

Regional Waste Energy Mapping Alberta Industrial Heartland



OUTLINE

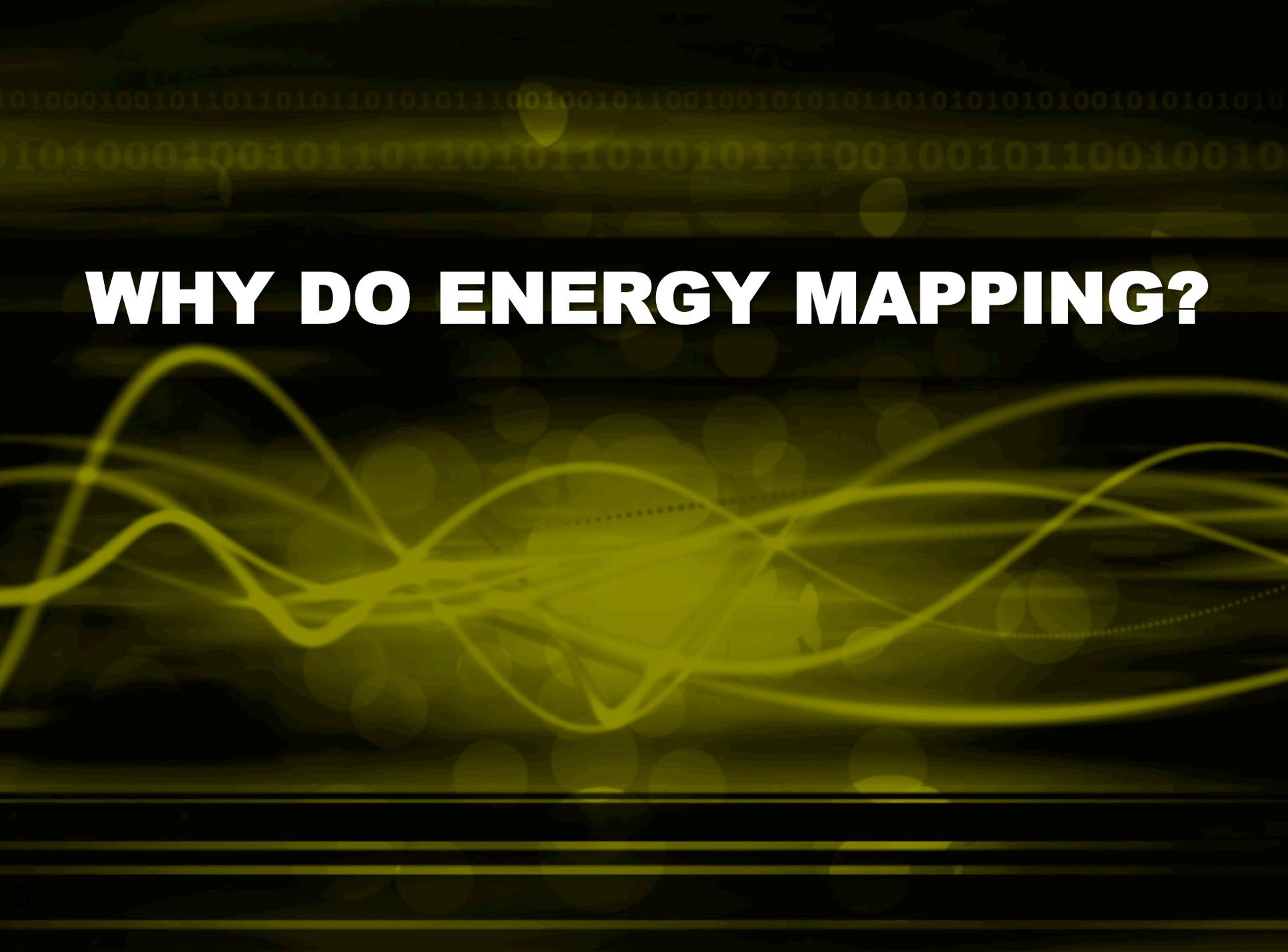
- What is energy mapping?
- Why do energy mapping
- Alberta Industrial Heartland project
- Technology Applications and Priorities
- Waste Energy Mapping Across Canada

The background is dark with a pattern of glowing green binary code (0s and 1s) at the top. Below this, there are several horizontal lines of varying thickness and color, ranging from light green to dark green. The central focus is a large, bold, white text element. At the bottom, there are more horizontal lines, some of which are solid and others dashed, creating a sense of depth and movement.

WHAT IS ENERGY MAPPING?

WHAT IS ENERGY MAPPING?

- Determine energy used and released in terms of:
 - **Type** – heat, electricity, petroleum, biomass, solar, wind, etc.
 - **Quantity** - how much in terms of MJ, MW, BTU
 - **Quality** – temperature, pressure, pollutant levels
 - **Variability** – over typical day, seasonally
- Group waste energies and energy needed by type, quality, and geographic location.
- Identify potential uses for “waste” heat including integrated energy options.

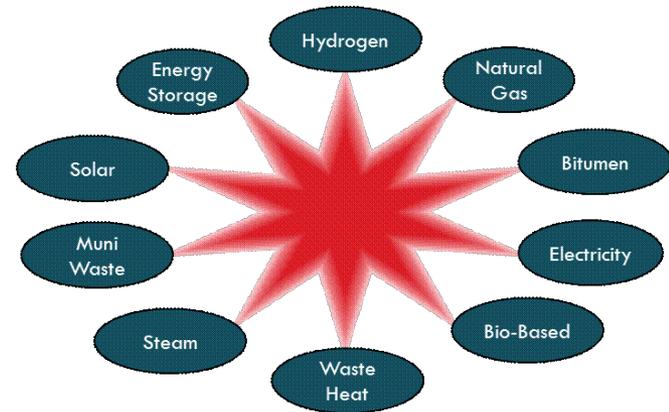
The background is a dark, almost black, space filled with abstract, glowing green elements. At the top, there are faint, horizontal lines of binary code (0s and 1s) in a light green color. Below this, several thick, wavy, glowing green lines sweep across the frame, creating a sense of motion and energy. The overall aesthetic is futuristic and digital.

WHY DO ENERGY MAPPING?

WHY DO ENERGY MAPPING?

- Identify and quantify waste energies so potential new uses can be found

- Develop viable integrated energy solutions



- Provide information needed to prioritize efficiency investment decisions
 - Technologies (e.g., energy conversion, storage, & sources)
 - Assess economic viability of possible integrated energy solutions
 - Evaluate regulation and policy implications

WHY DO ENERGY MAPPING?

- Help facilitate cultural changes - how we think about energy
 - Removes information barriers between business units
 - Enables holistic approach to energy systems
 - Supports regional energy planning
- Understand the wider sustainability implications for:
 - Water conservation
 - Waste reduction
 - Capacity building

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ENERGY MAPPING IN ALBERTA'S INDUSTRIAL HEARTLAND

SUPPORTED PROPOSAL TO NRCAN

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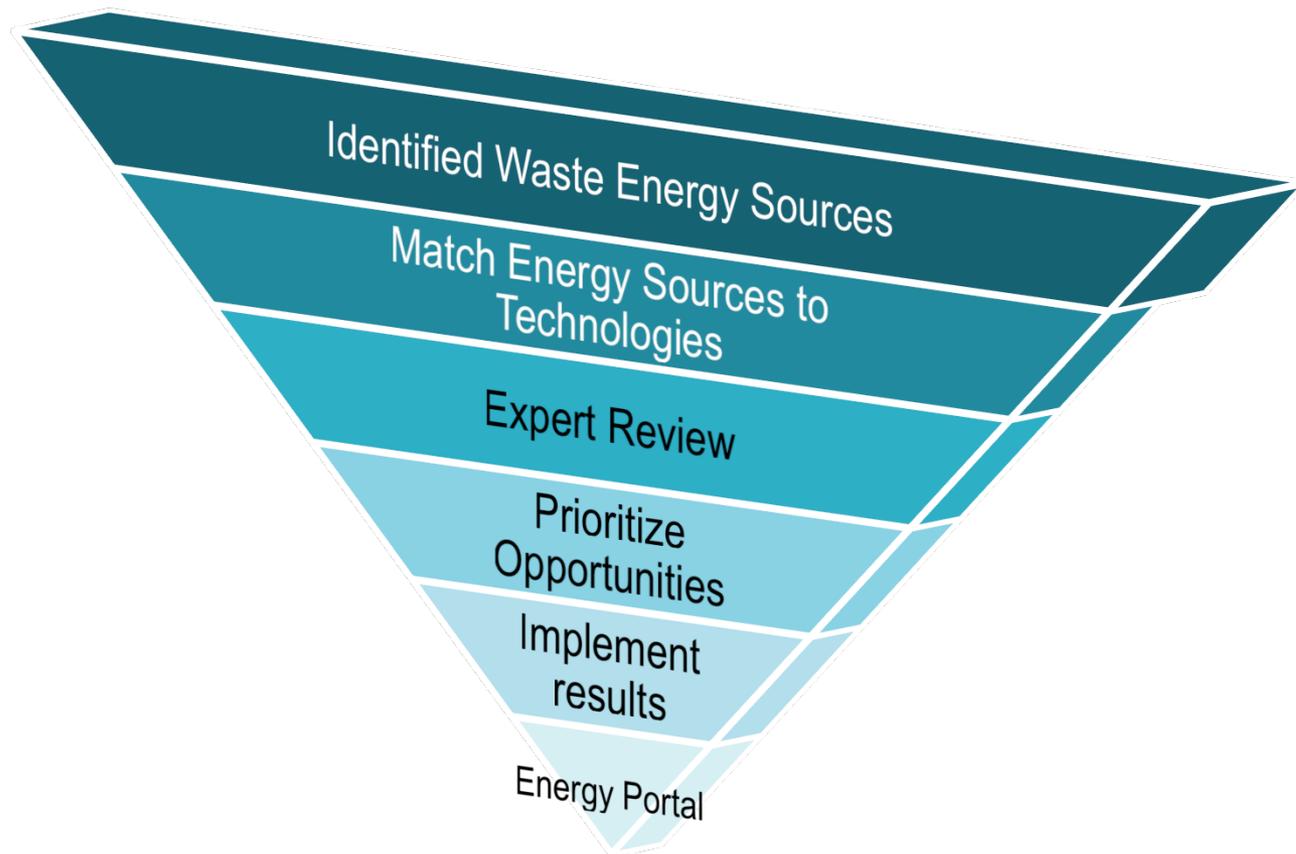
AIR
PRODUCTS

RioTintoAlcan

VERESEN

LONG-TERM GOAL

Achieve greater energy efficiency in the Heartland by identifying viable waste energy sources, matching them to recovery technologies to prioritize future regional integration projects



HEARTLAND ENERGY MAPPING STUDY

IMAGINE HARNESSING THE WASTE HEAT THAT COMES FROM INDUSTRIAL PROCESSES AND THEN USING THAT ENERGY TO HEAT AND POWER ENTIRE COMMUNITIES.

That's what the Heartland Energy Mapping Study is all about – investigating the opportunity to capture waste heat sources in Alberta's Industrial Heartland and feeding it into district heating systems to reduce or even eliminate the need for natural gas use in a neighbouring community.



PROJECT DESCRIPTION:

A lot of industrial activity happens in a relatively small area in Alberta's Industrial Heartland northeast of Edmonton. Over 40 companies are based in the region which includes land in five municipalities – the cities of Edmonton and Fort Saskatchewan, and the counties of Lamont, Strathcona, and Sturgeon.

The ultimate goal is to increase the energy efficiency in Alberta's Industrial Heartland by finding new uses for excess heat which is a by-product of normal industrial processes – thereby reducing greenhouse gas emissions. To do this, we need to better understand what the real opportunities are for capturing waste heat...

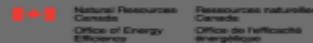
[Read More...](#)

Project Partners:

C3 – Energy. Ideas. Change.



Funded By:



Industry Partners:



If you have a facility located in Alberta's Industrial Heartland and would like to demonstrate your environmental leadership, it's not too late to be included in this project. Contact us today.

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RESULTS



ENERGY IDENTIFICATION BY SITE

- Assumed sites are internally optimized with no economically viable opportunities to use waste energy on site
- Asked experts to tell us about energies on site
 - 80-20 Rule - focus on “big” energy streams, no energy audit or process-level info on energy or mass flows
 - Energy inputs & wastes
 - Experts emailed info back to us
 - Phone-call to clarify

SITE-LEVEL WASTE ENERGY SOURCES

- Exhaust Stacks (Heaters & Boilers, Turbines, Petcoke)
 - Description of source, fuel type, rate of exhaust gas, temperature, qualitative description of contaminants & temporal variability
- Coolers & Compressors
 - Description of source, source temperature, temperature drop, flow rate of liquid, specific heat capacity
- Letdown of Pressurized Streams
 - Identified by a few participants

DATA SYNTHESIS: EXHAUST STACKS

- Classified each stream by:
- Pollutant level
 - Low
 - High or other risk
- Temperature:
 - 120-230 Deg C
 - 230-650 Deg C
 - 650-1100 Deg C
- Size (MW)
 - Based on cooling stream from actual temperature to 120 Deg C (sensible heat)
 - Also computed sensible & latent heat when cooled to 40 Deg C,

DATA SYNTHESIS: EXHAUST GASES

- Moisture content and composition of exhaust gases unknown in most cases, but knew fuel type so computed heat content using Aspen Plus® assuming:
 - Heaters or Gas Fired Boilers
 - Natural gas feed, 10% excess air, complete combustion of methane
 - Gas Turbine
 - Natural gas feed, 200% excess air, complete combustion of methane
 - Petcoke Pyrolysis
 - 20% excess air, complete combustion of carbon to CO₂, added additional water to reach reported moisture content.
 - Latent heat based on lowering to 175 C (not 120 C).

HIGH LEVEL FINDINGS

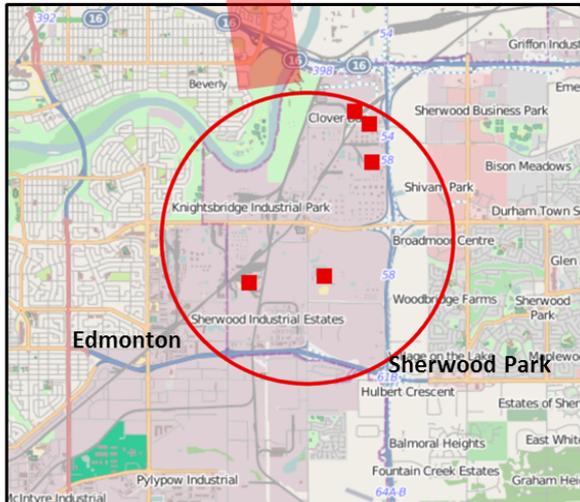
- The study revealed a significant amount of waste heat exists in the Strathcona and Heartland industrial areas.
- Geographically, the waste heat was clustered into three heat islands (see Figure 1) across the two industrial areas.

GEOGRAPHIC LOCATIONS

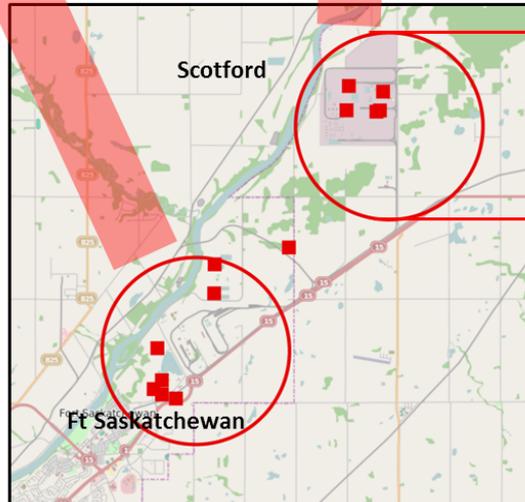
	Waste Heat (MW)	# Households Heated	Power Generation (MW)	# Houses Supplied Electricity	Reduction CO2e (t)
Exhaust Stacks					
120 to 230 C	23	4,500			41,100
230 to 1100 C	39		9	10,000	26,000
Coolers & Compressors					
80 to 230 C	136	26,400			239,500
Total 100% Capture	198	30,900	9	10,000	307,000
Total (33% Capture)	65	10,200	3	3,300	101,000

	Waste Heat (MW)	# Households Heated	Power Generation (MW)	# Houses Supplied Electricity	Reduction CO2e (t)
	13	2,500			23,100
	25		5	5,600	14,600
	10	2,000			18,000
	48	4,500	5	5,600	56,000
	16	1,500	2	1,800	18,000

	Waste Heat (MW)	# Households Heated	Power Generation (MW)	# Houses Supplied Electricity	Reduction CO2e (t)
	49	9,600			87,000
	5	1,000			9,000
	54	10,600			96,000
	18	3,500			31,700



Strathcona Industrial Area



Alberta's Industrial Heartland

HIGH LEVEL FINDINGS

- 300 MW of sensible waste energy was identified, of which:
 - 64 MW comes from low pollutant exhaust stacks with temperatures between 230 and 1100 °C;
 - 85 MW comes from low pollutant exhaust stacks with temperatures between 120 to 230 °C;
 - 151 MW comes from coolers and compressors with temperatures between 80 and 230 °C.

HIGH LEVEL FINDINGS

- These results are only for the 17 participating sites. Other companies known to have significant amounts of waste heat did not participate in the study.
- Further, not all participating companies reported on all of their major waste heat streams (e.g., a few only reported on exhaust stacks, but not cooling towers).
- Finally, lower temperature cooling streams between 20 and 80 °C have been excluded due to the inherent challenges of repurposing such low temperature heat.

HIGH LEVEL FINDINGS

- For each heat island, assuming that 33% of this total available waste energy could be captured and repurposed, the resulting 99 MW of waste energy could theoretically be used to:
 - Heat 15,200 average homes;
 - Generate 5 MW of power - enough to power 5,100 homes;
 - Reduce CO₂e emissions in the region by ~151,000 tonnes.

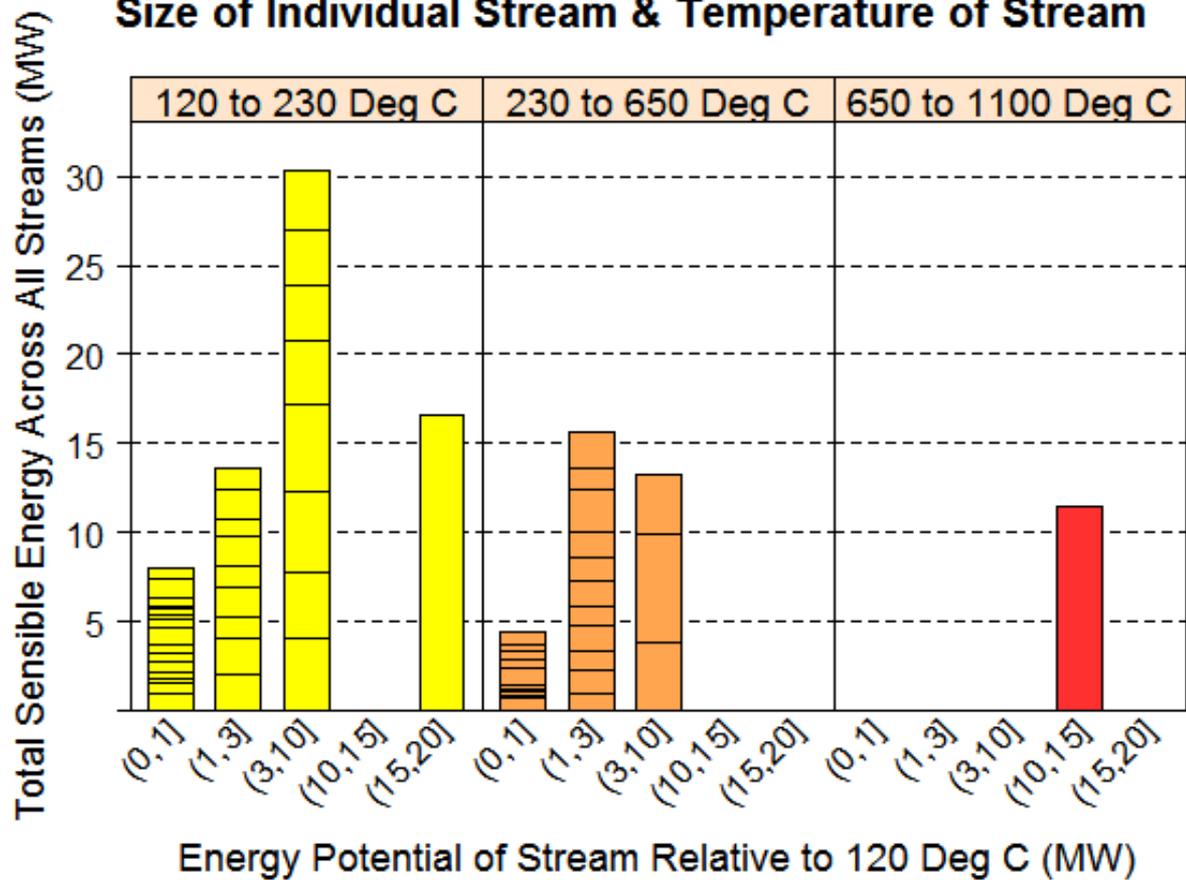
Based on NRCAN emission reduction factors

That 20-30% of the waste energy (depending on temperature) could be converted to power, and that a house requires 7,800 kWh of power a year.

<http://www.nrcan.gc.ca/energy/efficiency/industry/technical-info/benchmarking/canadian-steel-industry/5193>

RESULTS: EXHAUST STACKS

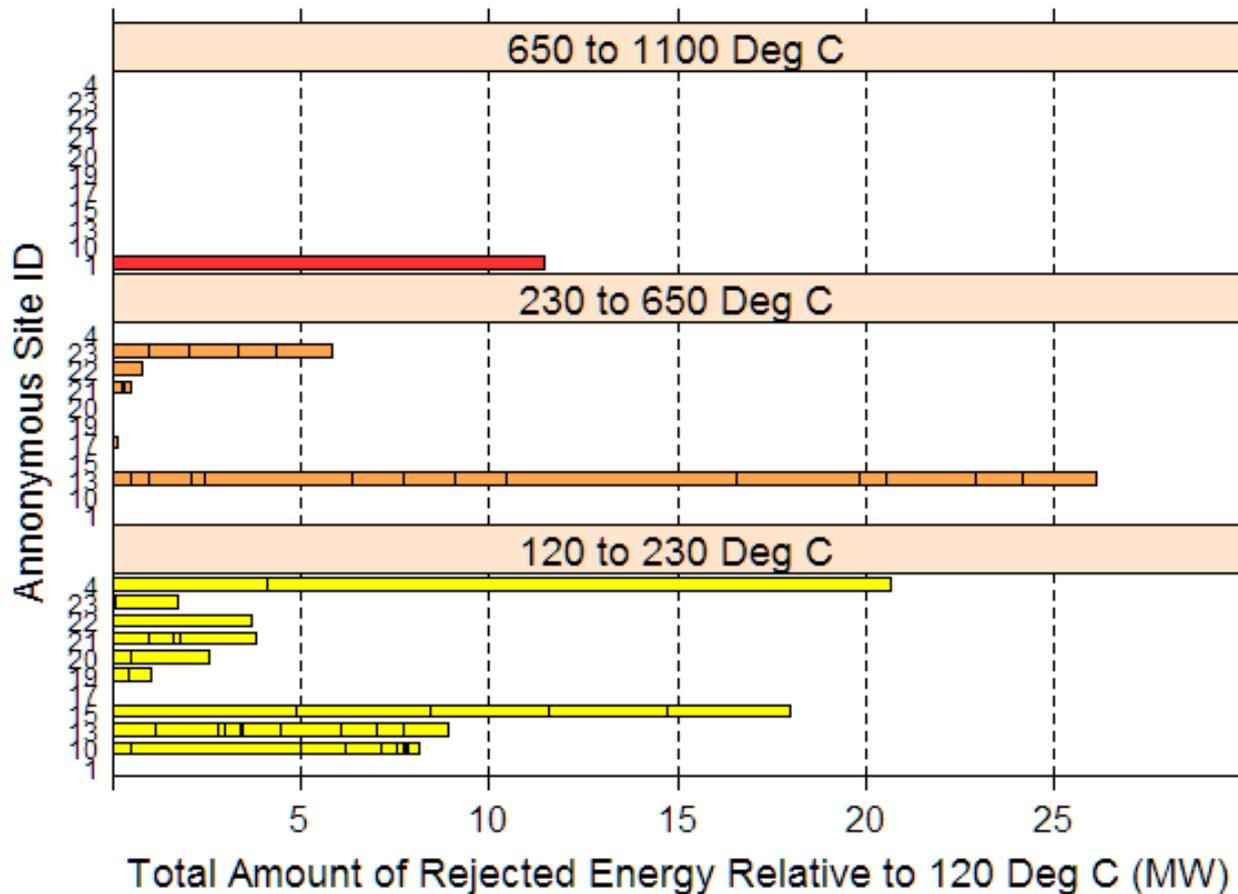
**Total Rejected Energy (MW) Relative to 120 Deg C of
Low Pollutant Exhaust Streams by
 Size of Individual Stream & Temperature of Stream**



Significant amount of higher temperature waste energy streams

RESULTS: EXHAUST STACKS BY SITES

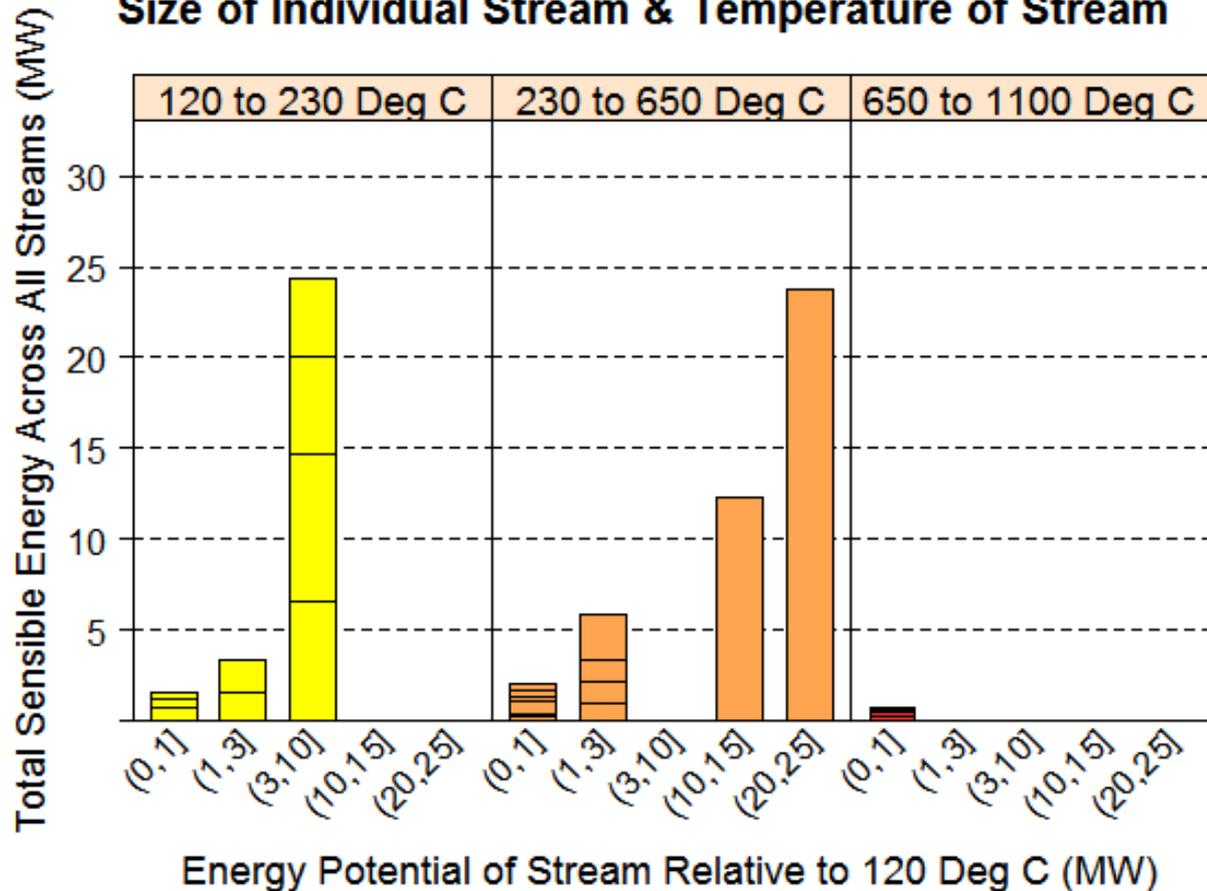
Total Rejected Energy Relative to 120 Deg C
of Low Pollutant Streams by Temperature of Stream



Higher temp
waste energies
concentrated on
a few sites

RESULTS: EXHAUST STACK

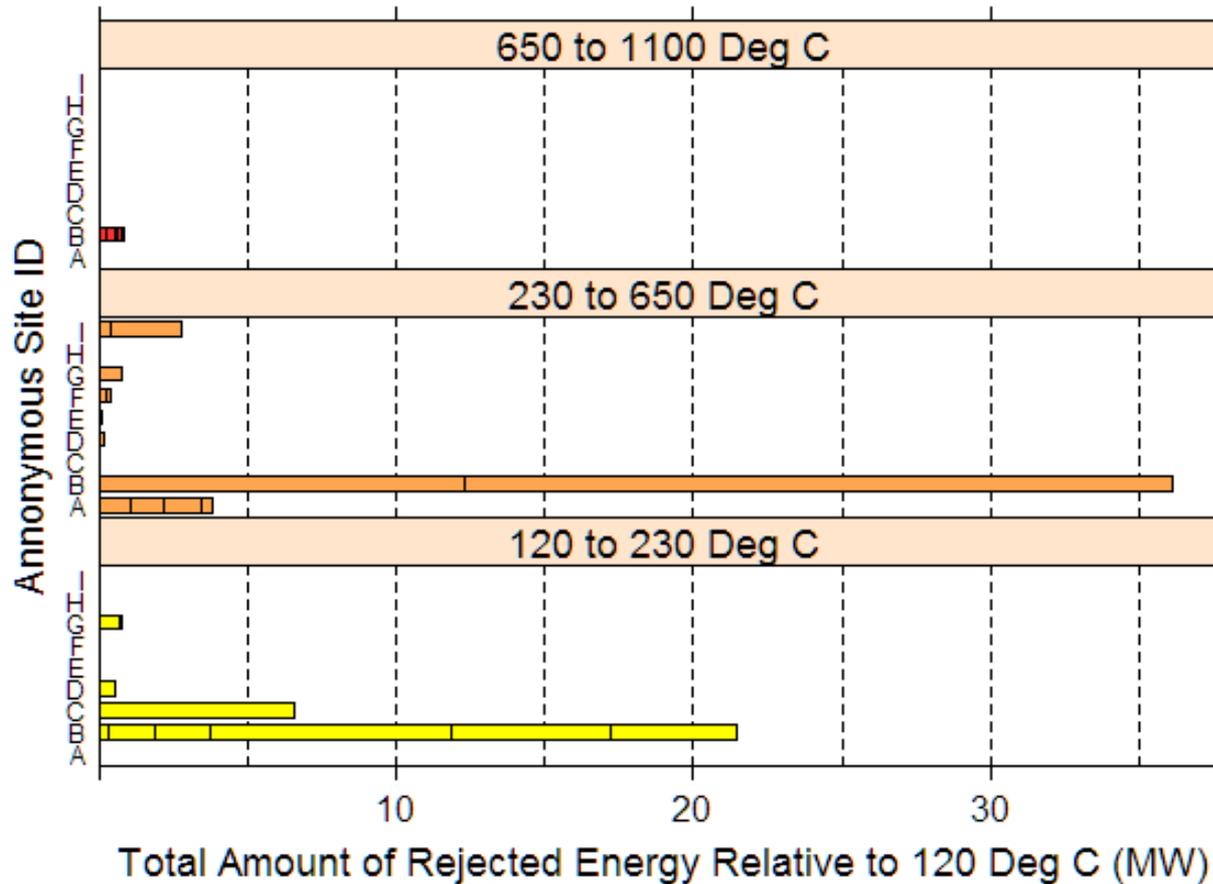
Total Rejected Energy (MW) Relative to 120 Deg C of High Pollutant Exhaust Streams by Size of Individual Stream & Temperature of Stream



Fair amount of mid-temperature energy if could deal with pollutant issues

RESULTS: EXHAUST STACK BY SITES

Total Rejected Energy Relative to 120 Deg C
of High Pollutant Streams by Temperature of Stream



A single site has most mid and lower temperature energy with high pollutants

SUMMARY FINDINGS – EXHAUST STACKS

Low Pollutant Streams:

- ~64 MW of mid and high temp waste energy which needs further investigation to assess feasibility of re-use.
- Waste Energy clustered across a few sites

High Pollutant Streams:

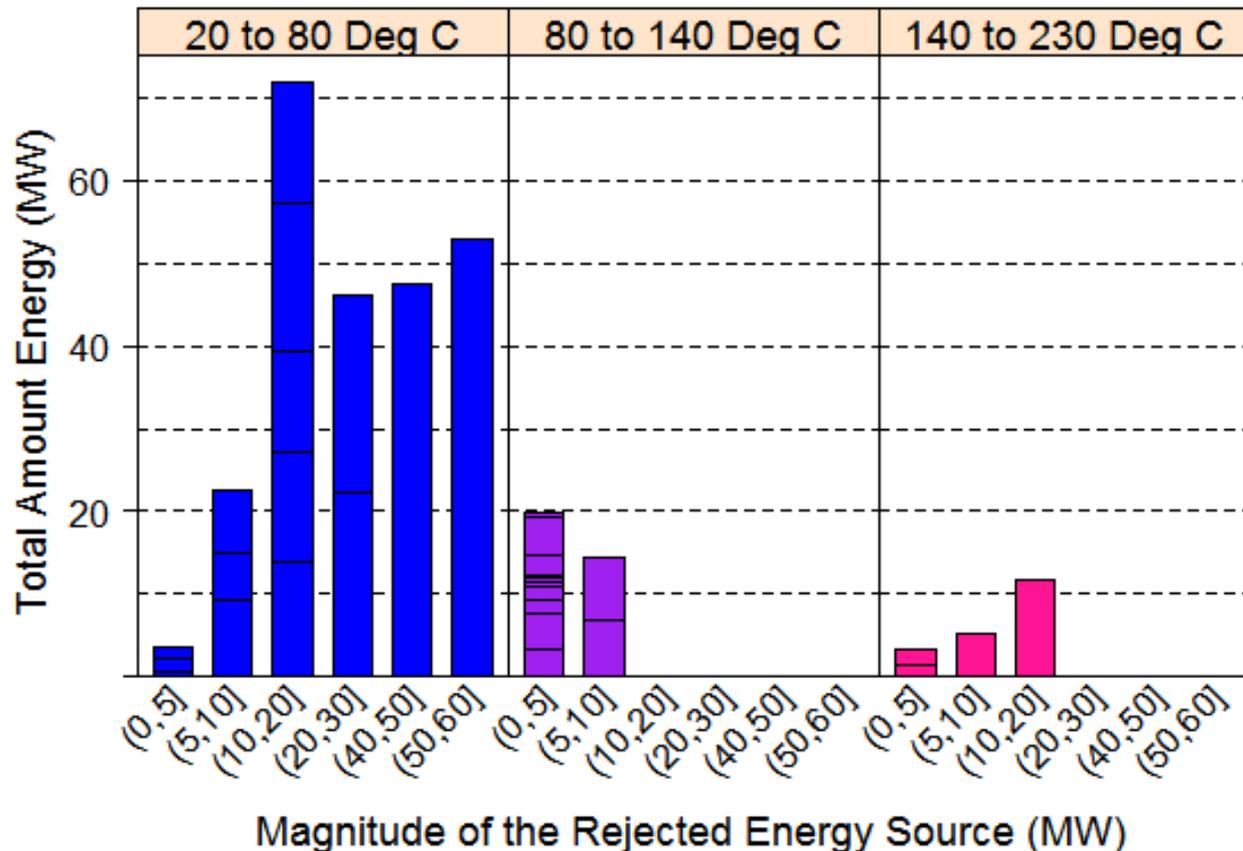
- >85 MW of mid temperature waste heat
- Unclear how much recoverable with advance technologies

DATA SYNTHESIS: COOLERS

- Computed rejected energy based on temperature drop, rate of mass flow, & specific heat capacity of liquid
- Classified streams by:
- Stream source temperature
 - 20-80 Deg C
 - 80-140 Deg C
 - 140-230 Deg C

RESULTS: COOLERS

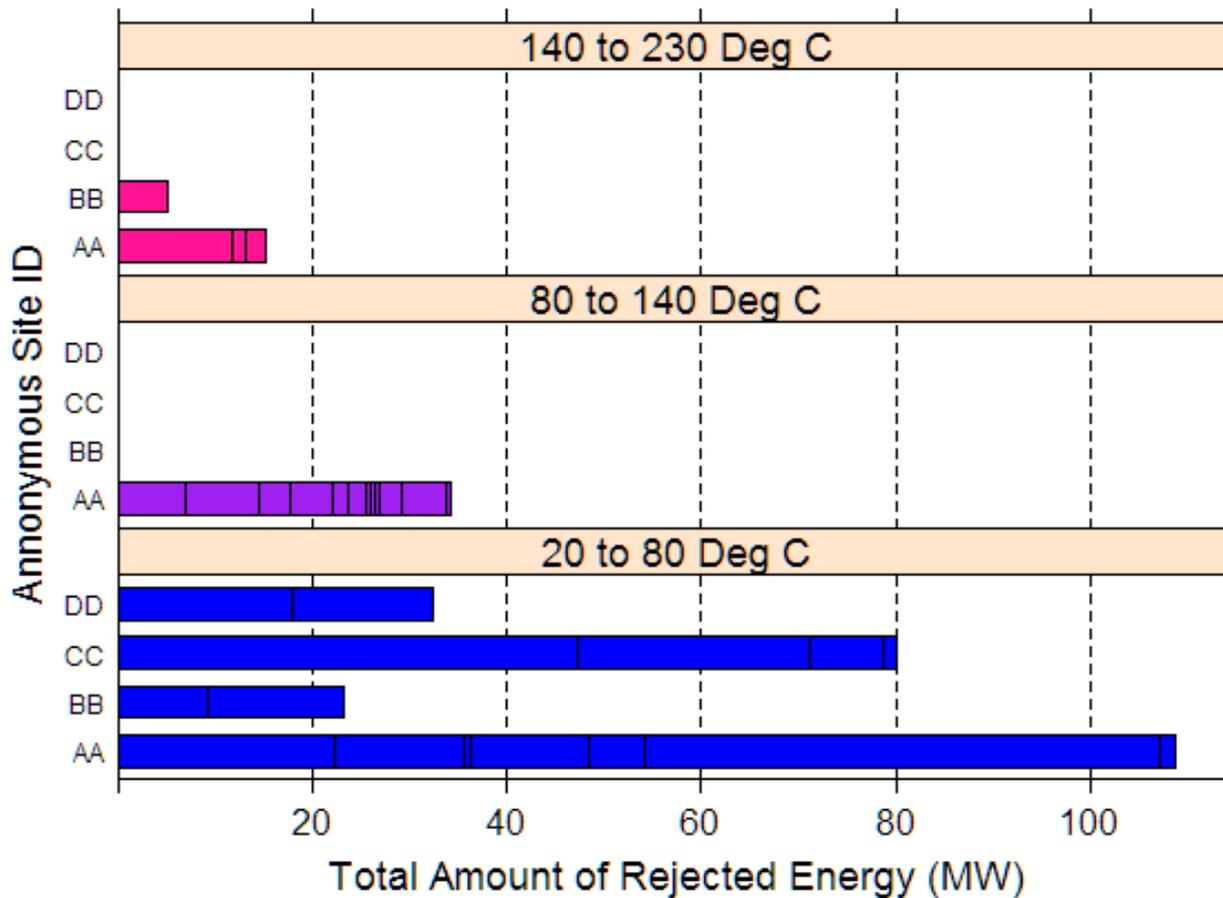
**Total Energy Rejected by Cooling Streams
by Temperature of Stream Before Cooler &
Size of Rejected Stream**



A few “higher temp” cooling streams with fairly large energy amounts

RESULTS: COOLERS

Amount of Rejected Energy in Cooling Streams by Site & Temperature of Stream Before Cooler



“Higher” temp Cooling Streams on just 2 sites

SUMMARY FINDINGS – COOLERS

- 20 MW of heat between 140-230 Deg C
- 32 MW of heat between 80-140 Deg C
- 244 MW of heat between 20-80 Deg C
 - 96 MW between 60-80 Deg C

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TECHNOLOGY APPLICATIONS AND PRIORITIES

EXPERT REVIEW PANEL

- **Neil Camarta**
 - CEO and President – Western Hydrogen
- **Bob Mitchell**
 - Manager, Climate Change, Business Development and Strategic Planning, Conoco Phillips Canada
- **Pat Bohan**
 - Director, District Energy Generation & Wholesale Energy, ENMAX
- **Jim Seaba**
 - Manager, Facilities Technology and Integration, Conoco Phillips Canada
- **Alan Chambers**
 - Alberta Innovates Technology Futures
- **Frank Vagi**
 - Senior Process Advisor, Bantrel
- **Warren Frost**
 - Director, Consulting Services, Genalta Power

TECHNOLOGY

- Natural Gas Pressure Reducing Turbo-expander
 - Natural gas pressure reduction to sites is through valves, but this dissipates energy
 - Pressure can be reduced through a turbine and electricity is generated

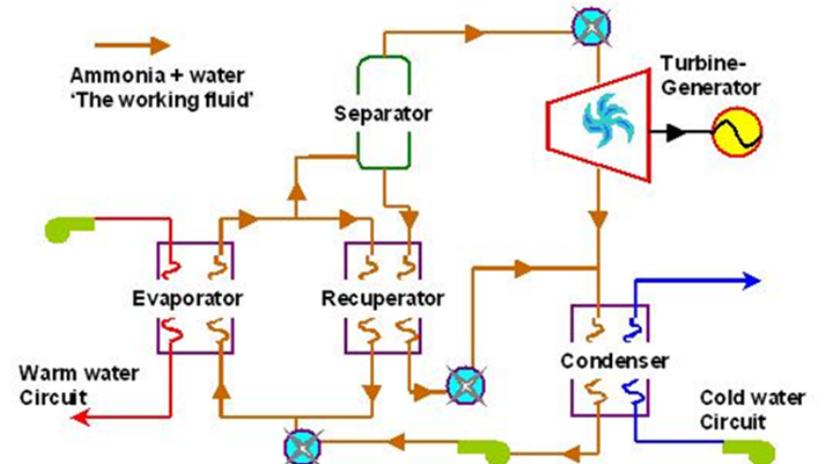


TECHNOLOGY

- Heat to Electricity
 - Organic Rankine Cycle (ORC)
 - Kalina Cycle
 - Thermoelectric

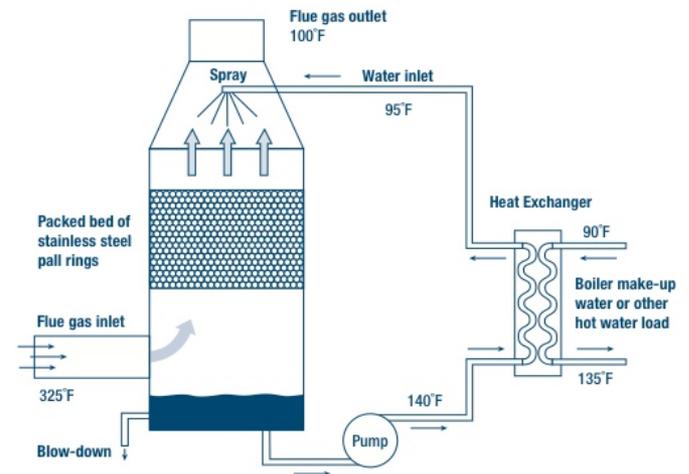
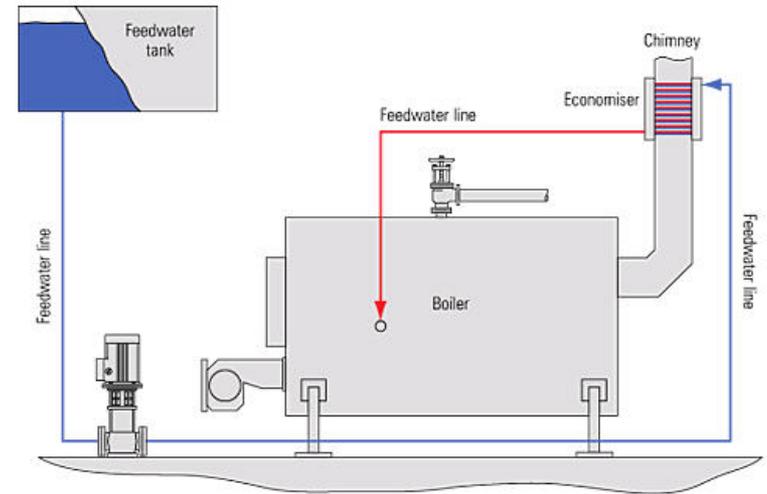


Simplified Kalina Cycle™ (Exergy, Inc.)



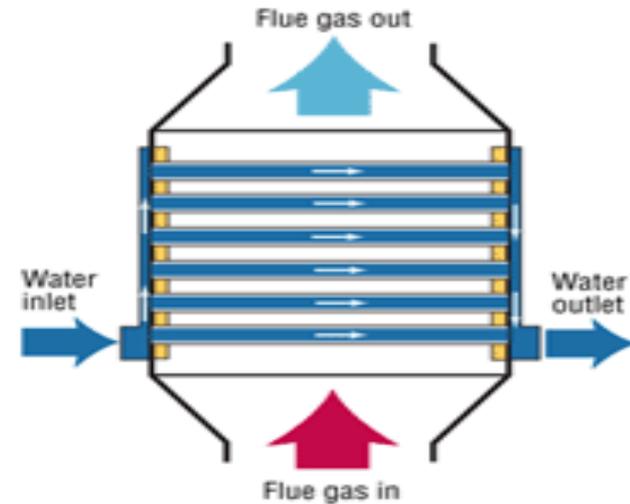
TECHNOLOGY

- Heat Capture
 - Non-condensing Heat Exchanger
 - Condensing Heat Exchanger

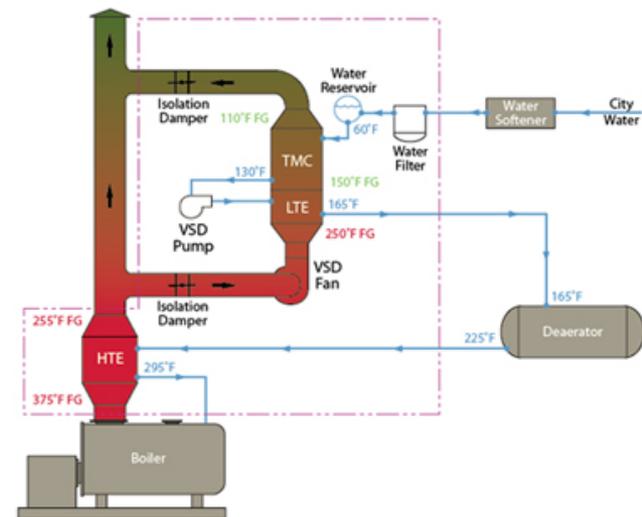


TECHNOLOGY

- Heat Capture
 - Transport Membrane Condenser
 - Heat Pipes



Flow through a transport-membrane-condenser bundle.



TECHNOLOGY

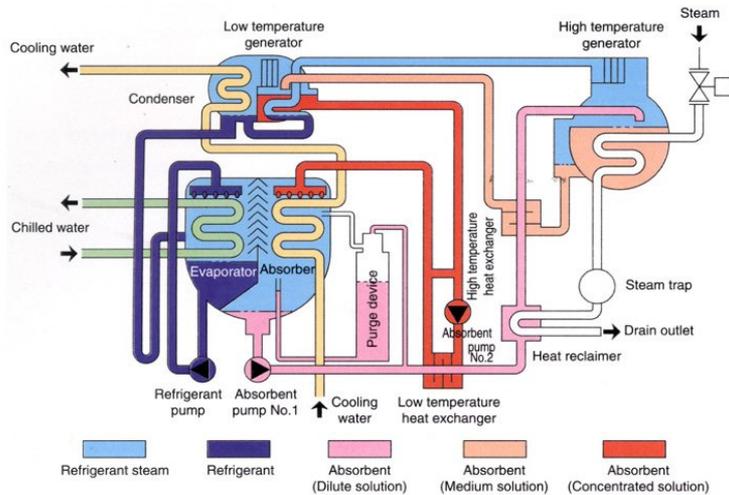
- Heat Upgrade
 - Steam recompression
 - Heat Pump



TECHNOLOGY

- Heat to Cooling
 - Absorption Chiller

Absorption chiller flow diagram



TECHNOLOGY

- End Uses for Heat
 - Combustion air pre-heat
 - Boiler feed-water pre-heat
 - Load Pre-heat
 - Process Heating
 - Office area heating / cooling
 - District heating for municipality

SUMMARY OF TECHNOLOGIES

- Proven technologies are available
- Innovative opportunities to explore
- Higher Temperatures = Higher Value
- Produce Electricity with the right conditions
- Condense flue gases to access latent heat
- Cascade waste energy through many end uses
- Low temperature waste heat (~ 80 C) is useful for space heating
- Lots of buildings (commercial and residential) can access heat through District Heating

FURTHER INVESTIGATION

Given the significant amounts of waste heat available, there are a number of opportunities within these energy islands that warrant further investigation and should be considered in the future. These include:

- **Electricity generation from waste heat streams** by routing the mid-grade waste heat identified in this study to technologies such as Organic Rankine or Kalina Cycle systems.
- **Natural gas pressure letdowns** that result from the large amounts of natural gas consumed in each of these industrial areas could be used to generate electricity.
- **High temperature energy sources** identified could be sufficient to support the installation of third-party operated power generation systems on selected sites.
- **Heating of intermediate product tanks** by using waste heat from primary operations.

FURTHER INVESTIGATION

Regional Steam Utilities should be explored as a way to increase the overall level of steam security on industrial sites, making it less likely that an interruption in steam supply would trigger a site shutdown. Such utilities could incorporate COGEN and such a utility would also lower the capital costs associated with developing new industrial sites in the region.

Redevelopment opportunities within sites and between sites represent a significant opportunity for COGEN and possibly even ‘sub-regional’ steam systems if ways can be found to locate other industrial sites close to these plants.

District heating systems in neighbouring communities are presently challenging given the large distances between the heat sources and neighbouring municipal development; and given that some of the surrounding municipal development is low-density, single-family houses. Further collaboration with municipalities neighbouring these industrial areas is needed to drive future development with the characteristics needed to take advantage of the identified energy resource.

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WASTE ENERGY MAPPING ACROSS CANADA

WASTE ENERGY MAPPING ACROSS CANADA

- With the success of waste energy mapping in Alberta Industrial Heartland, CMC Research Institutes is engaged in conducting feasibility studies that lead to GHG reduction in any regional industrial cluster area in Canada.

For information regarding waste energy mapping opportunities across Canada, please contact:

Jeff Reading

Vice President, Business Development

Jeff.Reading@cmcghg.com

403-210-9156

