In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

"This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying 1.25 code/energy hours of credit toward Building Officials and Residential Contractors continuing education requirements."

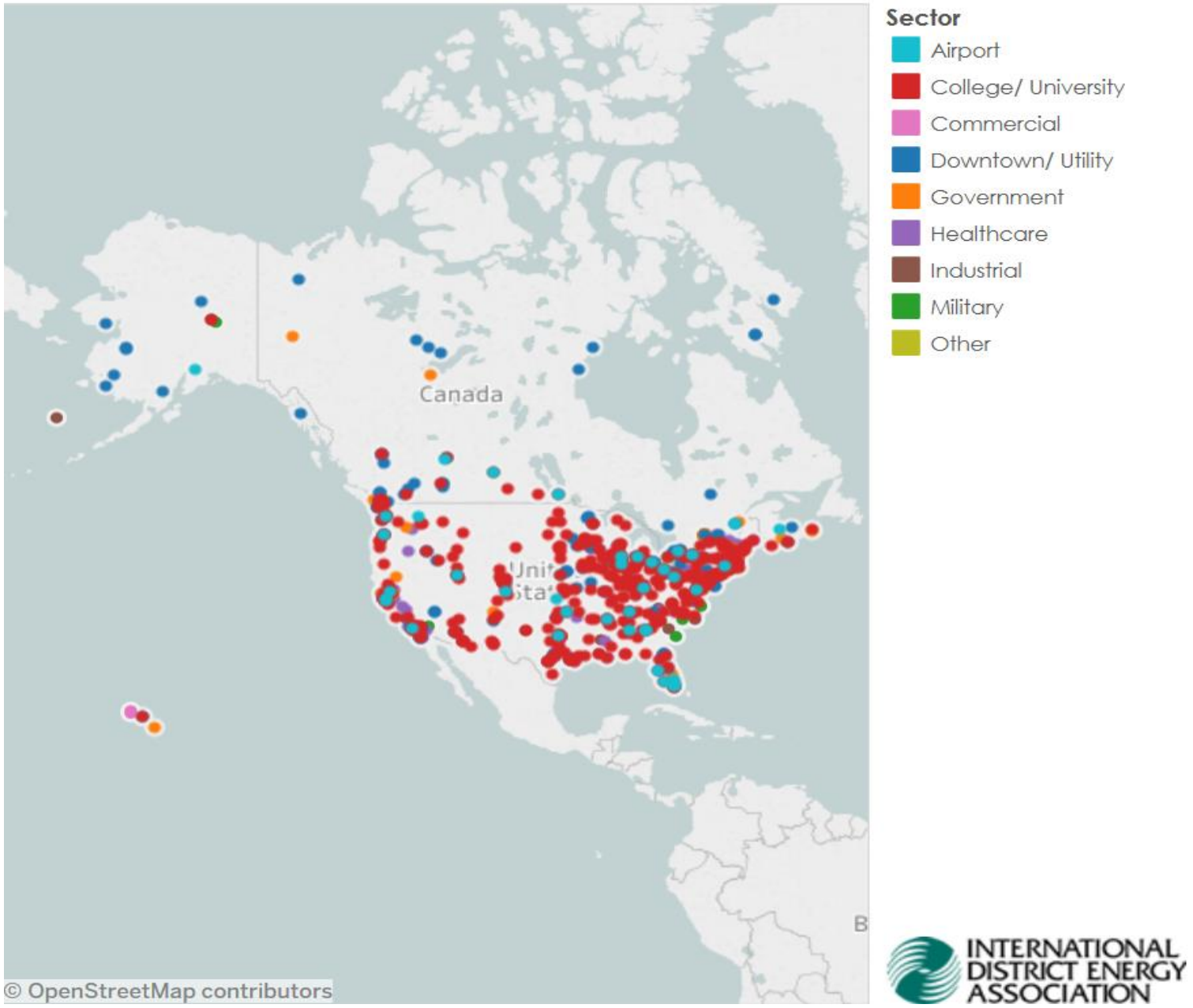
For additional continuing education approvals, please see the continuing education guide in the conference guidebook.

Decarbonizing through Thermal Energy Districts

Mindy Granley – Sustainability Officer, City of Duluth

Justin Reid – General Manager, Duluth Energy Systems

District Energy US/CAN



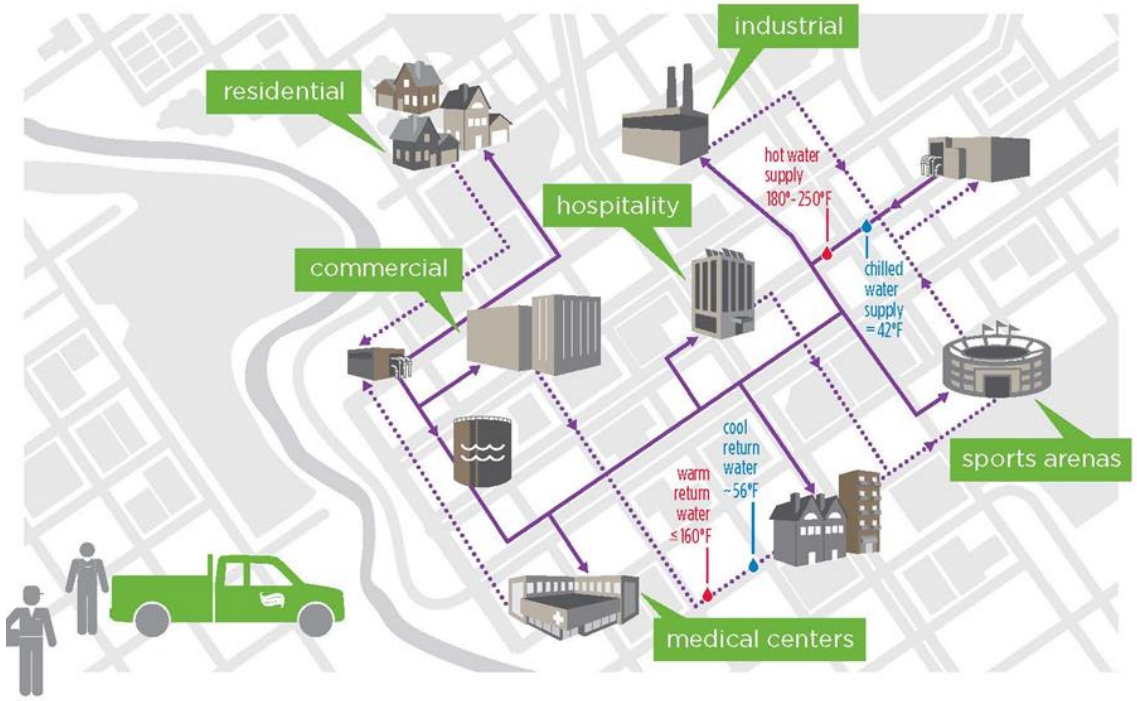
INTERNATIONAL DISTRICT ENERGY ASSOCIATION

90 Years of Service to Duluth

- Start up 1932
- City ownership 1979
- Ever-Green Energy hired to operate, maintain, and manage in 2012
- Master Plan 2013
  - 2022 update
- Integration with City's climate work

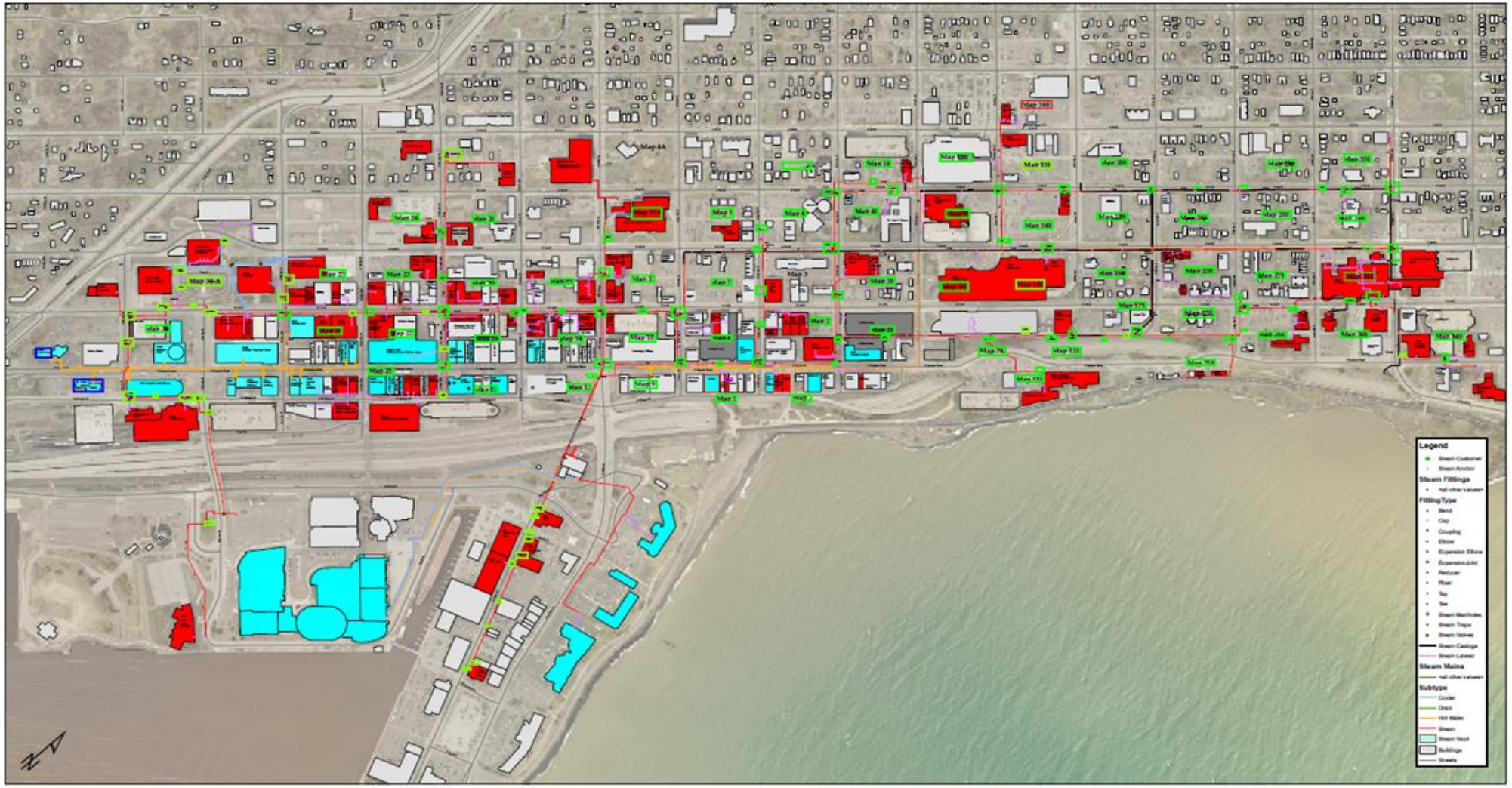
Duluth Energy Systems

- Serves Downtown and Canal Park
- Hot water & steam heating: 164 buildings = 8 M square feet
- Chilled water cooling: 5 buildings = 530,000 square feet
- Customers include:
  - Hospitals
  - Churches
  - Federal, state, county, and city gov
  - Financial institutions
  - Hotels and restaurants
  - Apartment buildings
  - Entertainment and civic
  - Local and small businesses



Service Area

4th St. to the northwest, 11th Ave. to the northeast, Lake Superior to the southeast, and Mesaba Ave. to the southwest

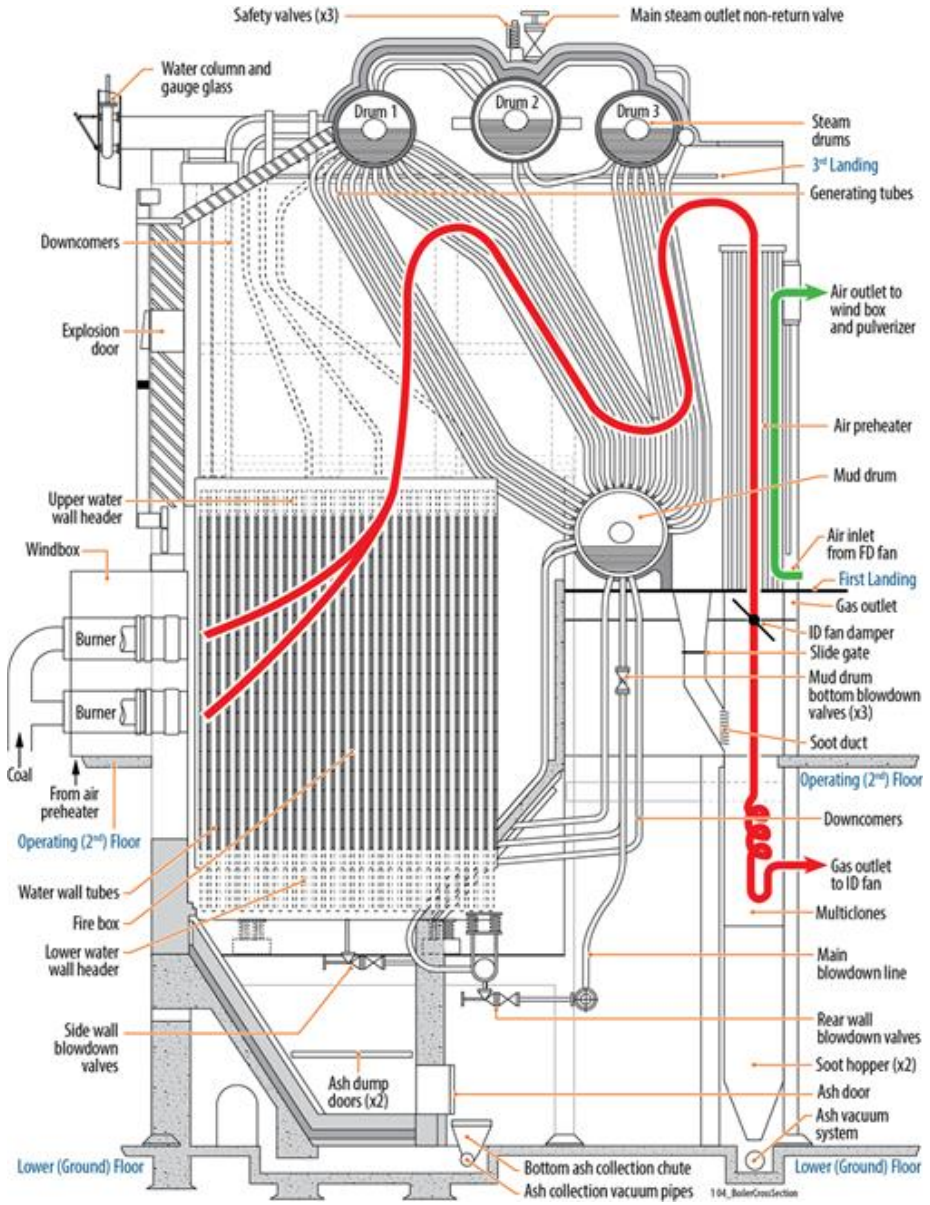


Customer Benefits

- Reliability (>99.99%)
- Cost competitive
- Redundancy and resiliency
  - Multiple energy inputs and feeds
  - N+1 equipment (Boilers, Generator, HXs)
- 24/7 operations, Licensed Boiler Operators
- Strategic investment in system and customer buildings
- City’s carbon reduction goal integration and ability to assist in achievement

Production Overview

- SATURATED STEAM
  - Four 1932 Edgemoor boilers
  - Two Coal Only
  - Two Coal / Gas
  - 225 psi
  - Rotating equipment - steam powered
  - 140 psi distribution
  - 8.5+ miles of steam pipe
  - 5.5+ miles of hot water pipe



Energy Transformation

Superior Street Project

- Replaced 16 blocks of the aged downtown system steam pipe
- Closed the loop
- Transition from steam to hot water for a portion of customers
- Upgrade customer building equipment

Superior Street/Medical District Hot Water

Superior Street Update:

- 29 Customers Connected
  - Gateway Towers (153 Units)
  - Lenox Place (152 Units)

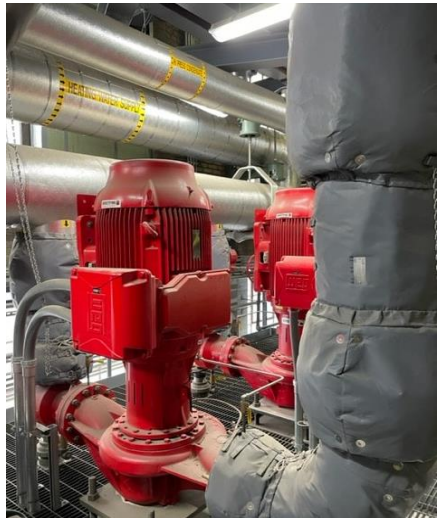
Future Connections

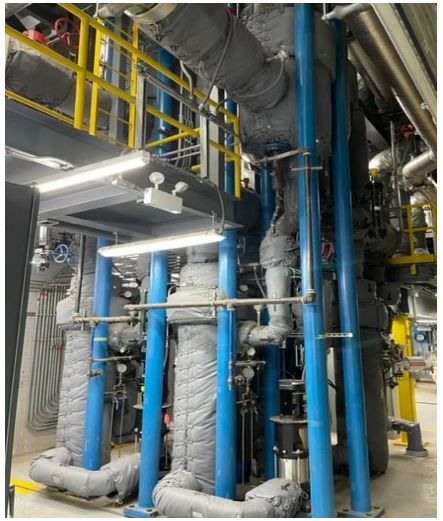
- Lakeview 333
- Zenith Historic Central
- ZMC (antique store)

Medical District Update:

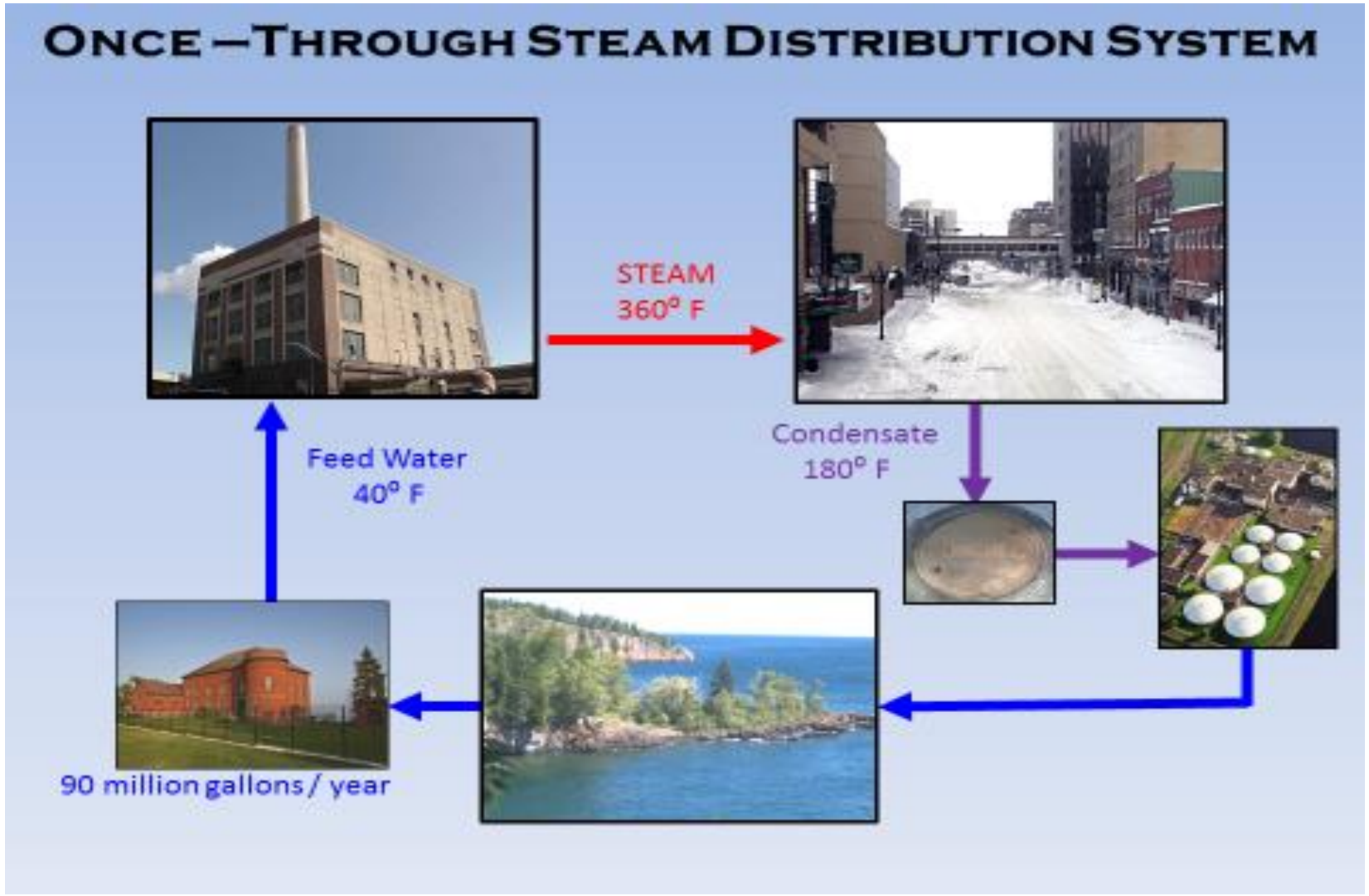
- Essentia Vision Northland Connected
- Future Connections
  - St. Luke's Bldg A
  - Essentia Duluth Clinic and Miller Dwan

Plant Infrastructure Investment

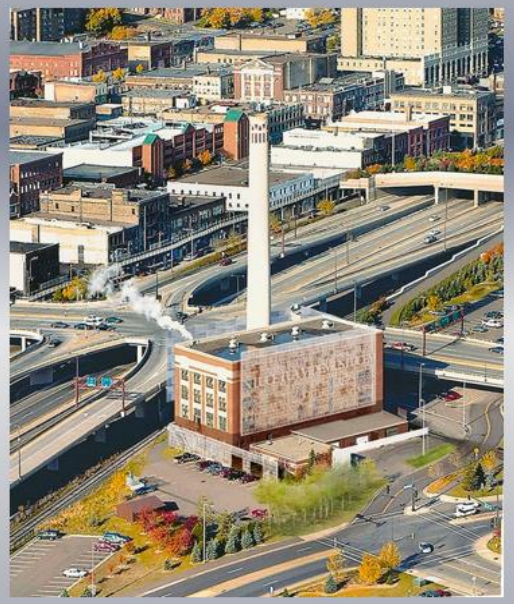




Open-loop Steam System



Closed-loop Hot Water System

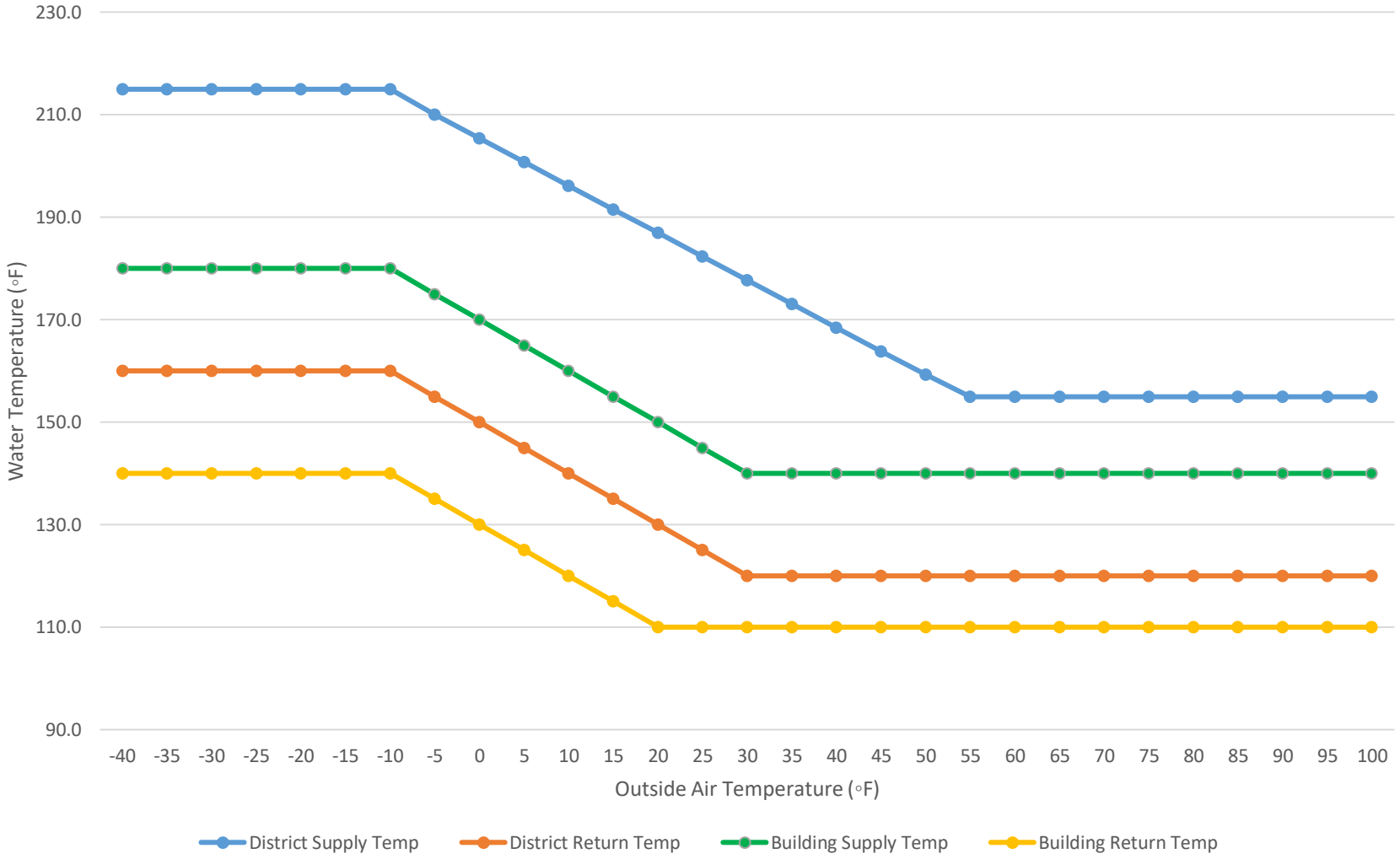


160° F
(180° F for Steam System)

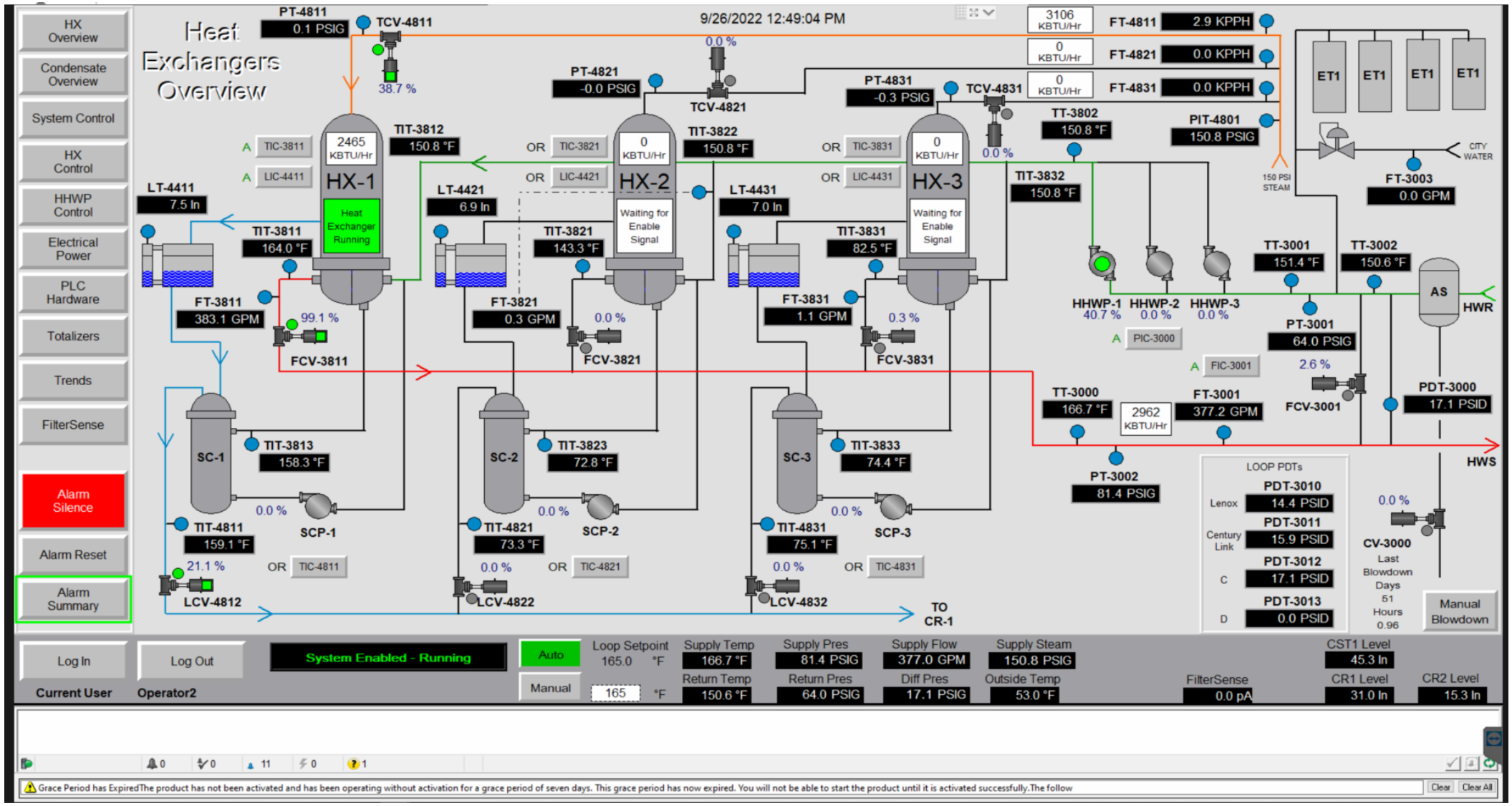
215° F
(Steam is 360° F)

160° F
(45° F for Steam System)

Outside Air Temperature Reset Schedule



Hot Water Heat Exchangers

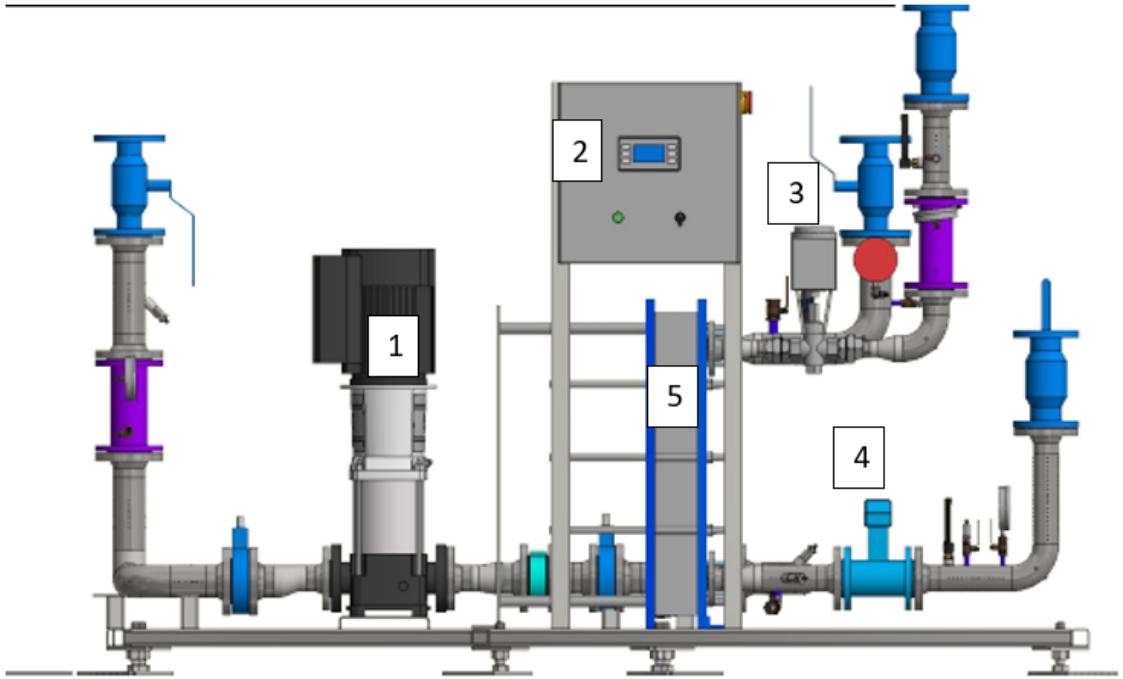


Hot Water Service

Benefits:

- Hot water customers energy saving 26% on average
- Conserve 20 million gallons of Lake Superior water every year
- Position the system for integration of renewables
- Improved temperature control within building (setback schedule)

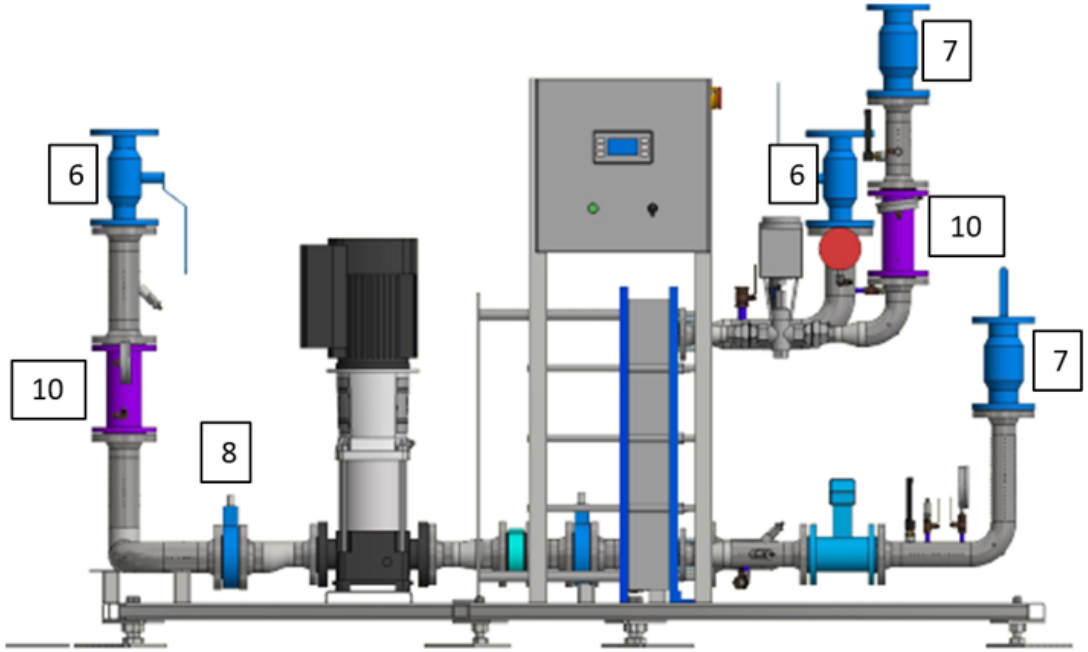
ETS Basics – Main Components



Energy Transfer Station (ETS)

1. Circulating Pumps
2. Control Panel
3. Control Valve
4. BTU Meter
5. Heat Exchanger

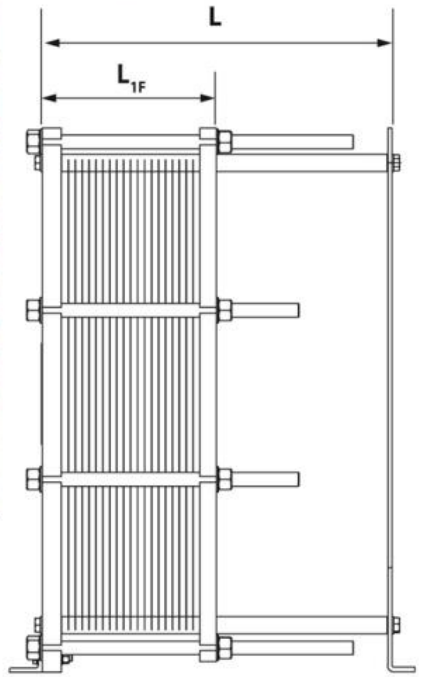
ETS Basics – Secondary Components



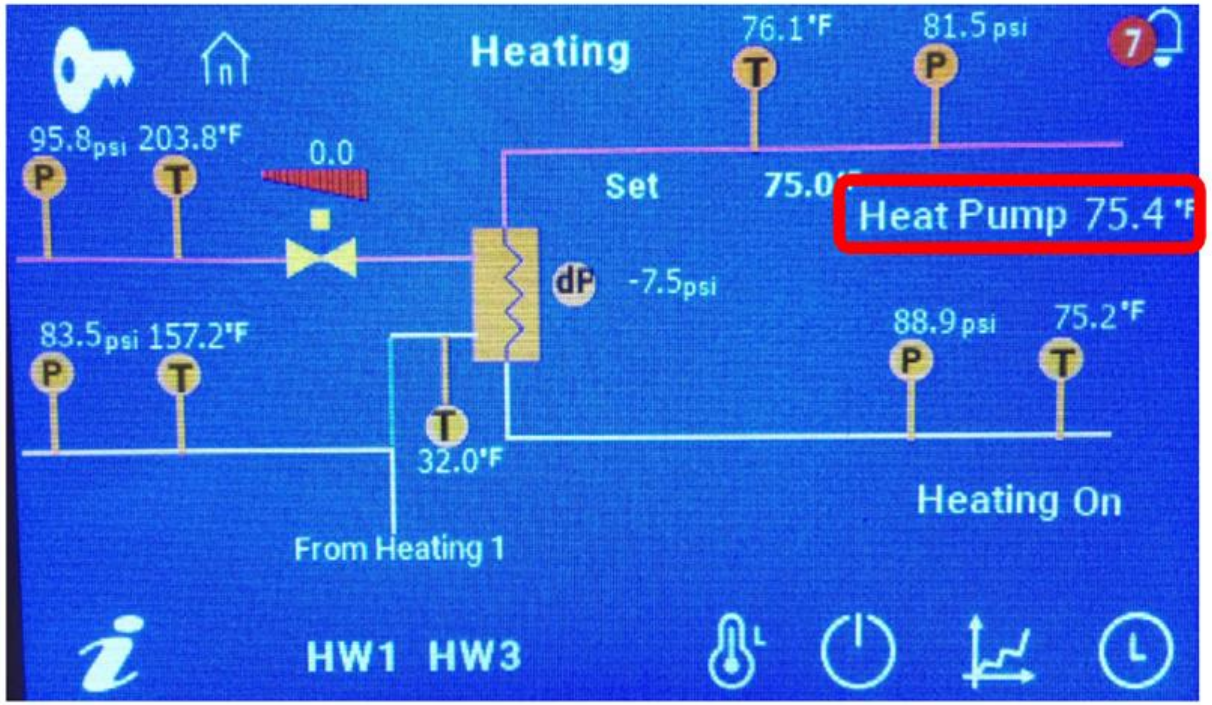
ETS Secondary Components

6. Building Side Isolation Valves
7. District Side Isolation Valves
8. Circulating Pump Isolation Valves
9. Check Valves
10. Wye Strainers

ETS Equipment

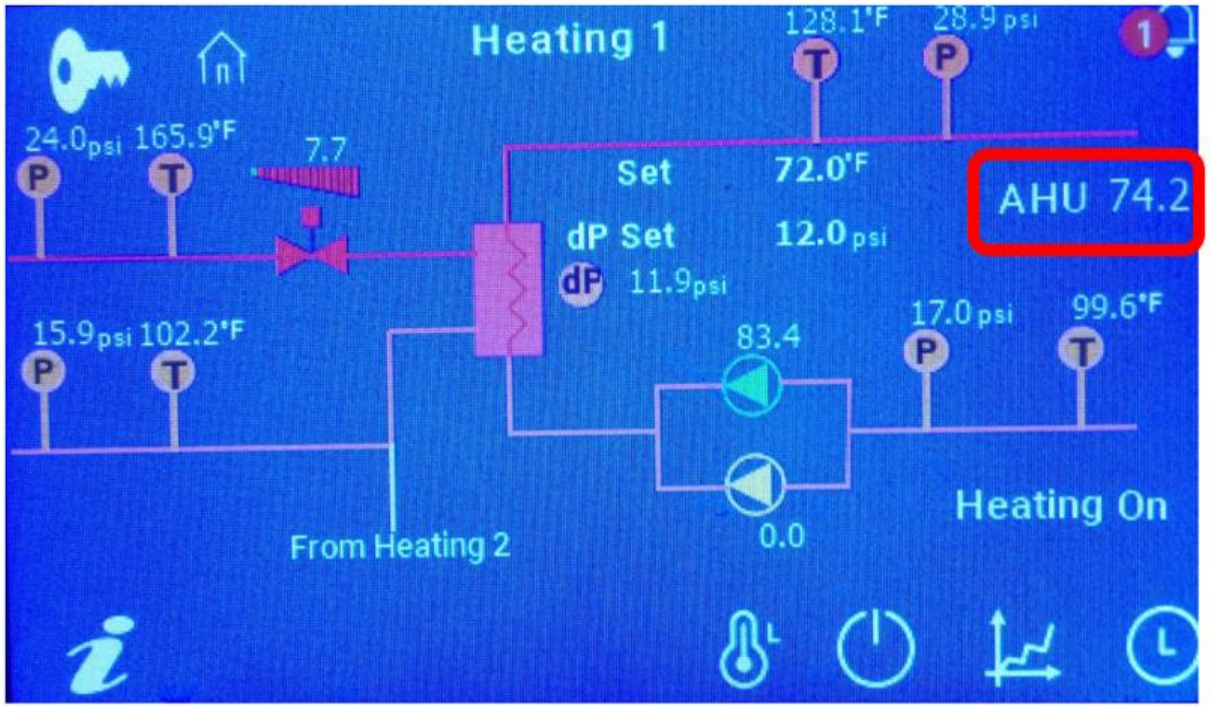


Types of Heating Systems



Heat Pump Loops

System reacts to maintain a consistent temperature in the Heat Pump loop using a temperature sensor downstream of hot water supply injection point



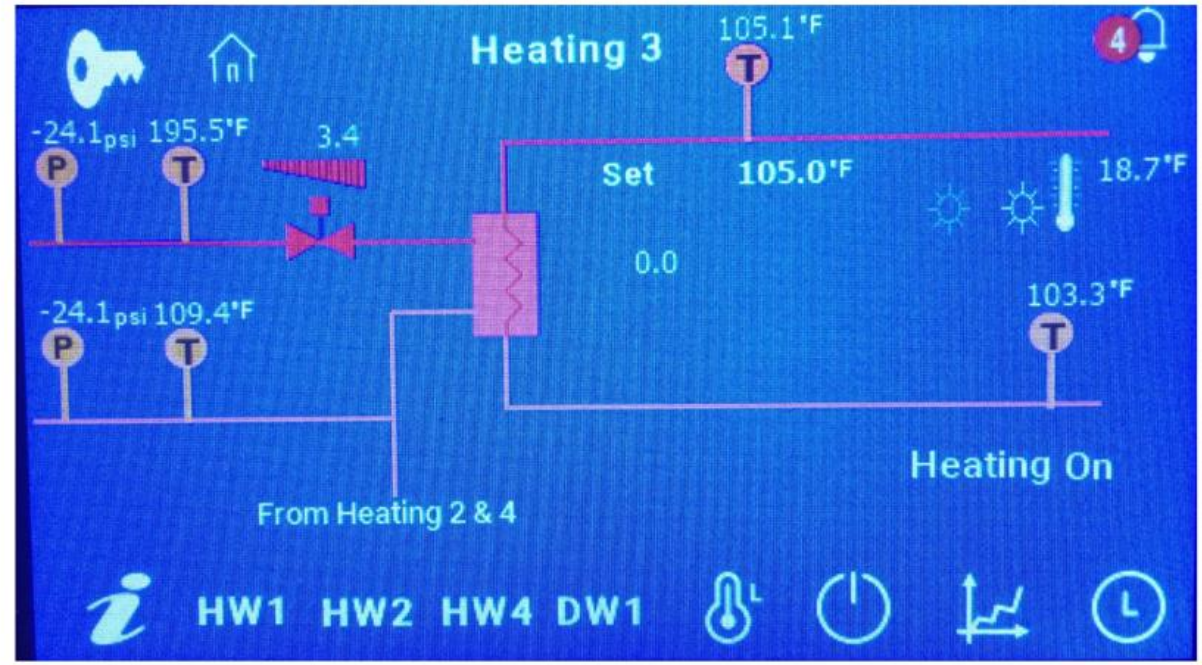
Air Handling Unit Loops

System reacts to control the Discharge Air Temperature downstream of an air handling unit by controlling the temperature of the water supplied to the AHU coil

Types of Heating Systems

Radiation Loop

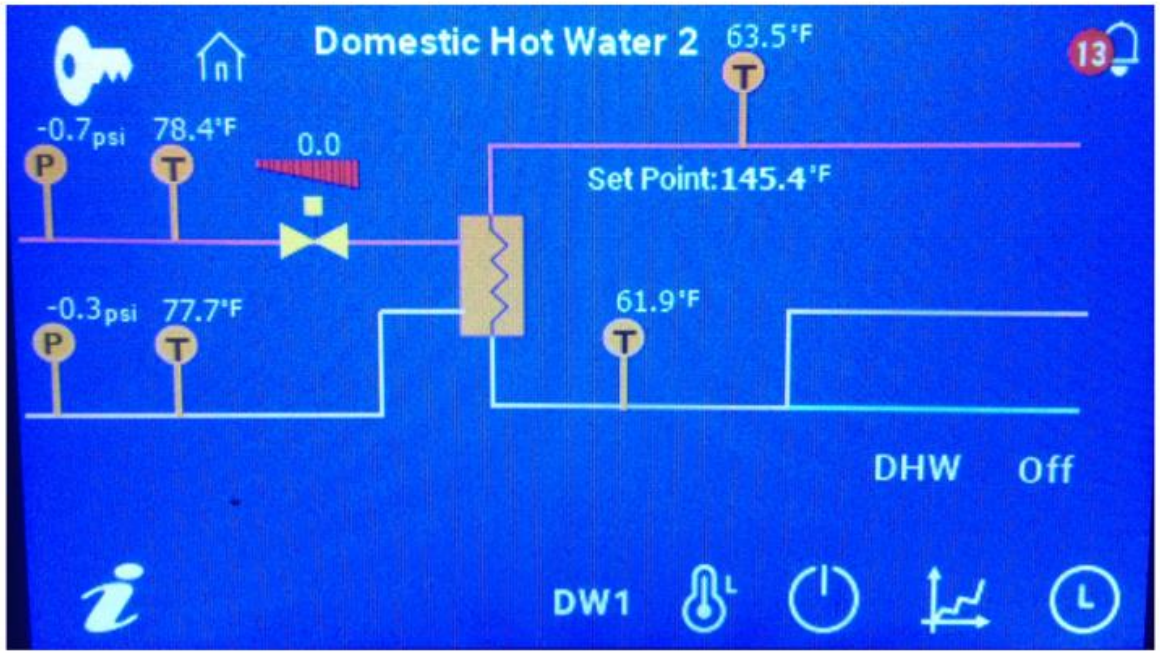
Loop temp is controlled to a setback program based on Outside Air Temperature. System can also be configured to a fixed Setpoint if customer prefers, but will lose system efficiency.



Pool/Spa System

Loop temp is set to a fixed setpoint. The system is controlled to the supply temperature. Fixed setpoint will need to be set slightly above desired pool/spa temp to maintain desired temperature.

Types of Heating Systems



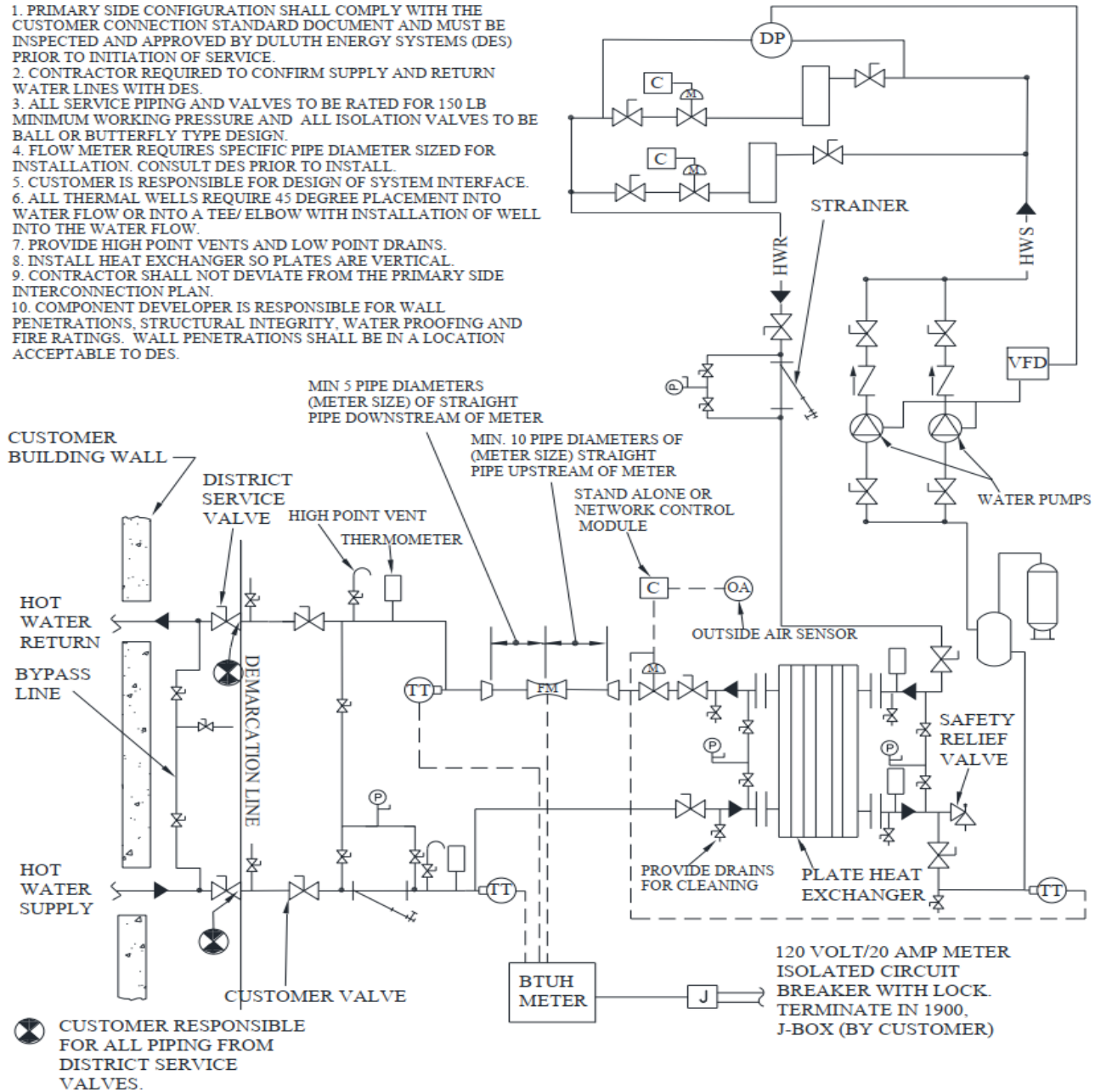
Domestic Hot Water

System is controlled to the supply temp. Setpoint is fixed based on customer preference. Operation of system will be dependent on whether the system has storage tanks or if it will operate instantaneously.

APPENDIX I. TYPICAL HEATING INTERCONNECTION

NOTES:

1. PRIMARY SIDE CONFIGURATION SHALL COMPLY WITH THE CUSTOMER CONNECTION STANDARD DOCUMENT AND MUST BE INSPECTED AND APPROVED BY DULUTH ENERGY SYSTEMS (DES) PRIOR TO INITIATION OF SERVICE.
2. CONTRACTOR REQUIRED TO CONFIRM SUPPLY AND RETURN WATER LINES WITH DES.
3. ALL SERVICE PIPING AND VALVES TO BE RATED FOR 150 LB MINIMUM WORKING PRESSURE AND ALL ISOLATION VALVES TO BE BALL OR BUTTERFLY TYPE DESIGN.
4. FLOW METER REQUIRES SPECIFIC PIPE DIAMETER SIZED FOR INSTALLATION. CONSULT DES PRIOR TO INSTALL.
5. CUSTOMER IS RESPONSIBLE FOR DESIGN OF SYSTEM INTERFACE.
6. ALL THERMAL WELLS REQUIRE 45 DEGREE PLACEMENT INTO WATER FLOW OR INTO A TEE/ ELBOW WITH INSTALLATION OF WELL INTO THE WATER FLOW.
7. PROVIDE HIGH POINT VENTS AND LOW POINT DRAINS.
8. INSTALL HEAT EXCHANGER SO PLATES ARE VERTICAL.
9. CONTRACTOR SHALL NOT DEVIATE FROM THE PRIMARY SIDE INTERCONNECTION PLAN.
10. COMPONENT DEVELOPER IS RESPONSIBLE FOR WALL PENETRATIONS, STRUCTURAL INTEGRITY, WATER PROOFING AND FIRE RATINGS. WALL PENETRATIONS SHALL BE IN A LOCATION ACCEPTABLE TO DES.



Hot Water Design Specifications

3.2 Primary System Pressure

System pressure maximum is 150 psig. All DES customers are required to connect to the district service valves with piping rated for 150 psig and able to withstand 225 psig test pressure to the heat exchanger prior to permitting service. The system minimum differential pressure is 15 psig.

4.0 DISTRICT HEATING INTERFACE - PRIMARY SYSTEM DESIGN

4.1 District Piping and Insulation

All piping shall be standard weight, black steel pipe, schedule 40, unless otherwise noted. Wall thickness shall be according to the schedules listed in American Standards B36.10 and B36.19. Fittings must be of the same material, finish, and strength as its associated piping. All piping on the primary side is recommended to be welded, however threaded piping with 150 lb rated fittings is acceptable.

The piping, valve body, etc., on the primary side shall have insulation based on the peak media temperature for the thickness specified in Table 5.1 of ASHRAE (American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc.) Standard 90-75.

Hot Water Design Specifications

5.0 PROCEDURE FOR CONNECTING HOT WATER SERVICE

5.1 Engineering Standards and Regulations

Engineering standards for the safety of unfired pressure vessels shall follow the current edition and current published revisions and interpretations of the construction codes of the American Society of Mechanical Engineers (ASME). Heat exchangers are pressure vessels that must conform in every detail to the boiler pressure vessel requirements of the latest Minnesota Construction Code. Each heat exchanger is required to be stamped with the ASME code symbol.

Any pressure piping to the heat exchanger or pressure vessel appurtenances - such as valves, meters, and gauges - shall be hydrostatically tested to ensure that it can withstand the peak temperature and pressure of the primary distribution system.

Hot Water Design Specifications

Mechanical Process:

1. Installation of hot water supply and return piping from tie points identified in mechanical piping drawings.
2. Insulation and jacketing of hot water heating piping.
3. Installation of ETS (Energy Transfer Station) skids.
4. Mechanical Contractor shall serve as Prime Contractor. All other Contractors shall be Sub-Contractors under the Mechanical Contractor.

Electrical work shall be performed by licensed electricians. No electrical engineering documents are provided in this package. Electrical contractor is responsible for connecting skids to each individual buildings electrical system. Contractor shall follow all applicable codes and standards. Contractor is responsible for connecting to the DES fiber communications network. This will require conduit with fiber to be pulled from the service valves to the ETS's shown on the plans.

Hot Water Design Specifications

All installations shall conform to the following codes and regulations amended to this date:

a. State and Local Heating, Ventilating, Air Conditioning and Refrigeration Codes
b. State and Local Plumbing Codes
c. State and Local Building Codes
d. State and Local Electrical Codes
e. State and Local Mechanical Codes
f. State and Local Elevator Codes
g. Americans with Disabilities Act
h. Municipal Water and Sewer Regulations
i. National Electrical Code
j. State and Local Board of Health Regulations
k. Local Applicable Ordinances
l. State and Local Fire Codes and Regulations
m. Gas Company Requirements
n. Occupational Safety and Health Act (OSHA)

Hot Water Design Specifications

All materials and equipment supplied shall conform to the following standards amended to this date:

a. American Society of Mechanical Engineers (ASME)
b. American Gas Association (AGA)
c. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
d. Underwriters Laboratories (UL)
e. National Electrical Manufacturers Association (NEMA)
f. Manufacturer's Standardization of the Valve & Fitting Ind.
g. American Welding Society (AWS)
h. American Society for Testing Material (ASTM)
i. American National Standards Institute (ANSI)
j. American Water Works Association (AWWA)
k. American Society of Mechanical Engineers Boiler Code
l. Air Moving and Conditioning Association (AMCA)
m. Air Conditioning and Refrigeration Institute (ARI)
n. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
o. Sheet Metal and Air Conditioning Contractors National Association
p. Occupational Safety and Health Act (OSHA)

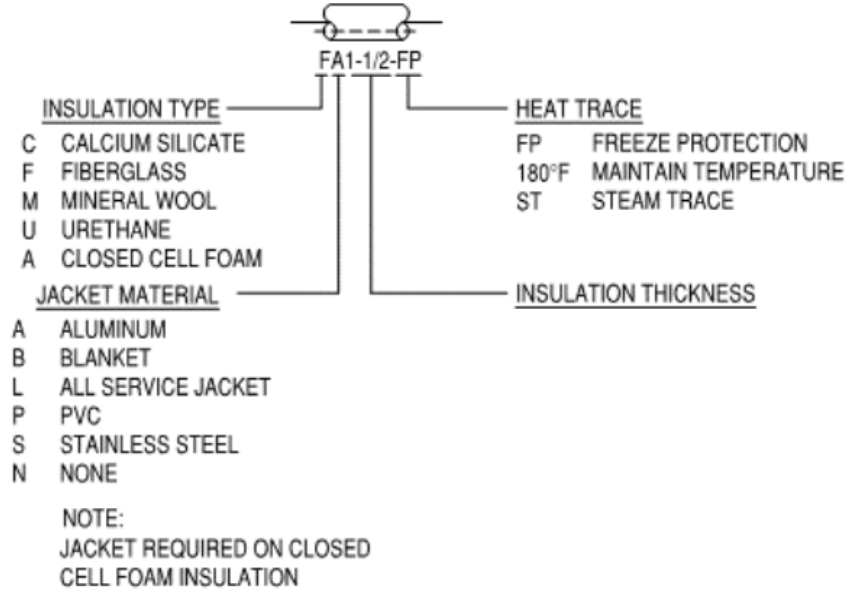
Hot Water Design Specifications

Pipe Spec		Line Service
C1 Carbon Steel 150# (Utilities)		
Maximum Pressure:	210 PSIG	HHW(S/R) - Heating Hot Water
Maximum Temperature:	250° F	ICW - Industrial Cold Water (Non-potable DCW)
		DR - Drain
C2 Carbon Steel 150# (Condensate)		
Maximum Pressure:	165 PSIG	LPC - Low Pressure Condensate (10 psig)
Maximum Temperature:	450° F	
C3 Carbon Steel 150# (Steam)		
Maximum Pressure:	165 PSIG	LPS - Low Pressure Steam (10 psig)
Maximum Temperature:	450° F	
R1 Copper - Potable		
Maximum Pressure:	150 PSIG	DCW - Domestic Cold Water <3"
Maximum Temperature:	250° F	DHW (Supply and Return) - Domestic Cold Water <3"

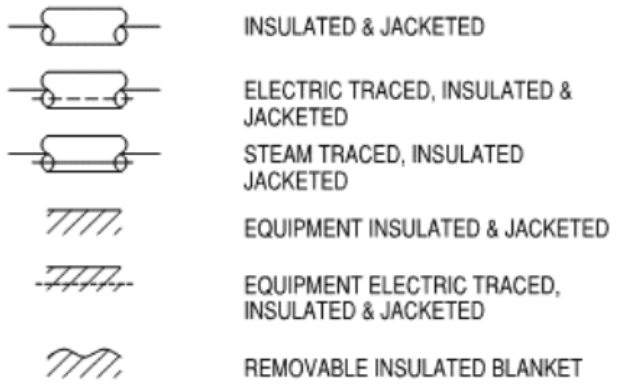
Hot Water Design Specifications

Service Designation	Service Description	Typical Insulation Indoors	
		0" - 1.5" Pipe	*1.5"+ Pipe*
LPS	15 PSIG STEAM	ML2-1/2	ML3
LPC	15 PSIG CONDENSATE (GRAVITY)	ML2-1/2	ML3
HHWS	HEATING HOT WATER (SUPPLY)	FL2-1/2	FL3
HHWR	HEATING HOT WATER (RETURN)	FL2-1/2	FL3
DCW	Domestic Cold Water	FL1	FL1-1/2
DHW (Supply and Return)	Domestic Hot Water	FL1	FL1-1/2

TYPICAL INSULATION NUMBERING

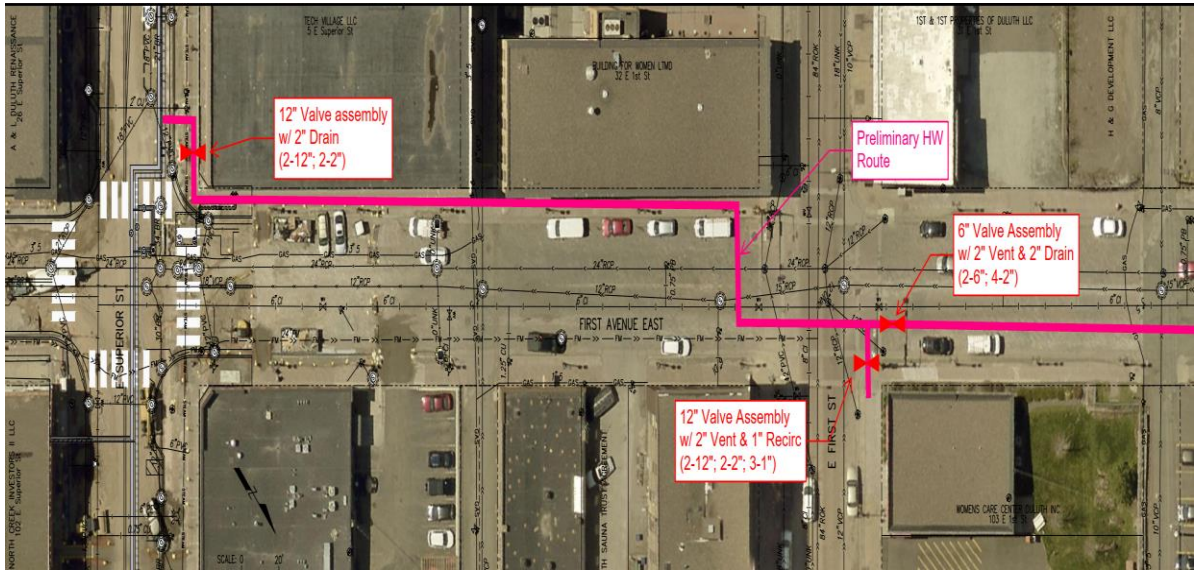


INSULATION SYMBOLS



1st Ave East Project - 2023

- Planned to install 12” main from Superior Street to 1st Street.
- Planned to install 6” main from 1st Street to 3rd Street
- Future project 1st Street, install 12” main to 4th Ave East



GREAT PLAINS INSTITUTE

City of Duluth

Climate Action Work Plan

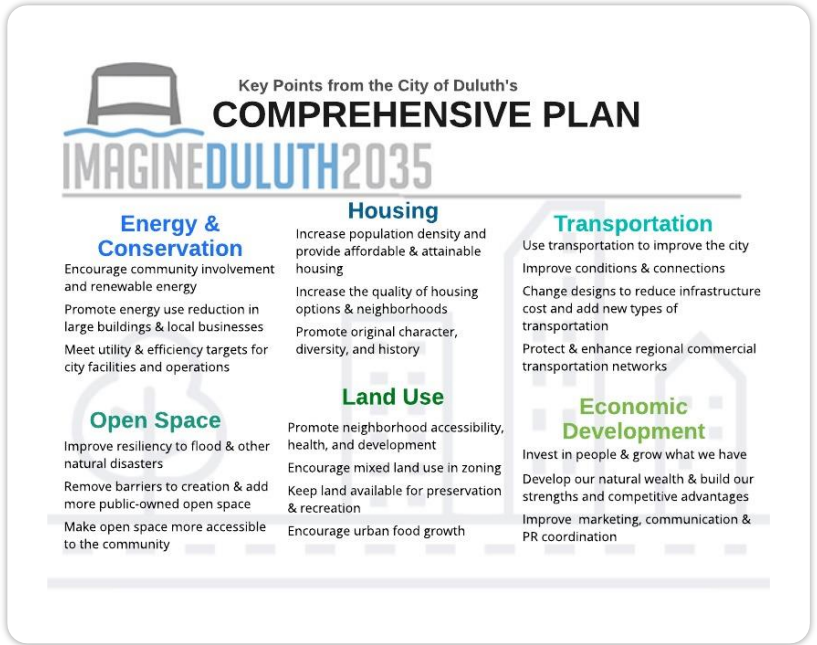
2022 - 2027

What is the Climate Action Work Plan?

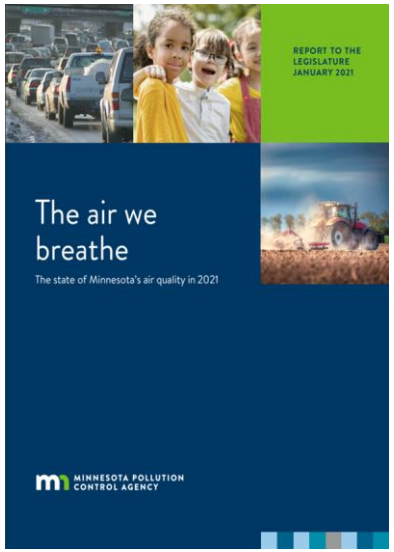
- Who?
  - City Sustainability Advisory Team = 11 Departments working together (20 people)
- What?
  - 83 climate actions to implement across City departments and community
- Why?
  - Actions in the plan are based upon **9 strategies** listed in the Climate Emergency Declaration by City Council
- Where?
  - City operations and community-wide action
- When?
  - Next 5 years

Climate Action Work Plan: Background

- ImagineDuluth 2035 and St. Louis County Multi-Hazard Mitigation Plan
- Community-led effort: Citizens' Climate Action Plan (2020)
- Mayor's climate goal: Race to Zero
- Council's climate emergency declaration (2021)



DULUTH CITIZENS' CLIMATE ACTION PLAN



Climate mitigation and adaptation strategies highlighted in the City's climate emergency declaration:

Strategy 1: Reduce energy consumption in buildings

Strategy 2: Increase efficiency and resilience in city utilities

Strategy 3: Support low carbon transportation options

Strategy 4: Support renewable energy

Strategy 5: Improve stormwater management

Strategy 6: Reduce solid waste

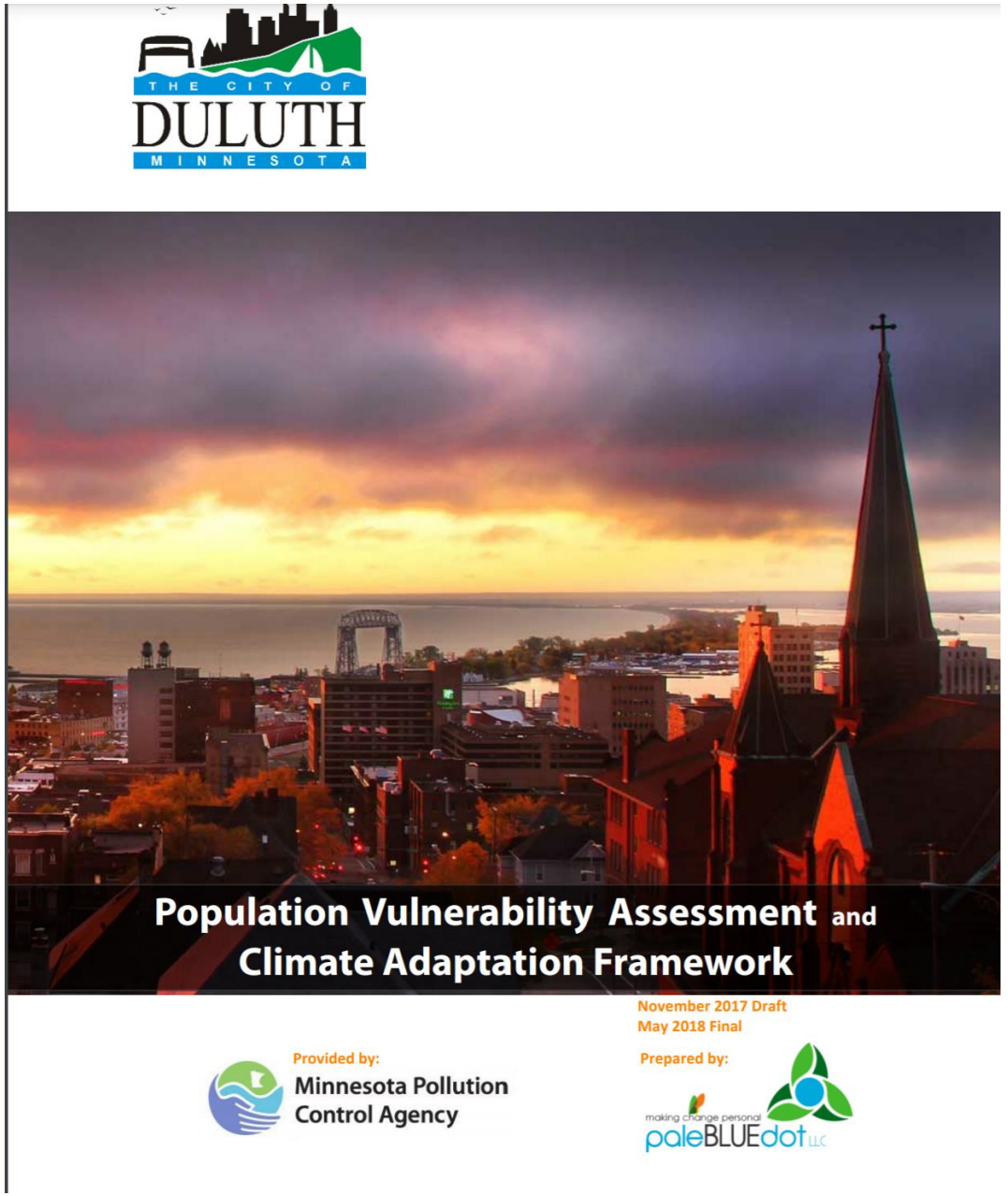
Strategy 7: Reduce disparities in public health

Strategy 8: Seek sustainability opportunities that support economic growth

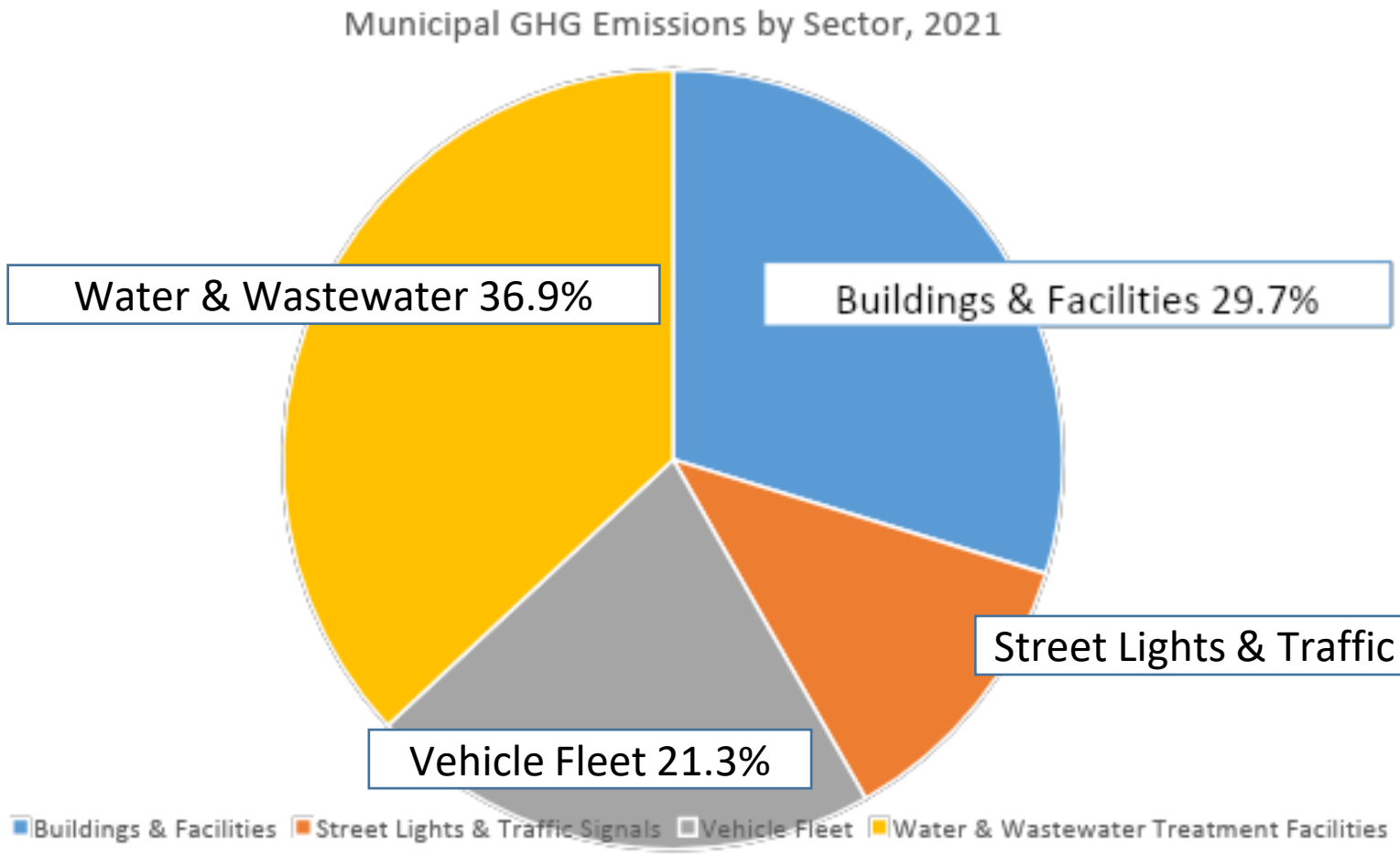
Strategy 9: Identify carbon sequestration opportunities

Climate Vulnerability Report

- Expected climate changes/impacts
  - Increased precipitation
  - Periods of drought
  - Loss of coldest part of winters
  - Extreme weather
- Vulnerable populations
  - Economic Stress
  - Limited Transportation (no vehicle)
  - Individuals with Disabilities
  - Older Adults
- Recommendations
  - Public health
  - Heat Stress/Extreme Weather
  - Air quality
  - Flood Vulnerability
  - Economic resilience



Municipal Emissions, 2021



Phase I

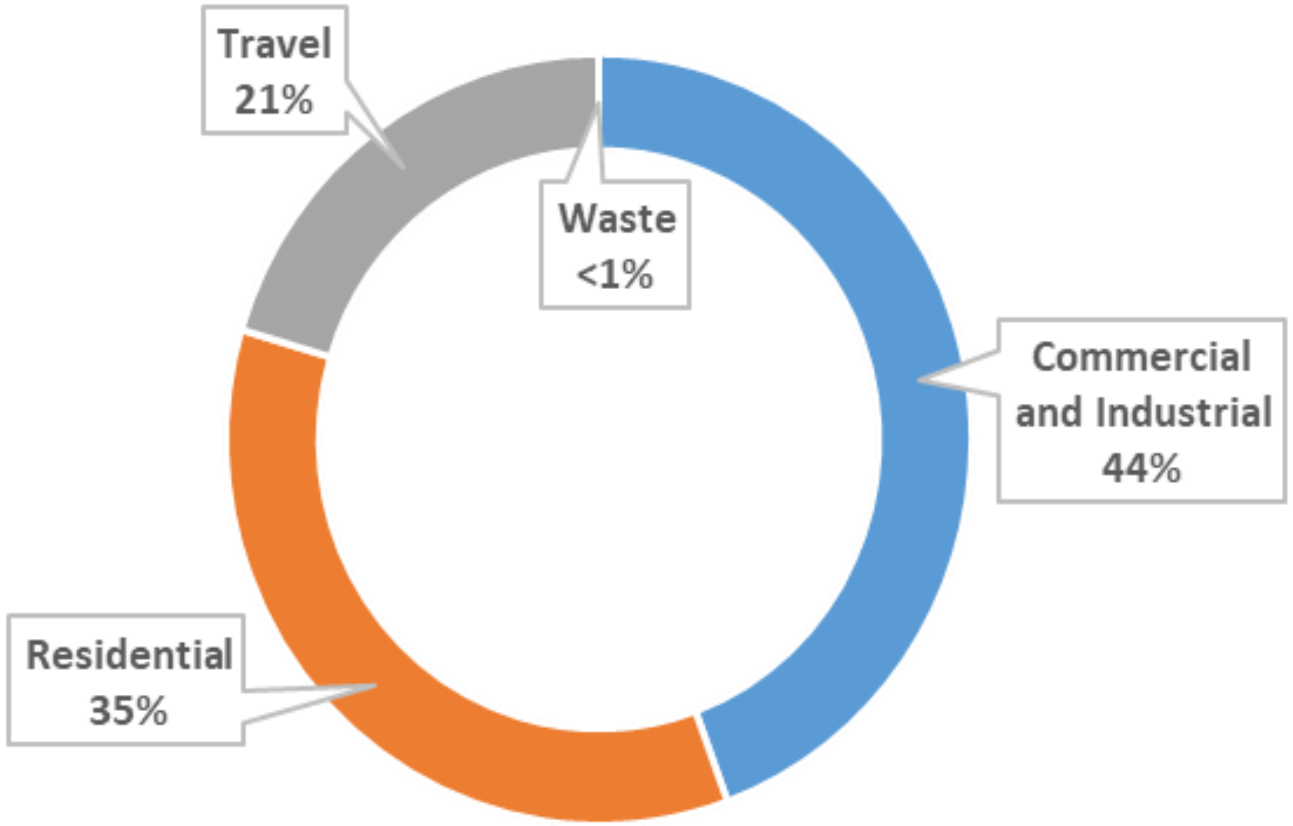
Drive down emissions from City operations
Strengthen community resilience
Eliminate barriers, enable action
Seek financial and workforce pathways
Shovel-ready and shovel-worthy projects

Reduced 62% from baseline:

2008: 39,066 MT CO2e **2021**: 14,232 MT CO2e

www.duluthmn.gov/sustain/

Community-wide Emissions - Duluth 2018



1,335,757 Tons of Co2e

www.regionalindicatorsmn.com/city-summary

Phase II

Community decarbonization

Obj. 1: Drive down emissions from City operations

	Actions	Action Leads	Resources Needed
Strategies	**S1** **1.1 Achieve energy reduction targets for city buildings and facilities to meet 10% emissions reduction goal, per mayoral term (80% by 2050).** ❑ Complete and implement the City of Duluth Energy Plan and share progress with the Energy Plan Commission ❑ Institutionalize regular benchmarking for all city buildings and facilities ❑ Continue energy audits and assessments and prioritize improving the performance of buildings with the greatest savings opportunities ❑ Track and publicly share energy use and greenhouse gas emissions for City Operations, annually ❑ Communicate successes and benefits of climate action to further community support for more action	Property and Facilities Management, Sustainability, and Communications	Energy Analyst
	S2 **1.2 Continue to improve the fuel emissions factor and efficiency for Duluth Energy System** ❑ Identify clean energy resources to replace fossil fuel inputs; eliminate coal in the next 5 years ❑ Encourage a transition to more efficient hot-water loop for new and existing customers of Duluth Energy Systems **1.3 Improve the efficiency of the water plant and distribution system** ❑ Set targets and identify opportunities to improve the energy use intensity at the water plant and distribution system	Duluth Energy Systems, Public Works and Utilities	Infrastructure for transition away from coal
	1.4 Reduce emissions from city fleet vehicles and employee commute ❑ Complete an assessment of city fleet to identify	Fleet, Property and Facilities Management,	Resources for initial fleet planning are in place







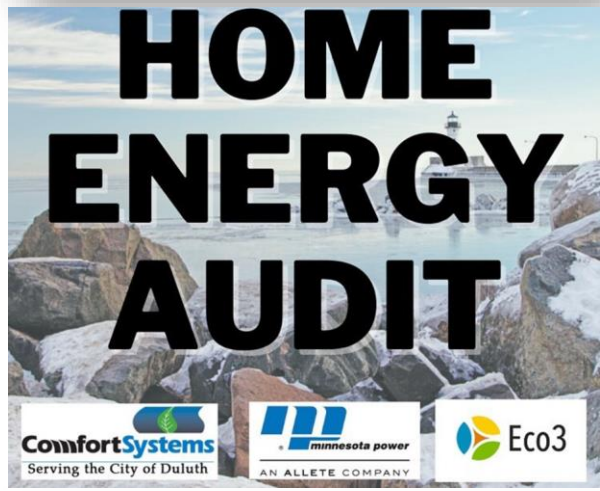
Buildings and energy efficiency/transition

- **Buildings**
  - Lighting retrofits and building projects continue
  - City Hall HVAC: improve efficiency by >30%, VRF
  - Building Owner Performance Requirements adopted
- **Duluth Energy Systems**
  - 5-year coal elimination plan
  - Co-application to geothermal/heat recovery grant
  - Continued thermal grid updates, avg. 26% efficiency savings for hot water customers!
- **Water Utility**
  - Continued/ongoing water main replacements
  - Advanced Metering infrastructure funded by ARP dollars
- **Fleet**
  - Fleet Work Group created
  - 2022 Vehicle Replacement Policy (July 2022)
    - Hybrid ladder truck, Police hybrids, new street sweepers

DULUTH ENERGY SYSTEMS

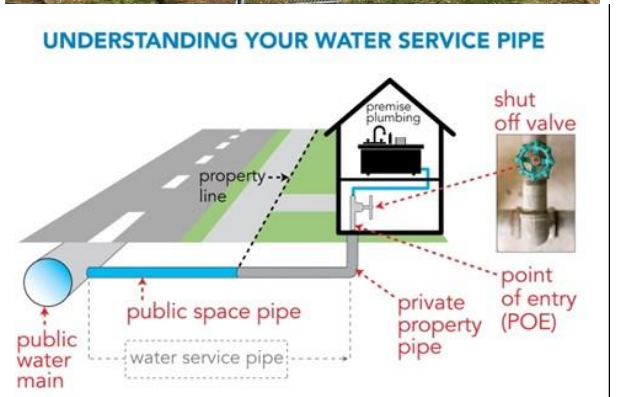
Obj. 2: Strengthen community resilience

	Actions		Action Leads	Resources Needed
Strategies	S2	**2.1 Improve the resiliency of the water plant and distribution system** Seek opportunities to improve resiliency of the water plant, including transformer upgrades, burying lines, back-up power, and clean energy procurement options. **2.2 Complete a citywide assessment of vulnerable built (sidewalks, roads, pipes, etc.) and natural (trees, soil, water, etc.) infrastructure** ❑ Manage Emerald Ash Borer, implement strategic planting plan ❑ Develop a plan to minimize risk to infrastructure, prioritizing highest risk and infrastructure located in vulnerable communities **2.3 Expand current CIP offerings from Comfort Systems for residential and commercial customers**	Public Works and Utilities, Stormwater, Property Parks and Libraries, Sustainability	Funding request is pending for water plant Funds required for citywide assessment Staff resources are available for CIP expansion
	S5	**2.4 Develop a stormwater management plan that integrates resilience and identifies financing opportunities and includes these elements:** • Identification of priority parcels for preservation, vegetation quality mapping and repair, inventory natural resource and flood protection opportunities • Prioritization of improvements in high-risk neighborhoods with vulnerable populations • Reduced stormwater runoff flow and volume through green infrastructure and on-site stormwater management • Demonstration of green infrastructure on City property • Recommendations to incorporate green infrastructure into the unified development chapter • Continued collaboration with the Regional Stormwater	Public Works and Utilities, Engineering, Property Parks and Libraries, Parks Maintenance, Stormwater, Sustainability	Funds needed for stormwater planning and installation of stormwater practices

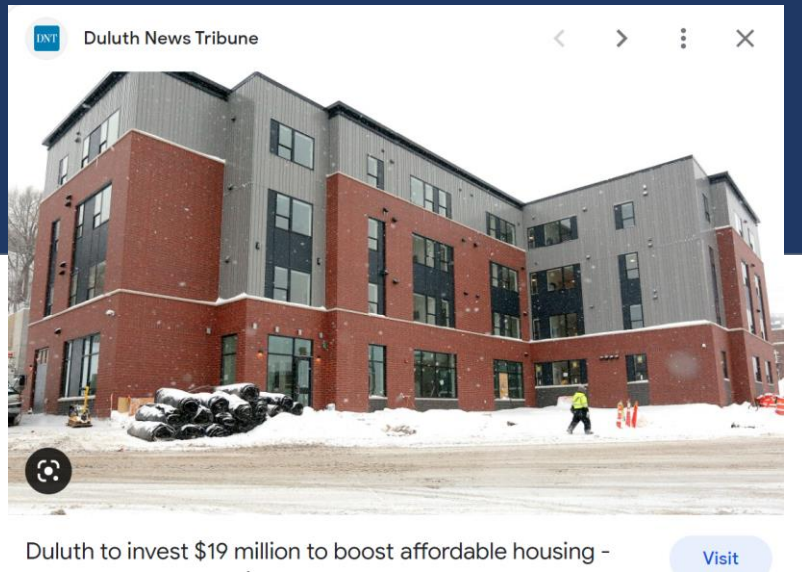


Infrastructure and Critical Services

- **Water Plant:** $7.8M FEMA Hazard Mitigation funding
  - Second transformer,back-up power, bury overhead power lines, and update switch gear
  - Shoreline stabilization completed
- **Lead water lines**: reduce cost for homeowners for replacement
- **Coastal erosion**
  - Advanced Assistance from FEMA to assess and prioritize coastal restoration
  - Park Point beach erosion study with Army Corps of Engineers
- **Green infrastructure**
  - Stormwater Resiliency Plan
  - Implementation projects: Keane Creek, Miller Creek, Lincoln Park
  - Code audit: remove barriers in the future, led by Minnesota Sea Grant
- **Legacy pollution**
  - St. Louis River clean-up and access work continues, partnering w/ State, Federal, and non-profit partners



Community Resiliency



- **Affordable housing**
  - $19M from ARP for affordable housing
  - Duluth Housing Trust Fund established
  - Energy Equity with ACEEE: multi-family programs and policies
  - Rebuild Duluth – private development on vacant infill lots in Duluth
- **Strengthening neighborhoods**
  - Love Your Block focuses on community and city connections
  - 13 mini-grants awarded to address neighborhood blight, clean-ups
- **Urban canopy**: forestry grant for EAB removal
- **Emergency planning**
  - Continued collaboration w/ Ready North Network
  - Dept of Energy RACER grant to study solar + storage

energy equity FOR RENTERS

READY NORTH

LOVE YOUR BLOCK DULUTH

Jean Duluth Solar Array

- 1.6 MW
- Utility-owned
- City land leased, payments to Energy Fund
- Solar power to 300 homes

Obj. 3: Eliminate barriers, enable action

	Actions	Action Leads	Resources Needed
Strategies S1	**3.1 Accelerate sustainable building design for new and substantially renovated buildings** ❑ Adopt sustainable building guidelines for all new or substantially renovated public buildings and private development that receives public funding or incentives. ❑ Require clean energy and energy efficiency improvements for housing projects that receive City funding assistance to reduce emissions and address high energy burden **3.2 Adopt a building benchmarking policy for public buildings with a voluntary phase-in for private-sector commercial buildings** **3.3 Support state policy and regulatory changes that enable the city to meet its climate and energy goals** **3.4 Incorporate climate mitigation, resilience, and justice considerations into city budget planning process** **3.5 Incorporate climate and energy actions into TIF district requirements**	Planning and Economic Development, Sustainability, Finance, Community Partners	Part-time Benchmarking or Energy Analyst position would be required Utility partners need to prepare tracking and reporting avenues
S2	**3.6 Integrate resilience in the capital improvement plan and internal policy for all city infrastructure projects**	Finance, Sustainability	
S3	**3.7 Reduce per-person, single-occupancy driving citywide** ❑ Review city code and policy to remove barriers and enable more opportunities for biking, walking, transit, and low-emissions vehicles ❑ Enhance and institutionalize complete streets policy to include user experience and green infrastructure, prioritize connectivity for vulnerable communities ❑ Gather early input on street projects to increase bike, walk, and wheelchair access along highly-used routes ❑ Collaborate with DTA to expand first mile and last mile	Planning and Economic Development, Community Partners	Code review requires additional resources

Policies and codes

- Building Owner Performance Requirements adopted for City projects
- Vehicle Replacement Policy adopted
- Residential solar fee schedule revised: fees reduced for solar install
- Parking revisions: eliminate minimums, add bike/EV requirements (under review)
- First protected bike lane added in 2021 in LNPK
- Transportation Planner: Better Bus program work and coordination
- Engagement in State policy

Managing Waterfront

- **Acquire** waterfront land
- Strategically **configure** public waterfront
- **Restore** the waterfront environment
- Formally **protect** waterfront land
- Provide **access** to all
- Foster appropriate **development** on adjoining upland

Obj. 4: Financing and workforce

Strategies	Actions		Action Leads
S1	**4.1 Find a sustainable mechanism to support internal energy funds for continued implementation of the City of Duluth Energy Plan**		Property and Facilities Management, Finance, Sustainability
S2	**4.2 Explore funding/financing mechanisms to reduce emissions from Duluth Energy Systems**		Public Works and Utilities, Duluth Energy Systems, Sustainability
S3	**4.3 Increase funding for non-motorized transportation and improved connectivity (Duluth-Superior Metropolitan Bikeways Plan)**		Planning and Economic Development, Community Partners
S4	**4.4 Seek resources and partnerships to catalyze renewable energy development and energy efficiency, especially in vulnerable communities**		Sustainability, Property and Facilities Management, Community Partners, Human Rights, Community Relations
S5	**4.5 Identify funding and financing opportunities to implement stormwater strategies**		Engineering, Public Works and Utilities, Property Parks and Libraries, Sustainability
S7	**4.6 Seek funding to engage vulnerable communities in city resilience planning initiatives and implementation**		Sustainability, Public Works and Utilities
	4.7 Collaborate with local partners to identify green job opportunities	❑ Increase the number of sustainability-related jobs in the community through workforce and economic development partnerships ❑ Work with local partners to identify and invest in business opportunities that will support sustainability and create new jobs, including those that can recycle waste streams to create new resource materials ❑ Support development and expansion of green-focused product and service lines among local businesses	Workforce Development, Sustainability, Human Rights, Community Relations, Community Partners

CareerForce™

Minnesota's Career Resource

Internal: Sustainability Fund

- $150k invested for Strategic Facilities Planning
- $250k for City building energy efficiency projects
- $200k in gap funding for hybrid/EV fleet replacement incentives established
- $300k for biofiltration/native plantings in Lincoln Park (City park green infrastructure)
- $100k match for Street Sweeping improvement euqipment
- $37,500 match for urban forestry work (Emerald Ash Borer work)
- $27,450 match for hybrid ladder truck
- $15,000 Lead for America Fellow- Community Resiliency Fellow

External Funding: grants and project awards

- $34M total for sustainability-related projects
- Partners include: FEMA, USDOT, DOE, MN DNR, GLISA, MN GreenCorps, AmeriCorps, MN Lake Superior Coastal Program, MPCA, Healthy Babies Bright Futures, Cities of Service, USDN, ACEEE

Healthy Babies Bright Futures

DEPARTMENT OF TRANSPORTATION · UNITED STATES OF AMERICA

FEMA

GLISA
A NOAA RISA TEAM

USDN urban sustainability directors network

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

DEPARTMENT OF NATURAL RESOURCES

AmeriCorps

ACEEE

Minnesota GreenCorps

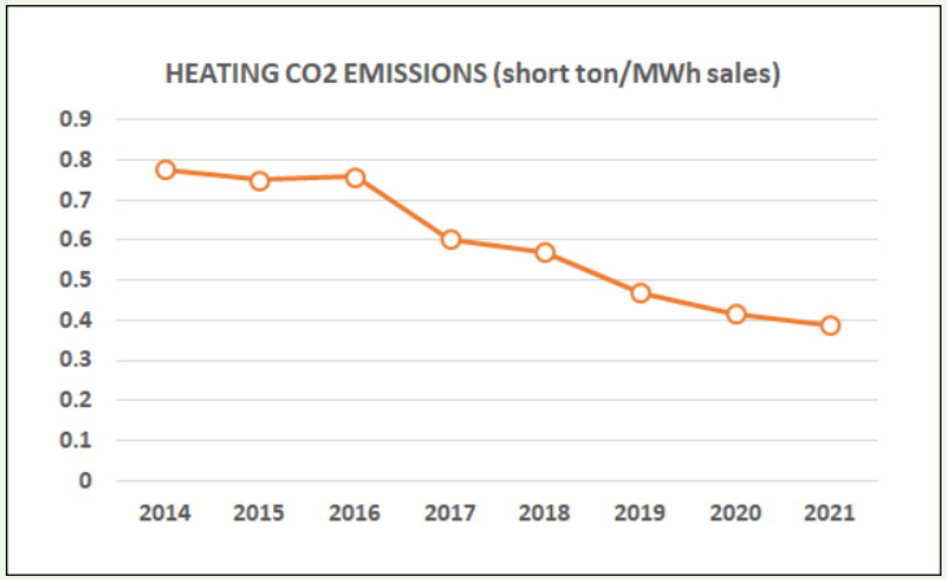
CITIES OF SERVICE

MINNESOTA'S LAKE SUPERIOR COASTAL PROGRAM

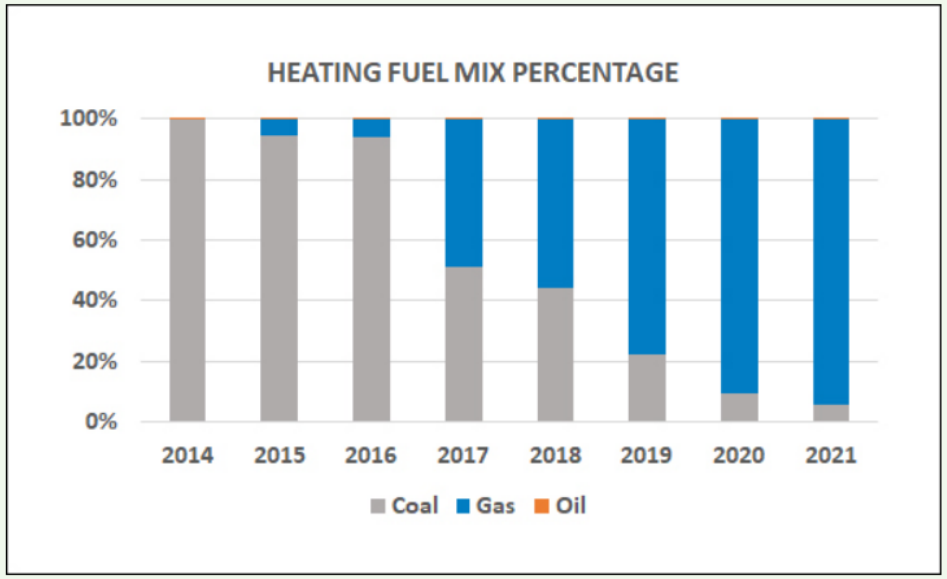
Climate Action Work

- Identify clean energy resources to replace fossil fuel inputs; eliminate coal in the next 5 years
- Encourage a transition to more efficient hot-water loop for new and existing customer of Duluth Energy Systems

Duluth Energy Systems Heating CO2 Emissions



Duluth Energy Systems Heating Fuel Mix Percentage



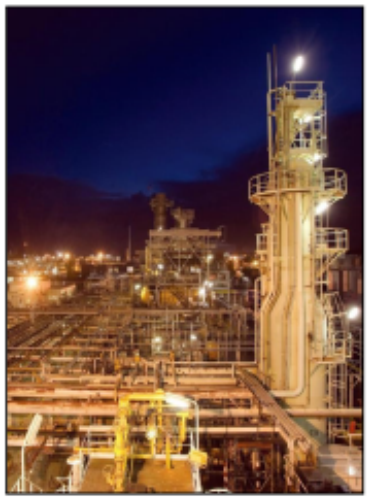
Future Gains

- Additional efficiency
  - Financial savings to invest in improvements
  - Modern building controls
  - Energy Audits

- Potential tools for to decarbonize
  - Biofuels
  - Waste heat recovery
  - Geo-Exchange/Heat Pumps
  - Renewable integration

Liquid Wood – densified biomass

- Liquid wood has essentially identical fuel and elemental properties as the solid wood from which it is produced
- DOE and NREL support the representation that Ensyn's primary step produces liquid wood (biomass), effectively by melting and densifying solid biomass
- Liquid wood (liquid biomass) is acknowledged by EPA as being a secondary biomass feedstock for the purpose of coprocessing

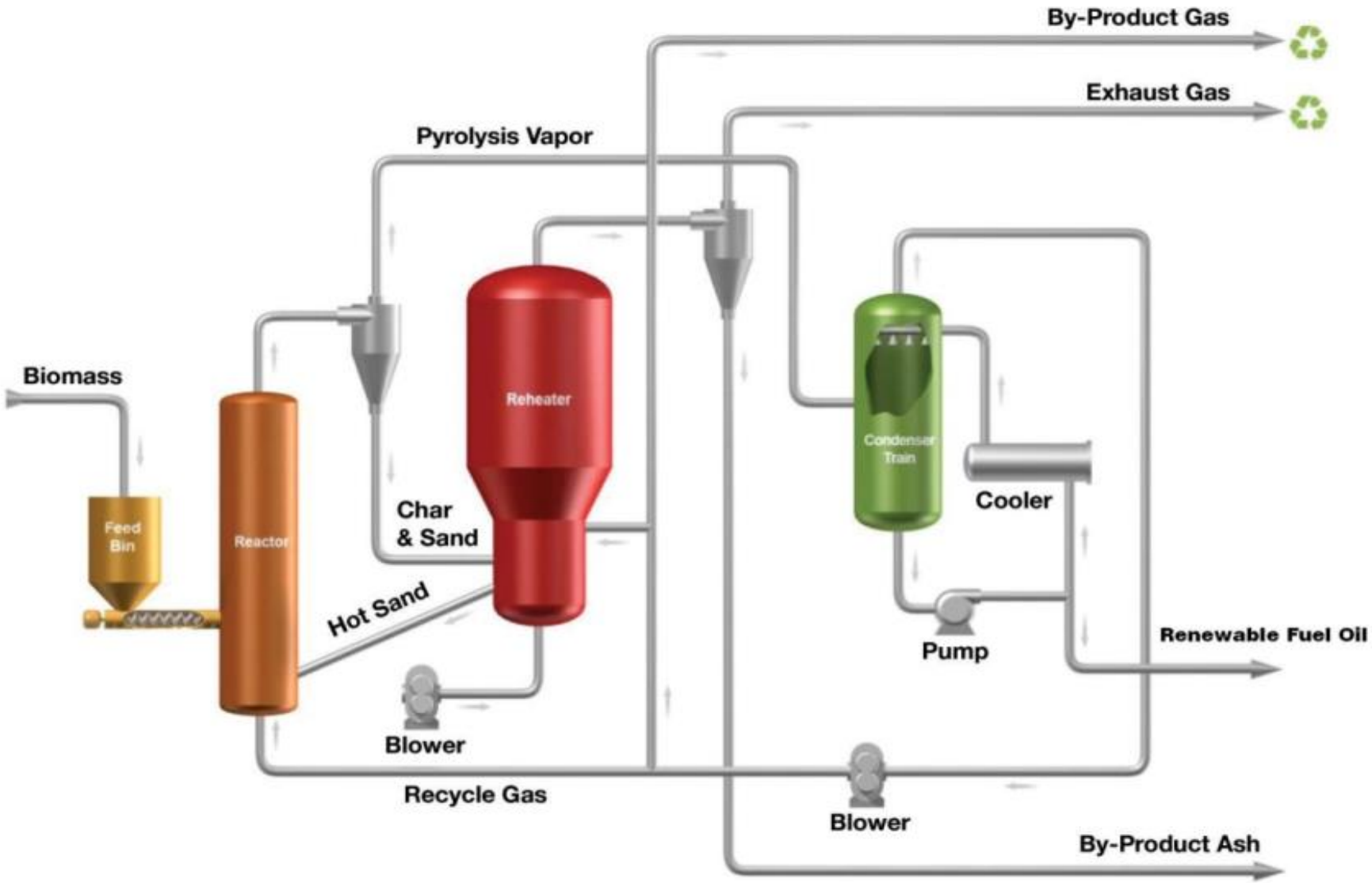


ENSYN

RTP™ (Rapid Thermal Processing) Process Flow Scheme

Ensyn Fuels Renewable Fuel Oil (RFO)

- Rapid heating of biomass in the absence of Oxygen



RFO Specifications

Property	Analytical Method	ASTM D7544 Specification	RFO Analysis - Imperial Units			
			Range		Typical Value	
			Min	Max		
Water Content	ASTM E203	<30	15	30	24	wt%
pH	ASTM E70	Report	>2.5	3.8	2.8	
Density @ 20 °C	ASTM D4052	9.2 - 10.8	9.3	10.7	10.0	lb/US Gal
Kinematic Viscosity @ 40 °C	ASTM D445	<125	15	125	25	cSt
Higher (Gross) Heating Value, Moisture Free	ASTM D240	N/A	9500	10400	9905	BTU/lb
Higher (Gross) Heating Value, As-Is	ASTM D240	>15	7125	7800	7528	BTU/lb
Lower (Net) Heating Value, As-Is	Calculated	N/A	6560	7101	6842	BTU/lb
Solids Content	ASTM D7579	<2.5	0.1	2.5	2.0	wt%
Ash Content	ASTM D482	<0.25	0.05	0.25	<0.15	wt%
Pour Point	ASTM D97	<16	-22	-10	-13	°F
Flash Point	ASTM D93, procedure B	>45	>143	N/A	>143	°F
Elemental Analysis (moisture & ash free)						
Carbon	ASTM D5291	N/A	51.5	58.3	54.9	wt%
Hydrogen	ASTM D5291	N/A	5.5	6.8	6.7	wt%
Nitrogen	ASTM D5291	N/A	0.1	0.4	0.2	wt%
Sulphur	ASTM D4294	<0.05	0.0	0.1	<0.05	wt%
Oxygen	Calculated, by difference	N/A	42.9	34.4	38.3	wt%

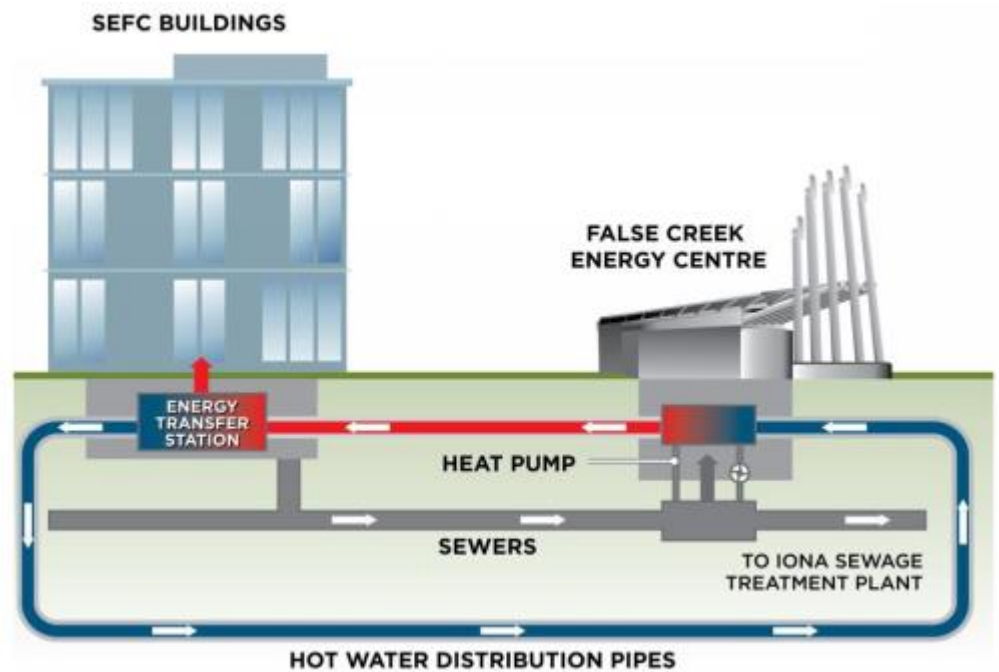
CO2/MMBtu

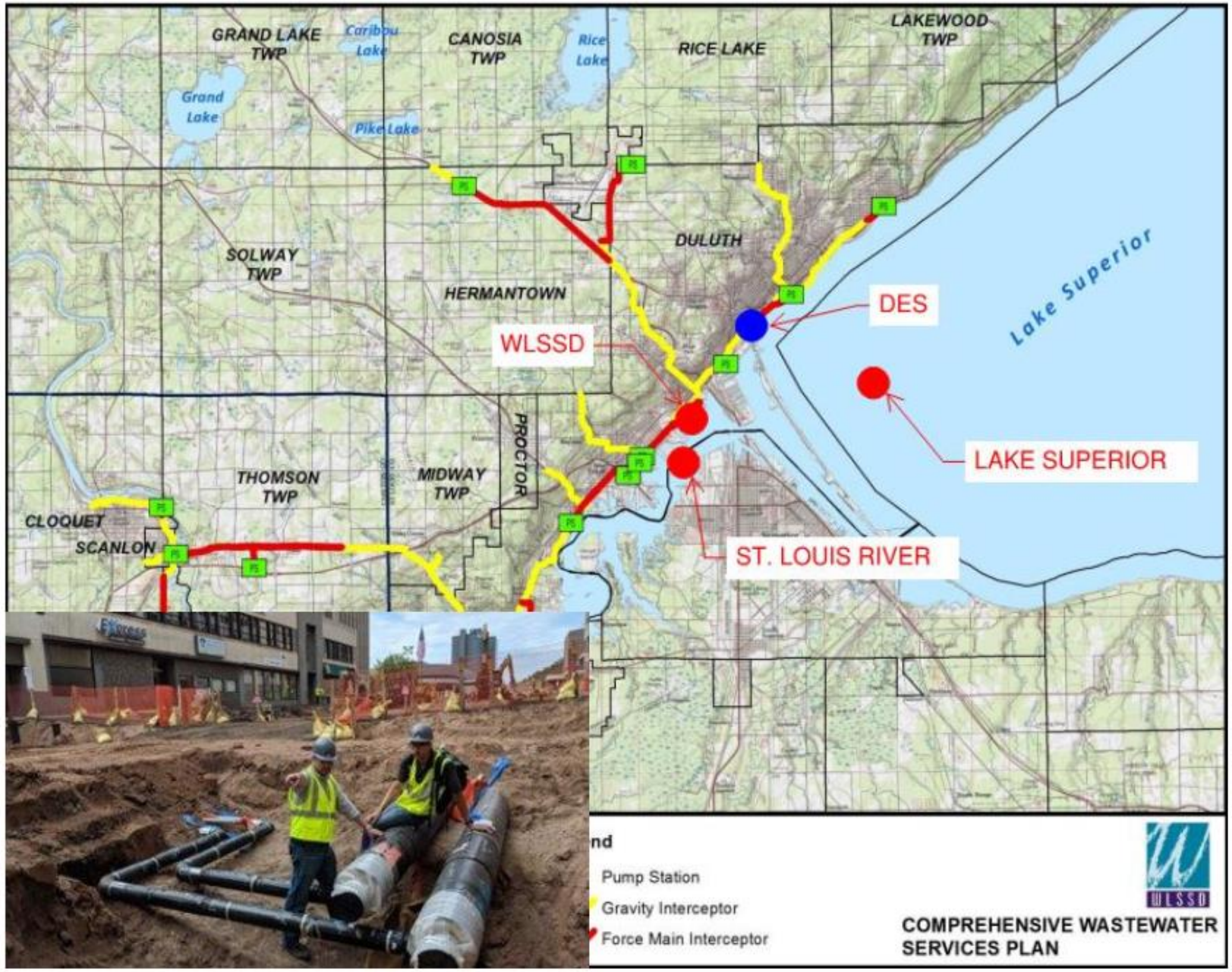
Coal = 200lbs
Fuel Oil = 160lbs
Natural Gas = 117lbs
RFO = 26lbs

FALSE CREEK DISTRICT VANCOUVER, BC

- First District Energy system in North America to use untreated municipal wastewater as the primary heat source

⇢ District energy system now uses 70% renewable energy to supply heat to area, other 30% covered by natural gas boilers





Point of Use Waste Heat Recovery

Central Waste Heat Recovery

Department of Energy (DOE)
Office of Energy Efficiency and Renewable Energy (EERE)

Community Geothermal Heating and Cooling Design and Deployment

Community Voice Lead

Eco3

Stakeholders
City of Duluth, Mindy Granley
Main Street LNPK, Lena Nguyen
St. Louis County, Josh Gorham
Duluth Transit Authority, Chris Belden
CERTS, Joel Haskard
LISC Duluth, Sumair Sheik

Analysis, Design & Deployment

EVER-GREEN ENERGY™

Stakeholders
City of Duluth, Mindy Granley
ComfortSystems, Jim Benning
Duluth Energy Systems, Justin Reid
WLSSD, Marianne Bohren
NREL, Jen King
Ecolibrium3, Jodi Slick
Duluth HRA, Jill Keppers
Main Street LNPK, Lena Nguyen
MN Pollution Control Agency
MN Power

Workforce Lead

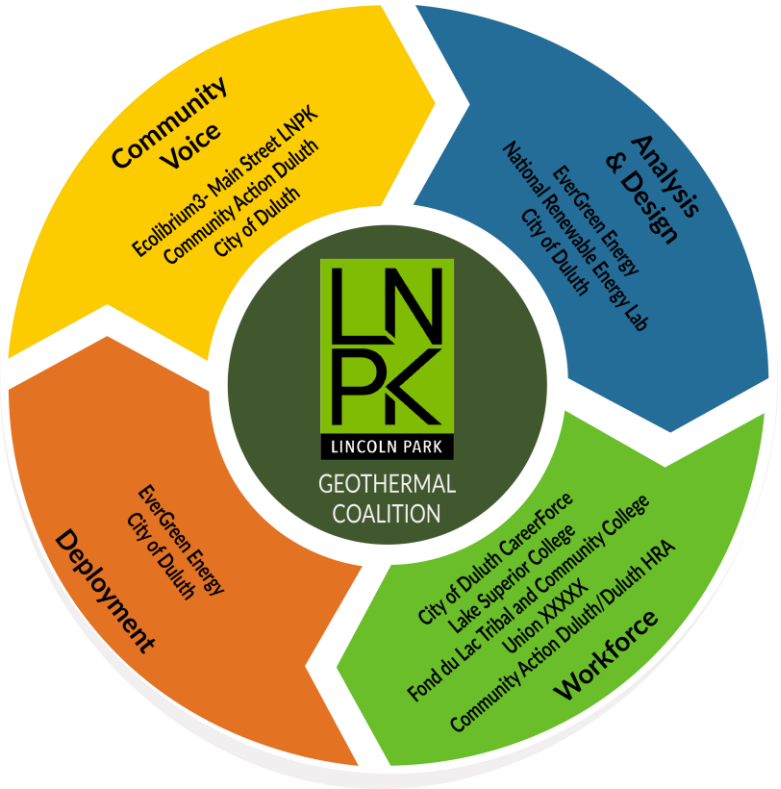
CORD
Leading Change in Education

Stakeholders
Technical Colleges:
Lake Superior College
Fond du Lac Tribal
Northwoods
UMD BBER, Monica Haynes
City of Duluth, Elena Foshay
MN DEED & Commerce
IUOE Local 70

Lincoln Park Just Transition

Geothermal District Design & Deployment in a Justice40 Neighborhood

Duluth, MN



Key Idea: Leverage a USDOT-funded main street rebuild in a Justice40 neighborhood to design and deploy a geothermal smart grid to heat and cool buildings. Determine viability of district energy as an economic and environmental justice tool.

Project Goals:

1. Determine economic and technical feasibility;

2. Complete design, maintenance plan, business model, and permitting;

3. Develop career pathways with training curriculum focused on advancing low-income and traditionally underserved members of the workforce;

4. Deploy system to stabilize energy prices, build community energy resilience, and reduce pollution;

5. Reduce neighborhood health, environmental, and economic disparities.

6. Determine feasibility of new geothermal system's ability to further energy transition for downtown district heat system through capturing effluent waste heat.

Key Partners:

City of Duluth
Ever-Green Energy
Ecolibrium3
NREL

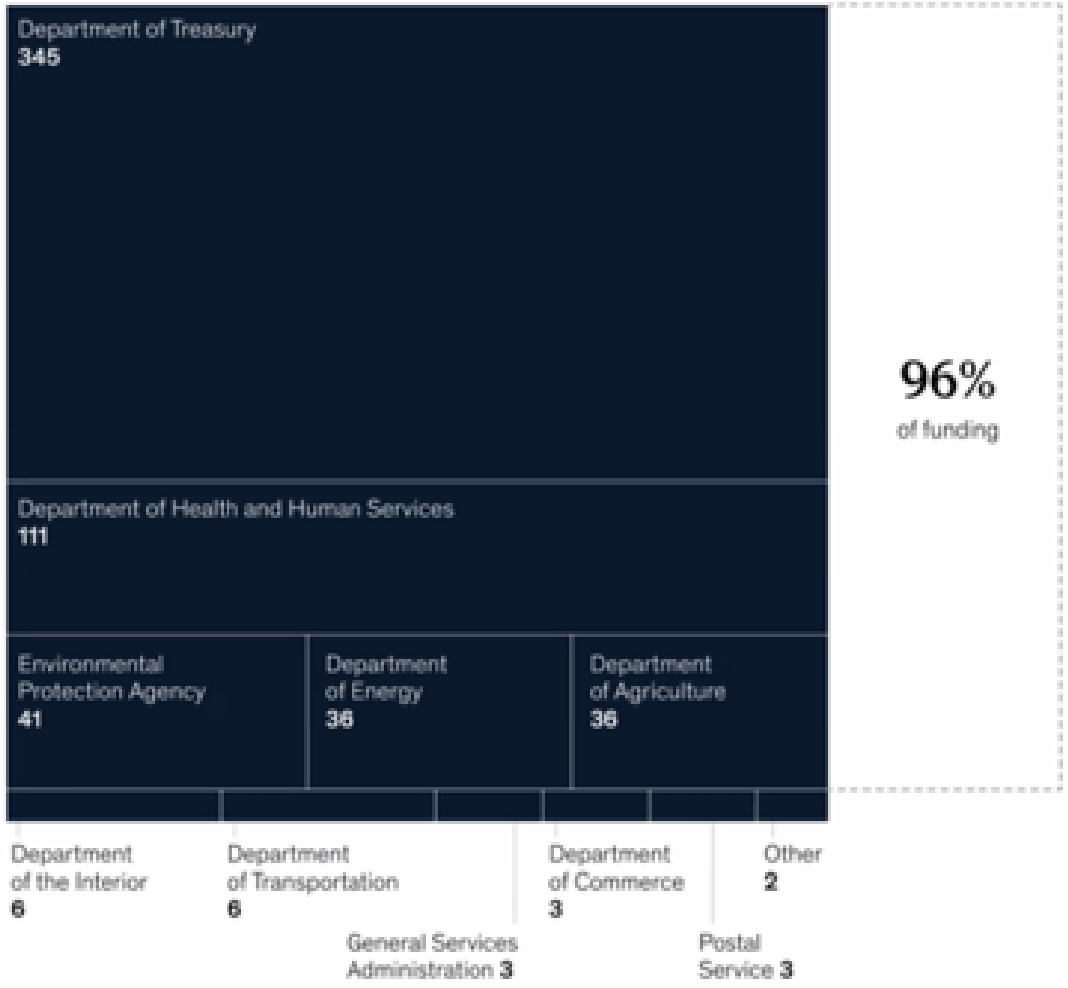
- Rebuild of West Superior Street, 1.6 miles, opportunity to move away from natural gas to geo-exchange
- 40% civil cost savings partnering with infrastructure project
- WLSSD 40 MGPD of wastewater, discharged to St. Louis River
- Lincoln Park is a Justice 40 disadvantaged community
- Opportunity to buildout snow melt for bus stops, ADA compliant
- Workforce development training, specific skills, knowledge, and abilities to support geothermal industry

Inflation Reduction Act (IRA)

GHG Reductions and Climate Action

Greenhouse Gas Reduction Fund (aka, the Green Bank)	Feb 2023	EPA	$27 billion
Energy Efficient Commercial Buildings Deduction (179D)	2023	Tax Deduction	Varies
Environmental and Climate Justice Block Grants	Feb 2023	EPA	$3 billion

Inflation Reduction Act



McKinsey & Company

IRA – Commercial Clean Energy Incentives

8 Significant Changes

1. Make the Production Tax Credit and the Investor Tax Credit quasi-permanent – restored to prior rates*.
2. New tiered-system for PTC and ITC based on wage and labor agreements, and on project size for solar ITC projects.
3. Credit adders for Domestic Content (PTC and ITC); Energy Communities (ITC) and Environmental Justice Communities for solar and storage (ITC).
4. New credits for new technologies:
   - Energy storage
   - Clean hydrogen
   - Nuclear
   - Sustainable aviation fuel

IRA – Commercial Clean Energy Incentives

8 Significant Changes

5. Expanded and improved carbon capture and storage credits.
6. Starting in 2025, technology-neutral alternative to ITC and PTC for low-carbon technologies.
7. "Elective payment" option for tax-exempt project owners, and one-time transferability of the ITC and PTC.
8. Increased 179D deduction for energy efficiency in commercial buildings, with wage and labor bonuses up to $5 / square ft total.

Source: CEEM – IRA Explained - Avisen Legal

Questions?
THANK YOU!