JAMESTOWN

TECHNOLOGY SCREENING

April 14th, 2023

Bright ideas. Sustainable change.

Entire process – where are we

Task 2A: Baseline Evaluation of Existing Site

Task 2B: Lower the District Energy Supply Temperature

Task 2C: Technology Screening

- Select Technology
- Select Scenarios

Task 2D: Converting Customer Buildings to Alternate Sources

Task 2E: Scenario Evaluation

- EnergyPRO Modeling
- Electric Capacity Assessment
- Hydraulic Modeling
- Scenario Selection

Task 2F: Economic Analysis

Task 2G: Identify Funding Opportunities

Task 2H: Permitting & Regulatory Review

Task 3: District Heating Study

Agenda

Project Drivers:

- **Viability of District Heating System**
- **Climate Leadership and Community Protection Act (CLCPA)**
  - **Utility Thermal Energy Network and Jobs Act (July 5th, 2022)**

- **NYSERDA's Program Opportunity Notice (PON) 4563 – Just Transition**
  - *Goal: Determine if there is an economic alternative to the current fossil-fuel energy source*
  - *$150,000 funding allocated for each eligible study.*
  - *High level study*

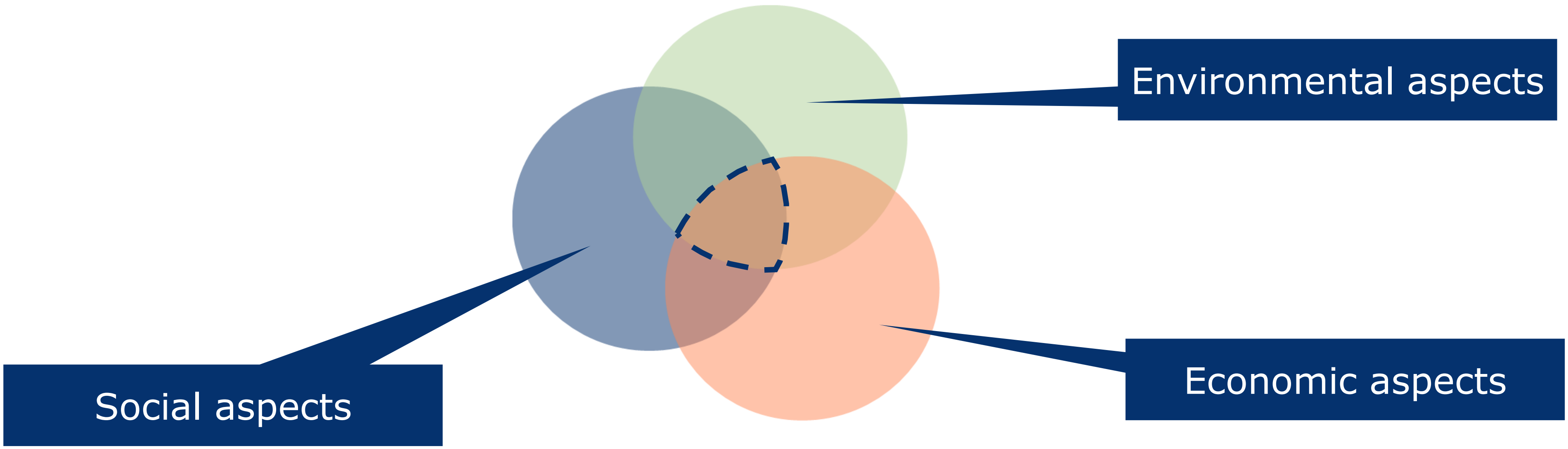
- **PON 4614 – Community Heat Pump Systems**
  - *If Geothermal is viable, PON 4614 to help fund the detailed design & construction.*

- **DOE Funding Opportunity** ***($300k - $750k Possible Funding Available***)
  - Determine most viable geothermal solution (technically & economically)
    - Detailed Geological Surveying
    - Detailed Building Assessments

7 AFFORDABLE AND CLEAN ENERGY

Sustainability considerations

- **Sustainable projects balances**

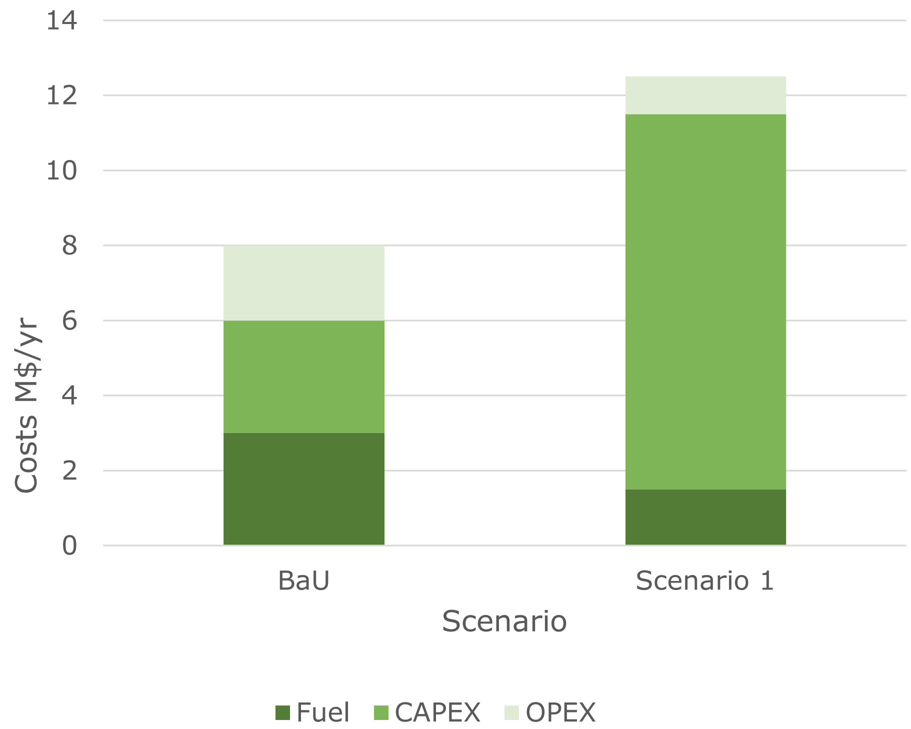


Sustainability considerations – Shadow price of carbon

Example: Shadow price of carbon

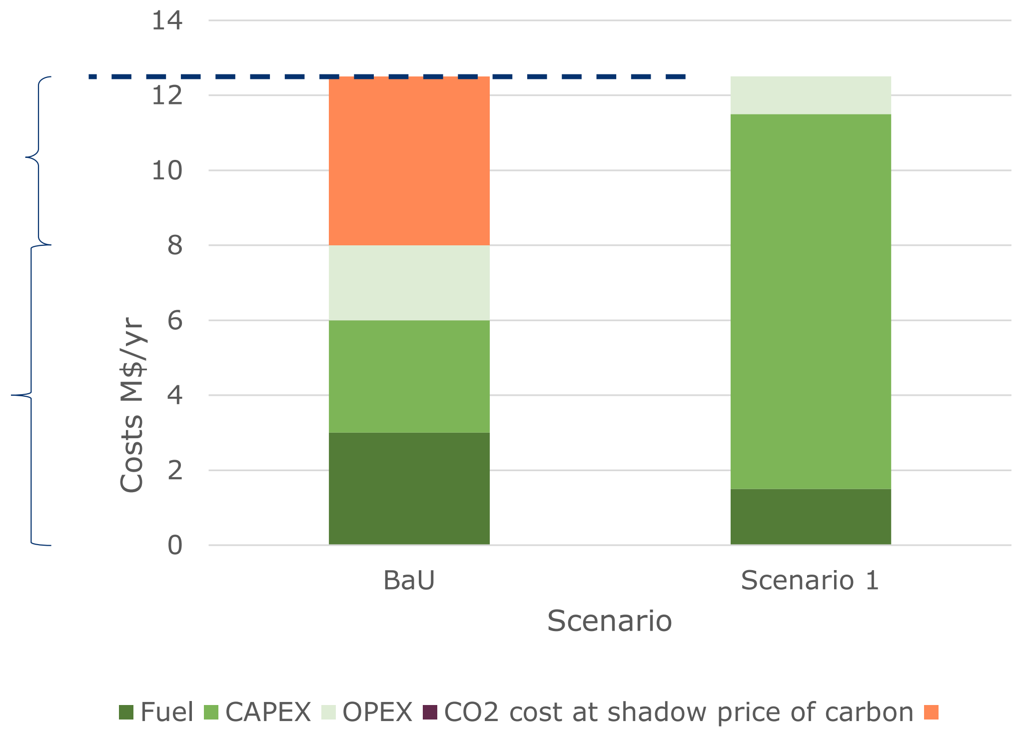
Business as usual:
- High CO_2 emissions, low costs

Scenario 1
- Low CO_2 emissions, high costs



Sustainability considerations – Shadow price of carbon

Shadow price of carbon equals the cost of carbon which exactly levels out the difference in cost between business as usual and scenario 1

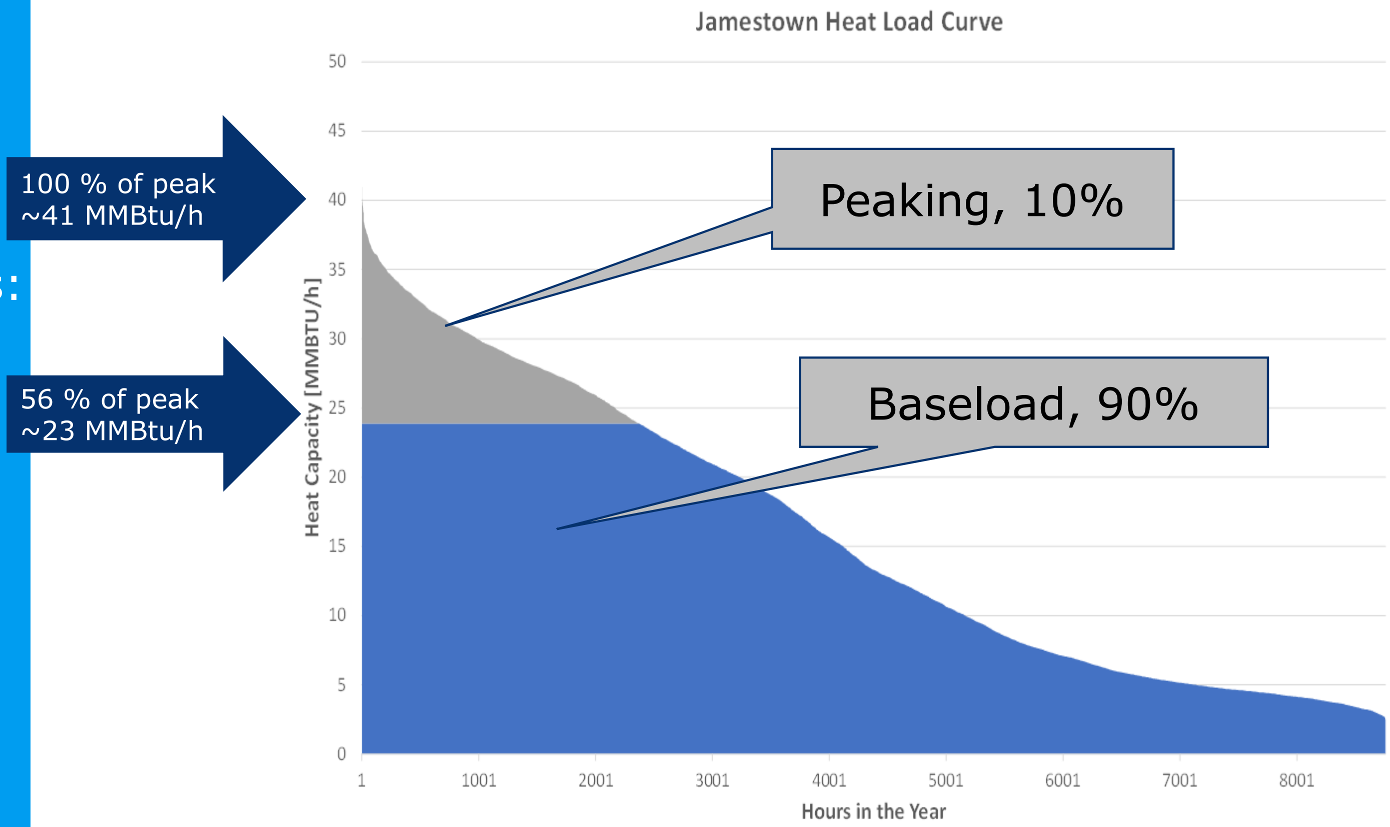


The lower the shadow price of carbon, the higher the sustainability of the project. By focusing on projects with the lowest costs, the consequences will be economic and social improvements of the local community and reduced risk of energy poverty.

Baseload and peaking technologies

Baseload / peaking production (preliminary load curve)

- Total annual heat load is ~160,000 MMBtu/yr
- Heat Load Curve Includes:
  - Building Space Heating
  - DHW
  - Distribution Losses



Baseload / peaking characteristics

Some base load technologies characteristics

- Often high capital expense (CapEx) (should be in operation many hours per year)
- Should have low fuel costs

Some peaking / backup technologies characteristics

- Often low CapEx (*e.g.*, boiler technology)
- High fuel costs
- Very high technology reliability (backup)
- High fuel supply reliability

Presentation of Technologies -1

Fossil technologies / fuels

1	2	3	4	5

1= poorest performance 5= highest performance

Technology	Output	Type	Notes	CO2 neutralit	CAPEX	OPEX	System integration
Gas turbine (simple cycle), Gas turbine combined cycle, rankine steam turbine, gas engines	- Electricity	Fossil fuel	- Base load technology, well proven - Not carbon neutral if NG is used - High CAPEX	1	2	4	5
Solid oxide fuel cell CHP	- Heat - Electricity	Fossil fuel	- High CAPEX - Base load technology - Not carbon neutral if NG is used - Local use of biogas seems unrealistic - Long start up times, high minimum load %	2	1	4	4
Gas boiler	- Heat	Fossil fuel	- Peak / backup technology, very limited operation - Not carbon neutral - Very low CAPEX	2	5	3	5
Oil boiler	- Heat	Fossil fuel	- Peak / backup technology, very limited operation - Not carbon neutral - Very low CAPEX	1	5	2	4
Grey Hydrogen	Fuel	Fossil fuel	- Derived from n-gas and produced from fossil fuels - CO2 is released into the air	1	1	2	3

Renewable sources / technologies

1	2	3	4	5
1= poorest performance				5= highest performance

Technology	Output	Type	Notes	CO2 neutralit	CAPEX	OPEX	System integration
Bio-oil fired turbine (simple cycle)	- Heat - Electricity	Renewable fuel	- Base load technology - High CAPEX - Very high OPEX	4	2	1	3
Bio-oil engines	- Heat - Electricity	Renewable fuel	- Base load technology - Very high OPEX	4	2	1	4
Biomass ORC CHP, wood chips	- Heat - Electricity	Renewable fuel	- Relatively high CAPEX - Low OPEX	4	1	4	3
Biomass ORC, wood pellets	- Heat - Electricity	Renewable fuel	- Relatively high CAPEX - High OPEX	4	1	2	3
Biomass HOB, wood chips	- Heat	Renewable fuel	- Low CAPEX - Low OPEX	4	4	4	5
Biomass HOB, wood pellets	- Heat	Renewable fuel	- Low CAPEX - High OPEX	4	4	2	5
Bio oil boiler	- Heat	Renewable fuel	- Low CAPEX - High OPEX	4	5	2	5
Photovoltaics	- Electricity	Renewable source	- Intermittent source / need backup from grid - Limited production winter / high in summer	5	2	5	3

Renewable sources / technologies

1	2	3	4	5
1= poorest performance				5= highest performance

Technology	Output	Type	Notes	CO2 neutralit	CAPEX	OPEX	System integration
Wind turbine	- Electricity	Renewable source	- Low CAPEX - Need backup from grid	5	2	5	3
Bio gas production - anaerobic digester	- Gas	Renewable fuel	-High CAPEX / OPEX	5	1	2	2
Large Solar Thermal	- Heat	Renewable source	- High CAPEX - Limited production in winter / high in summer	5	1	5	3
HOB - conversion from n-gas to bio-oil	- Heat	Renewable fuel	- Very low CAPEX - High OPEX if used in baseload	4	5	2	5
Boiler, hydrogen	- Heat	Renewable fuel	- High CAPEX / OPEX	4	1	1	1
Cogeneration, hydrogen	- Heat - Electricity	Renewable fuel	- High CAPEX / OPEX	3	1	1	1
Blue Hydrogen	Fuel	Renewable source	- Derived from n-gas and produced from fossil fuels - CO2 is captures in a CCS process and stored	4	1	1	2
Green Hydrogen	Fuel	Renewable source	- Produced from electrylyzes - Electricity is based on renewable electricity	5	2	1	2

Presentation of technologies - 2

Electrification technologies

1	2	3	4	5
1= poorest performance				5= highest performance

Technology	Output	Type	Notes	CO2 neutralit	CAPEX	OPEX	System integration
Electric boiler	- Heat	Electrification	- Base load or peak load - Very low CAPEX for boiler - High requirement for electric load. Potentially need for larger upgrade of electric feeders - High OPEX	4	5	1	5
HP (air-to-water) - large scale	- Heat - Cooling	Electrification	- Air as secondary heat source - Low efficiency in winter period - Reduction in load in winter season	5	3	3	4
HP (air-to-water) - small scale	- Heat - Cooling	Electrification	- Standardized product, low CAPEX - Low efficiency in winter period	5	2	3	3
GSHP open-loop, deep geothermal	- Heat - Cooling	Electrification	- Base load technology - High risk and high CAPEX	5	1	3	3
GSHP closed-loop, horiz, individual	- Heat - Cooling	Electrification	- Closed loop, baseload technology - Requires high available area	5	1	3	3
GSHP closed-loop, vert	- Heat - Cooling	Electrification	- Closed loop, base load technology - Requires much available space - High CAPEX - Boreholes would require balancing in summer periode	5	2	3	4
HP (sewage water-to water)	- Heat - Cooling	Electrification	- Base load technology - Often, relatively low CAPEX compared to benefits	5	3	3	4
Heat recovery chillers, electric	- Heating - Cooling	Electrification	- low OPEX considering that heating and cooling is produced simultaneously - higher CAPEX compared to conventional chiller	4	3	4	4
Chillers, electric	- Cooling	Electrification	- low OPEX considering that heating and cooling is produced simultaneously - lower CAPEX compared to heat recovery chillers	4	3	3	5

Potential heat pump heat sources

1 – lowest, 5 - highest

HP heat source	Quality	Availability	Jamestown
Cooling of buildings	4	2	
Wastewater (effluent)	4	3	
Wastewater (influent)	3	2	
Surface water from Chadakoin river	2	4	
Heat from electrical substations	4	2	
Ground water aquifers for energy purposes	3	?	
Ground as heat source (GSHP)	2	4	
Air	1	5	
Data Center	?	?	
Nearby industrial heat sources	?	?	

Quality: Temperature, costs etc.

Availability: Accessible amount of the heat source

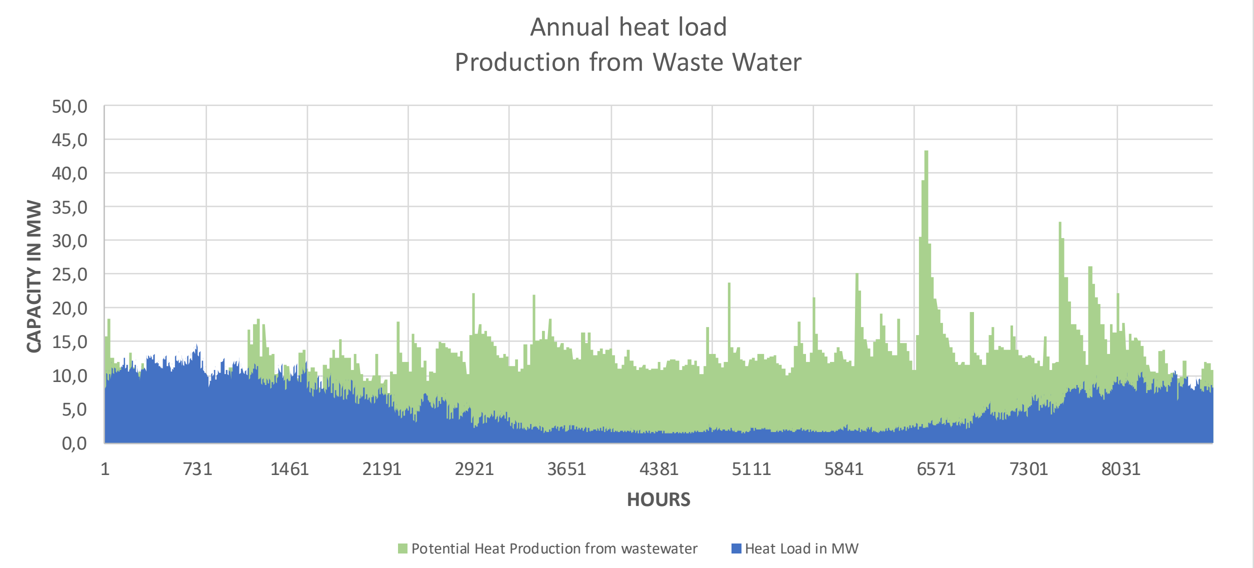
Cooling technologies

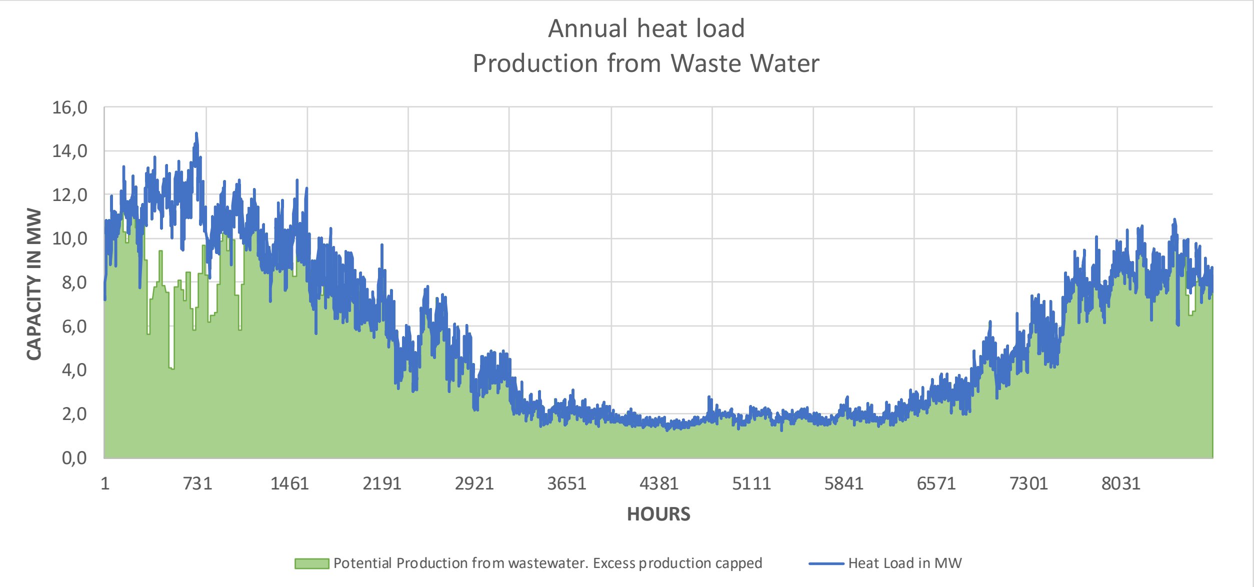
	Pros	Cons
Chillers, electrical	• Very well-known technology • Low CAPEX • High efficiency	• Normally, heat is wasted instead of being reused
Absorption chillers	• Can be cost-efficient – especially if steam (or other high temperature source) is available	• Very often, a fossil fuel is used • Low COP value
Heat recovery chillers	• Very efficient production of heating / cooling • Limited additional CAPEX compared to chiller only	• Requires connection to a heat network incl. thermal storage to enable good utilization of the heat

Wastewater effluent

Potential heat production from wastewater

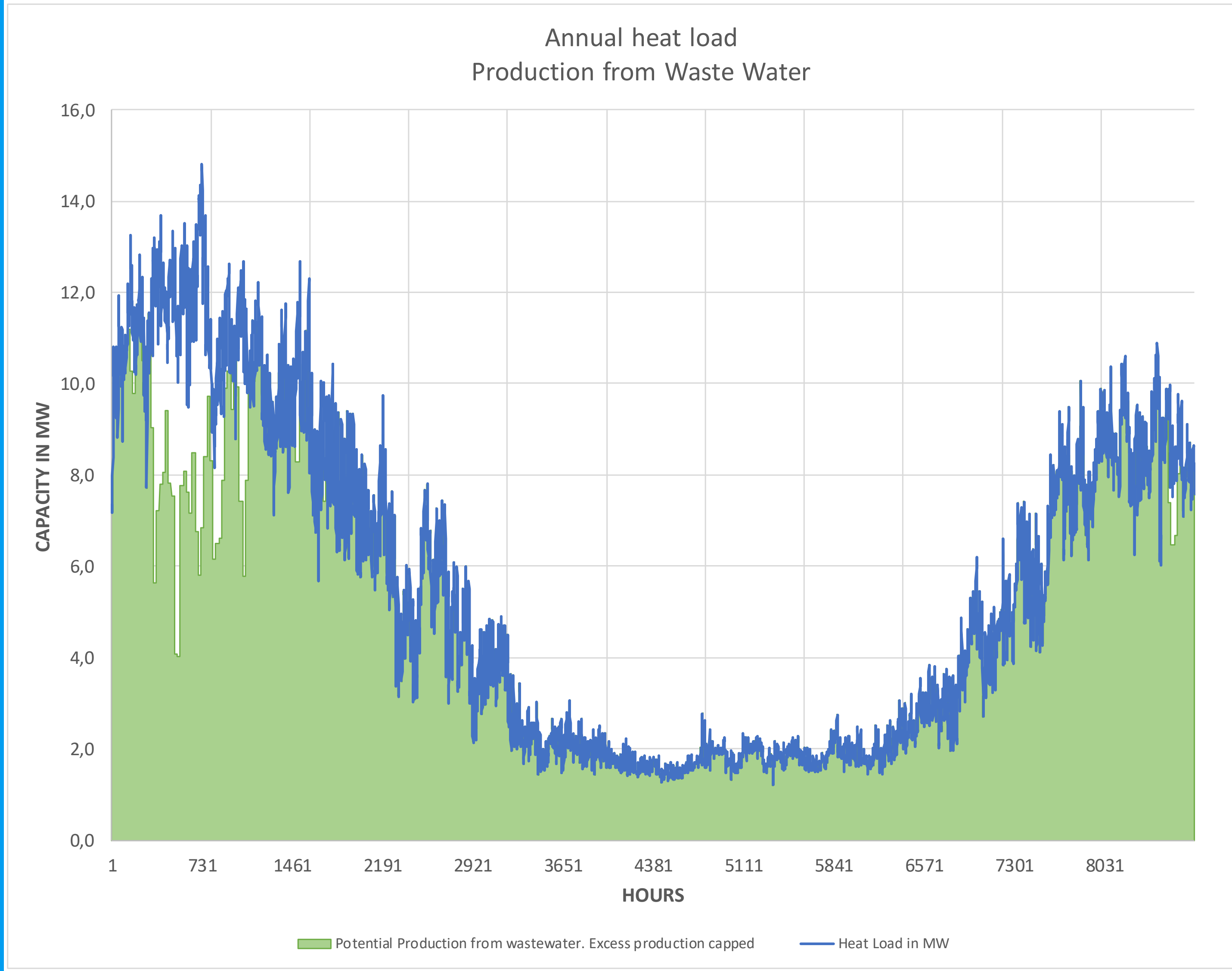
- Total potential production of heat from wastewater ~ 43,900 MWh/yr (capped)
- Total heat demand 47,400 MWh/yr
- Wastewater flow and temperatures are based on daily average from Jamestown WWTP





Potential heat production from wastewater

- Huge potential for covering the annual heat load with wastewater. Approximately 92% covered (without accounting for potential outages)
- BUT: Costly to establish a wastewater distribution pipe



Energy storage

Energy Storage - Options

	Pros	Cons
Battery storage	• Most established technology for electric storage at small scale (households) • Very suited for frequency regulation • Well-known technology	• High CAPEX, compared to energy content • Limited energy content per unit weight and unit volume • Limited technical lifetime compared to thermal storage
Tank thermal energy storage (TTES)	• Low CAPEX and OPEX • High energy content • Well-established technology in DK • Very suitable for daily storage, • Site-independent • Long technical lifetime	• Expensive at large scale, therefore, not feasible as seasonal storage • Less known in the US
Aquifer thermal energy storage (ATES)	• Very cost-effective at large scale • Very limited space requirements	• Highly site-dependent (requires specific geological conditions), • Regulation/legislation may apply • Approval process
Borehole thermal energy storage (BTES)	• much less site-dependent compared to ATES, • modular, therefore easily scalable	• High CAPEX compared to ATES • Limited capacity per borehole • Campus disruption
Pit Thermal Energy Storage (PTES)	• Low specific CAPEX ($ per MMBtu) • Low OPEX • Can store energy for long periods	• Requires lots of space • Heat source for the storage, e.g. solar thermal also requires lots of space
Ice Storage	• Limited in size • Known technology	• Lower efficiency in chillers (due to lower temperature • Less

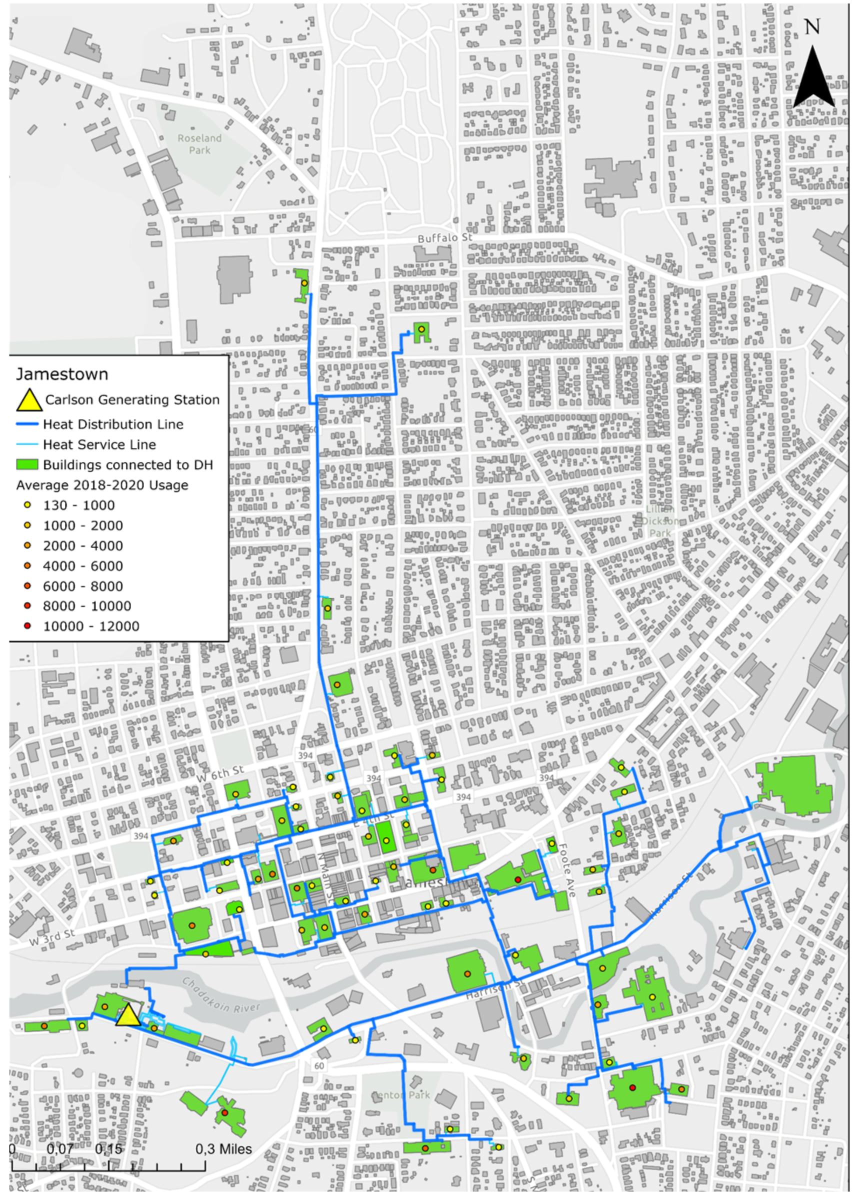
Examples of storage types under development or with limited operational experience
- Different types of molten salt storage, gravity storage, sand storage, flywheels, compressed air storage

GIS overview of system

Current state

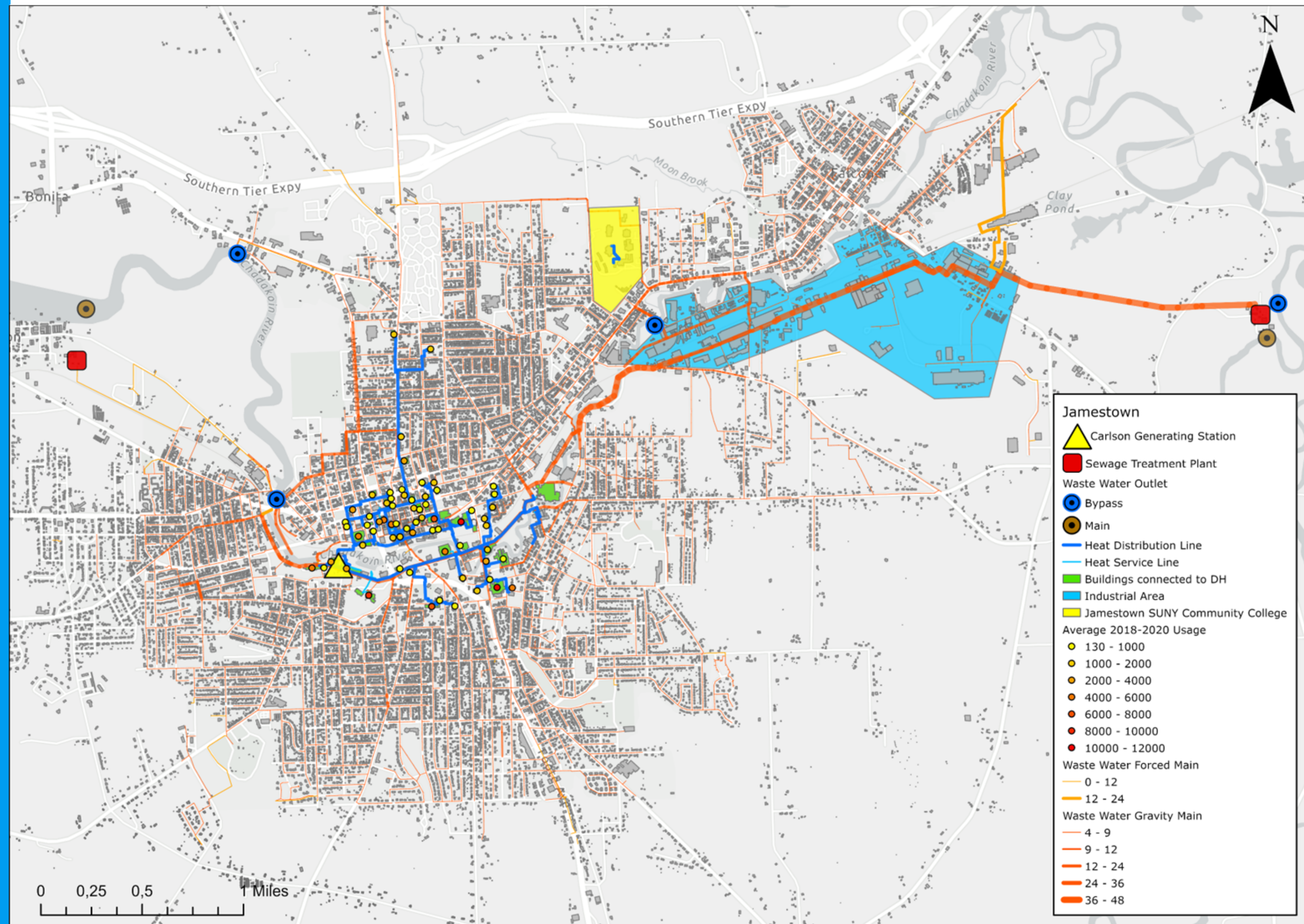
A look at the current DH system

- 67 current consumers
- 139,762 MMBtu/yr
- 15 miles of distribution pipe (supply + return)



A broader perspective

- Utilization of waste water from either waste water treatment plant
- Expansion of customer base
  - Large individual customers
  - SUNY Jamestown
  - Industrial area



Scenarios

Jamestown. Potential scenarios and variations

TWO Scenario Description ->	Business As Usual	Centralized Option & Centralized Hybrid Option						Ambient Loop		Dentralized Option 1	Decentralized Option 2
TWO Scenario ->	*Scenario A*	*Scenario's B&C*						*Scenario D*		*Scenario E*	*Scenario F*
Scenario Variation ->	1	1	2	3	4	5	6	1	2	1	1
Demand (Campus Load)	Current	Current	Current	Current	Current	Current	Current	Current	Current	Current	Current
Network Configuration	Centralized HTW	Centralized /Hybrid	Centralized /Hybrid	Centralized /Hybrid	Centralized /Hybrid	Centralized /Hybrid	Centralized /Hybrid	Ambient Loop	Ambient Loop	Decentralized HP's	Decentralized HP's
Baseload Technolgy	NG	GSHP (Closed Loop), ASHP	GSHP (Closed Loop), ASHP	ASHP in cascade w/W-W HP	ASHP in cascade w/W-W HP	WSHP (Waste Water)	WSHP (Waste Water)	Individual HP's	Individual HP's	HP's	HP's
Peaking Technology	NG	NG Blrs	Electric Blrs	NG Blrs	Electric Blrs	NG Blrs	Electric Blrs	Individual HP's	NG Blrs	NG Blrs	Individual HP's
Borefield Balancing	N/A	ASHP	ASHP	N/A	N/A	N/A	N/A	ASHP	ASHP	N/A	N/A
DHW (Summer)	Centralized	Centralized	Centralized	Centralized	Centralized	Centralized	Centralized	Local	Local	Local	Local
DHW (Winter)	Centralized	Centralized	Centralized	Centralized	Centralized	Centralized	Centralized	Local	Local	Local	Local
Space Cooling	Local-Elec	Local-Elec	Local-Elec	Local-Elec	Local-Elec	Local-Elec	Local-Elec	Individual HP's	Individual HP's	Individual HP's	Individual HP's
Thermal Energy Storage	None	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Backup Heat (Emergency)	Fuel Oil	NG Blrs	NG Blrs	NG Blrs	NG Blrs	NG Blrs	NG Blrs	NG Blrs	NG Blrs	NG Blrs	NG Blrs
Network	2Pipe/2G	2Pipe/4G	2Pipe/4G	2Pipe/4G	2Pipe/4G	2Pipe/4G	2Pipe/4G	2Pipe/5G	2Pipe/5G	N/A	N/A

Discussion/Next Steps

Bright
ideas.
Sustainable
change.

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