SURPLUS HEAT OPPORTUNITY IDENTIFICATION STUDY

FINAL REPORT

PREPARED FOR

REGIONAL ECONOMIC DEVELOPMENT INITIATIVE

ASSOCIATION FOR NORTHWEST ALBERTA

HIGH LEVEL, ALBERTA

PREPARED BY

SERECON MANAGEMENT CONSULTING INC., EDMONTON, ALBERTA

AND

MALLOT CREEK STRATEGIES INC., FERGUS, ONTARIO

MARCH, 2008

March 27, 2008

Mr. Michael Cheeks
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High Level, Alberta
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Dear Mr. Cheeks:

RE: SURPLUS HEAT OPPORTUNITY IDENTIFICATION STUDY – FINAL REPORT

Please find attached our final report.

We have enjoyed doing this most interesting study. If you have any further questions, please call.

Yours truly,
SERECON MANAGEMENT CONSULTING INC.

Ralph Ashmead

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Enclosure

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REPORT OUTLINE

This is a draft final report with respect to the Surplus Heat Opportunity Identification Study.

This report provides a summary of the research, consultations and analysis, options assessment, an estimate of excess heat/energy supply, and a implementation strategy.

The report is organized in the following major sections.

Supply Analysis: An analysis has been completed of the potential different sources of surplus heat available in the Mackenzie MD region. This phase involved consultations with stakeholders, as well as secondary research within the region. An estimate of the amount of surplus heat and energy by sector is quantified.

Technology Alternatives and External Examples: This analysis, based primarily on secondary research, examines examples and technologies that exist in both Canada and internationally, and possibilities to use different amounts of waste heat that may be available in the region.

Potential Surplus Heat Uses and Opportunities: From the supply analysis and the research on other heat use examples and technologies, a short list of possible applications and uses was developed.

Options and Implementation Strategy: The last part of this study identifies some possible options and alternatives, builds on one that is considered most feasible, and outlines an implementation strategy.

SUPPLY ANALYSIS

Serecon has undertaken selected consultations with natural gas and forestry product companies in the REDI region, as well as one company based in Calgary (EnCana). In addition, secondary research was conducted on the region to support the analysis. Based on these consultations and research, the following observations have been made.

FORESTRY

There is an abundant source of surplus biomass from the forestry products industry in the REDI region. Only recently have companies begun to look at more creative ways to use their waste materials, either within their existing operations, or to sell the materials off as a revenue source.

Much of the biomass that is currently produced is transformed into hog fuel and transported to Daishowa-Marubeni International Ltd. (DMI) north of Peace River for use as an energy/heat source. DMI has a major energy requirement for heat in its pulp manufacturing operations.

Tolko Industries has indicated that the company does produce surplus heat at their facilities near High Level by burning surplus biomass. They have for some time, been looking to apply better technologies and systems to capture the heat, and to use it within their facilities, particularly with respect to drying their lumber products. They are currently investigating replacing their infrastructure and using their remaining surplus heat internally.

The sawmills that currently ship the biomass south were generally satisfied with this arrangement, and had no intentions of changing their practices or transforming the biomass to energy on site.

The forestry products industry is in a poor financial position at present, and the short term supply of either the biomass or surplus heat is not guaranteed.

Forestry Findings

- While there is a great deal of biomass produced in the REDI region that could be transformed into energy, either for heat or other uses, much of the biomass is currently transported out of the region.
- The energy production from wood waste depends on its moisture content. Newly harvested forest has a moisture content of 40-50%, with the resulting energy potential of 5,500 BTU's per pound. Dry wood waste material (moisture content of 5-10%) can produce 7,500 BTU's per pound. On a per tonne basis, the wet and dry material can produce heat energy of between 12 and 16 million BTU's per tonne respectively.
- A plant such as Tolko is estimated to produce 50 to 75 tonnes per day of waste materials. For 50 tonnes, assuming a relatively high moisture content, this represents 600 million BTU's of heat. A BTU is the amount of heat required to raise the temperature of a pound of water by one degree F. Therefore, the BTU required to heat a tonne of water from

freezing to boiling, involves increasing the temperature by 180°F, for 2,200 pounds, or about 400,000 BTU's. Using 50 tonnes of waste could then heat 30 tonnes of water from freezing to boiling per day.

- Measuring the surplus heat that is created trough existing facilities like Tolko would be required. This is done in a later section of this report.

OIL AND GAS

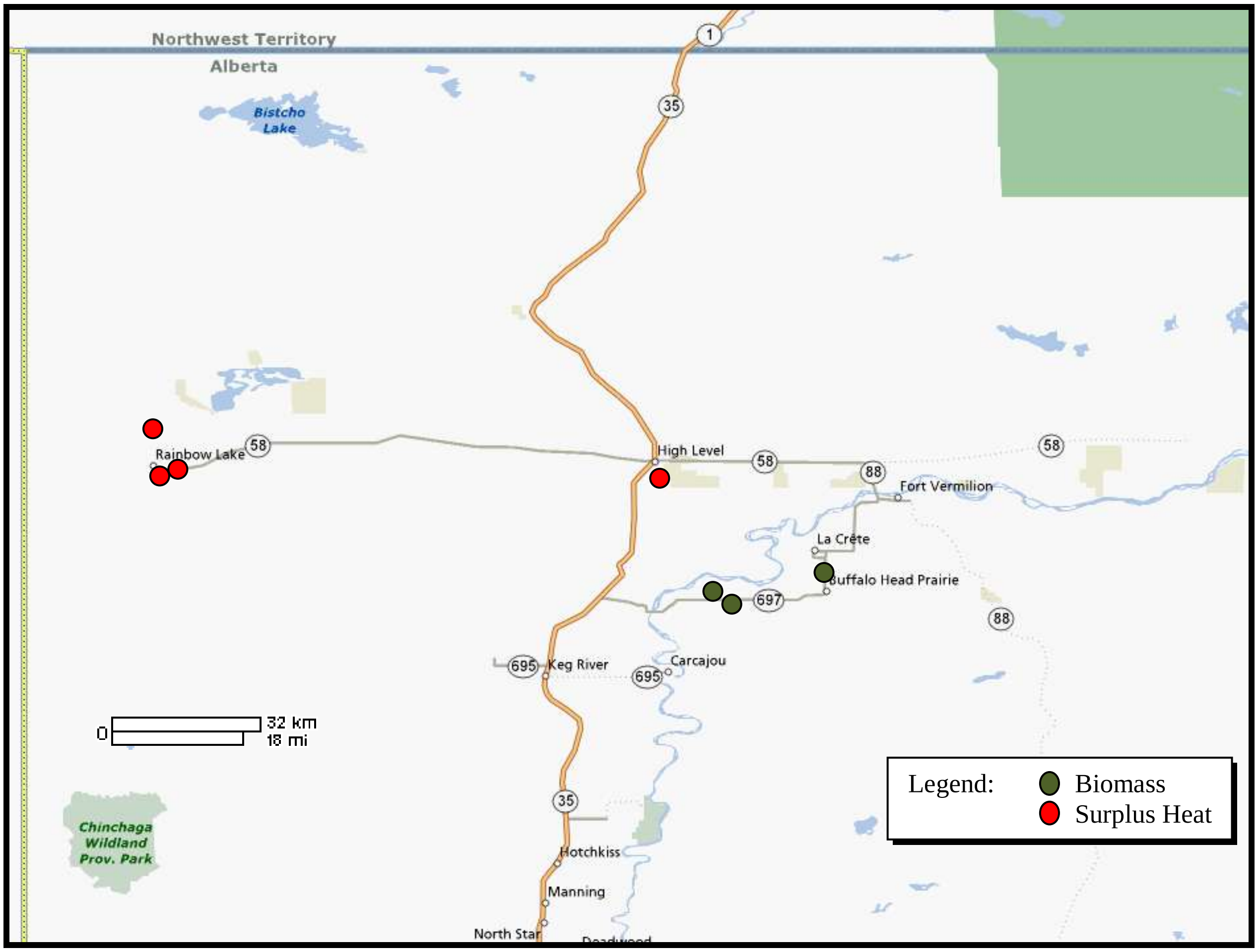
- In general, surplus heat is generated from three different sources in the oil and gas industry:
  - From boilers used in oil extraction, where steam is used to extract and separate heavy oil/bitumen.
  - From compressors used in gas production in order to move the gas through pipelines.
  - In sour gas processing plants where processing must be undertaken to remove primarily hydrogen sulfide from the gas.
- For natural gas, it appears as though small facilities only produce a minimal amount of surplus heat:
  - Some small facilities do not feel it is economical to capture this surplus.
  - Most facilities have not measured the volume of heat produced.
  - Some facilities indicate the surplus heat is captured, but that it is used within their internal facilities to heat buildings and reduce energy costs.
- It was indicated that larger oil and gas facilities do recapture their surplus heat, turn it into electricity, and sell it into the grid (Cold Lake example):
  - However, this is expensive and the plant has to have some minimum capacity. Husky may represent the only opportunity of scale in the REDI region.
- None of the interviewees knew the amount of surplus heat their facilities generated:
  - The quantification of this heat should be a priority in further evaluating the potential for surplus heat in the REDI region. This is done in a later section of this report.
- The other possibly significant source of waste heat is from the sour gas plants. In the process of removing H_2S gas and other GHG's, considerable pressures are required, and waste heat generated. EnCana has indicated that the temperature on their existing flue stacks is 700°C. This is currently vented into the atmosphere. They have been looking at ways to use this waste heat. CanMet is reported to have some scientists looking at ways in which the heat from these stacks could be captured and brought back to the ground, and then reused. This energy company has been given some consideration to the creation of greenhouses near their plants in order to use some of this heat. There are a number of sour gas processing plants in the region, particularly in Rainbow Lake.

Oil and Gas Findings

- Measurements of surplus heat are a limiting factor to understanding the potential.
- Much of the industry is interested in making use of surplus heat, in an effort to reduce costs and improve efficiencies.

A map of the surplus heat and biomass residual available for surplus heat is being developed. While what is shown is incomplete, the attempt has been made to try to identify the location of potential surplus heat and biomass that could be transformed to heat.

Figure 1: Draft Overview of Surplus Heat and Biomass Supplies



AGRICULTURAL INDUSTRY

The potential sources of waste heat in this industry could come directly from food processing companies, and indirectly from the supply of biomass that the industry may generate, both within the livestock industry and from waste agricultural straws and grasses.

There are no food processing establishments in the region that have any significant amount of possible waste heat, or which would be a user of waste heat.

On the agricultural side, there are some potential sources of heat, based on the amount of waste materials they can generate.

In Census Division 17, comprised of the MD of Mackenzie, Northern Lights, Clear Hills, Lesser Slave Lake, Big Lakes and Northern Sunrise, there are some 74,000 head of breeding cattle (2006 Census of Agriculture) and about 1,200 sows.

A beef feeder will produce about 1.55 tonnes (dry matter basis) of manure per year. A 10,000 head feedlot would therefore generate about 15,500 tonnes of biomass per year. One tonne of biomass will produce 125 cubic meters of biogas, of which about 60% is methane gas. This gas can be used for cogeneration of electricity and heat.

The amount of agricultural straws that may be available biomass for energy production is more difficult to estimate. Much of the straw on the land needs to be retained to build up soil organic matter. There is however, a reasonable amount, but this would require more extensive analysis. This analysis is done later in this report.

TECHNOLOGY ALTERNATIVES AND EXTERNAL EXAMPLES

EXTERNAL EXAMPLES

An extensive analysis has been done to identify examples where surplus heat is being found and used. This evaluation has included as well, an identification of the technologies that are, or can, be used. A summary of these findings is shown in the table below. This is not an exhaustive list, but does give a fairly broad picture of the possibilities.

Figure 2: Summary of Surplus Heat Sources and Applications

Waste Heat Source	Technology or System Description	Evaluation of Potential and Applications
Biomass Gasification Systems	Biomass, such as wood waste (but also could be other agricultural and other organic wastes), is gasified. Gasification is a thermo-chemical process that uses heat to convert any carbon containing fuel into a clean-burning gas, called “syngas”. This is a oxygen starved process that provides enough heat to pyrolyze and chemically break down the material into a clean gas, that can be used much like natural gas. The syngas is then burned in a boiler. The hot water from this is then transported by pipe to provide heat and water to end users.	Example may be in industrial or residential buildings, where municipal waste, or wood wastes are gasified and heat and water supplied to the community. Dockside Green (BC), supported by Natural Resources Canada is one of the first. Installation costs est of $6-8 million, handles 3000 tonnes of wood waste, reduces CO_2 emissions, etc.
Biodigestor	Waste organic materials (not wood wastes) are digested through anaerobic digestion, to produce methane gas, and some limited amount of heat. The methane gas is then used to fire a turbine, which then generates both electricity and excess heat. The electricity can be used locally, or sold onto the Alberta grid system. The heat can be used as well in a adjoining industrial or residential facility. Another by product is organic fertilizer. The Kompogas system – one tonne of biomass converts to 120 cubic meters of biogas (50-60% methane) which equates to 70 litres of gasoline. The gas can be processed in a standard gas engine. The gas can also be upgraded and made available into a gas pipeline network either as compressed natural gas or methane gas – produces both compost and liquid fertilizer.	Is one of the more simpler systems, but many systems are not that efficient. Advanced system are the Compgas system (Europe) which converts organic waste to biogas and compost.
Wood Waste (e.g. Tolko plant)	Wood waste burned directly, or in palletized form, to produce heat directly to heat space, or used to heat water in a boiler, resulting in heated water that can be used in manufacturing, or as a source of heat. In the case of Tolko, the heat could be used to dry their processed lumber.	Palletized wood stoves are becoming in more demand, particularly in the US. Some Canadian companies are both making the stoves and supplying the wood pellets. Wood pellets are currently being exported to the EU, where there is a stronger demand and high price ($200 plus per tonne).

Waste Heat Source	Technology or System Description	Evaluation of Potential and Applications
Geothermal Heat	Based on pumping the heat from below the surface of the ground which is typically over 8°C. A heat pump concentrates the earth's thermal energy and transfers it to the air circulated within a building, etc. Generally high initial costs of installation, but low ongoing costs. These can be combined with solar heat, to drive the heat pumps.	Applications include residential properties, and industrial locations.
Super-Efficient Water Electrolysis	Water is super heated, by an electrolysis process, and the hydrogen is separated from the oxygen, and thermal energy is released.	Indications there is a project underway in Saskatchewan, may be of value to investigate further.
Biomass CHC Systems	Combined Heat and Power (CHP) systems that take different types of biomass, and can generate both heat and power. There are a number of systems that a developing and some that are commercial. The biomass can be wood, agricultural or municipal waste. The biomass is burned, or gasified, to fire a turbine, which generates both electricity and heat. These two sources of energy are either sold or used in a home, industrial park, or municipal structure.	Has potential in the High Level area, for example the installation of such a system adjacent to High Level, and using municipal wastes.
Sugar Manufacturing Plant	Successful integrated group of farmers and industry partnered to take the hot water from a sugar manufacturing plant, pumped it to a industrial park for use as energy source, and for the production of farm fish (Tilapia). The company MinAqua is now the largest indoor fish farm in the US– Tilapia need very warm water to grow and are fed soybean pellets, also have established greenhouses in the industry park.	Could be application in High level area for aquaculture using hot water, thermal energy generated from biomass, and for greenhouse production
Hydrogen Production	Taking of the waste heat from any industrial facility, and using biomass, under the right conditions, biological organisms (methanogens) can produce hydrogen. The key is to being able to have a controlled environment where there is little or no methane being produced from the biomass, as this will kill the methanogens. Waste materials could be organic materials from a food processing facility, sewage, and manure.	Hydrogen is one of the cleanest energy sources, not GHG emissions. Uses of hydrogen are as an alternative fuel, in production of hydrochloric acid, fuel cells, welding industry, etc.
Wood Chips	Small scale combined heat and power system (CHP) are now on the market – one system (Biomax 15) takes wood chips, which are first dried, then gasified in an starved-oxygen condition, which produces a syngas, and other by-products to generate power and heat	Growing industry developing of CHP system for home and industrial uses, based on biomass raw materials.
Blue Mountain Lumber Energy Facility	This sawmill expanded and wanted to produce its own energy. It needed heat and energy to dry timber, heat buildings, and to preheat resins. The system takes all the wood waste including green saw dust, dry shavings, dry sawdust, off-cuts, bark and chips. The system is comprised of a steam boiler fueled by the sawmill residues, a 1.4 MW steam turbine generator which generates the electricity.	A possible application of a proven system to the Tolko plant.
Highland Feeders Feedlot and Biodigester	Pilot project but now becoming commercial. Developed by ARC and Highland feeders. Manure from 7500 animals now produces 1 MW of electricity using the Integrated Manure Utilization System (IMUS). This system produces electricity, bio-fertilizers, reusable water. Plans are now underway for the establishment of a ethanol plant to be integrated with it.	A useful model for consideration

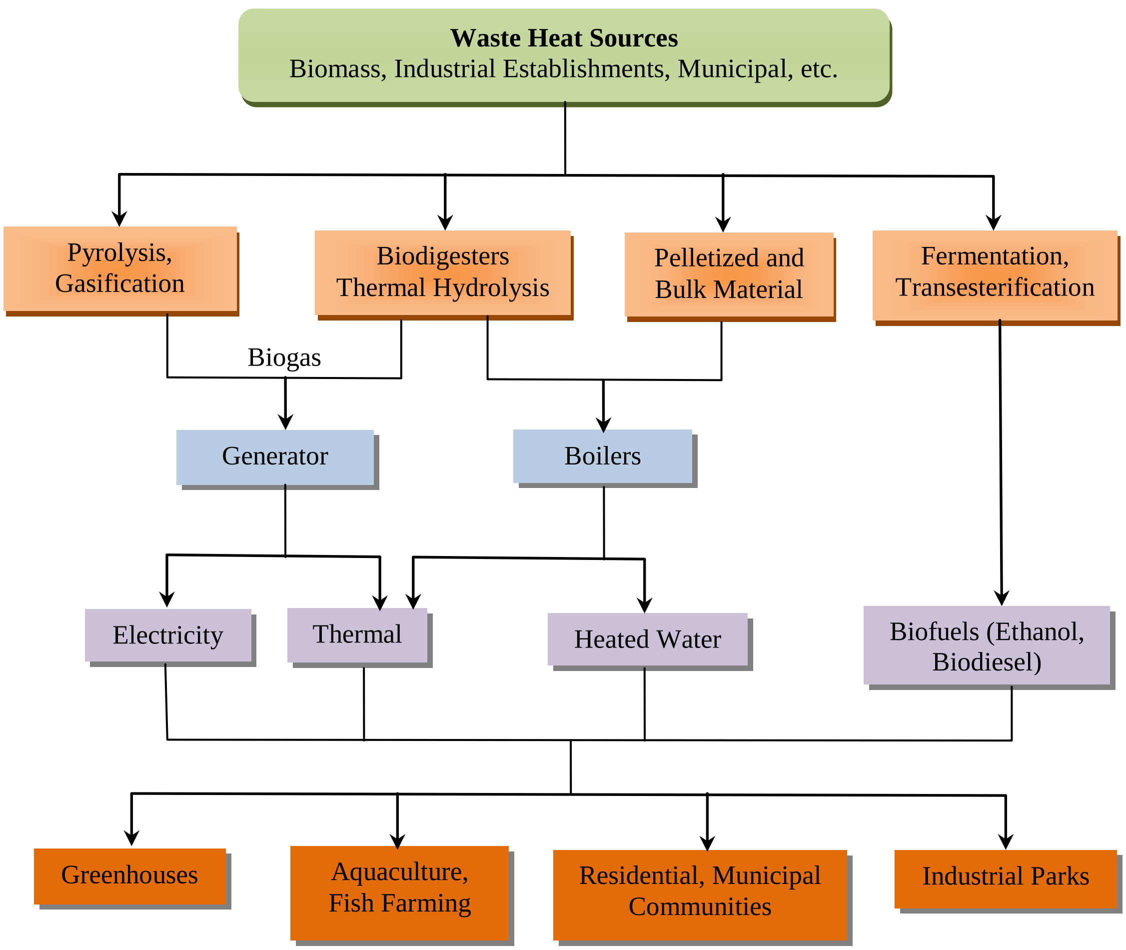
INTEGRATION

It is useful to try and integrate ways in which the potential types of waste heat can be transformed through the use of different technologies, and how this can lead to the production of different forms of heat and energy, and the possible applications of these.

Figure 3 provides one simplified overview of this integration. The important aspect of this is the applications that are possible. A number of the major categories are illustrated in this diagram.

Solar and wind power systems have not been included in this diagram.

Figure 3: Integration of Surplus Heat Supply, Technologies and Applications



SURPLUS HEAT SUPPLY ANALYSIS

Further research has been done to get an overall view of the potential surplus heat that may be available in the northwest region of Alberta from all the natural resource sectors. The waste heat that may be available is looked at from the perspective of the forestry industry, oil and gas, agriculture and the amount that would be available from municipal waste streams.

The results of this analysis are shown in the two figures below. Figure 4 provides an estimate of the amount of waste materials (in either tonnes of biomass or cubic meters of oil and gas) that may be available. Figure 5 provides an estimate of the amount of heat or energy that these raw materials could be converted into, on a theoretical basis.

In summary, the forestry industry has the most significant supply of materials that could be used in one way or another, to produce energy and heat. There is an estimated 6.8 billion BTU of energy that is not utilized in this sector. If this energy could be converted to electrical energy and sold into the grid, this would represent a sales value of $278 annually. The second most available energy source is within the oil and gas industry. It is estimated that up to $35 million is not being collected and reused in the industry on an annualized basis.

The agricultural industry also represents a possible energy source. There is both raw materials such as straw and animal wastes (manure) that could be captured and used. The annualized value of the two major agricultural wastes is estimated at $30 million.

The other area that has been considered is with respect to municipal wastes, both solid wastes and municipal sludge materials. High Level is the largest town in the area, and a detailed assessment was done, with the help of the town official who operates these municipal operations. On the solid waste side, only a very small proportion of the wastes are organic and could be a reliable source of materials – about 4%. The rest is industrial wastes such as rocks, cement, some waste construction materials, glass and plastic. On the municipal sludge side, about 2% is solids that could be used. While these could be separated out, the problems of water separation, and then disposal of the water becomes a major environmental and cost problem. Consequently, there does not seem to be a useful supply of municipal wastes that is a practical surplus heat source.

What is not considered in this analysis is the concept of “energy crops”. There is the potential to take certain lands, usually more marginal lands, and grow specific crops or trees for the purpose of energy versus food production. Examples of this include hybrid popular trees, switch grass, hemp, and other similar crops.

Other typical sources of material from which surplus heat can be generated is from food processing industrial establishments. There currently are no major establishments in the area. If the NWAAVC project goes ahead, this facility will have the potential to produce certain materials that could be used to generate surplus heat. This could include the excess distillers grains, other heat being generated from the fermentation process, and waste materials from the feedlot.

These numbers and values should be interpreted with care. A very major issue with respect to the collection and use of possible waste heat is the ability to collect it at source, the cost of purchasing it, transporting it, and in converting it into a usable form of energy and/or heat.

Figure 4: Description and Estimate of Available Materials for Potential Waste Heat Production

Industry Sector	Resource Description	Available Material
Forestry	From saw mills – bark, sawdust, shavings, yard waste From Kraft Pulp mills – yard and other wastes From CTMP pulp mills – yard waste, sludge. From OSB mills – bark, shavings, sawdust, trim blocks, yard waste Residual waste left in the forest	Total wood waster quantity produced per year summary of all plants: approx 2.5 million tonnes[1] Of this, 1.6 million tonnes or about 65% is utilized, leaving about 940,000 tonnes per year excess. This is for all of the Northern Alberta region. The northwest region would represent about 60% of this, or 564,000 tonnes This does not include the wood waste left in the forest during harvest.
Oil and Gas	Heat is generated in three ways: 1) From boilers used in oil extraction, where steam is used to extract and separate heavy oil/bitumen. 2) from compressors used in gas production in order to move the gas through pipelines, and 3) In sour gas processing plants where processing must be undertaken to remove primarily hydrogen sulfide from the gas.	No direct measurement of excess heat is made. Estimates can be made by proxy based on amount of oil and gas production. Total northern region natural gas production averaging 55 million cubic meters, oil 30 million cubic meters, and in making of condensates of 145,000 cubic meters per year.[2] Sour gas sulphur extraction will generate the most energy. The estimated waste gas and oil, is estimated at 10%. This would result in the total supply of excess gas in the range of 8.5 million cubic meters. Much of it cannot be captured, and some is already being used for co-generation. An estimate of 10%, or 25.5 billion would likely be available to be captured and used
Agriculture - Straw	Agricultural land can generate excess straw and grasses. This region of Alberta does not typically have a lot of excess straw, due to need to put back in the soil. **There are about 1.3 million crop acres in Census Division #17.**	**The average** total amount of straw that is generated, across a mix of crops, is about .7 tonnes per year per acre, depending on many conditions. However, of this, most is used for soil improvement and a bit in the livestock industry. It is estimated that about 5% of the total straw produced could be available as surplus biomass, and used in some form of energy/heat production. The total straw produced then is 1 million tones, of which 45,000 tonnes would be excess

[1] Northern Alberta Development Council, Forestry in the Northern Alberta Development Council Region, Economic Profile, 2004.
[2] Ibid, Oil and Gas industry Profile , 2004.

Industry Sector	Resource Description	Available Material
Agriculture – animal waste	The number of livestock in Census Division #17 is about 74,000 head of breeding cattle, and 1200 sows There are few confinement feeding operations which typically can be a location for the collection of manure	The effective number of cattle and hogs from which manure could be collected is 7,000 and 3,000 head respectively. A beef animal generates 4.8 tonnes of manure per year, and a hog 1.6 tonnes per year. The total biomass would be about 39,000 tonnes, and of this about 70% would be collectable,
Municipal Waste	The town of High **L**evel has both **s**olid waste and municipal sludge. Of the 17,000 of solid waste, only 700 tonnes is organic. Of the sludge, only 2% is solid wastes that could be used as a biomass energy source. Sludge is mostly water, and this becomes a major disposal problem. Due to the composition of the sludge, even separating the water out is difficult	There is no effective supply of bioma**s**s **in towns like High Level, or** La Crete, that could be used to generate heat and or energy.

Figure 5: Estimate of Excess Heat and Energy Value in Northwest Alberta

Sector/Material	Quantities	Btu/unit	Total BTU(m)	Kwh Equivalent (m)	Value (m)
Forestry (tonnes)	564,000	12,000,000	6,768,000	1,983	$278
Gas and oil(cubic meters)	8,500,000	100,000	850,000	249	35
Straw(tonnes)	45,000	8,800,000	396,000	116	16
Manure(tonnes)	27,000	12,000,000	324,000	95	13.3
Municipal waste	-		-	-	-
Totals	**9,136,000**		**8,338,000**	**2,443**	**$ 342**

Conversion Factors

Cubic feet per cu meter	35.70
BTU per cubic foot gas	100,000
BTU per Kilowatt hour	3,413
Btu per tone of wood	12,000,000
Btu per tonne manure	12,000,000
Btu per tonne straw	8,800,000
Value Kwh	$0.14

POTENTIAL SURPLUS HEAT USES AND APPLICATIONS

Building on the previous sections, there are a number of possible applications that are listed for review at this time. These are not qualified as to potential or feasibility. These are considered to help provide options for consideration, and for the possible development of an industry strategy. This is further discussed in the next section.

Possible Opportunity/Application	Comments
Application with major energy company for use in heavy oil separation, gas transport, sour gas plants	➡ High business development cost ➡ Need proven technology ➡ Need to identify technology partner ➡ May be difficulty in establishing need ➡ Application may be in sour gas plant and greenhouse use
Wood waste, combined heat and power (CHP) application	➡ Some potential ➡ Wood industry not in strong position ➡ Proximity of Tolko an advantage ➡ Have already been considering this option
Municipal CHP application	➡ Using available organic wastes, sludge ➡ Partnership with local government for pilot ➡ Need to identify appropriate technologies ➡ Heating and possible power supply to limited number of establishment ➡ Showcase project
High Level Industrial Park Concept	➡ Identify reliable supply of biomass as heat source ➡ Establishment of an industry park ➡ Attract interest, based on the supply of electricity and heat from CHP system
Aquaculture, fish farming project	➡ Possibly Tilapia fish production ➡ Identify heat source ➡ Market assessment ➡ Further processing of fish
Greenhouse project	➡ Establish first year round greenhouse ➡ Supply from biomass, the organic fertilizer, heat, power, light and CO_2 required ➡ Focus on specialty products
Pyrolysis biorefinery	➡ **Pyrolysis** produces biogas, bio oil and charcoal ➡ Four main companies in Canada in this now – Organi**c Power technologies (Victoria)**, Dynamotive – Vancouver, Ensign Group, and Nexterra Energy ➡ Feedstocks include wood and other biomass ➡ Outputs are gas for electricity or heat, bio-oil for bio-chemicals or fuel, and charcoal for energy and other uses.

STRATEGY DEVELOPMENT

This section focuses on the outline of a strategy by which the Surplus Heat Steering Committee could choose to move ahead.

The development of a strategy involves the following steps.

1. what are the major options for moving ahead,
2. for at least the more practical or possible options, what would be the requirements for heat supply, heat use perspective, and what are the technology implications, investment requirements, and costs, and
3. based on what is considered the most practical and viable, outline what steps would need to be taken to move ahead.

These steps are laid out below.

As these steps are being considered, the decision criteria that must be kept in mind is that there must be a sustainable supply of inexpensive feedstocks, in order for any process or option to be viable.

OPTIONS

In the previous major section, a number of possible options were identified. The options that are possibilities from the perspective of this analysis are:

1. **Working with Forestry Company** – one alternative is to work with a company like Tolko to better utilize their waste wood materials, both within the plant operations, or/and to attach a value added use for the excess energy/heat that would be generated. This may involve a greenhouse or like application. This option has some potential. However, it is not known what contribution REDI could make, that Tolko would now already have the capability of realizing themselves, if they chose to go this direction.
2. **Partnering with an Energy Company** – EnCana in one energy company who has a specific interest in utilizing the waste heat they are losing from the gas plants. One anticipated problem is that it is likely they do not have a gas plant in Northwestern Alberta, although they have plants in Northeastern BC and other places. They have been considering this for some time.
3. **Municipal/Industrial Application in High Level** - there could be a possibility to provide heat and power into a targeted municipal application in High Level, or some other town in the area. This target may be certain schools, hospitals, or other building sites. The challenge would be to ensure there is an inexpensive supply of feedstocks. The potential of using municipal solid wastes and/or sludge materials was considered. There does not however, appear to

be sufficient supplies of such raw materials to sustain a reliable supply of heat and power.

4. **Specific Industrial/Agricultural Combined Heat and Power Application**. Such an application would be based on gasification technology, which would create biogas from waste (technologies include gasification and digestion), and taking the biogas (methane) to cogenerate electricity and heat. The application could be a greenhouse, aquaculture enterprise or fish farm. Has some potential, although the technology would limit the major outputs to biogas and then energy.
5. **Integrated Waste Pyrolysis Biorefinery** - an integrated combined set of waste raw material would be used, a pyrolysis technology applied to produce bio-oil, biogas and charcoal. These three materials would be further manufactured and used to produce biochemicals, biodiesel, and cogenerated into heat and energy for further use.
6. **Combined #4 and #5 Above** - based on a pyrolysis technology, integrated types of feedstocks could be processed, and within the concept of a biorefinery, intermediate products such as bio-oil, gas, charcoal produced, and final products such as heat for a industrial application, greenhouse, biochemicals, etc produced.
7. **REDI Undertakes to Facilitate Energy Market Access** – one other option or role that REDI could undertake, is not to advance any specific project option or idea, but undertake to ensure that the electrical energy market into the Alberta grid would be stable and sustainable for any supplier. In the course of the interviews and consultations, the issue of security with respect to companies making investments for the cogeneration of waste heat into electrical energy, and then finding that the market shifts to other southern suppliers, is a risk.

OPTION DESCRIPTION AND ELABORATION

Without wanting to prejudge what the Steering Committee may recommend, a more detailed description of the requirements and implementation issues have been developed for Options 5 and 6 above, assumed they are combined.

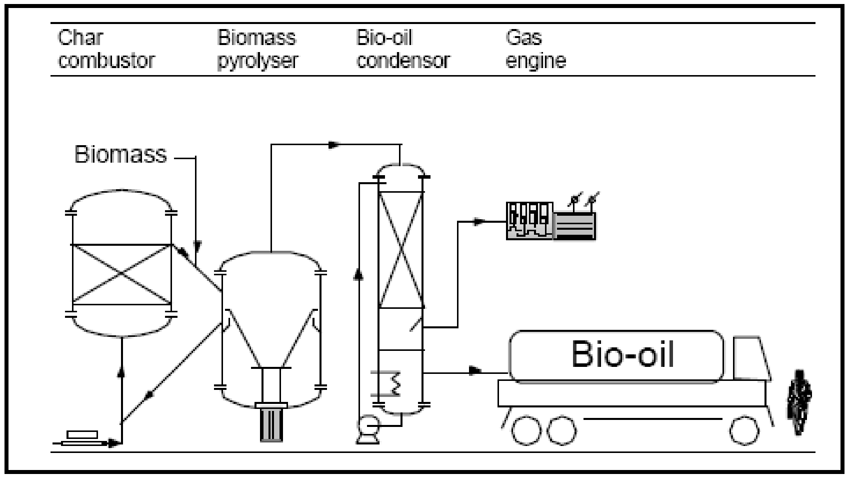
Feedstock supply: If a pyrolysis technology is used, the flexibility for feedstock supply is enhanced. The ideal business model would be where there is one major source of biomass supply, likely forestry waste, and in addition, other biomass such as agricultural wastes, some industrial wastes. The supply requirements of a semi-commercial pilot plant would be 200 tonnes per day, and with the vision to expand to 400 tonnes per day over time.

Technology: It is suggested that a pyrolysis technology be applied. There are a number of possibilities in Canada which include the following. Their name and what they produce is indicated.

- OPT Organic Power Technology Ltd. (fast carbonization, makes gas, oil and charcoal)

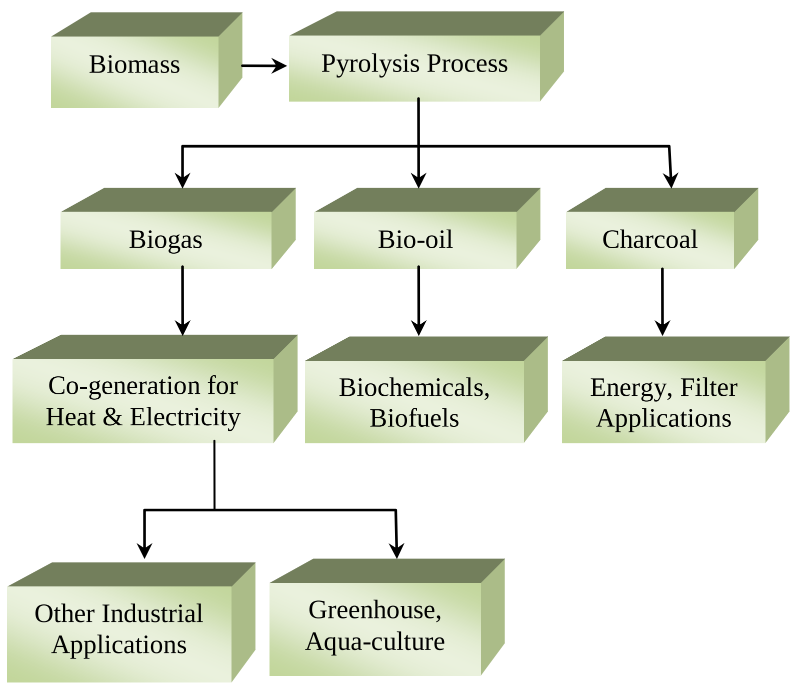
- Dynamotive Energy Systems (fast pyrolysis, makes mostly oil)
- Ensyn Group Ltd. (fast pyrolysis, makes oil, different production system)
- Nexterra Energy Corp (gasification systems, makes entirely gas.)

Process description: Pyrolysis is a process, where biomass is decomposed into bio-oil, gas, and charcoal. A diagram of the process is outlined below.



Outline of Biorefinery Economic Value Chain

The possible value chain by which this option could be realized is illustrated below.



Costs and Investment Issues

As indicated above, the basis of any waste to heat/energy project is that of raw material costs. If the full delivered costs of the raw materials exceed in the range of $90 or $100 per tonne, many or most technologies and systems will likely not be economic. This is considering the fact that Alberta does offer a 6 cent producer energy credit per Kwh.

A full commercial scale plant, whether it is a pyrolysis, or gasification system, will be fully installed in the range of $25 to $30 million. A non-economic beta scale pilot would likely be a fraction of this cost, but still a few million.

Provincial and Federal Support Programs

There are a number of programs that may be accessed to potentially move ahead this initiative, if so desired by the Steering Committee. Some of these options are laid out below. It is known that this list is not complete, but does identify some options.

Provincial and Federal Ministries and Programs (Draft and Incomplete)

Energy	Agriculture and Food	Sustainable Development	Employment, Immigration and Industry	Advanced Education & Technology	Federal Government
➨ Biorefinery commercialization and market **commercialization** ➨ **Bioenergy and infrastructure** program	➨ AFSC ➨ Agronomic crop research ➨ Industrial bioproducts	➨ **Infrastructure** support ➨ Forestry ➨ Sustainable resource development	➨ Training progra**ms** ➨ Rural Development Fund	➨ AARI ➨ Innovation and Science ➨ Bioproducts ➨ Alberta forestry Research Institute	➨ **Agricultural** bioproducts programs. ➨ Agri-opportunity program ➨ SREDs ➨ IRAP ➨ Western Economic Diversification

IMPLEMENTATION STEPS

If a decision is made by the Steering Committee to move further on this initiative, there are some recommended steps in doing so. It is assumed in the steps below that the approach would be to undertake a pilot demonstration project in the High Level area.

1. **Securing of funding for technology and project feasibility assessment**. This next step lays out both a technology assessment and a project feasibility stage. Funds will be required to do this. The suggested best provider would be the Biorefinery commercialization and market commercialization program of Alberta Energy. Western Economic Diversification is another possibility.
2. **Technology assessment and evaluation**. This would involve using appropriate technical expertise, of a review of the main gasification, pyrolysis, and digestion technologies, that are available. This study has identified some of the main ones but there are more. This would

be done in three ways – a secondary research review, limited consultations with industry experts, and then direct contact with the limited two or three possible technology providers.

3. **Project feasibility study** – based on the selected option, a pre-feasibility assessment would be done to detail what a specific project would involve and require. This would first better define the scope of the pilot project. Then based on the project design, would identify the markets for the end products, a first order magnitude of investment and operating costs, and a measure of the possible economic and financial feasibility. This study would as well propose possible locations for the plant, estimate feedstock supply availability, and feedstock costs.

APPENDIX A: COMPANIES CONTACTED

APPENDIX B: CONSULTATION QUESTIONS

Appendix A: Companies Contacted

Forestry

- Tolko Industries, Marcel Lecoure
- Pineridge logging Ltd, Paul Dreidger
- Ridgeview Mills; George Darren
- La Crete Sawmills; John Unger
- Precision Lumber Products

Oil and Gas

- Imperial Oil, Ron Hiemstra
- Apache; Wally Samson
- Provident Energy: Sid
- Husky Energy; Ron Arnason
- EnCana, Lloyd
- Tony Barreira, Haliburton

Others

High Level Municipal Waste Management Authority
High Level Sewage waste authority
Alberta Energy – Mike McClesky – Bioenergy Biorefinery Industrial Program

APPENDIX B: CONSULTATION QUESTIONS

My name is ______________, of Serecon Management Consulting Inc. We are doing a project for the Regional Economic Development Initiative (REDI) for Northwest Alberta. REDI is attempting to review any sources of excess heat in the region. The purpose is to evaluate the opportunity for using surplus heat and generate extra economic revenue for the region. An example might be flared gas, or the burning/gasification of wood wastes.

We have number of questions we would like to ask if you have twenty minutes.

1. Does your company produce excess heat?
2. Do you produce waste materials that could be used to produce heat or energy?
3. Can you describe the process that produces the heat?
4. Would you know how much excess heat is produced per hour or year?
5. Have you tried to make use of the heat yourself?
6. How far are you located from a town, and what town is that?
7. What possibilities or technologies do you know of that could be research, or acquired, that would help to better utilize waste heat or materials to produce energy.