Potential for WTE District Heating in Northern U.S. and Canada

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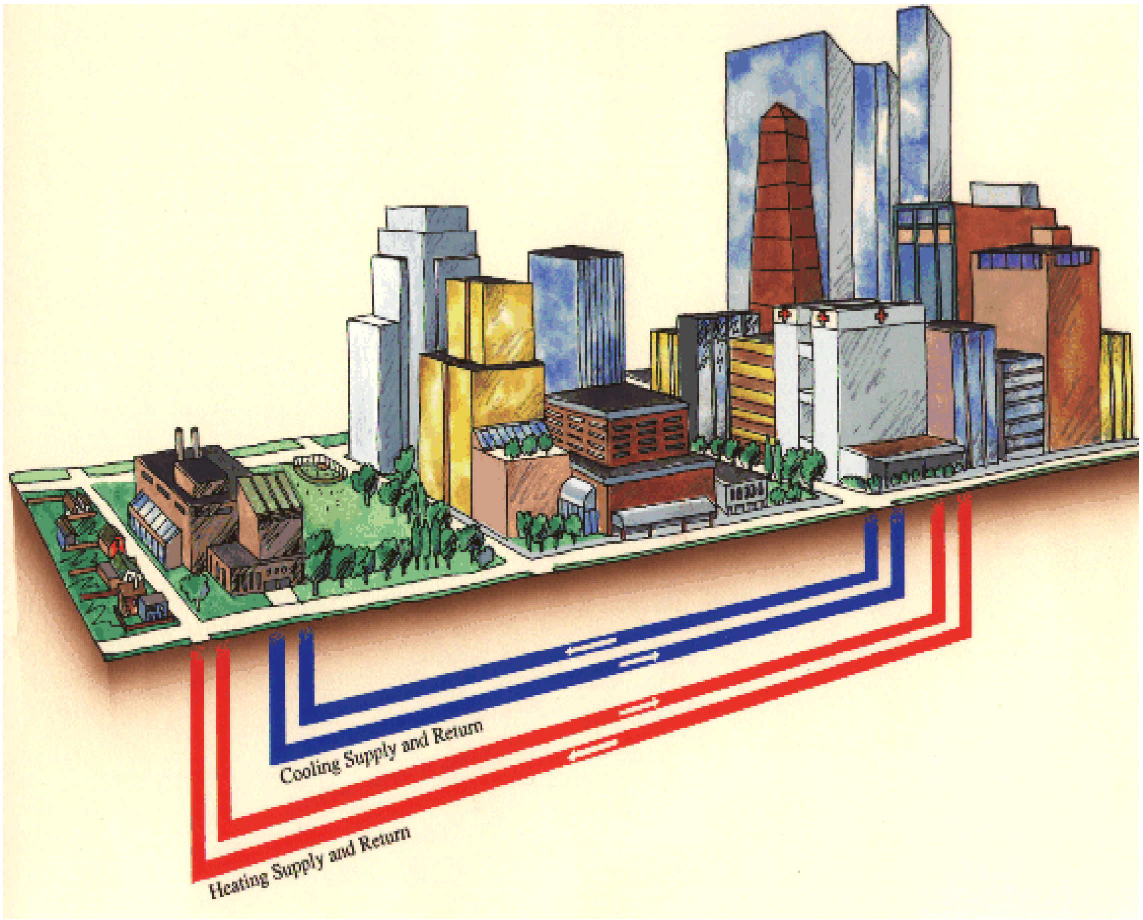
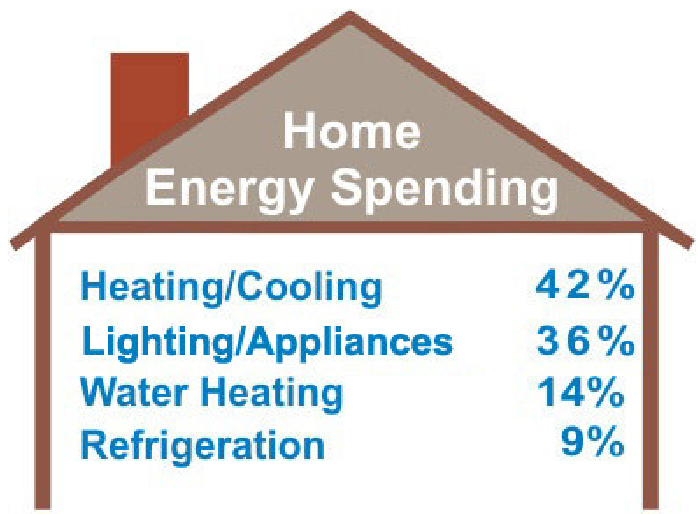
District Heating & Cooling

- Distribution of thermal energy from a central source for space heating & cooling
- Source:
  - Boiler
  - Cogeneration (or CHP)

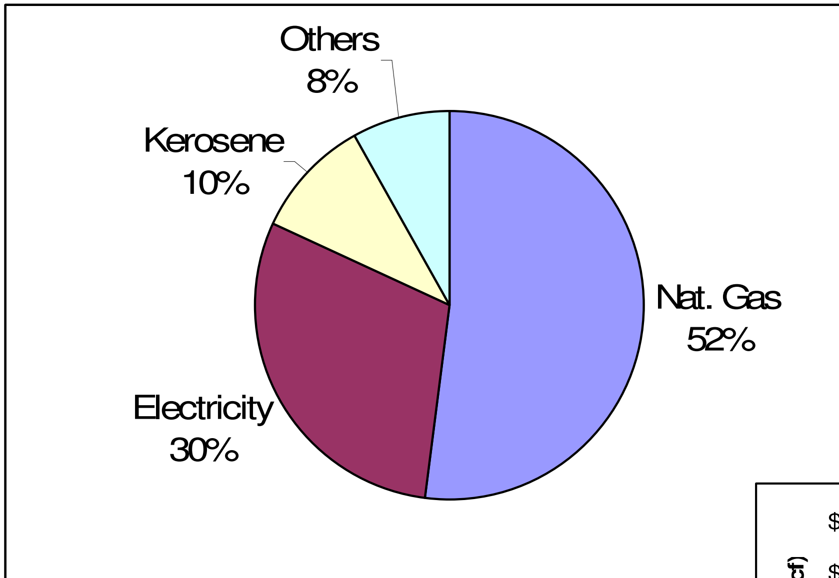


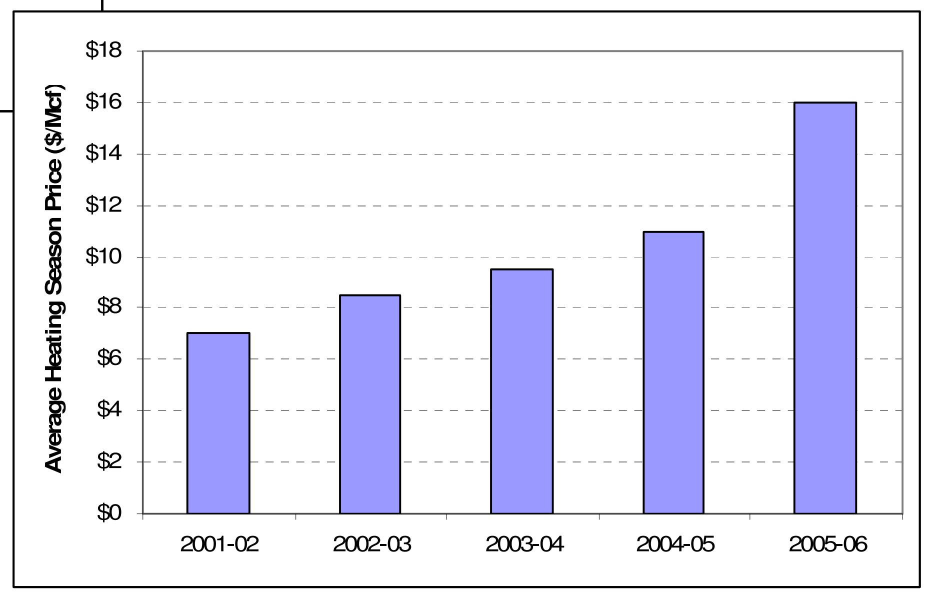
Current Situation of District Heating in US

- 5,800 district heating/cooling systems, mostly steam
  - Total of 320,000 GWh (compare with 14,000 GWh of electricity from US WTE industry)
  - 5% of US energy used for heating and cooling
  - >2,000 institutional facilities



Natural Gas:
Main Heating Fuel in the U.S.

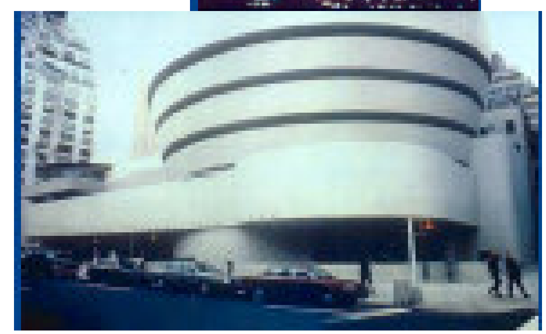




New York City:
Largest Steam District Heating

New York City
Steam District Heating

- Started in 1882
  - 105 miles pipe
- Delivers 27 billion lbs steam annually
- 1,800 customers
  - 70% commercial buildings
- Capacity: over 3,000 MW (12 million lbs steam/hr)
- Winter peak load: 10.5 million lbs steam/hr
- Pipe cost:
  - Distribution $2,000/ft
  - Transmission $4,000/ft



Advantages:
Hot Water vs Steam District Heating

Hot Water

- Piping can range to 15-70 miles
- Less co-generator electricity is sacrificed
- Closed loop
- Low heat loss : 5% - 15%
- Installation, operation, retrofit to buildings is easy
- Metering energy use is easy
- Easy to operate under conditions of varying thermal load
- Hot water can be stored
- Less expensive pipes
- Hot water piping installed 3 feet

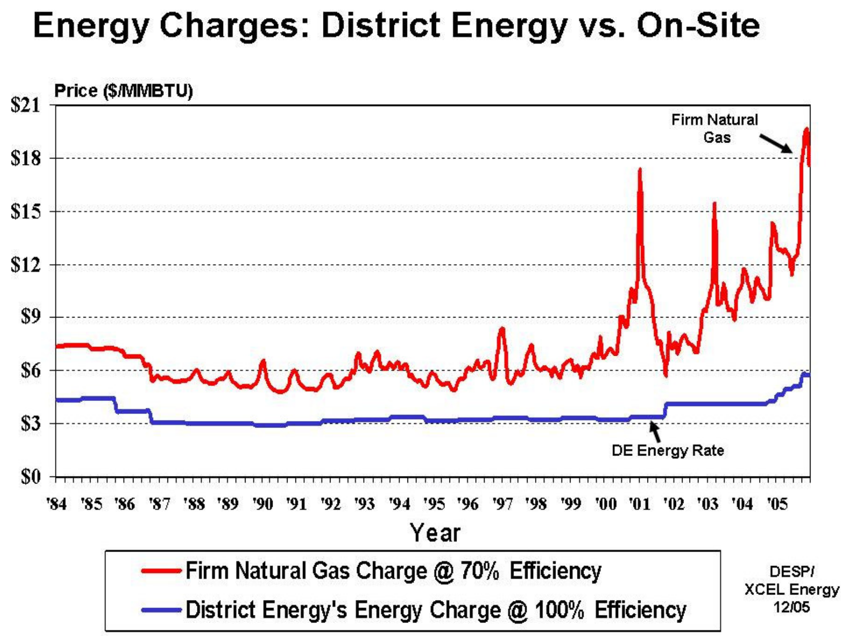
Steam

- Pumps are not required
- Can be a one-pipe system with no return
- Retrofit of old urban steam buildings may be easy

Co-Op City, Bronx, NY
Hot Water District Heating/Cooling

- Largest single residential U.S.
  - 35 high-rise buildings
- Combined cycle CHP plant
  - Natural Gas
  - 2x 13 MW gas turbines
- Pre-insulated hot-water pipes 27 mi
- Excess electricity distributed to NY power grid

St. Paul, MN
Hot Water District Heating/Cooling

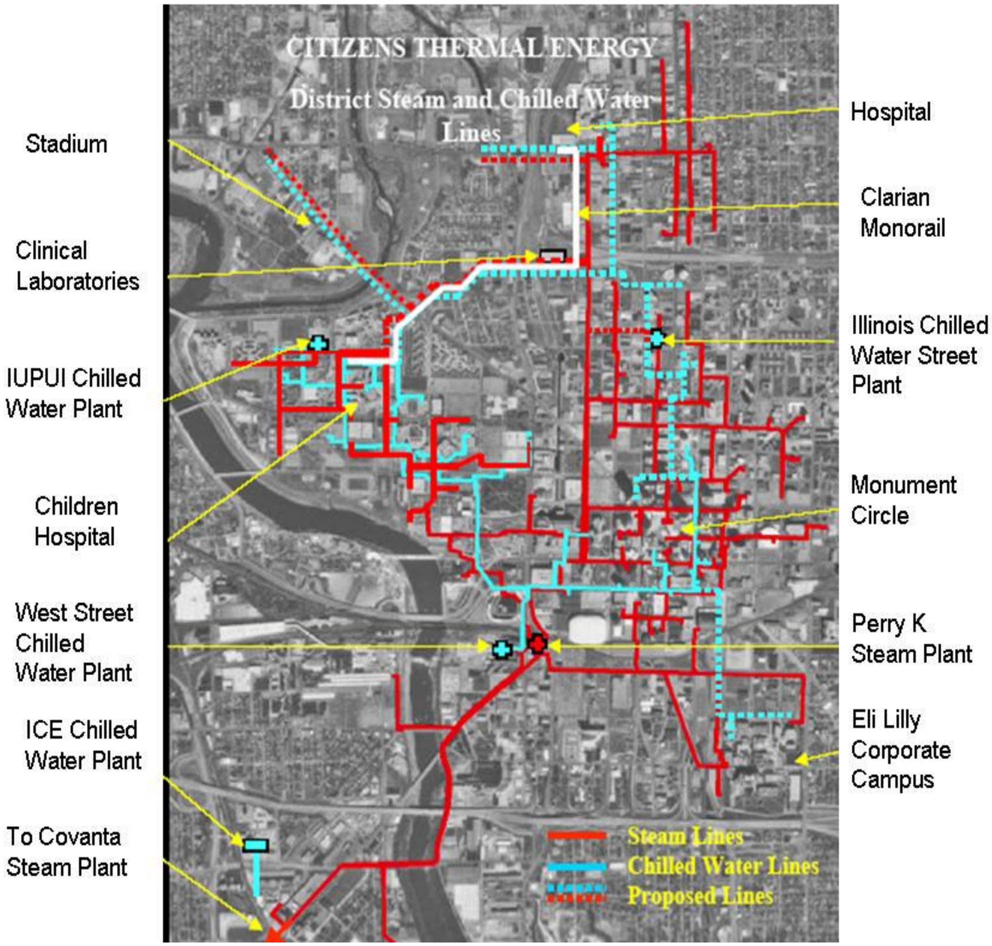


- Hot water district heating system
  - 18.5 mi –hot water
  - 6.2 mi – chilled water
- CHP plant
  - 65 MW thermal
  - 25 MW electricity
- Waste wood, coal, oil, natural gas
  - 280,000 tons waste wood/y
- Reduce pollution
  - 600 tons SO_2; 280,000 tons CO_2
- Rates have been stable

Waste-to-Energy & District Heating in the U.S.

- 1970s, energy recovery from MSW began to develop
- 1974, Nashvillle, TN, first WTE to provide steam district heating & cooling in the world
  - 2004 modify to use Natural Gas
- 1986, the Baltimore Southwest was largest cogeneration WTE plant
- Today, 28 WTE plants sell some steam out of 88
  - 21 co-generate 470 MW thermal (1.6 million lb steam/hr) and 272 MW electricity
  - 7 generate 273 MW thermal (929,000 lbs steam/hr)

Indianapolis WTE, IN



- Indianapolis WTE
  - Started in 1988
  - 2,175 TPD of waste
  - 1.3 MWh thermal/ton (4,500 lb steam)
  - Half of the steam for Indianapolis DH
- Indianapolis DH (Citizens Thermal Energy) distribution piping
  - District Heating:24 mi
  - District Cooling: 15 mi

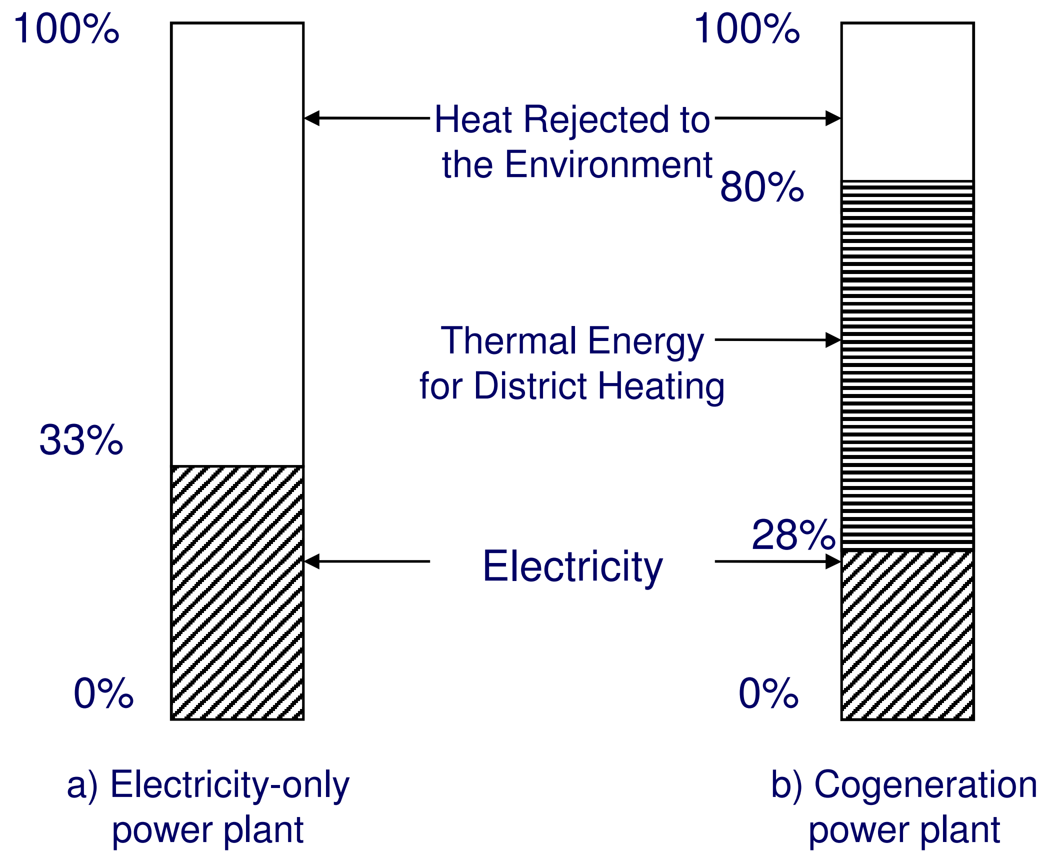
Huntsville WTE, AL

- Started in 1990
- 690 TPD of waste
- All steam for U.S. Army's Redstone Arsenal
- 180,000 lbs steam/hr
- Repair steam traps and vault piping
- Income: 52% steam, and 48% tipping fee
- Tipping fee: $39.90/ton

Technical and Economic Aspects of a DH system in an Existing WTE

- Retrofitting a WTE plant:
  - Avoid long delays associated of permitting a new WTE plant
  - Increase energy efficiency
  - Reduce capital requirements
- Economic criteria to establish a CHP WTE plant
  - Climate and demand density by location
  - Thermal and electrical efficiencies of the power generating units before and after retrofit
  - Density of residential, commercial and institutional buildings in the area
  - Facility of building the required infrastructure for distribution and use of thermal energy by the WTE

Efficiency of a CHP vs. an Electricity-only Power Plant



District Heating: Distribution Network

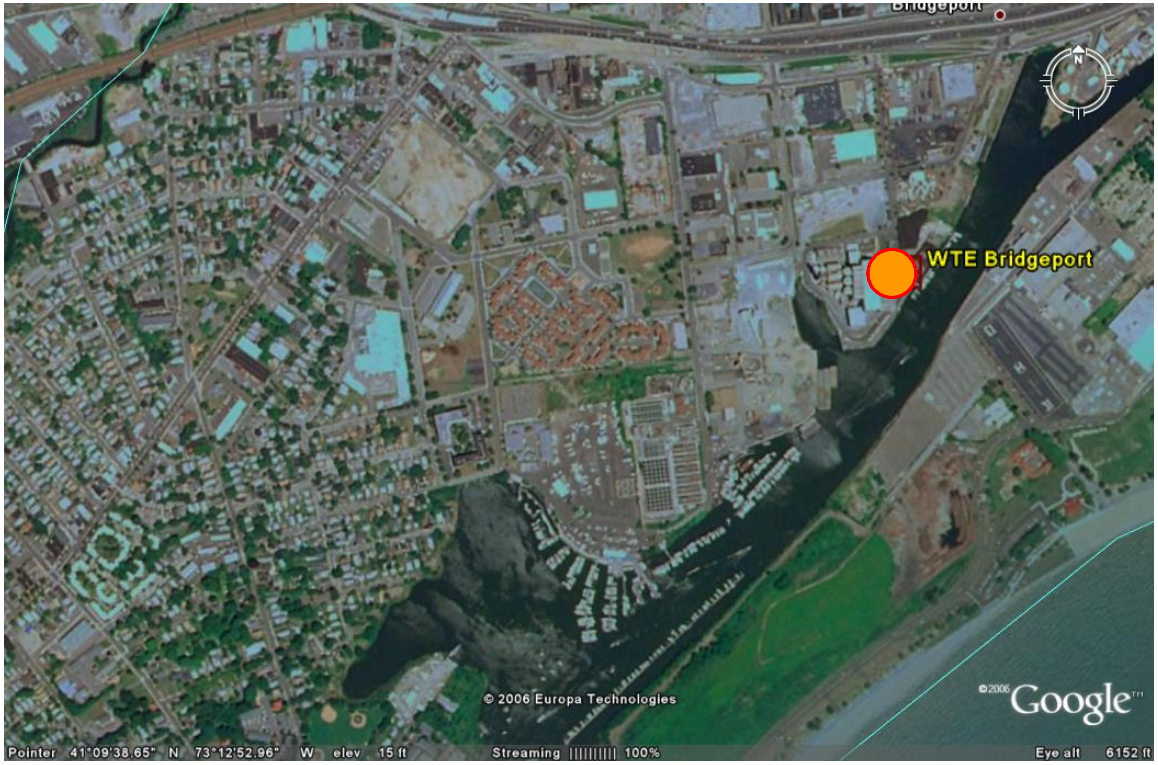
- Main cost of a DH system is the installation of the pipeline network
- A typical cost distribution for installation in an open field:

Component	Percentage
Supply of pipe	55%
Excavation	20%
Laying and jointing	5%
Fittings and specials	5%
Engineering and survey costs	5%
Others	10%
Total	100%

Case Study: Bridgeport WTE

- Population : 140,000
- Density population: 8,720 inh./ mi²

Bridgeport WTE:
- 700,000 tons MSW/yr
- 67 MW electricity
- Tipping Fee: $72.5/ ton MSW
- Nearest an urban area, 2 mi away from downtown area



Case Study:
Assessment Bridgeport Hot Water DH

- Service area: 1 square mile
  - Floor area : 1.3 million sq. meters
  - Peak demand: 97 MW, minimum heat load density of 60-90 MW/sq. mi must be available for a DH to be economical
  - Total energy demand: 211 GWh/yr
- Cost distribution pipes:
  - Minimal cost : $24 million
  - Distribution cost: $110/MWh thermal
- Economic benefit
  - $6.8 million annually considering the number of housing units of 3,398/ mi², and average heating bill of $2,000

Case Study: Preston WTE

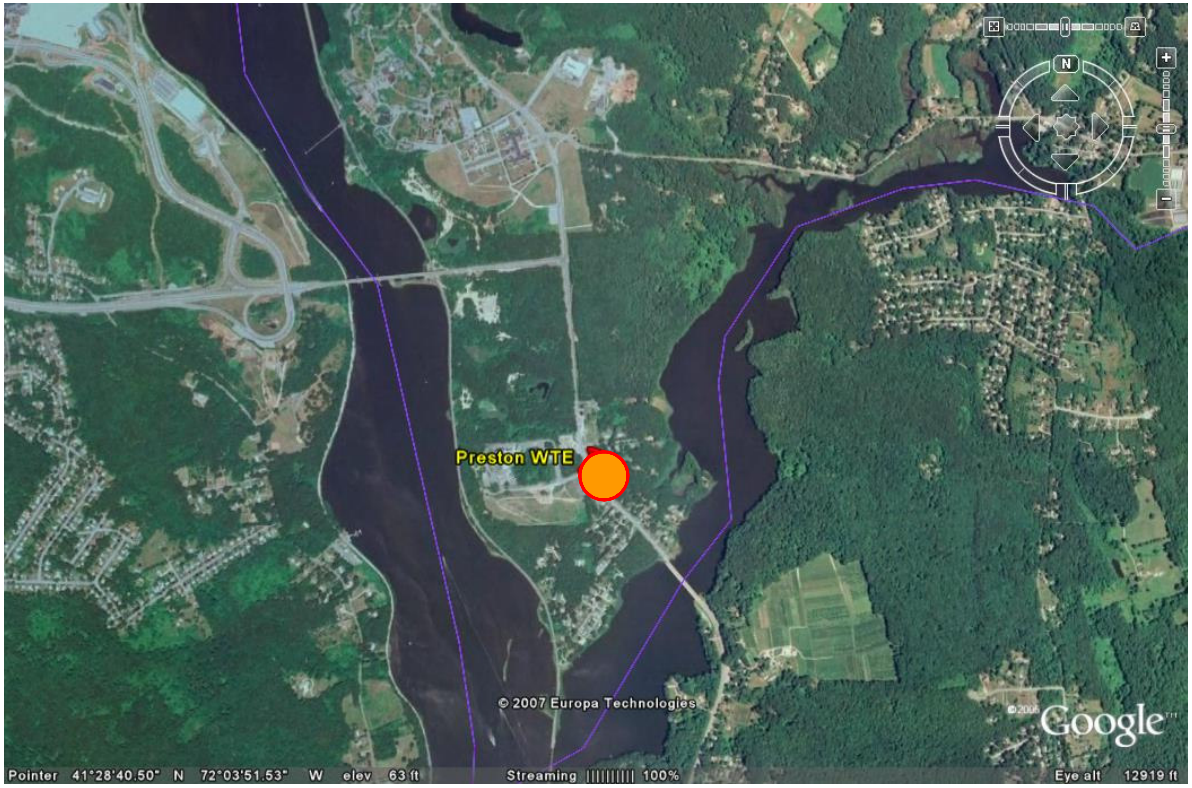
- Population :4,688
- Density population: 151 inh./mi²

Preston WTE:

•147,,000 tons MSW/yr

•17 MW electricity

•Planning to add a third line



Distribution Cost Pipeline

European cost, hot water (1)	Minimum American cost, steam (2)	Manhattan cost, steam (3)
$305 per linear foot ($1,000/mt)	$700 per linear foot	$2,000 per linear foot

(1) Bettina Kamuk, Ramboll , DK

(2) Dominick Chirico, District Heating specialist, Columbia University

(3) NYC Steam District Heating Report

Conclusion (1)

- WTE and DH are complementary
  - Increase energy recovery of new WTEs
  - Reduce uncontrolled emissions of residential/commercial boilers
  - Reduce use of non-renewable fossil fuels
  - DH is a centralized and efficient way to supply heating to a residential area
  - WTE costs are predictable and do not fluctuate like natural gas
- DH for new WTE plants in northern US and Canada
  - Densely populated, cold winters, large heating expenditures
  - Retrofitting technology is available in the U.S.
  - Ample supply of MSW

Conclusion (2)

- Lack of energy policy relating to DH and increasing energy efficiency of BOTH coal and MSW-fired power plants
- Need for alliance between WTE industry and International District Energy Association (IDEA) to advance favorable policies for DH
- DH for Bridgeport WTE should be examined further by Wheelabrator Technologies. DH for the Preston WTE is less favorable because of low density housing and overall heating demand)

Future Work

- Identify WTE plants that are amenable to switch to cogeneration
- Hartford
  - Hartford Steam Company has a three DH Network: Capitol Area (16 buildings), Downtown Area (47 buildings), and South End Area (8 buildings)
  - Population : 121,578
  - Density population: 7,025/mi^2
  - Hartford WTE:
    - 624,000 tons MSW/yr
    - 68.5 MW electricity