HOLLAND

District Heating Systems

10.28.11

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Summary

- Who We Are
- What is District Heating
- Advantage of District Systems
- Proposed District Heating Concept
- Alternative Considerations

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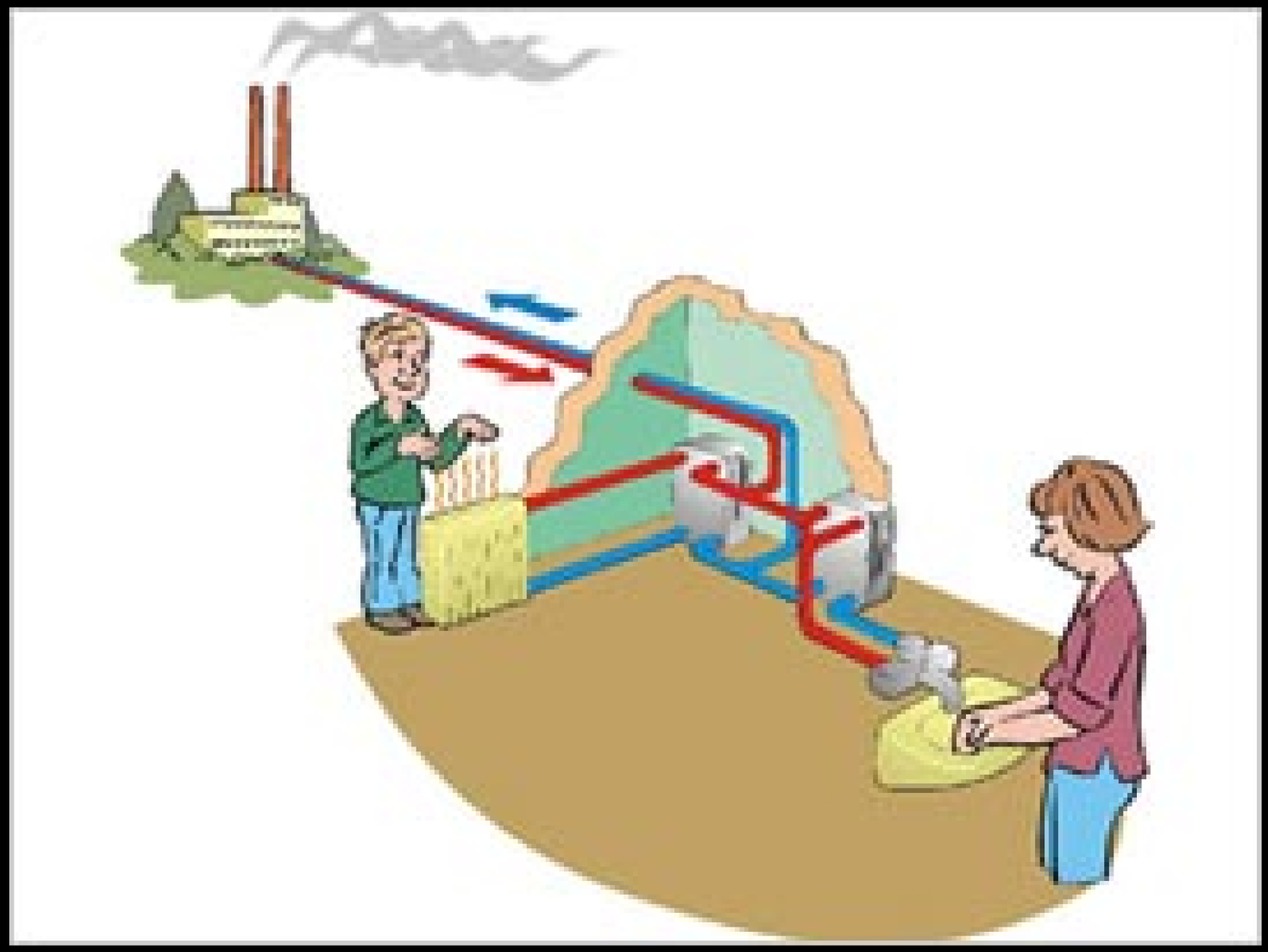
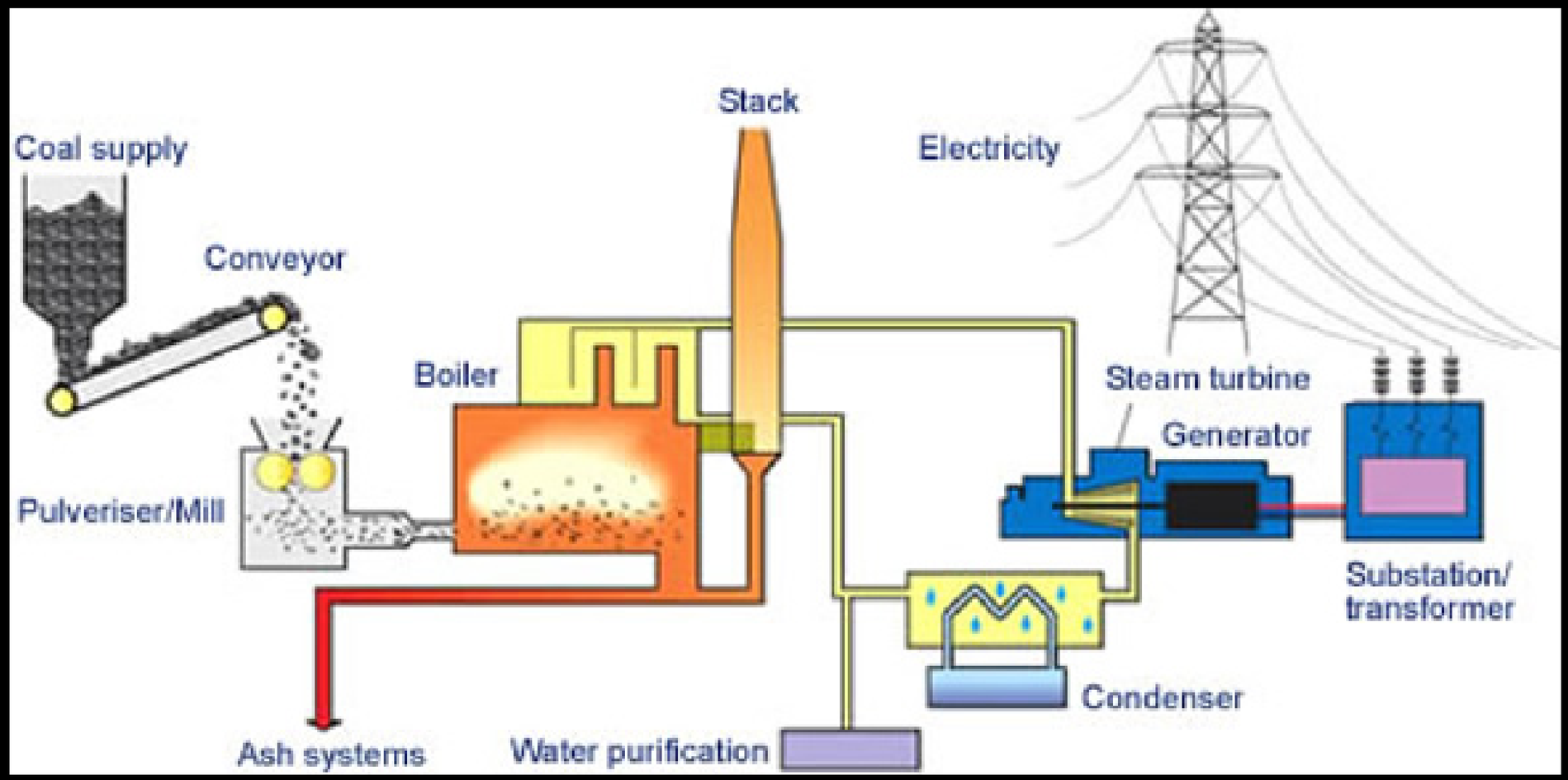
What is District Heating?

- District heating is a system for distributing heat generated in a centralized location for residential and commercial heating requirements such as space heating.

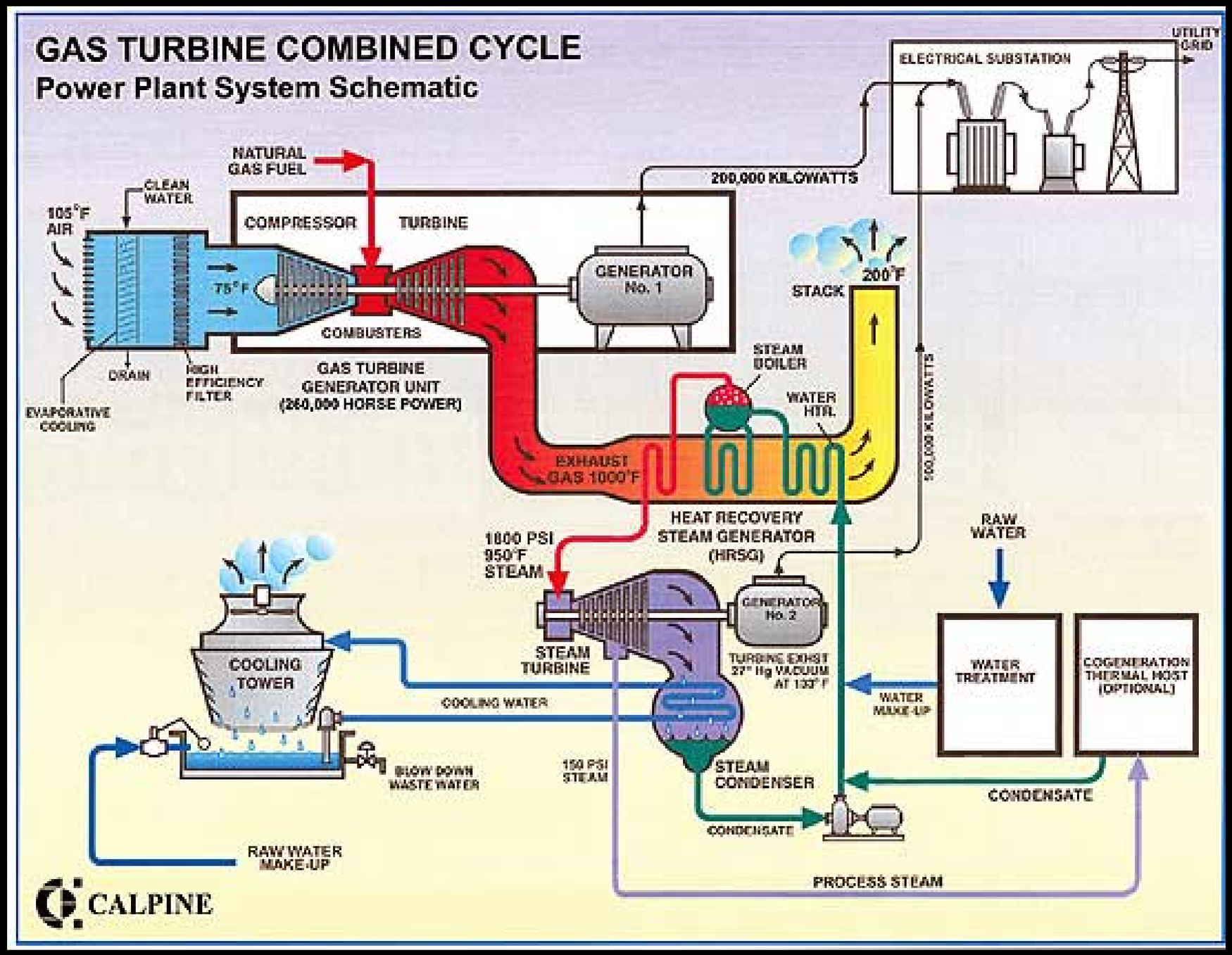


What is District Heating?

- Coal Power Plant Schematic

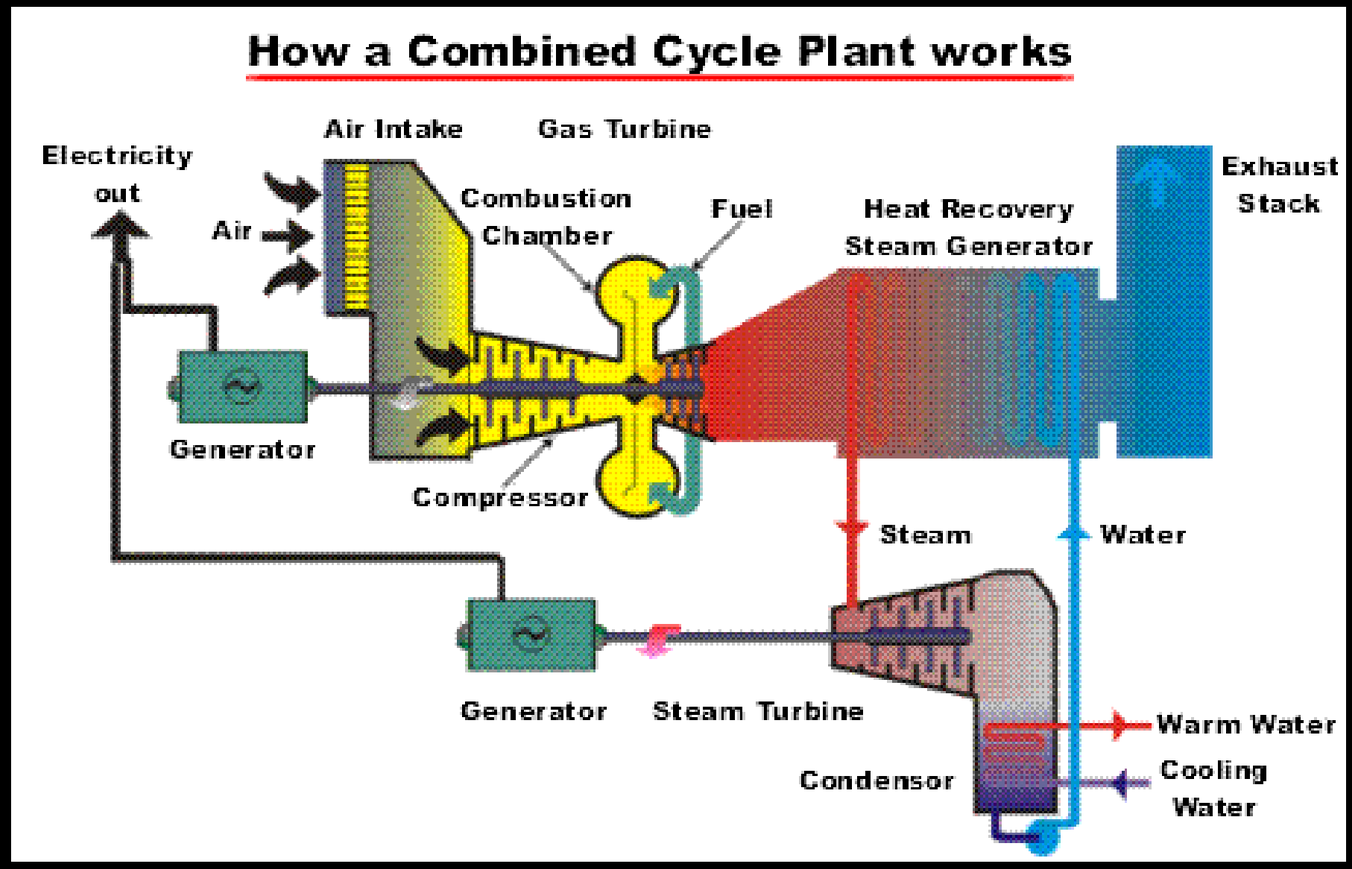


What is District Heating?



What is District Heating?

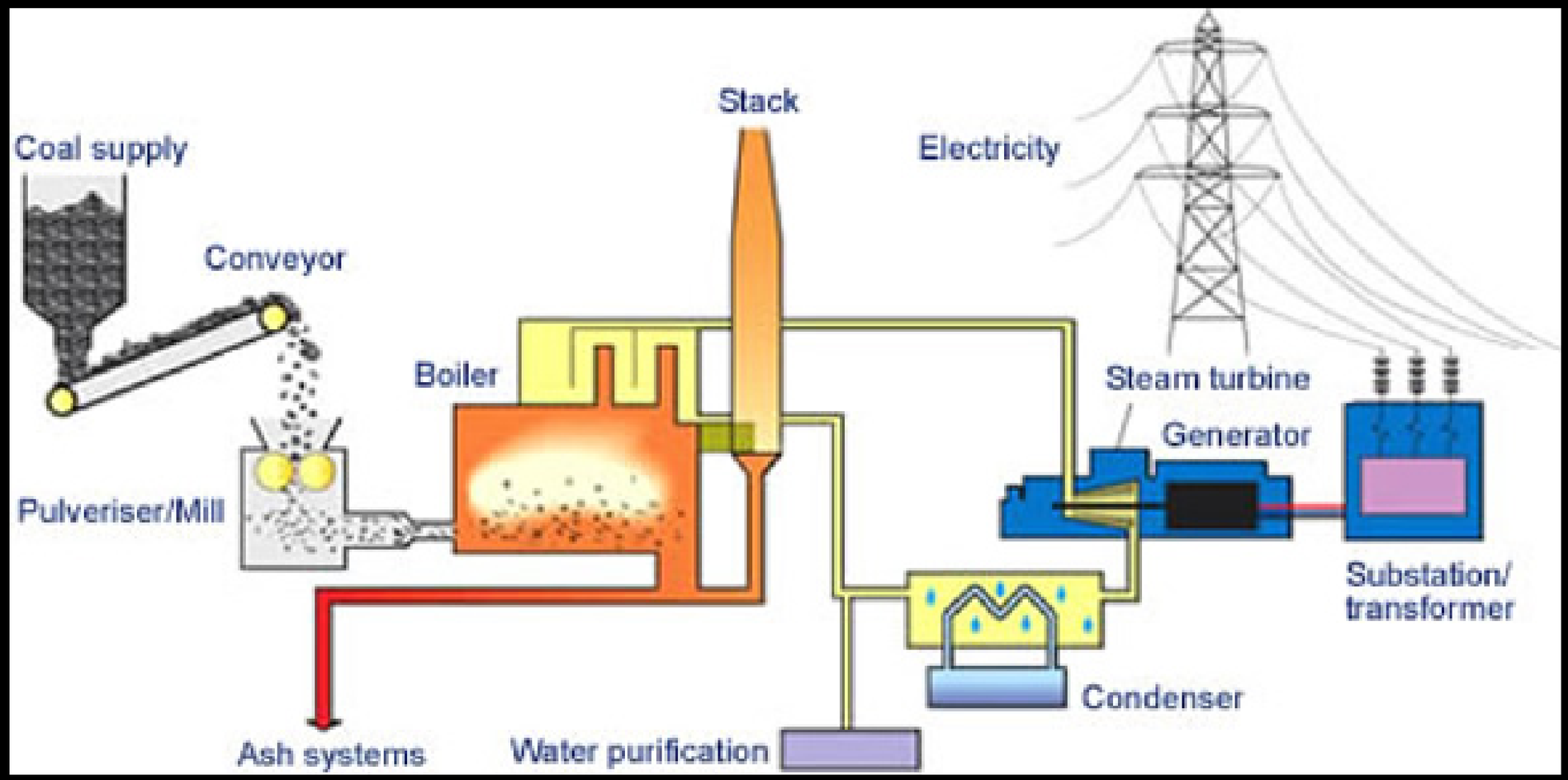
- **The Combustion Turbine**
  Natural gas is mixed with air and burned in the combustion chamber to create the high pressure gasses needed to spin a turbine. This part of the plant is a single cycle, combustion turbine. These are sometimes called CTs. CTs are normally designed to meet peak loads.
- **The Combined Cycle Plant**
  A combined cycle power plant is a dual cycle plant. The "2nd" part of the combined cycle is a heat recovery unit. It takes advantage of the energy in the exhaust gasses to create steam. The steam spins a steam turbine to generate additional electricity. The combined cycle plants are normally designed to meet base and intermediate loads.



This diagram provided by Nooter/Eriksen, a St. Louis based company which calls itself the "world's leading independent supplier of heat recovery steam generators."

What is District Heating?

- Coal Power Plant Schematic



Advantage of District Systems

- Reduce Building Energy Costs
- Utilize Waste Heat from the Power Plants
- Single Source for Future Diversification of Holland's Energy Portfolio

It's a good decision

ECONOMICALLY

ECOLOGICALLY, AND

SOCIALLY

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Advantage of District Systems

- Advantage of District Systems

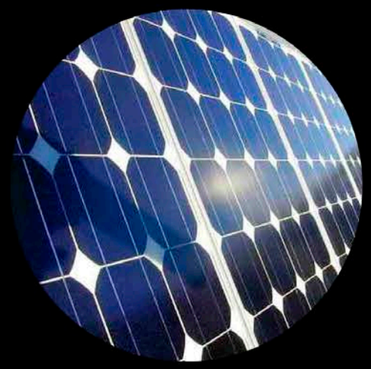
GAS

WATER

BIOMASS

ELECTRIC

WIND



SOLAR

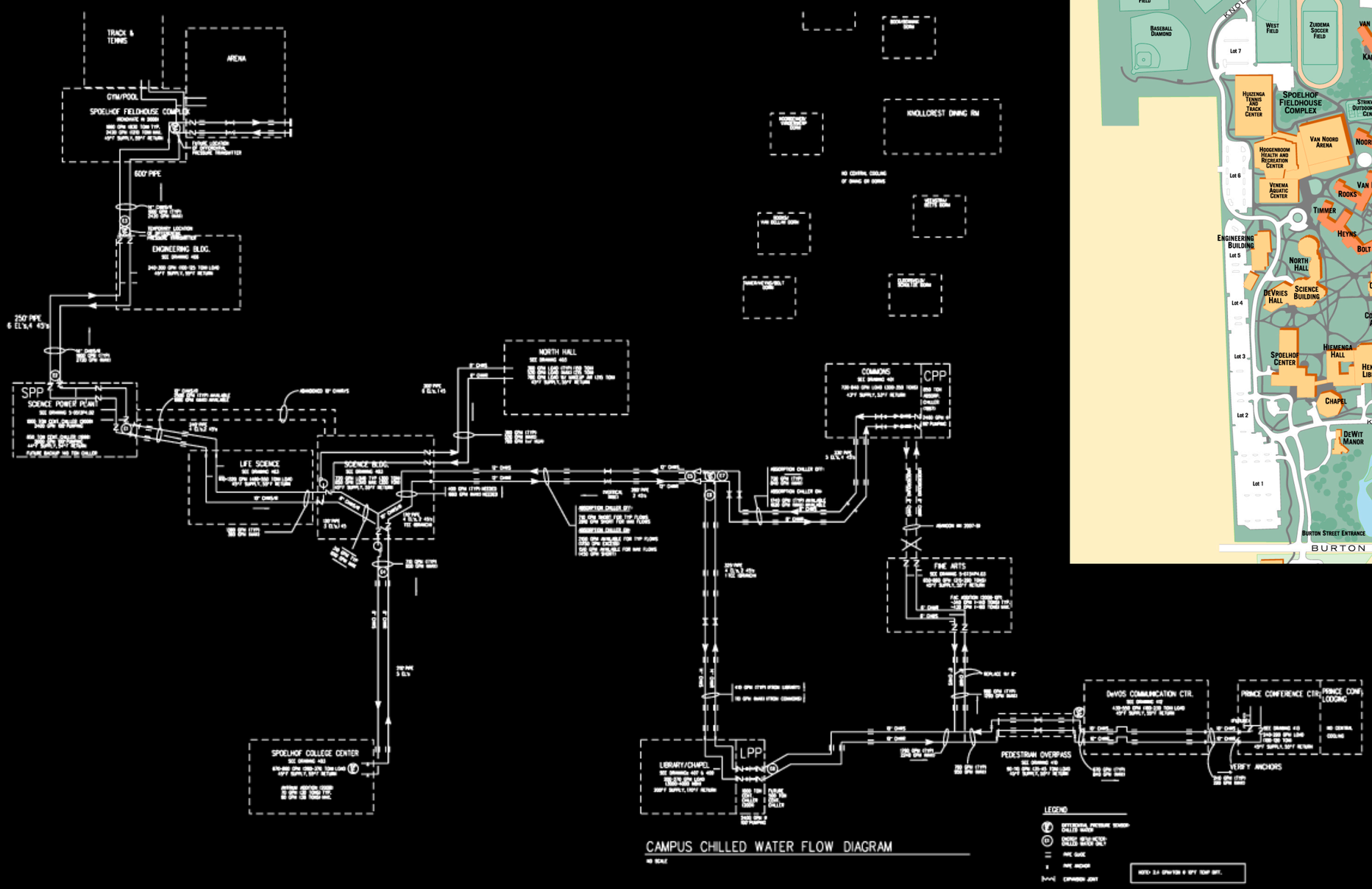
GEOTHERMAL

Advantage of District Systems

- Examples of Existing Similar Systems
- Calvin College
- Purdue University
- Grand Haven Snowmelt
- Holland Snowmelt

Advantage of District Systems

- Calvin College



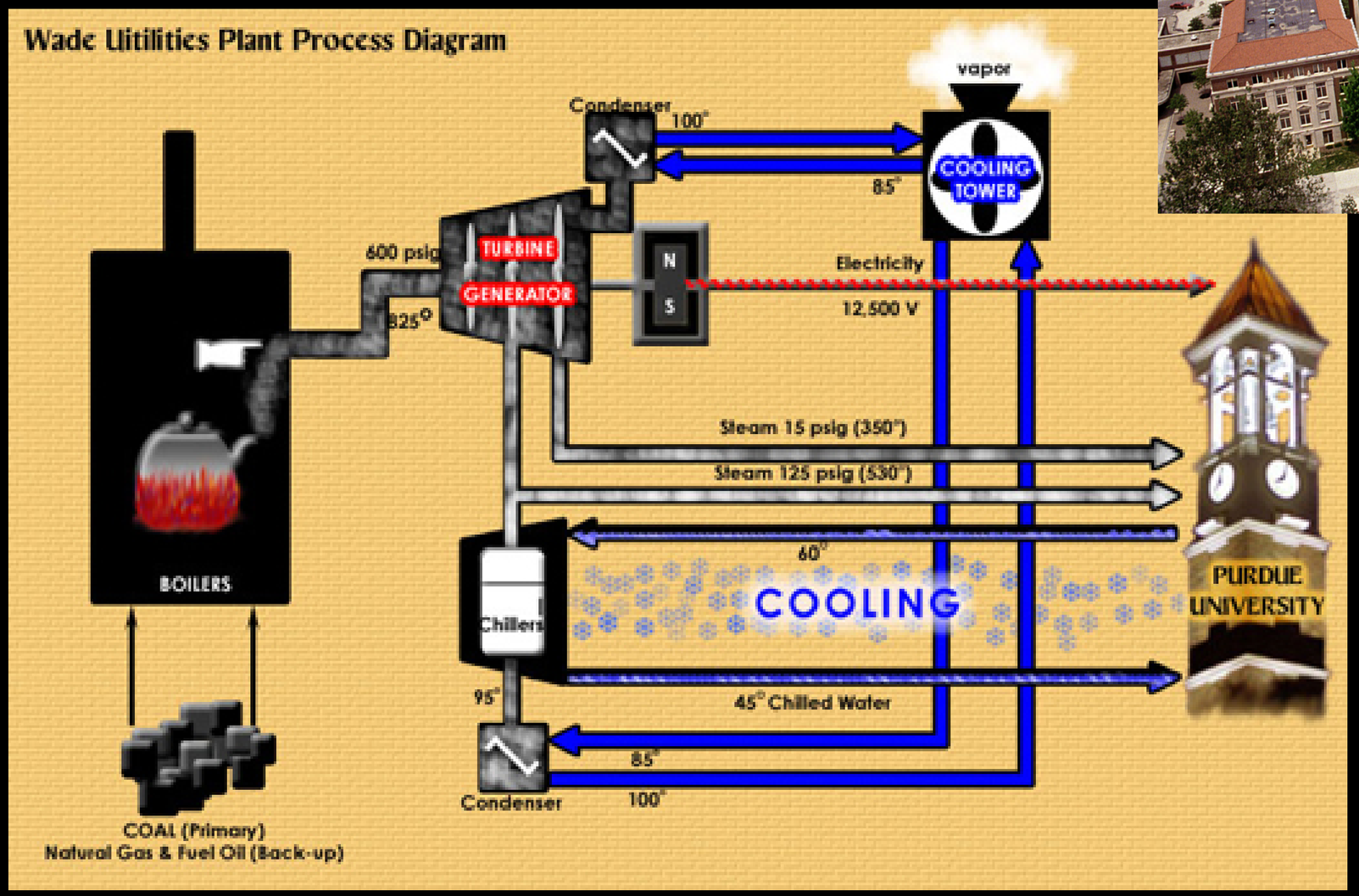
CAMPUS CHILLED WATER FLOW DIAGRAM

Advantage of District Systems

- Grand Haven Snowmelt

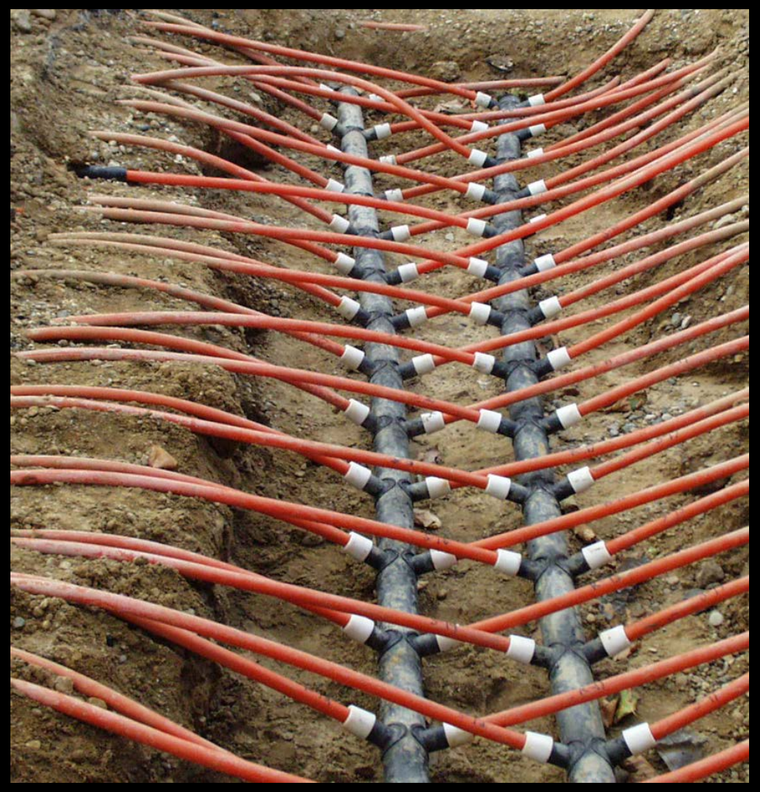
Advantage of District Systems

- Purdue University



Advantage of District Systems

- Holland Snowmelt



Proposed District Heating System Concept

- Implementation of a New High District Temperature Heating Loop

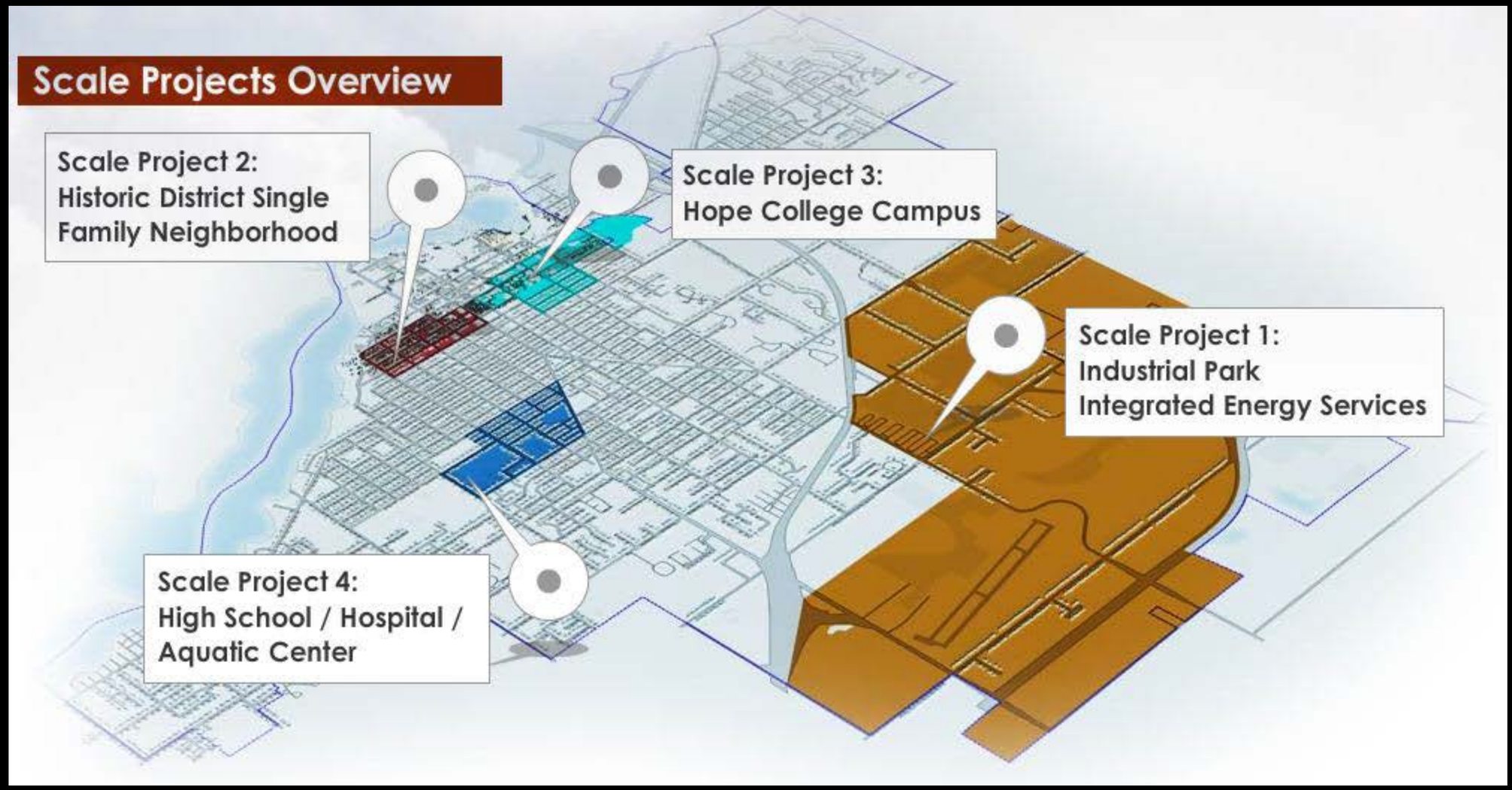


Figure 6.1 Four Neighborhood Scale Projects

HOLLAND COMMUNITY ENERGY EFFICIENCY AND CONSERVATION STRATEGY
Prepared by:
Garforth International llc
in collaboration with
City of Holland
Holland Board of Public Works

Proposed District Heating System Concept

- Implementation of a New High District Temperature Heating Loop

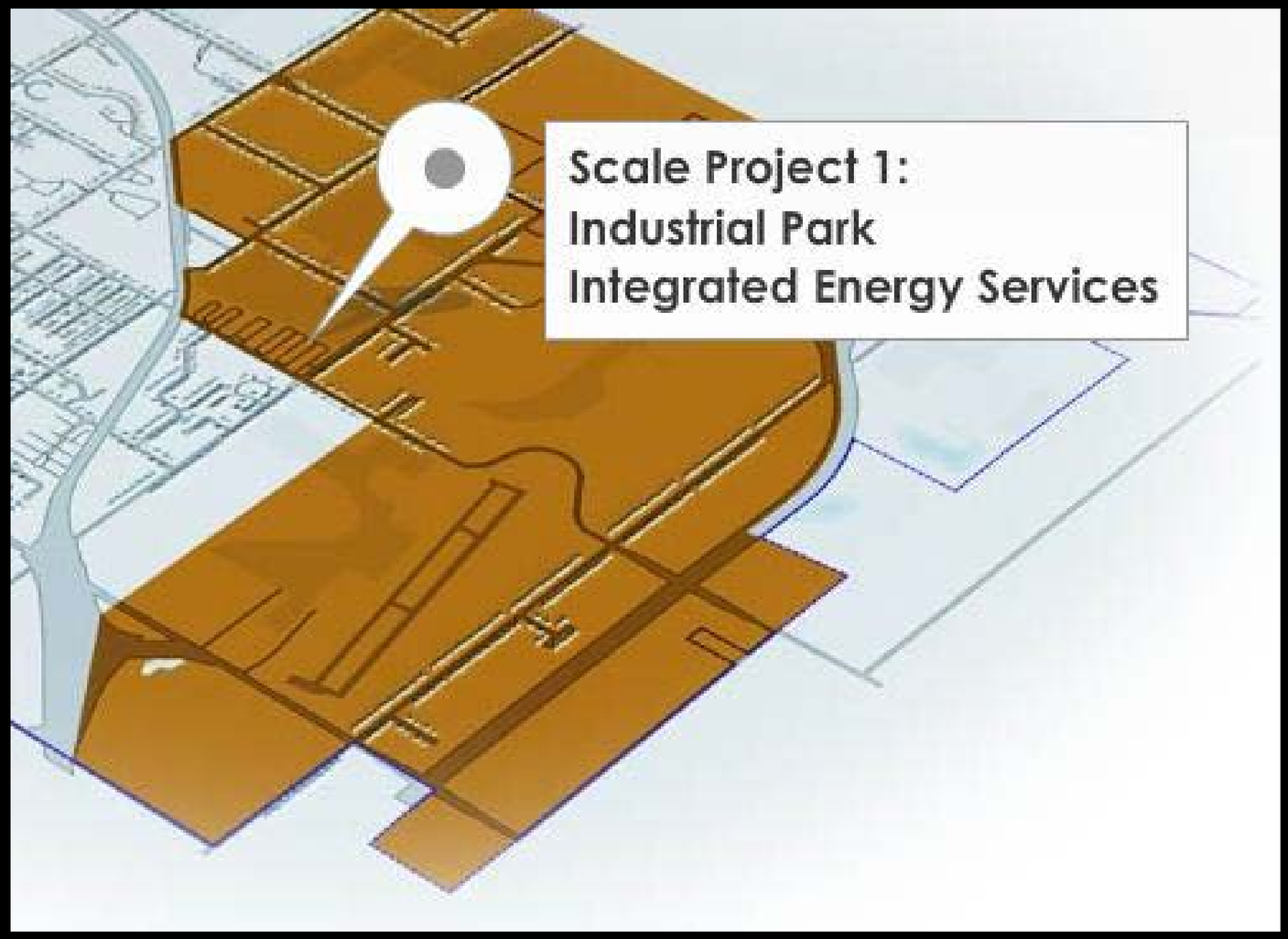


Figure 6.2 Scale Project 1 – Holland Industrial Park Integrated Energy Services

Proposed District Heating System Concept

- Implementation of a New High District Temperature Heating Loop

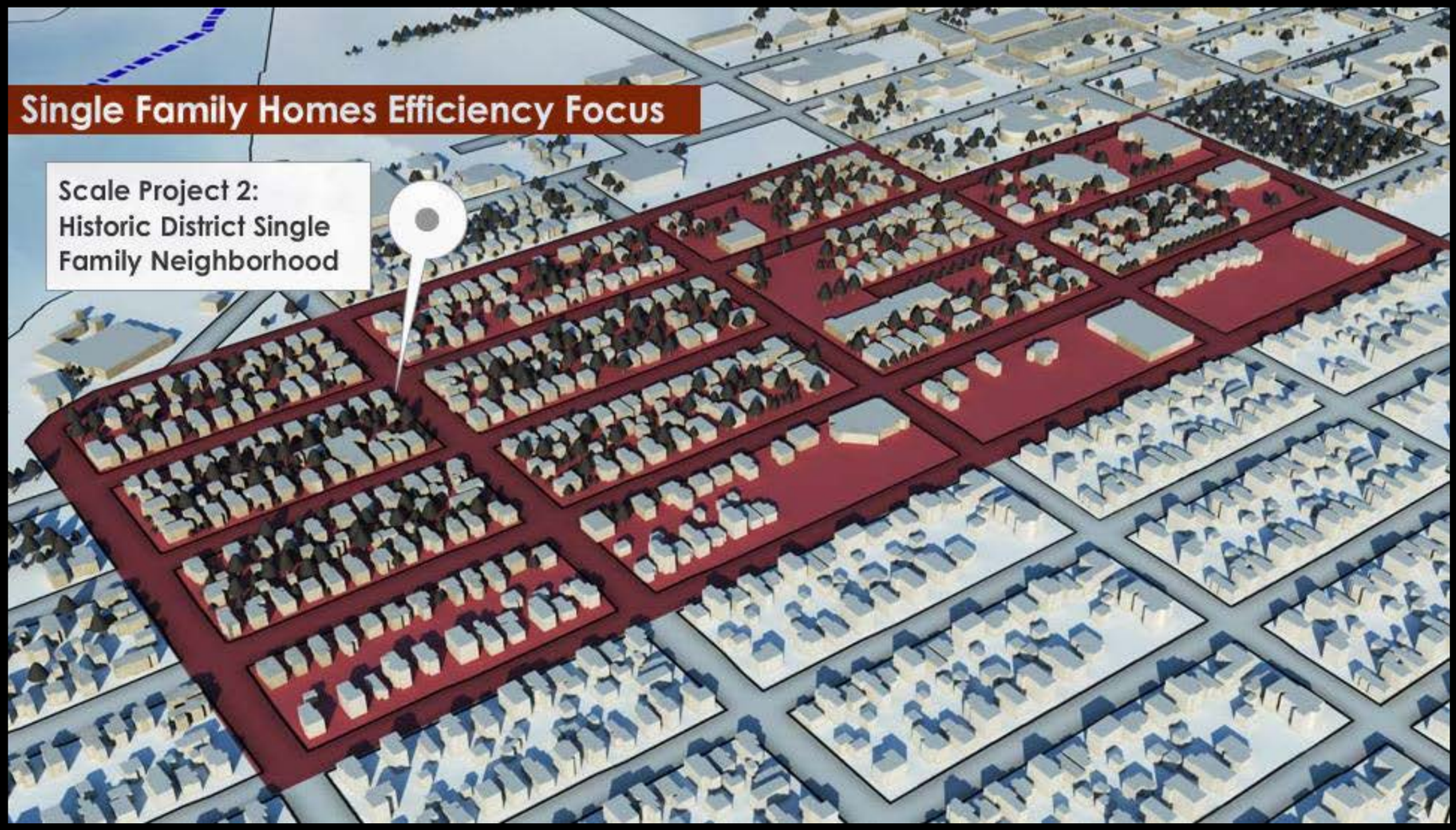


Figure 6.3 Scale Project 2 - Historic District Single-Family Home Neighborhood

Proposed District Heating System Concept

- Implementation of a New High District Temperature Heating Loop

Figure 6.5 Scale Project 3 - Hope College Campus

Proposed District Heating System Concept

- Implementation of a New High District Temperature Heating Loop

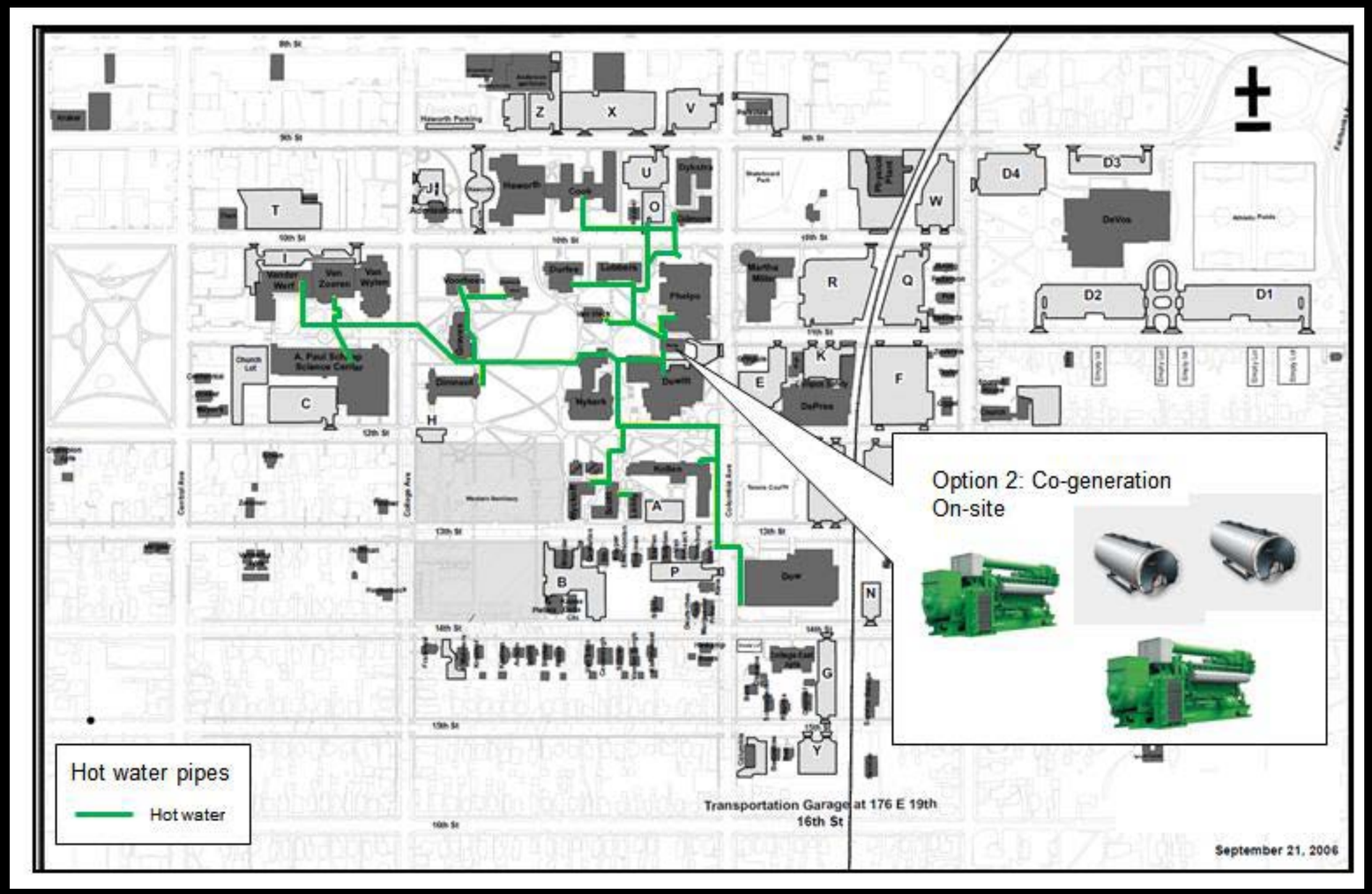


Figure 6.7 Hope College Campus – Potential Future Supply Structure

Proposed District Heating System Concept

- Implementation of a New High District Temperature Heating Loop

Figure 6.10 Scale Project 4 – Hospital – High School – Aquatic Center Cluster

Proposed District Heating System Concept

- Implementation of a New High District Temperature Heating Loop

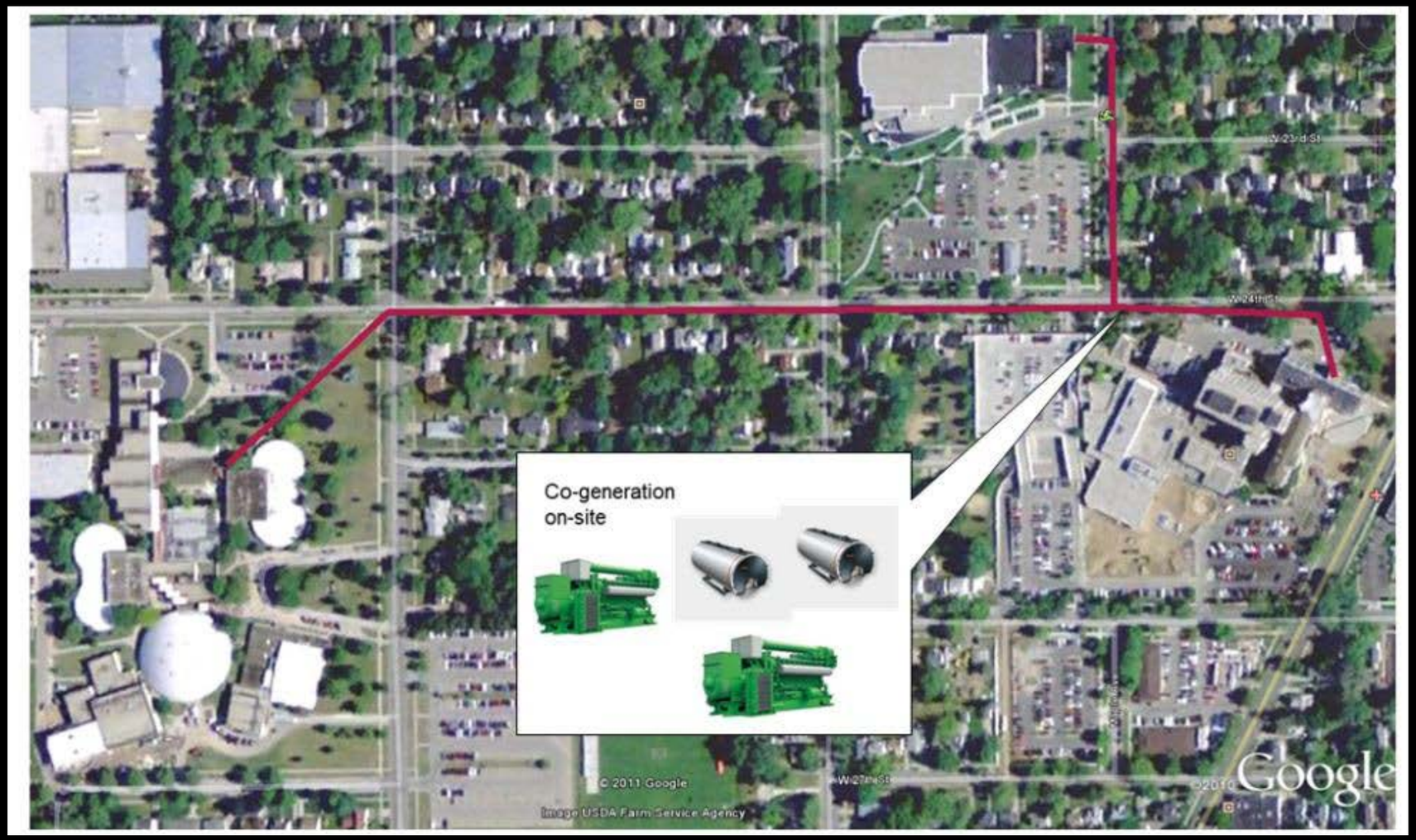


Figure 6.11 Scale Project 4 – Possible Heat Supply Structure

Proposed District Heating System Concept

- Implementation of a New High District Temperature Heating Loop

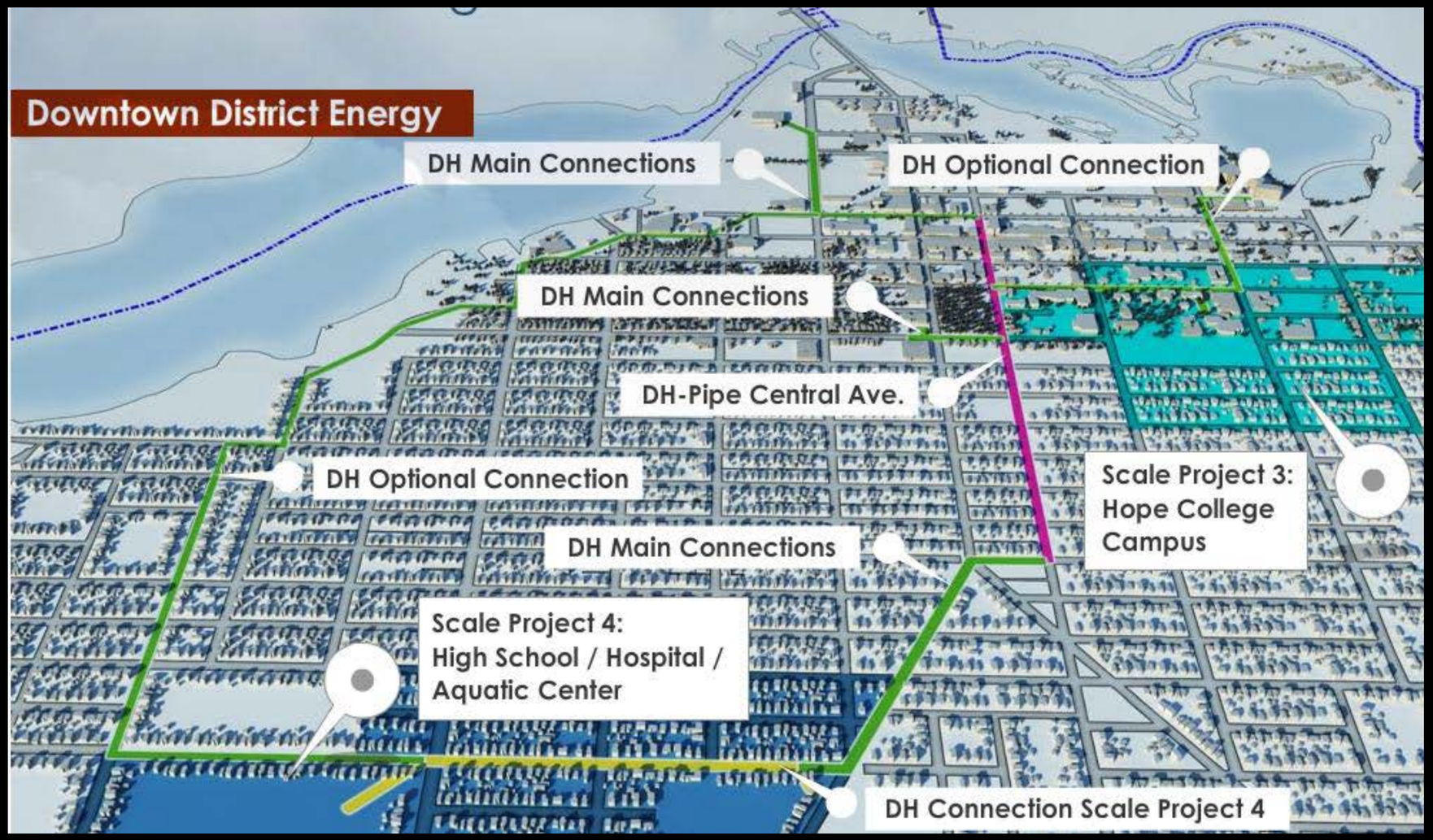


Figure 6.13 Scale Project 5 - Initial District Heating Network

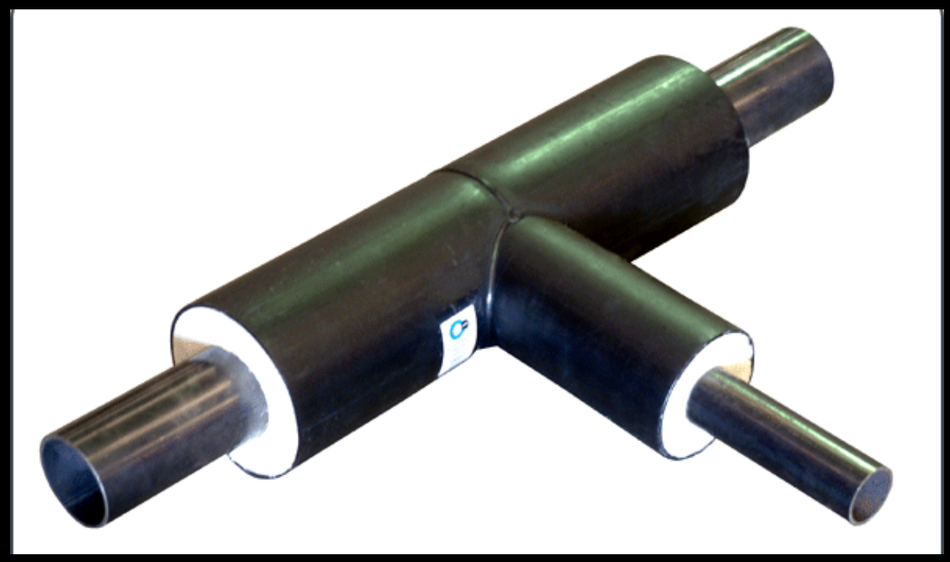
Proposed District Heating System Concept

- Advantages

-Smaller Piping

-Direct Connection for Buildings with Existing Hot Water Systems

-Significant Heat Capacity in 250 deg F Hot Water



Proposed District Heating System Concept

- Disadvantages

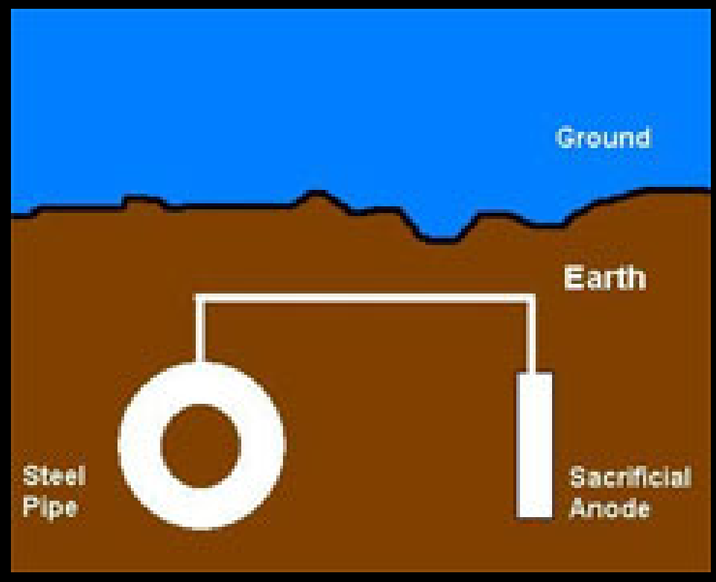
-Cost

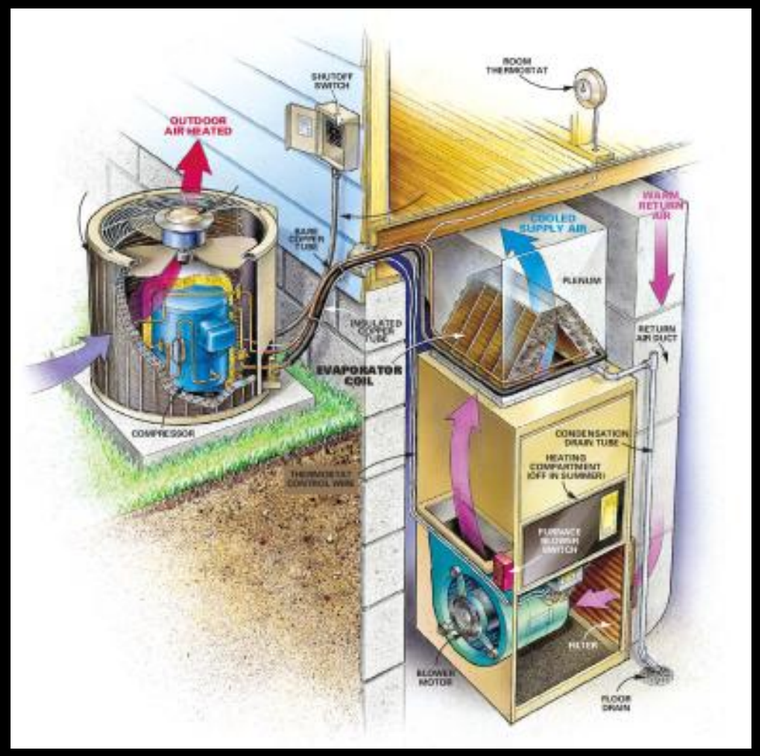
-Heating Only

-New Infrastructure & Infrastructure Longevity

-Loss of Electrical Production to Create Higher Temperature Heat

-Pipe Expansion





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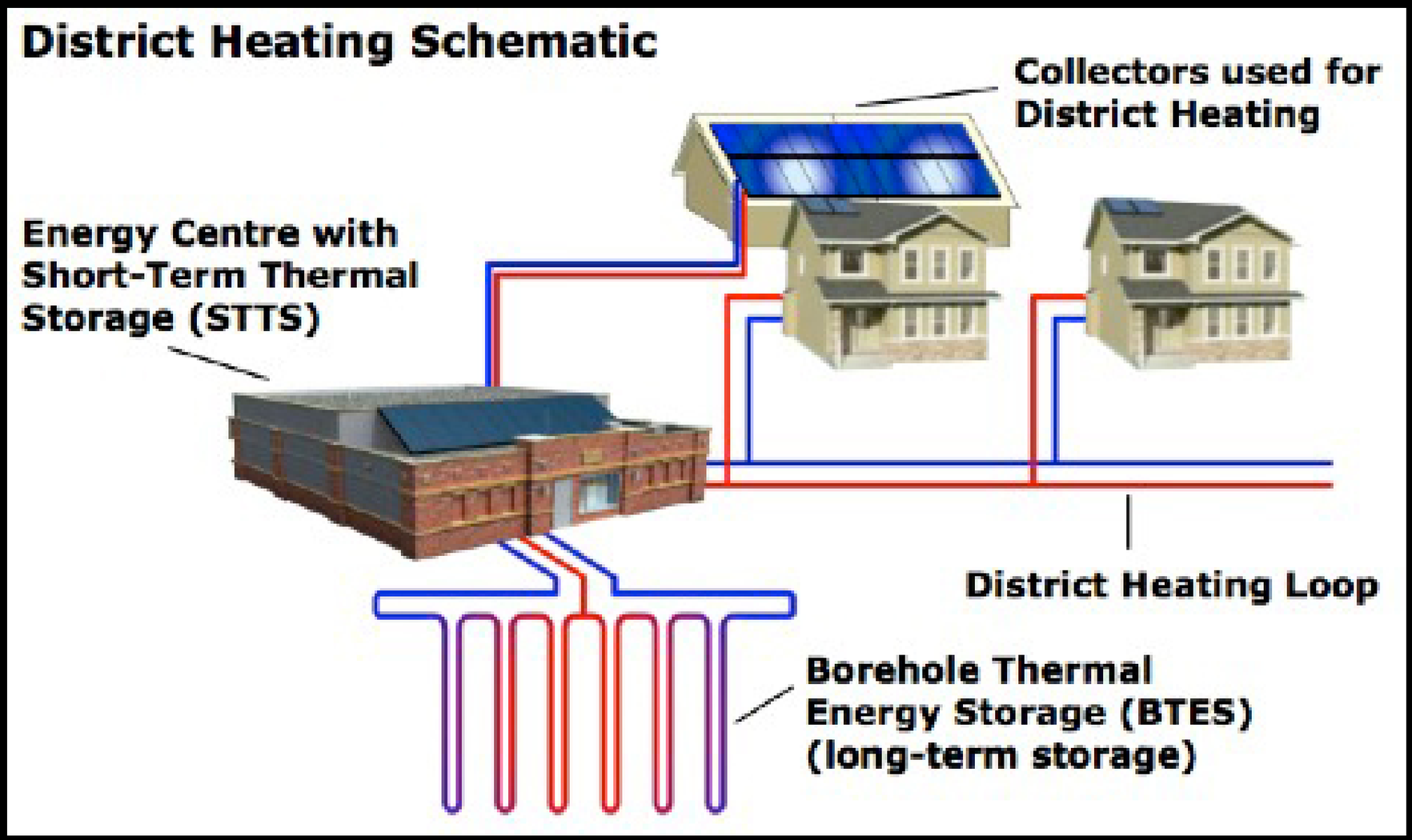
Alternative Considerations

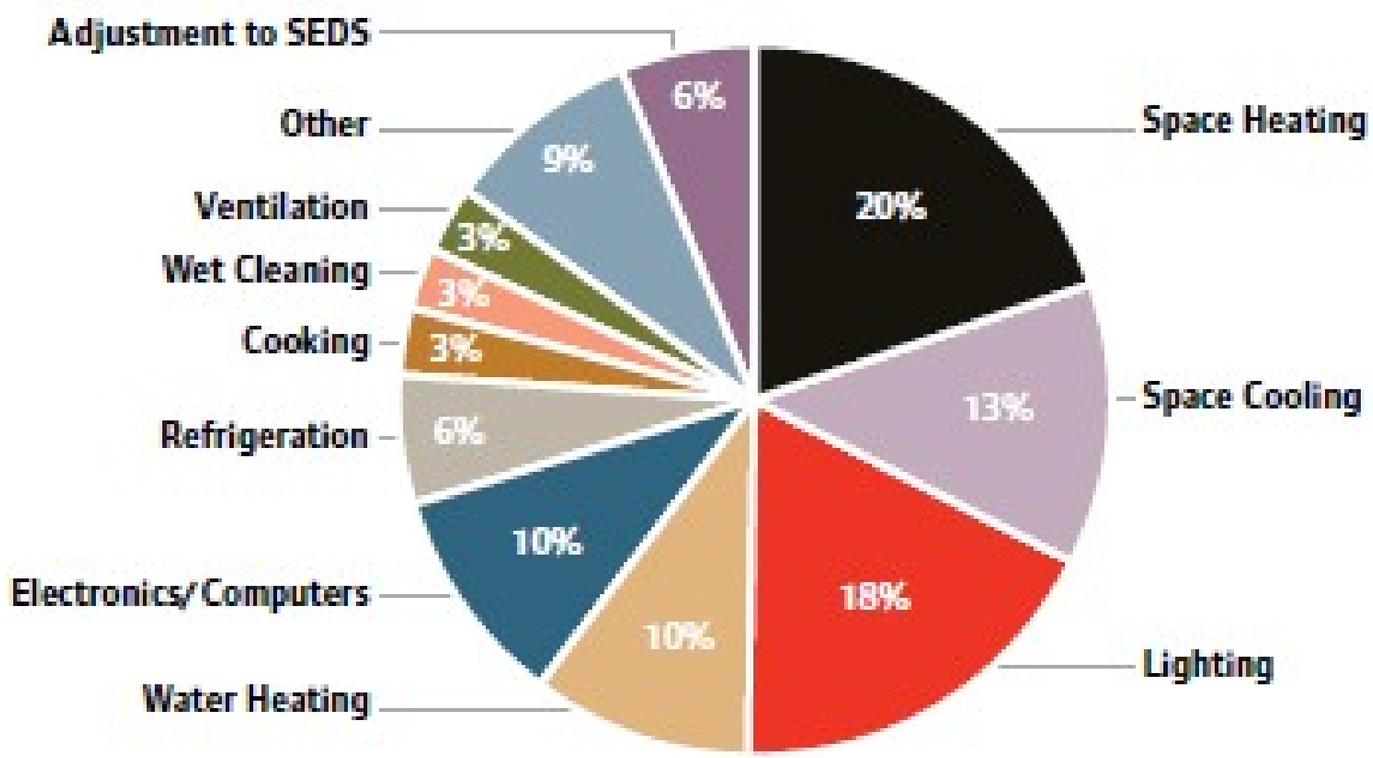
- Take a Step Back: What are Holland's Options?



Alternative Considerations

- What Makes up the Building Energy Needs
- Usage typical generic building

Figure 2.1: Buildings Sector Energy Consumption by End-Use Activity

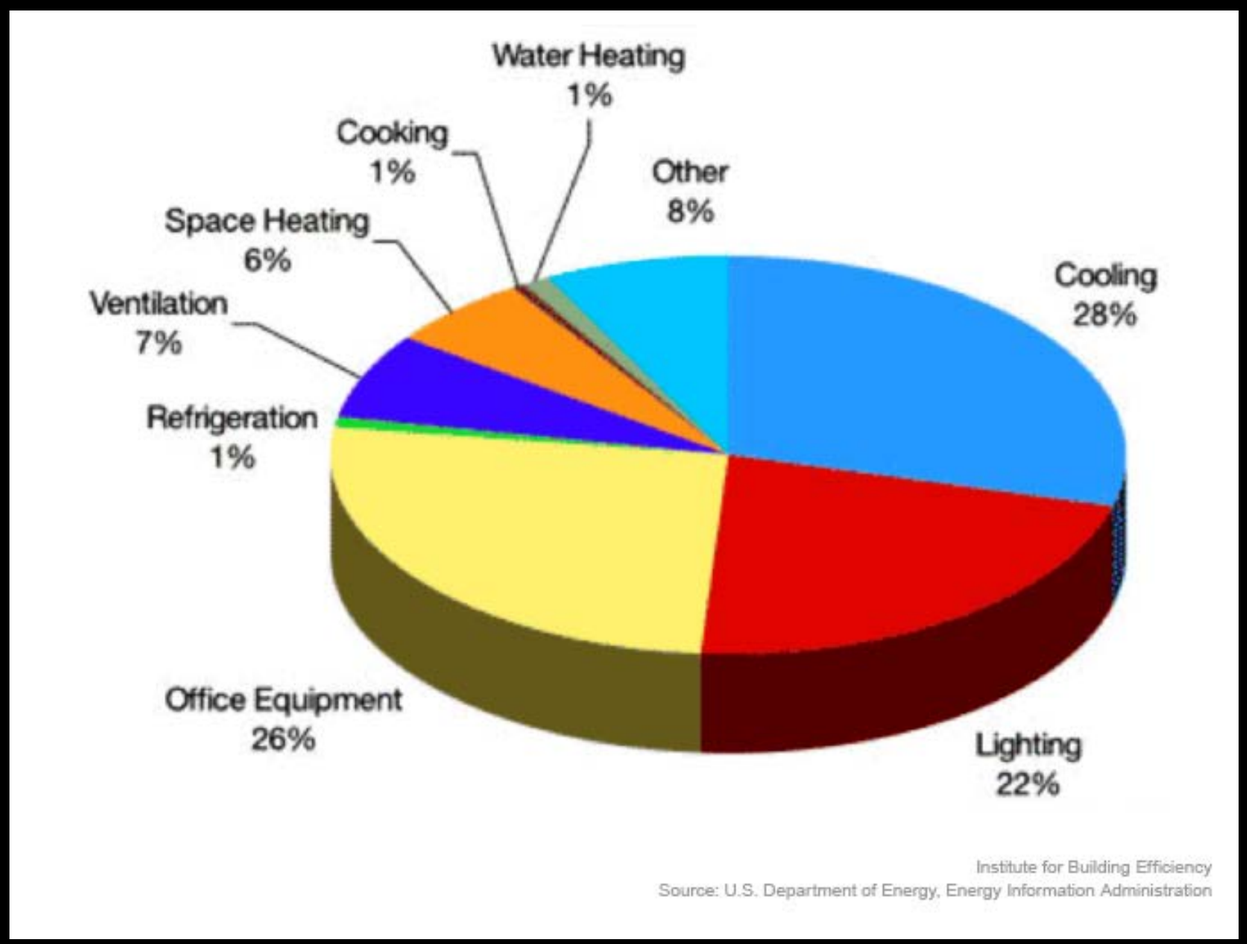


Source: U.S. Department of Energy (DOE), Energy Efficiency and Renewable Energy (EERE) (September 2008), *2006 Buildings Energy Data Book*, Table 1.1.4

Alternative Considerations

- What Makes up the Building Energy Needs
- Usage typical office building

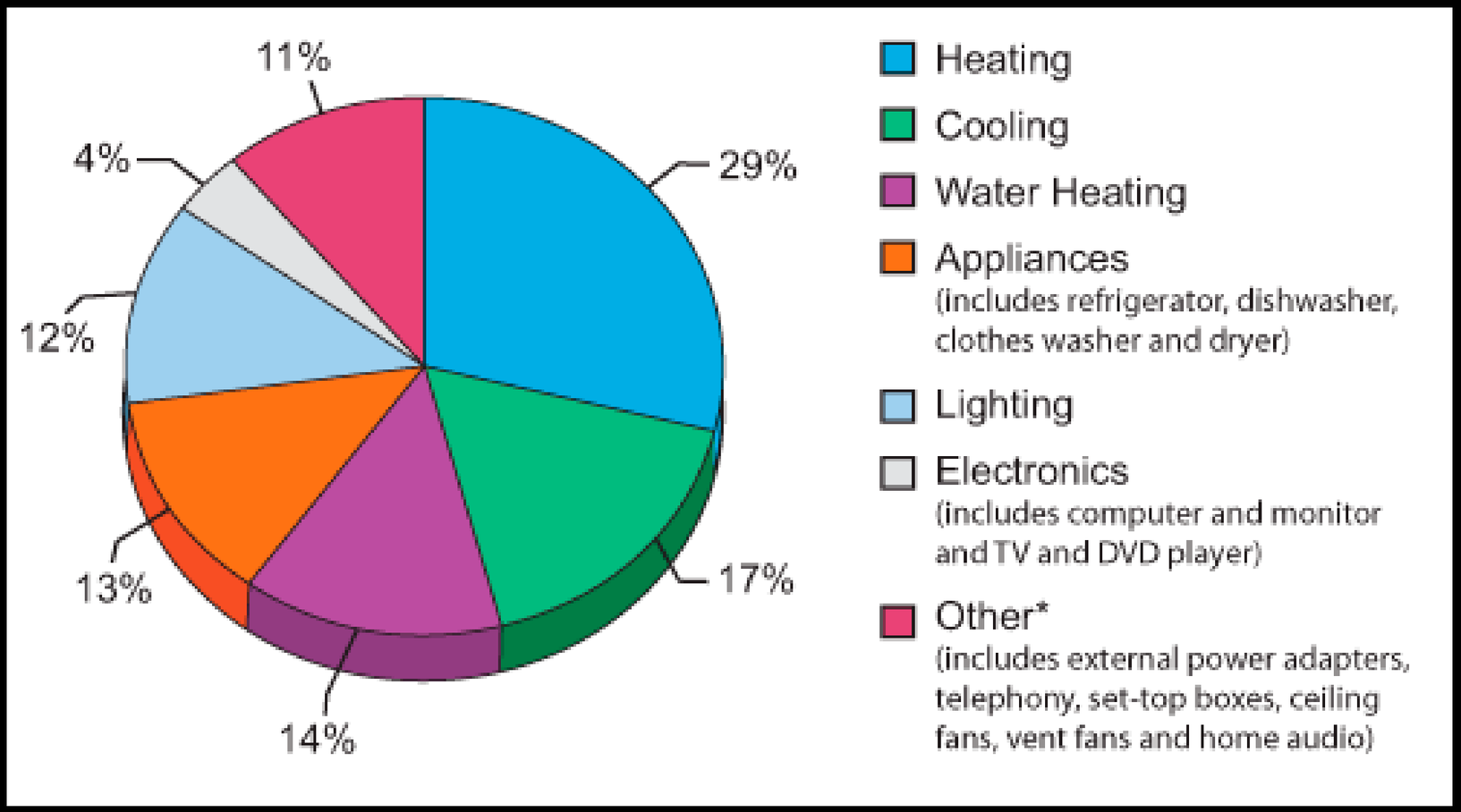
OFFICE



Alternative Considerations

- What Makes up the Building Energy Needs
- Usage typical home

TYPICAL SINGLE FAMILY HOME



Alternative Considerations

- What Makes up the Heating and Cooling Energy Needs

Design Philosophy (everything connects to everything…)

Whole Building Design

Whole Campus Design

Whole Community Design

Classical engineering training says “solve problems one at a time”.

We say “NO!”

This is partly how we got into the challenging position we are in today – we’ve solved problems without first considering the solution in a larger context.

A Different Approach…

- Traditional Building Energy Analysis looks at each component and seeks to maximize its efficiency as a stand-alone entity.
- We consider that in our analysis, but more importantly we look for synergies between entities and systems such that when we impact one item there are multiple positive impacts on other items.
- For example: Holland Snowmelt

Consider A View of the Whole…

- Some buildings and campuses have systems that generate heat most of the year and others that need heat most of the year.
- Refrigeration and air conditioning dump heat into the atmosphere while we burn fossil fuels to create heat for hot water and other processes.
- Why not capture energy in the form of heat that you've already paid for or the energy available around us?

Consider:

(in order of importance)

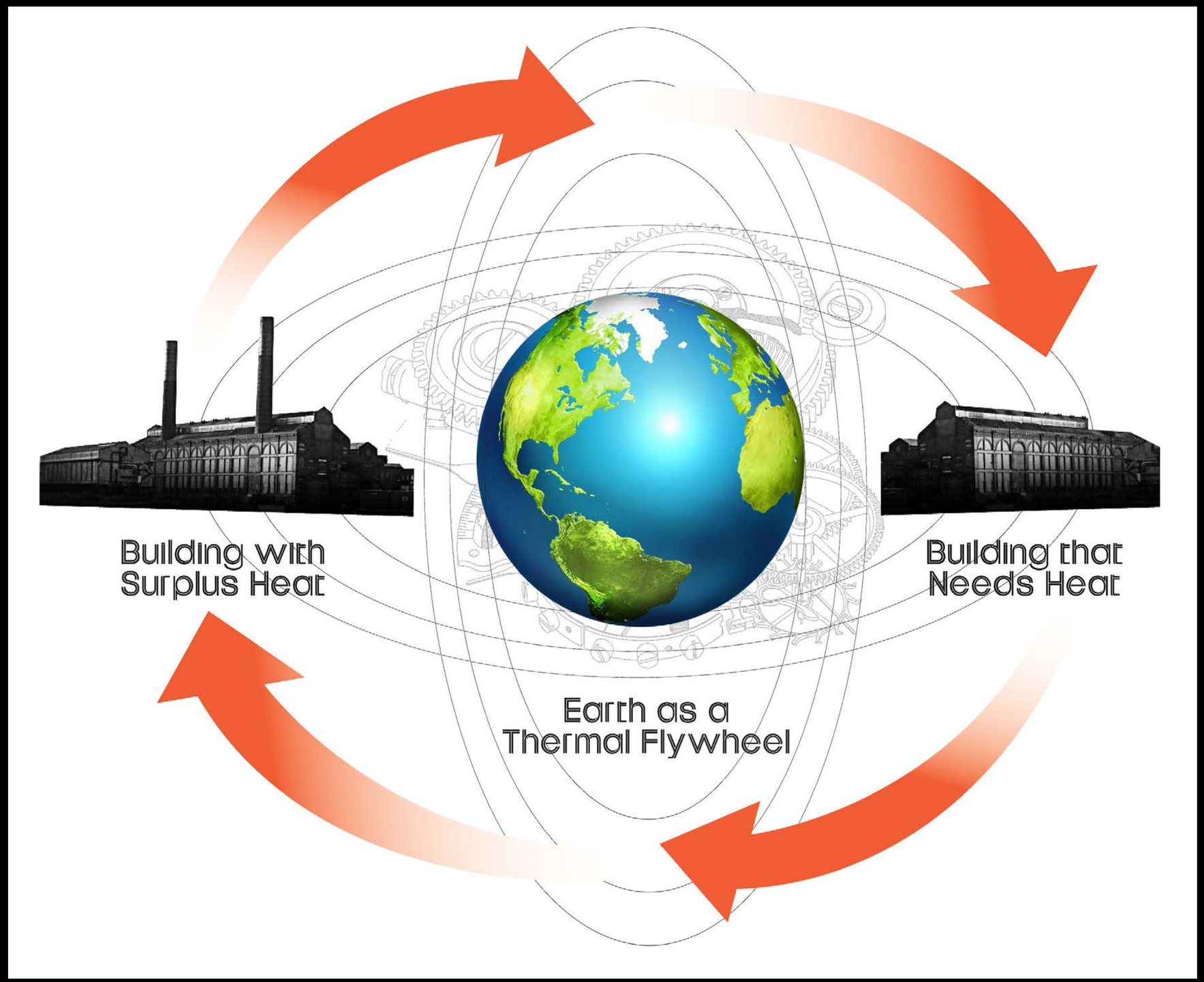
1. **Reduce the loads, reduce the loads, reduce the loads…**
2. **Recover wasted energy wherever you can**
3. **Find ways to reuse waste energy**
4. **Consider innovative energy systems**
5. **Consider renewable energy systems**
6. **Measure, verify, learn, improve, repeat…**

How do we create sustainable campuses and communities of tomorrow?

Part of the answer could lie in moving heat instead of creating it from fossil fuels.

Consider energy transfer between systems within buildings, buildings to buildings and across property lines!

Design Philosophy



Keep your eye on Geothermal Heat Pump (GeoExchange) Systems

Why do we bring up this specific type of heating/cooling/ energy-transfer system?

Simply, we believe that this will be the dominant heating/ cooling system in the next 100 years.

Geothermal Heat Pump Systems also typically reduce summer peak electrical demand and provide a stable winter electrical load – both of these can **improve the efficiency of power generation and distribution.**

Alternative Considerations – Heat Pump

Vertical Closed Loop Configuration

- We've designed nearly 4,000,000 square feet of buildings using this technology here in Michigan! It works!

Alternative Considerations – Heat Pump

Pond Loop Configuration

- Boatwerks, *Holland*
- Heating, cooling and refrigeration from Lake Macatawa!

Alternative Considerations – Heat Pump

Open Loop Configuration

- Harbourfront Place,
  Grand Haven

Alternative Considerations – Heat Pump

Equipment

Geothermal Heat Pump (GeoHP) Systems have typically used Unitary Water-to-Air and Water-to-Water Heat Pumps

½ to 25+ tons capacity

(plus rooftop package units to 100+ tons)

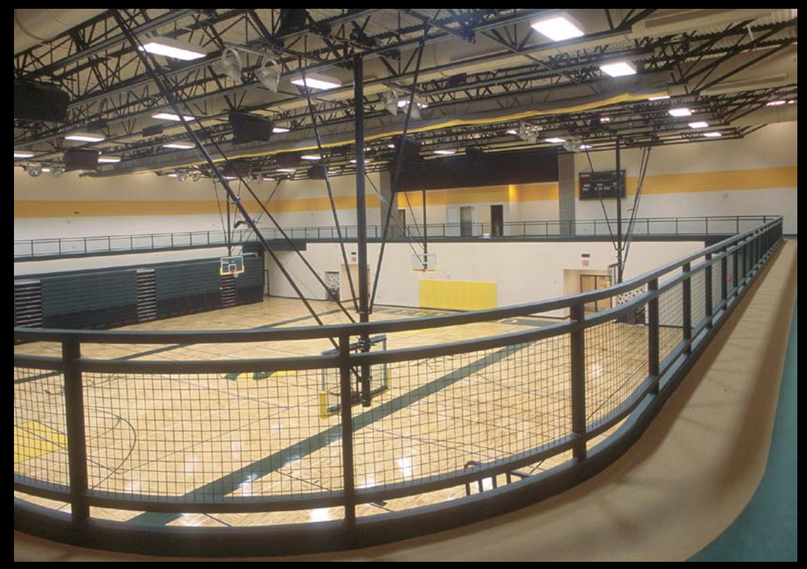
Equipment

Central Station Extended Range Heat Pumps
30 to 1,000+ tons capacity

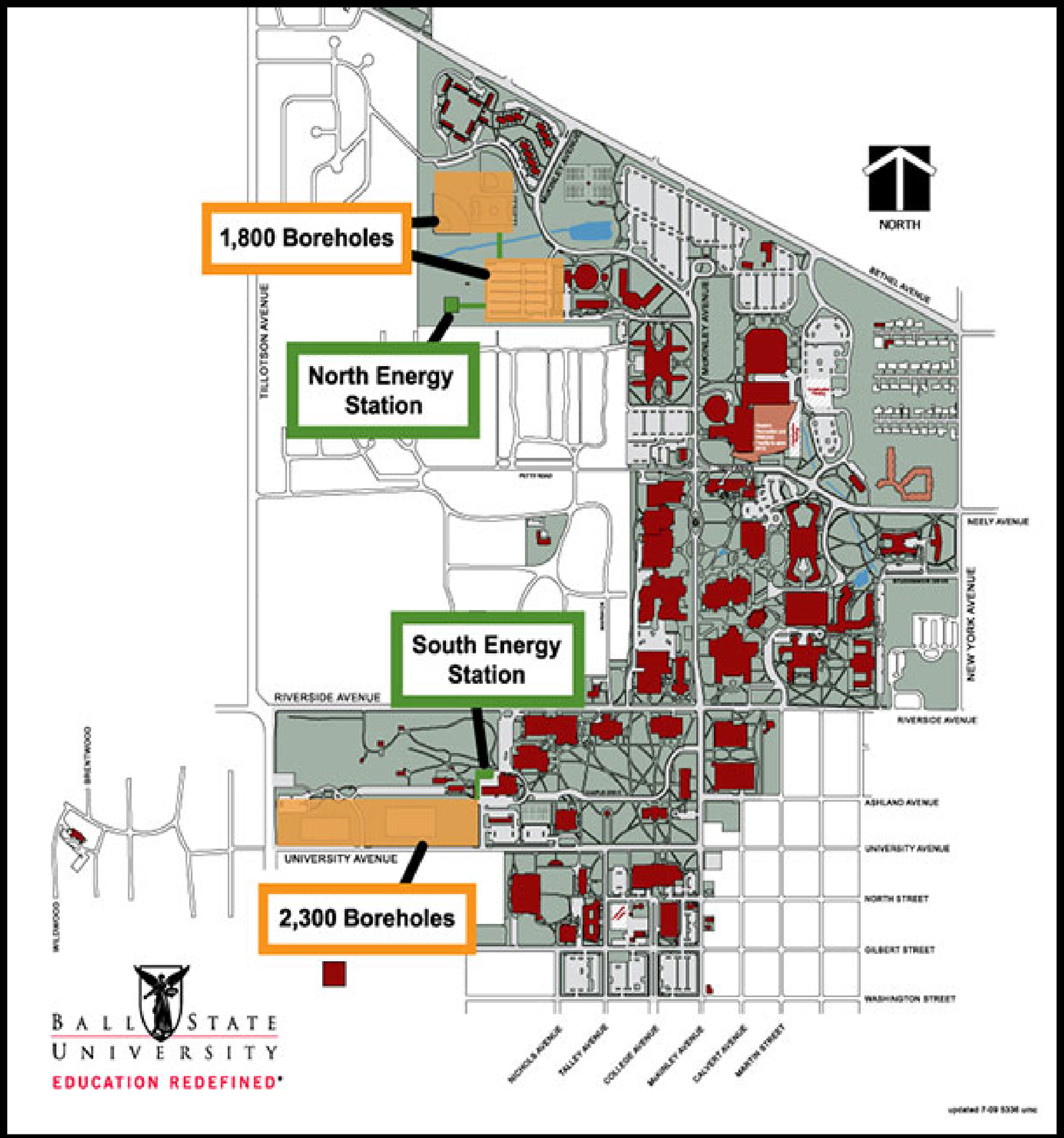
Davenport University

- Dual Wheel Passive Desiccant ERU
- Displacement Induction Heat/Cool 120 F HW, 58 F CHW
- Central GeoHP + unitary GeoHP in Residence Halls
- Waste heat recovery

Zeeland West High School



Ball State University



- $80M cost ($45M in incentives)
- $2M annual savings
- 50% GHG reduction
- 4,100 bores 400 ft deep

Alternative Considerations

US Goals and Mandates

Obama-Biden comprehensive *New Energy for America* plan and *Livability of Cities* Urban Policy

- **Reduce our Greenhouse Gas Emissions 80 Percent by 2050**
- **Build More Livable and Sustainable Communities**
- **Use Innovative Measures to Dramatically Improve Efficiency of Buildings**
- **Weatherize One Million Homes Annually (note that there are 28 million homes that qualify)**
- **Make the U.S. a Leader on Climate Change**

New mandates in the Energy Independence and Security Act of 2007

- **Vehicle efficiency: 40% increase in fuel economy standards by 2020**
- **Renewable fuels: 36 billion gals/year biofuels (21 billion advanced) by 2022**
- **Lighting: 30% increase in efficiency**
- **Appliances: significantly increased efficiency standards in 9 categories**
- **Federal buildings: 30% reduction in energy use by 2015**

State and Local mandates

- **Building Codes**
- **Renewable Portfolio Standards**

Government Incentives

- Federal tax credit – 10% of all geothermal equipment and installation through 2016 – no limit
- Depreciation – Classified as 5-year depreciated property on an accelerated MACRS basis
  - –For a corporation in the 35% bracket, this is equivalent to a 33.25% savings over five years.
  - –Compare to 4.5% savings for traditional equipment usually depreciated on a 39-year straight line basis
- Energy Efficient Building Tax Deduction – up to $1.80 per square foot. Based on comparison to minimally code compliant building
- Owners that cannot use tax advantages may explore other options such as sale-leasebacks, “flip” structures or energy purchase contracts

Alternative Considerations – Heat Pump

- Advantages

- Expand Existing Infrastructure
- Infrastructure Longevity
- Cooling and Heating
- Current Incentives
- Less Impact on Power Productions
- Lowest Energy Cost
- Lowest Maintenance Cost
- Lowest Life Cycle Cost
- Lowest Emissions
- Future Flexibility

Alternative Considerations – Heat Pump

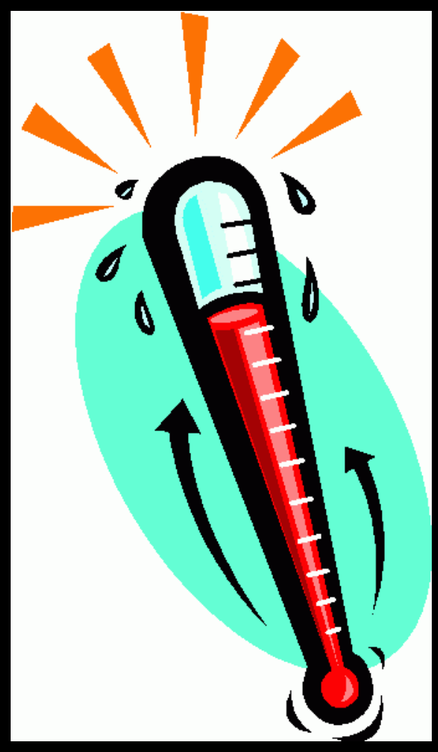
- Disadvantages

-Upgrades to Heat Pump Based Equipment

-Upper Heating Hot Water Temperature Limit of 120-140 Deg F

-Additional Heat Rejection to the Lake

-Additional Water Filtration



Concluding Thoughts

- Where Should We Go From Here?
- The 40 Year Outlook Demands Flexibility and Open Minds
- The Solution May Lie in a Combination of Both Ideas

THANK YOU

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