HELP STOP CLIMATE CHANGE! RECOVER WASTE HEAT FROM SEWERS AND REDUCE FOSSIL FUEL USE FOR SPACE AND WATER HEATING

THE PROBLEM:

Global Impact

- Cities are primary centres of energy consumption relying heavily on centralized fossil fuel energy systems.
- Damaging impacts from climate change and economic shocks from fossil fuel scarcity and price volatility are expected to be concentrated in urban areas.

Local Impact (Ontario)

- In 2011 86% of Ontarians lived in urban areas (Employment and Social Development Canada 2012)
- In 2012 Space/water heating for Ontario's residential and commercial/institutional sectors equals 25% (645.2 PJ) of total provincial energy consumption (Natural Resources Canada 2015).
- Natural Gas accounts for 76% of all energy types consumed for space and water heating in the residential and commercial/institutional sectors (Natural Resources Canada 2015).

THE FOCUS

- It is in the best interest of cities in Ontario to shift from fossil fuel dependence and help avoid harmful shocks to people, ecosystems, economies, property, and infrastructure.
- The high reliance on natural gas in Ontario for space/water heating is an area of concern with ample opportunity to investigate fossil fuel reduction solutions.
- A growing area of research focuses on the energy potential of wastewater heat. Despite the valuable potential of wastewater heat it is currently an underutilized resource.
- Wastewater Heat Recovery addresses the issue of shocks from climate change, fossil fuel scarcity, and price volatility as it simultaneously reduces a community's reliance on fossil fuel imports and increases a community's utilization of local distributed renewable energy.
- Despite the valuable potential of wastewater heat it is currently an underutilized resource.
- Wastewater heat is readily available and can be more stable year round than solar and wind energy.

THE QUESTION:

How can optimal supply locations of municipal sewer wastewater heat be matched with urban space and water heating demand?

THE OBJECTIVES:

1. Contribute to the development of the first stage in a multi-stage decision support system that assesses the viability of harvesting wastewater heat resources at ideal locations across a municipal sewer network for a district energy system.

2. Demonstrate through the use of a case study how a deficiency of pertinent wastewater and/or energy consumption data can be overcome by using spatial analysis tools and techniques.

3. Produce steps for replication so that the system of analysis established in the case study can be used in other Ontario jurisdictions.

4. Examine the linkages between spatial planning, community energy planning, and waste heat recovery, in order to identify implications for enhancing energy efficiency in Ontario urban areas.

WASTEWATER DISTRICT ENERGY EXAMPLES:

Vancouver, BC - Southeast False Creek Neighbourhood Energy Utility

Cheakamus Crossing, Whistler, BC - Whistler Olympic Village

THE METHODS:

Case study methodology that incorporates findings from a contextual review of theories and practice regarding topics including:

- Wastewater heat recovery system (WWHRS) siting and integration
- The planning of District Energy Systems (DES) that utilize waste heat resources
- The role of spatial planning in developing WWHRS
- The role of spatial analysis in planning a WWHRS

CASE STUDY

Study Area: GUELPH, ON

Aims and Outcomes:

- Energy Supply and Demand Analysis
- GIS Heat Map
- Site Suitability Analysis
- Pre-feasibility Project Assessment

- **ESTIMATING DEMAND** (Residential and Commercial Space/Water Heating):

1. Obtain spatial data for buildings from City of Guelph: property parcels, total floor area, property type.
2. Obtain energy usage estimate data from Natural Resources Canada: annual energy intensity data by sector and end-use, based on energy consumed per unit of space (i.e. GJ/m2).
3. Multiply the total floor area per building by the appropriate energy intensity coefficient yielding estimated space and water heating demand for each building.

- **ESTIMATING SUPPLY** (Available Wastewater Heat):

1. Obtain spatial data for the sewer network from City of Guelph.
2. Obtain wastewater measurement data volumetric flow rate of sewage (e.g. m^3/s) and estimated sewage heat for various parts of the sewer network.
3. If wastewater measurement data across the network is not available attempt to obtain per capita wastewater flow data based on publicly available annual wastewater treatment plant reports. Conduct a GIS buffer analysis that identifies catchment areas serviced by sections of sewer. Estimate population within each catchment area and multiply per capita flow by the estimated population.
4. If wastewater temperature data is not available use the wastewater treatment plant estimates that indicate wastewater heat by average temp (Celsius) per month/season.
5. Available thermal energy in wastewater can be calculated as follows:

$$Q = \rho * V * C * \Delta T$$

Where,

Q: Thermal energy [kW]

ρ: Wastewater density [kg/m^3]

V: Volumetric flow rate [m^3/s]

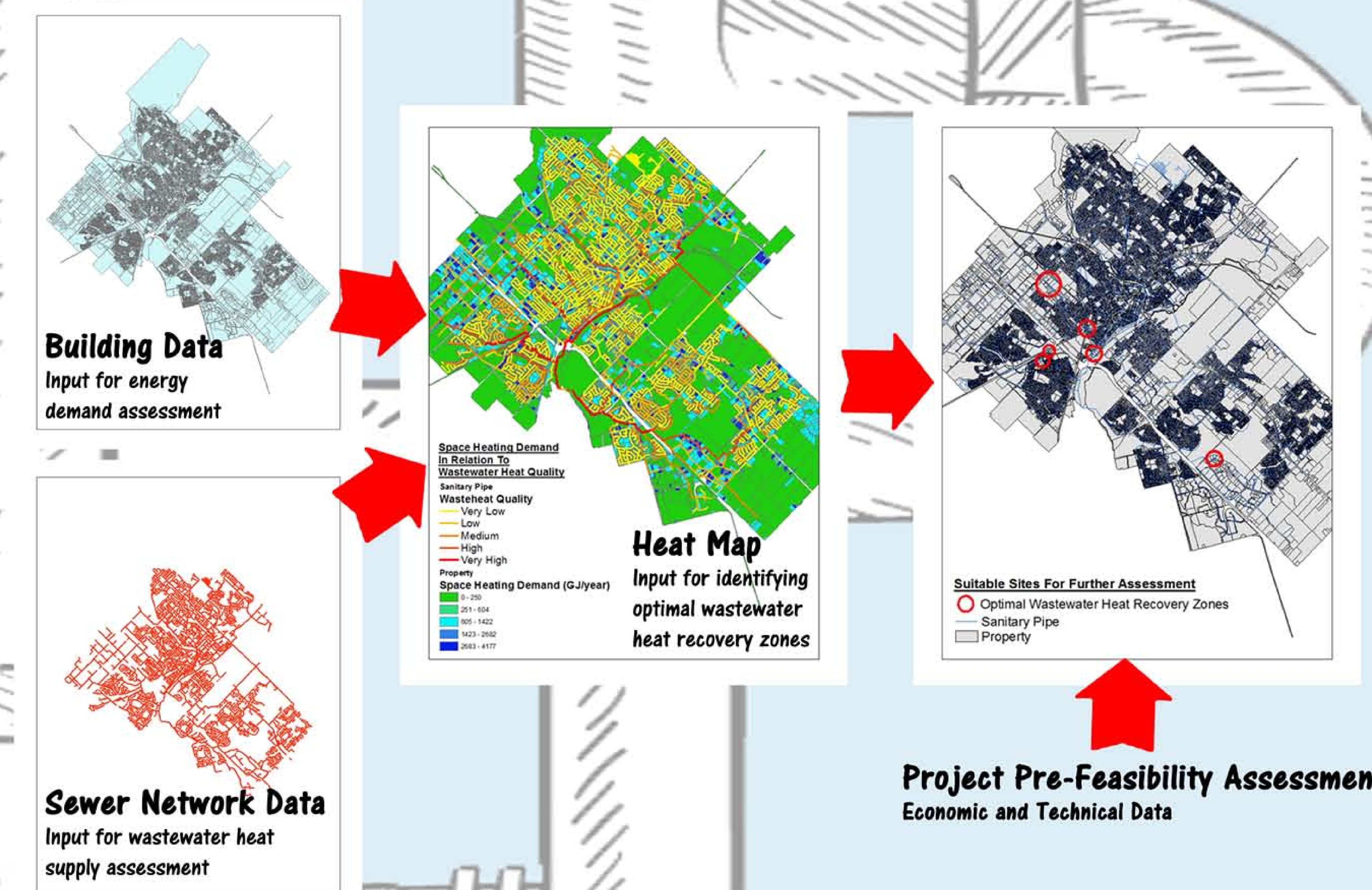
C: Heat capacity of water [kJ/kg•K]

ΔT: Temperature difference [K]

The crucial input parameters are flow rate and temperature.

6. Demonstrate how using the results from the Supply and Demand analysis and GIS site suitability analysis, in conjunction with a project feasibility assessment tool such as RETScreen, can inform a cost/benefit analysis and contribute to choosing economicallyfeasible locations for implementing a WWHR system in an Ontario municipality.

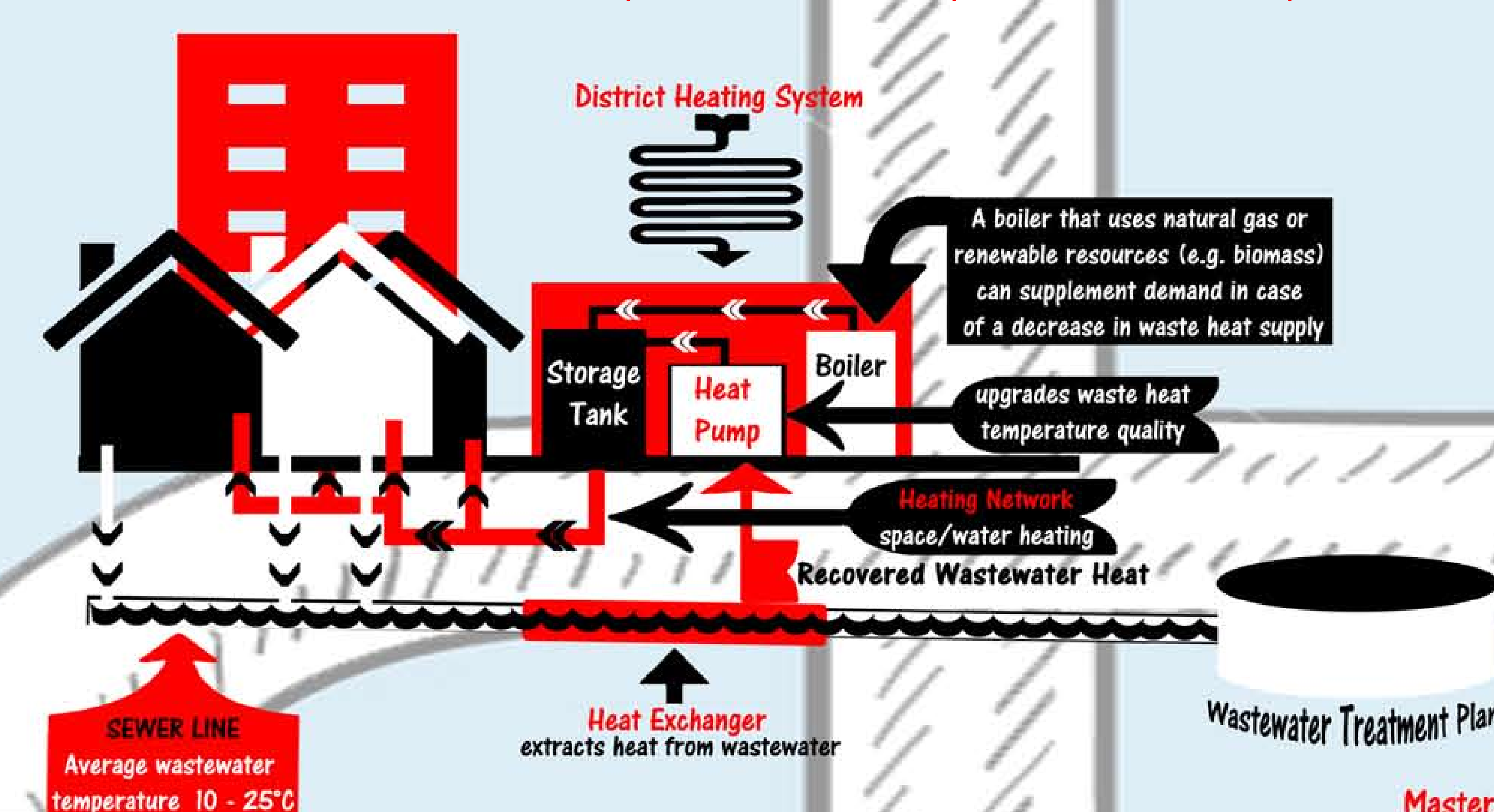
DECISION SUPPORT SYSTEM: STAGE I



THE RECOMMENDATIONS:

This research project is intended to inform planners, policy makers, and other urban energy system stakeholders. It is better to consider the assessment of wastewater heat supply as part of a larger assessment process whereby wastewater heat would be one of multiple local resources assessed for their viability for a district heating system. This could then lead to a district heating system achieving optimal balancing of supply and demand. Further research opportunities exist for developing additional stages of the site selection process wastewater heat recovery systems.

WASTEWATER HEAT RECOVERY SYSTEM



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