Duluth Steam

Energy System Transformation

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Overview

- Industry-Wide Aging Infrastructure
  - Opportunities for Efficiency Improvements and Renewable Integration
- Duluth Steam Background
- Vision for Duluth Community Energy System
  - Steam to Hot Water Transition
  - Biomass Integration
  - Customer Building Improvements
- Expected Results and Next Steps

Aging Infrastructure

- Inherent inefficiencies
- Distribution losses
- Fossil fuel dependent

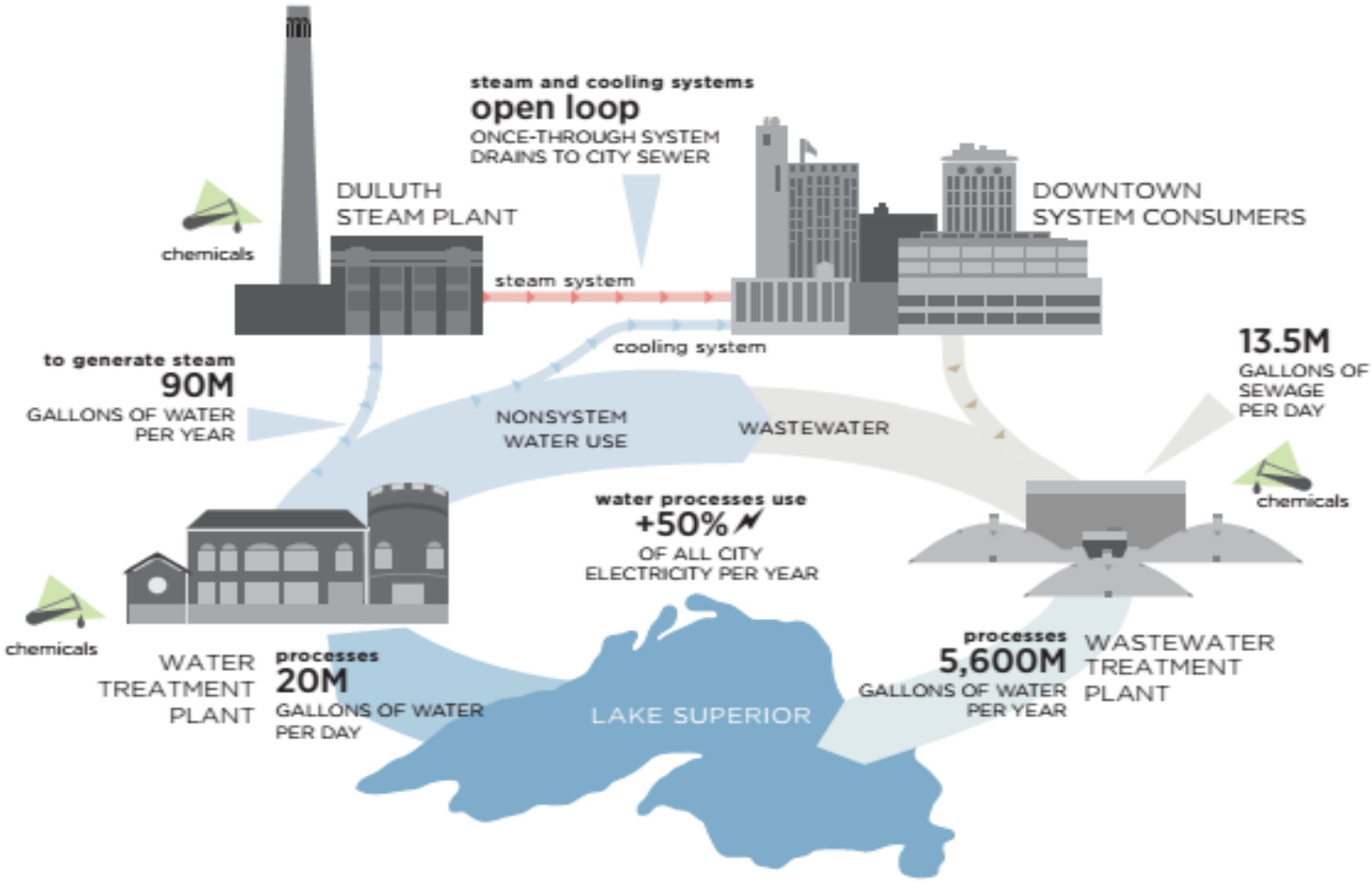
Aging Infrastructure

- Not adaptable
- Inefficiencies make it more difficult to be cost-competitive with the current gas market

Duluth Steam
Current Operations

- 158 customer buildings
- Over 80 years old
- No condensate return
- Coal-fired
- Over 90 million gallons of water consumed annually

Current System



Upgraded Infrastructure -
A path similar to that followed in St. Paul

- Production
  - CHP
  - Local renewables
- Distribution
  - Hot water to improve efficiency
- Customer interface
  - Consistent monitoring
  - Improvements that add value for the customer

Upgraded Infrastructure - Production

- Fuel diversification
- Local renewables
  - Biomass
  - Solar thermal
- Combined heat & power

Upgraded Infrastructure -
Fuel flexibility and local renewables

Upgraded Infrastructure - Hot Water Distribution

- A robust and efficient distribution network is the foundation for the district system.
- Opportunistically upgraded during other planned infrastructure projects to reduce cost.

Upgraded Infrastructure - Customer interconnection

- Efficient utilization in the customer building – control, delta T, cascading uses
- Metering – communicated to the utility in real time
- Customer/Energy engineer on staff to support customers adds value and builds relationships

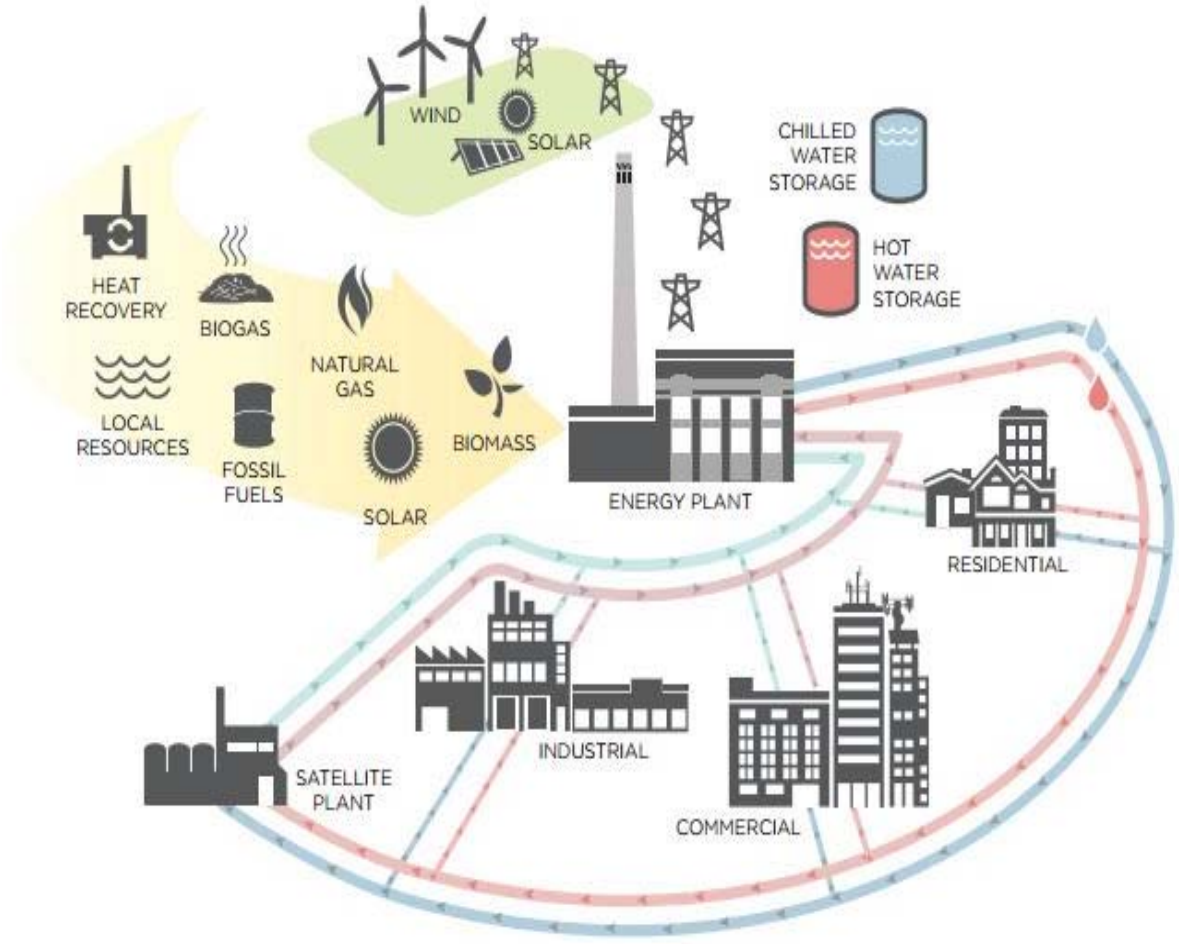
Step in the Right Direction
Hot Water Loop Serving Canal Park

- Serving 6 buildings
- 86,600 MMBtu annually
- Majority of load is served using turbine-driven pump and fan exhaust steam that had previously been vented to atmosphere

Community Energy Vision

- Enhance system efficiency
- Maintain reliability
- Improve resiliency to the market and weather events
- Remain cost-competitive
- Utilize local energy sources
- Reduce carbon emissions
- Reduce water usage

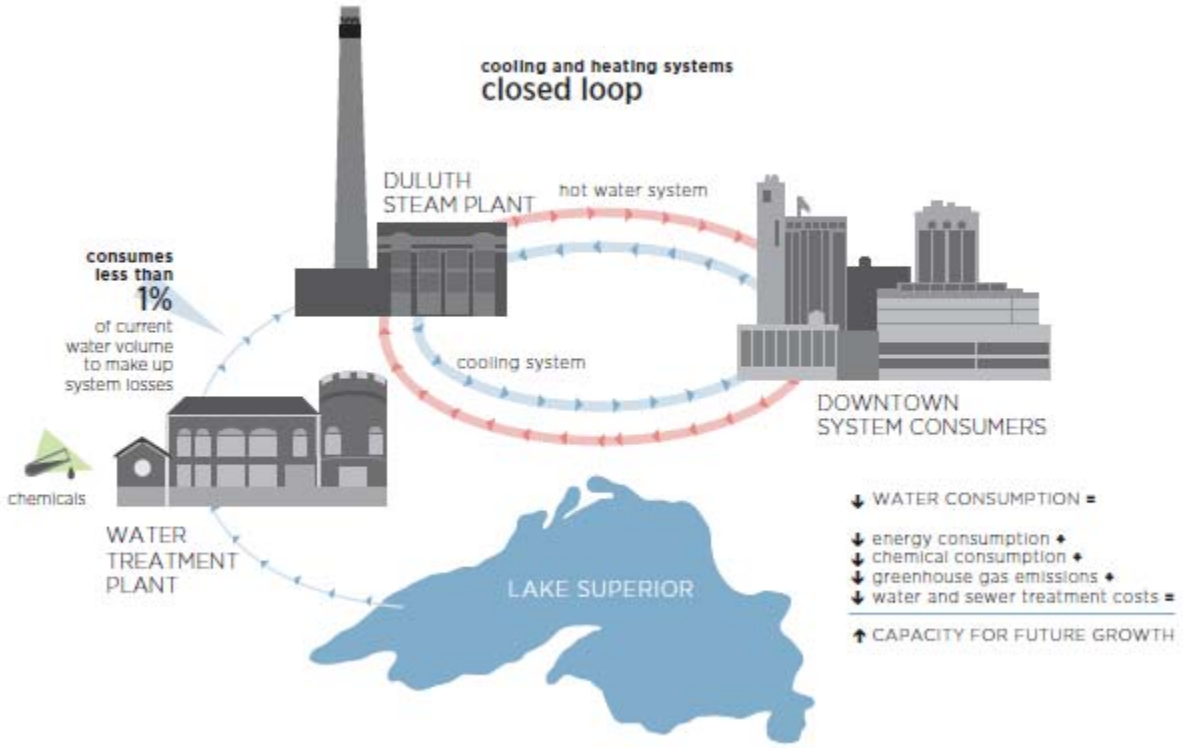
Community Energy Vision



Steam to Hot Water Transition

- Immediate opportunity to upgrade distribution system during major reconstruction of a downtown street beginning in 2017
- Coordination of these infrastructure projects could present savings of approximately 40%
- Hot water infrastructure will also allow condensate return from the areas still served by steam, making the steam system more efficient
- Opportunities for snow melt and solar thermal

Steam to Hot Water Transition



Biomass Integration

- Coal currently serves as a primary fuel with oil and gas backup capability. Gas is cost-prohibitive with current steam distribution inefficiencies.
- Permit recently modified to allow woody biomass integration.

Biomass Integration

- Modifications within the plant needed for fuel handling.
- Supplier has been identified for ~20,000 tons/year
- Expected to complete integration by December 2015

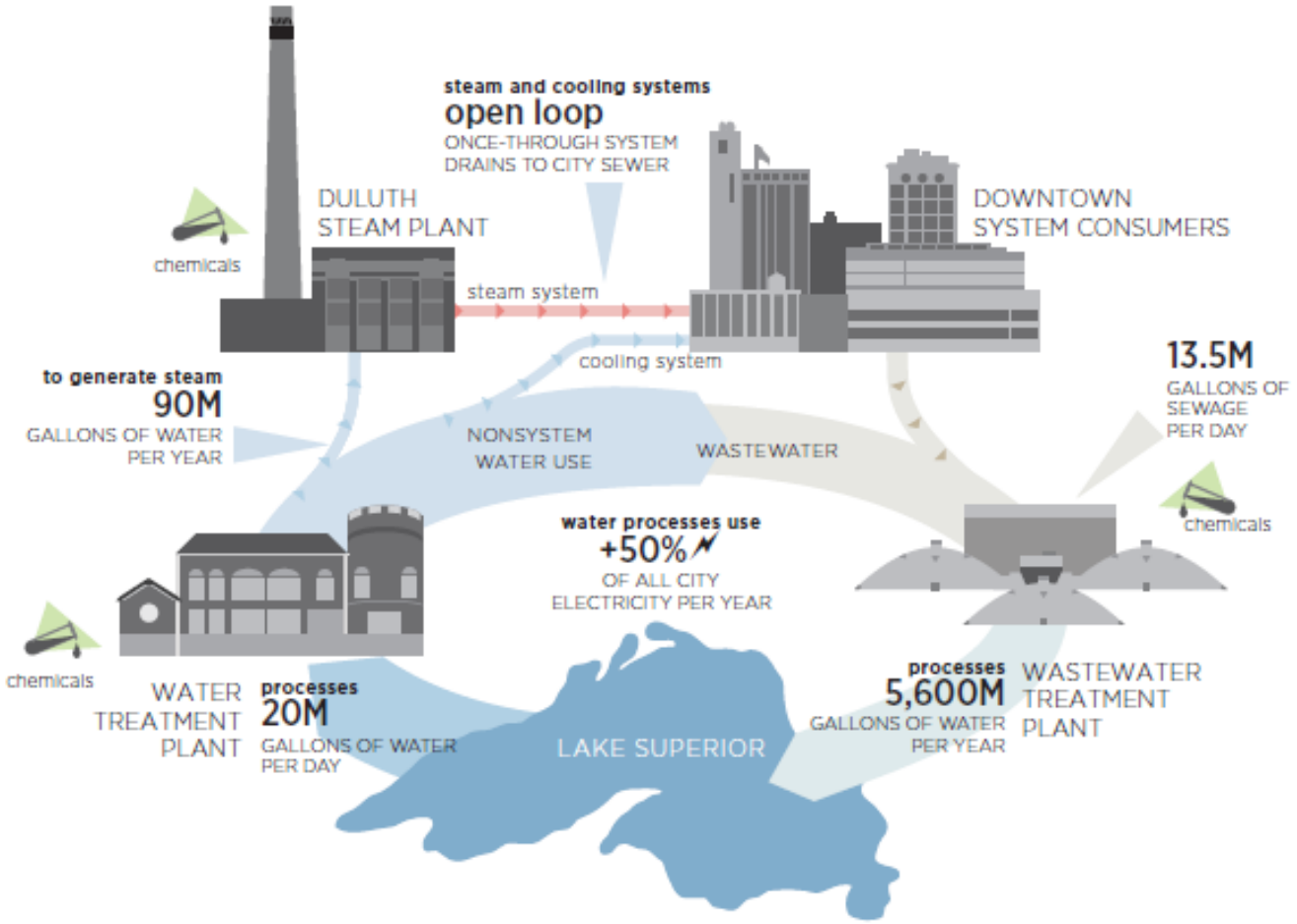
Customer Improvements - DECC

- Currently more than double the expected energy intensity
- Has lacked incentives to improve efficiency
- Energy saved can be used to expand the current hot water loop

Customer Improvements - DECC

- Infrastructure investment required to transform and transport energy conserved at DECC for productive use in Canal Park is estimated at $6 million.
  - Double the building area served with no additional fuel consumed
  - Reduce water consumption by 1.5 million gallons / year
  - Reduce coal consumption by 1,000 tons / year

Expected Results



The Vision

- The improvements described here are the first, enabling steps towards Duluth's vision for a sustainable, resilient energy future.

- Such an energy transformation is costly, but if done opportunistically and with long financial time horizons, it can be done cost-effectively.