Community Integrated Energy Mapping Feasibility Study in Alberta's Industrial Heartland and Strathcona Industrial Area

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Alberta's Industrial Heartland

Alberta Innovates Technology Futures

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EXECUTIVE SUMMARY

The Community Integrated Energy Mapping Feasibility Study obtained data from 17 industrial companies in the Strathcona and Heartland Industrial Areas near Edmonton, Alberta to understand the energy flows and associated waste energy within the region. An understanding of the energy types, amounts, qualities, temporal variability and geographic constraints of this energy is essential for the development and implementation of a business case for regional energy integration solutions.

The need for Canada (and Alberta) to find and exploit all efficiency opportunities is highlighted by a recent US National Academy of Sciences report[1] which noted that Canada's energy use per dollar of GDP is ~1.5 times higher than that of the US, and ~two times higher than Japan, Germany, and the UK. To remain competitive, Canada must become more energy efficient. Becoming more energy efficient will reduce Alberta's greenhouse gas (GHG) emissions, which has an environmental benefit while also improving industry productivity and competitiveness, thereby creating more vibrant Alberta communities.

The project team, which included C3 (formerly Climate Change Central), Alberta Innovates Technology Futures (AITF) and the Alberta Industrial Heartland Association (AIHA), focused the study on the Heartland and Strathcona Industrial Areas. The Heartland region, northeast of Edmonton, Alberta includes five municipal districts while the Strathcona Industrial Area is situated between Edmonton and Sherwood Park. Both industrial areas are home to approximately 40 companies in total across a variety of sectors primarily producing and processing oil, gas, and petrochemicals, as well as advanced manufacturing. Over the past several decades, these areas have grown into Canada's largest hydrocarbon processing region.

Companies that participated in the study include Agrium, Air Liquide, ATCO Energy Solutions, Keyera Energy, Suncor Energy, Western Hydrogen, Rio Tinto Alcan, Northwest Redwater Partnership, Veresen, Sulzer Metco, Sherritt, Umicore, Keyera Alberta EnviroFuels, AltaSteel, Air Products, Shell Scotford Manufacturing Centre, and Plains Midstream. The wide industrial mix and proximity to municipalities helps to ensure that the methods developed in this region can be applied to other industrial parks and regions across Canada.

Project funding was provided by Natural Resources Canada and the Alberta Industrial Heartland Association.

[1] National Academies Press, 2010. "Real Prospects for Energy Efficiency in the United States", Figure 1.1.1, http://www.nap.edu/catalog.php?record_id=12621

Between May 2013 and June 2014, the project team completed the following activities:

- Secured sufficient industry stakeholder participation from the ~40 companies in the Strathcona and Heartland industrial areas to generate useful results;
- Secured access to appropriate data on energy supply and demand from participating industrial sites, along with confirming high-level information on the major industrial processes occurring on each site;
- Validated the types, quality, quantity, and variability of energy flowing across these industrial sites to better understand overall regional energy availability;
- Reviewed similar industrial parks around the world to identify lessons learned and best practices;
- Completed a technology review of existing and emerging technology solutions regarding recovering surplus energy and transferring it between sites or even outside the boundaries of this heavy industrial area to adjacent future light industrial or residential development;
- Built trust among participant companies, local municipalities and other relevant organizations across the greater Heartland region to enable subsequent phases of work to proceed;
- Developed a value proposition for implementation, based on study results, of viable opportunities that would achieve regional energy efficiencies;
- Established a business case for expanded waste energy mapping in other regions of Alberta and Canada.

While this is the first regional industrial energy mapping study completed in Canada, energy mapping is done in other parts of the world. A global review of industrial parks demonstrated that three critical factors must exist for stakeholders to even begin the first phase of this long-term transformation:

1. A convincing business case must exist that indicates ways to reduce costs or generate new revenue, and these actions can actually be undertaken by local businesses;
2. The social license to achieve efficiencies exists meaning that the policy or regulatory barriers to achieving efficiencies can be overcome, and communities potentially affected by the initiative endorse the activities;
3. The use of proven technology within the processes and equipment needed to enable resource synergies must exist, have been proven to work meaning it has low implementation risks for the companies.

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. These geographic limitations have implications for the feasibility of using the waste energy on a regional basis. While the results contain many subtleties described in the full report, the study identified:

- 293 MW of sensible waste energy, 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;
  - 144 MW comes from coolers and compressors with a temperature between 80 and 230 °C.

It should be stressed that these results are only for the 17 participating companies. Some 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. Thus, the results above are conservative relative to the actual waste energy available in these industrial areas.

For each heat island, assuming that 33% of this total available waste energy could be captured and repurposed, the resulting 97 MW of waste energy could theoretically be used to:

- Heat 14,700 average homes[2];
- Generate 5 MW of power – enough to power 5,100 homes[3];
- Reduce CO_2e emissions in the region by ~147,000 tonnes[4].

2 Assuming that heating a house requires 160 GJ of natural gas.

3 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.

4 Based on NRCAN emission reduction factors (http://www.nrcan.gc.ca/energy/efficiency/industry/technical-info/benchmarking/canadian-steel-industry/5193).

	Waste Heat (MW)	# Households Heated	Power Generation (MW)	# Houses Supplied Electricity	Reduction CO2e (t)	Waste Heat (MW)	# Households Heated	Power Generation (MW)	# Houses Supplied Electricity	Reduction CO2e (t)	Waste Heat (MW)	# Households Heated	Power Generation (MW)	# Houses Supplied Electricity	Reduction CO2e (t)
Exhaust Stacks															
120 to 230 C	23	4,533			41,148	13	2,490			22,605	49	9,585			87,009
230 to 1100 C	39		9	9,962	26,014	25		5	5,593	14,606					
Coolers & Compressors															
80 to 230 C	136	26,381			239,472	3	623			5,651	5	992			9,007
Total	198	30,900	9	10,000	307,000	41	3,100	5	5,600	43,000	54	10,600			96,000
Total (33% Capture)	65	10,200	3	3,300	101,000	13	1,000	2	1,800	14,000	18	3,500			31,700

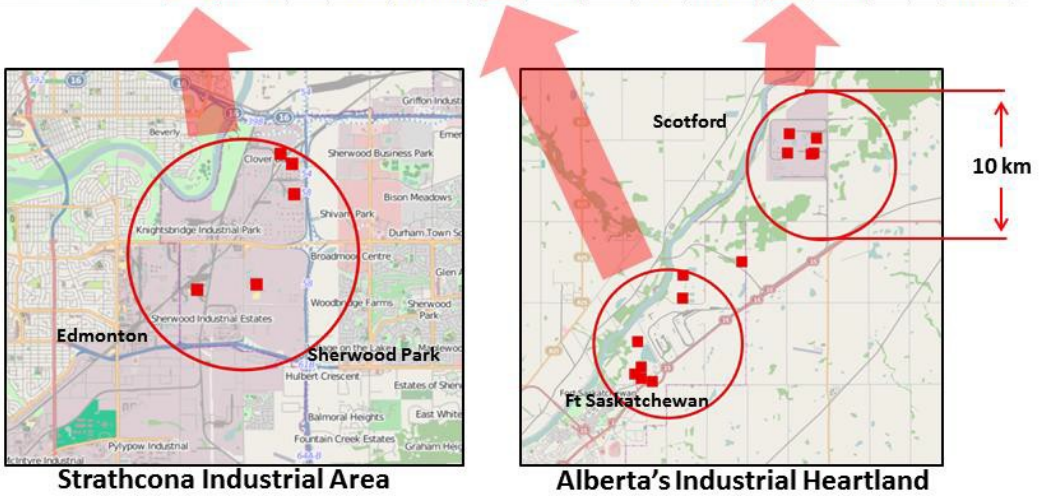

Figure 1: Aggregate summary of the amount of potentially recoverable waste heat from exhaust stacks and coolers and compressors across the heat islands identified in the two industrial areas. Energy sources which had high levels of pollutants or other associated risks are NOT included in this summary. The diameter of each red circle is 10 km.

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.
- 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 of new industrial sites locating in the region.

- Heating of intermediate product tanks by using waste heat from primary operations.
- 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 neighboring communities are presently challenging given the large distances between the heat sources and neighboring municipal development; and given that some of the surrounding municipal development is low-density, single-family houses. Further collaboration with municipalities neighboring these industrial areas is needed to drive future development with the characteristics needed to take advantage of the identified energy resource.

The knowledge generated by this regional industrial energy mapping study suggests a number of key recommendations which are critical to enabling the next phase of work which would focus on implementation to achieve meaningful results.

- Third-party led engagement of industry and government is needed if implementable solutions are to be realized. Sites with significant amounts of waste heat need to be engaged to determine their interest level and ability to explore the variety of use options identified for this resource, and similarly sites which could use this heat need to be identified and engaged. Provincial and municipal levels of government are also key, given their ability to create regulatory or other types of incentives. Such engagement is critical, given the many significant social barriers which must be overcome for waste heat in this region to be repurposed.

- Create a business case for developing regional utilities (regarding steam and water) which would enable existing and future companies to simply tap into this utility, thereby reducing capital expenditures and the number of processes companies need to operate on their site.

- Explore the impact of various incentives for achieving energy efficiency improvements and GHG
- reductions.

- Work with government, and existing industry and community organizations to create a dedicated program focused on dealing with the social and technical innovation barriers facing these industrial areas. Possible Program focus areas could include: finding ways to break
- down the information barriers between companies, removing the risks associated with trying to achieving greater symbiosis across companies, reducing the risks of implementing new technologies on industrial sites, strategically identifying the best ways improve efficiencies and improve overall competitiveness of the region; or scoping out how these areas could be strategically positioned to attract other industries and increase industrial diversity.

- Explore the potential for viable district heating options in Strathcona (which sits between
- Sherwood Park and Edmonton) or in the Heartland near Ft Saskatchewan.

- Publicize the results of the study across industrial, commercial, manufacturing and government sectors
- Scale the work to other industrial areas in Alberta and the rest of Canada.

In conclusion, the results of the Community Integrated Energy Mapping Feasibility study indicate a positive value proposition for further industry and government engagement in implementation actions that reduce GHG emissions, improve competiveness, enhance efficiency and contribute to economic diversification.

For information regarding this report, implementation efforts in Alberta's Industrial Heartland or to explore regional waste energy mapping in your area, please contact CMC Research Institutes (www.cmcghg.com) or call 403-210-7104.