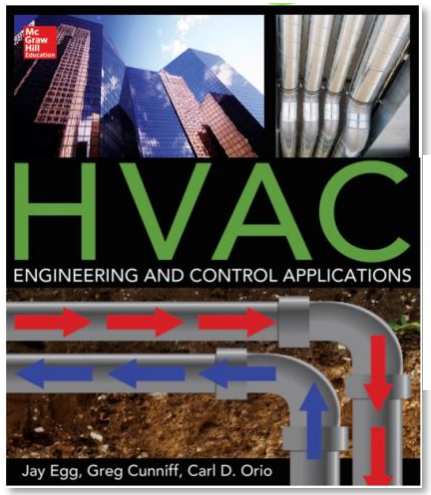
FIG. 2-1. *Borehole with the differentiated lithology represented. Geothermal installation project in sport pools (DCL Geo-Energy, 2018)*



DCL GEOTHERMAL PROBE







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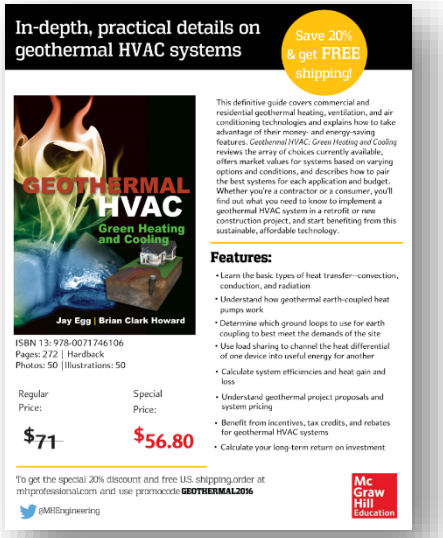

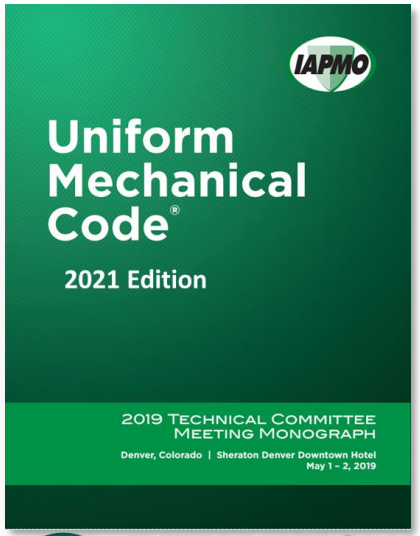

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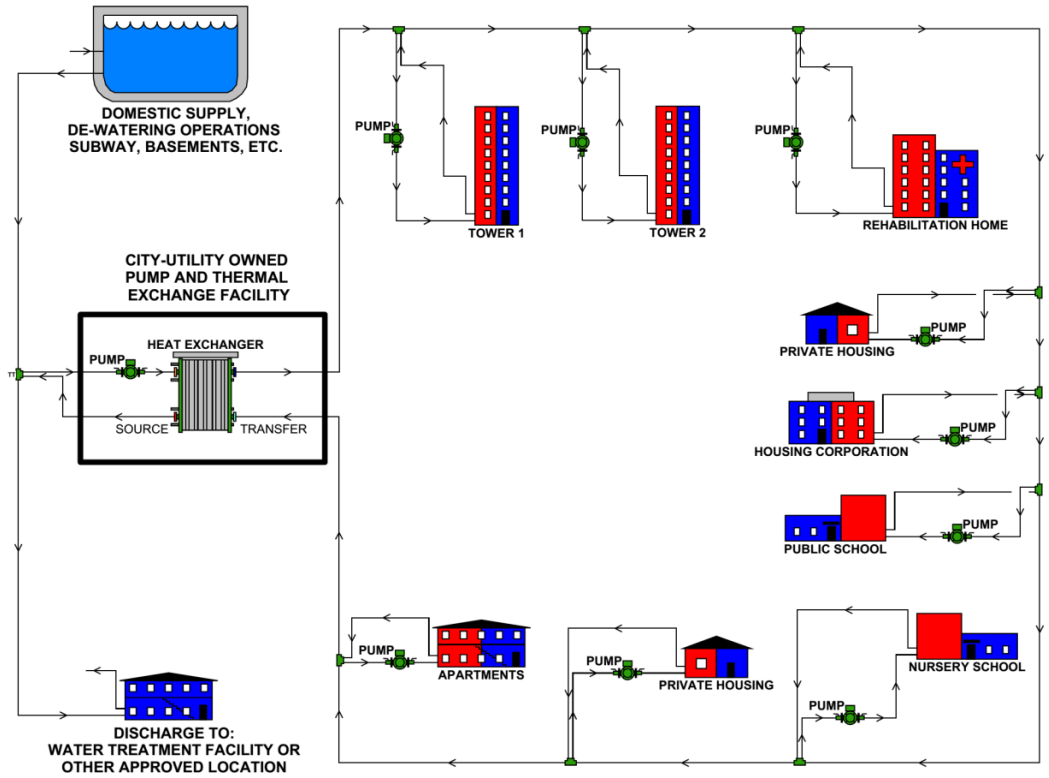
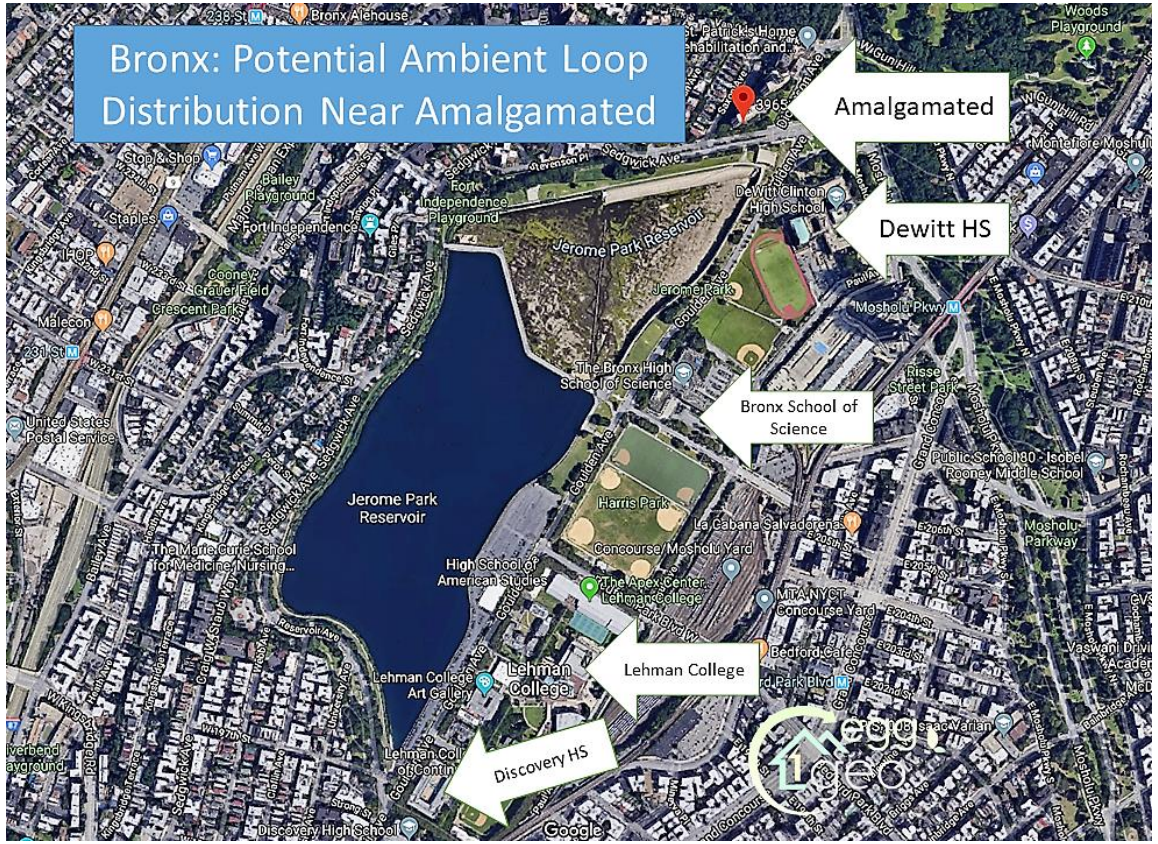
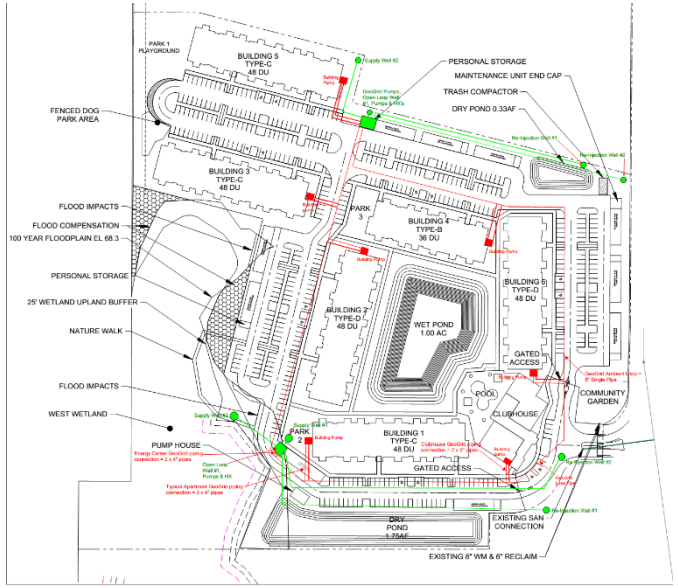
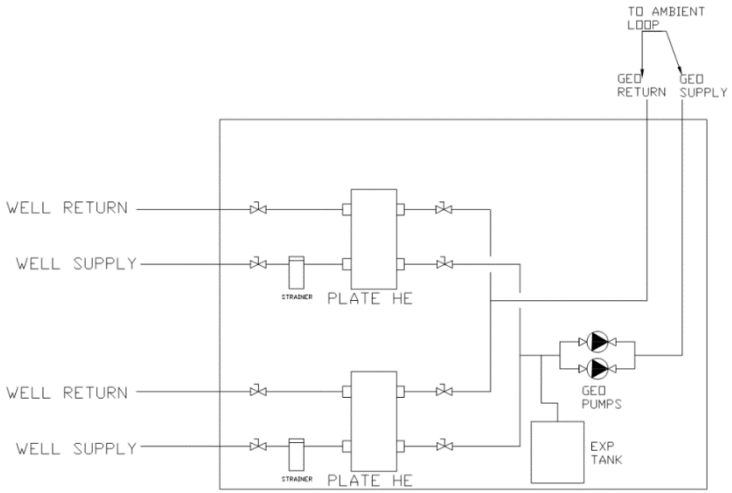
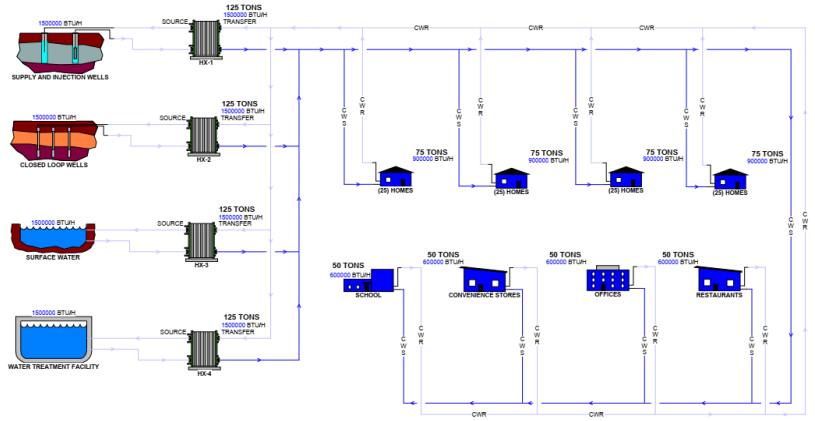


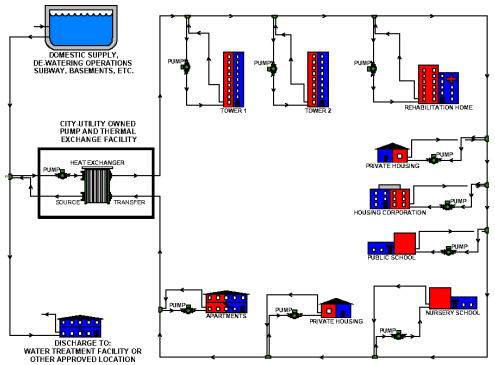


Project Construction Drawings

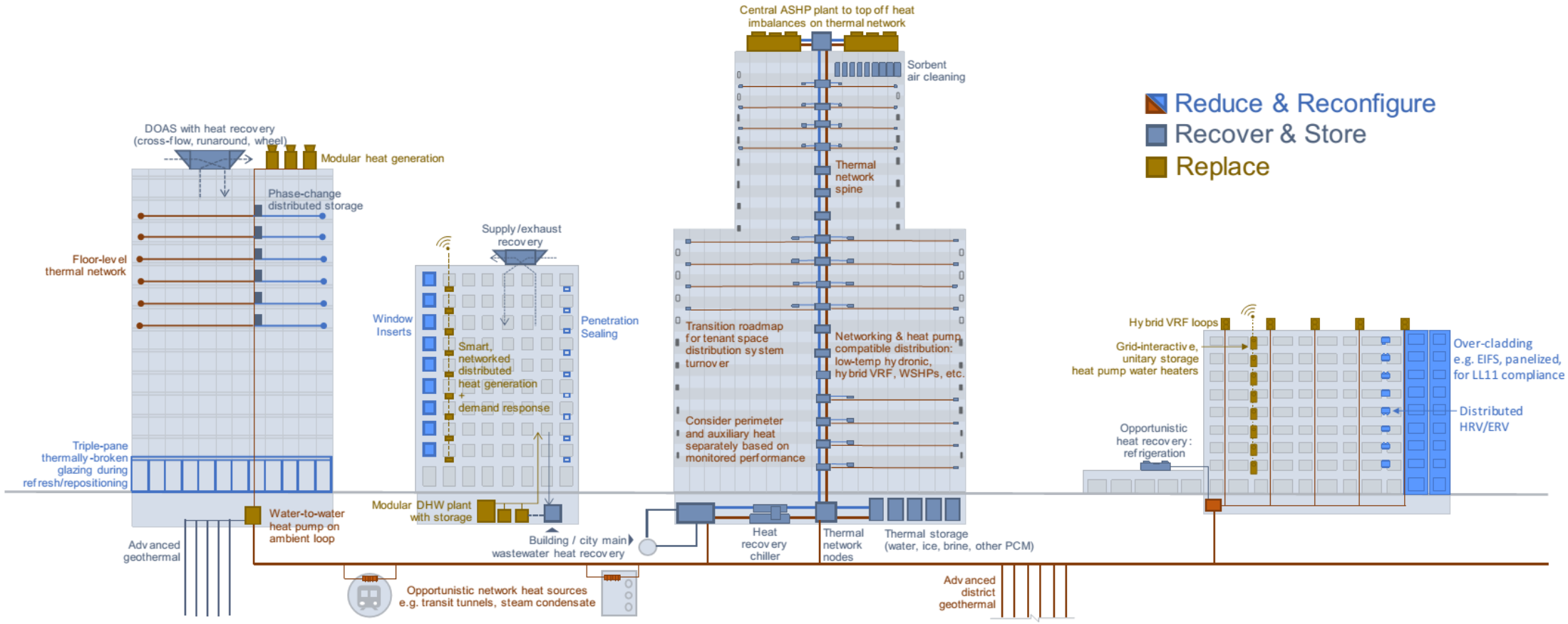








Thermal Energy Networks - Empire State; Developed for NYSERDA



Thank You!

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