Rationale for initiating the revision of the existing Quantification Protocol:

Two changes are proposed:

1. The inclusion of energy recovery projects that convert waste pressure at pressure letdown sites into electricity.
2. The modification of the parameter "volume of fuel combusted" in SSR B4 Generation of Heat and Power (pg 22) to clarify the requirement to measure the heat output (rather than the volume of fossil fuels consumed) in order to quantify the baseline emissions from waste heat recovery projects that generate heat for use by other processes to reduce fossil fuel combustion.

The proposed inclusion of energy recovery from pressure letdown projects shares the same baseline and quantification methods as the original waste heat recovery protocol. The inclusion of pressure letdown projects would require only a simple modification to the flexibility mechanism that would not alter the intent of the protocol: quantifying energy recovery from processes where energy was previously wasted.

Secondly, in the quantification of SS B4 (pg 22) the parameter "volume of fuel combusted" was revised to improve the quantification approach by specifying that the project proponent calculate the baseline volume of fossil fuel based on the measured heat output from the waste heat recovery unit in the project condition. The measurement of the heat output is central to the accurate determination of the baseline emissions and this was not explicitly stated in the current version of the protocol. Modification of this parameter includes specific measurement guidance to improve the clarity of the protocol.

Part B: Description of Proposed Revision

This section should provide an overview of the proposed revision to existing Quantification Protocol including any changes to: project type, project-specific technology, quantification methodology and how the revision will continue to meet or exceed requirements of the Alberta Offset System.

B.1. Description of the Change to Project Type/Eligibility: (The **project type** is a set of project practices or technologies that represent the change from a normal business operation/practices or common industry practice.)

The waste heat recovery project type would be expanded to include energy recovery projects that use waste pressure to generate electricity. In the project condition, the wasted energy from liquid or gas pressure letdowns is converted into useful electricity, using a turbo-expander and generator. This technology enables the recovery of wasted energy and the generation of electricity with zero or very low emissions (some projects may require small amounts of supplemental fossil fuels). For projects that use waste pressure from gas streams, some heating or drying of the gas may be required to avoid condensation and freezing.

Instead of using a heat transfer process, as is used for waste heat recovery projects, a typical pressure letdown project uses the expansion of a gas in a turbo-expander to produce work that can be used to drive a generator. A typical situation where this project may be implemented is where pressure letdowns between natural gas transmission and distribution lines.

For projects that convert waste pressure from liquid letdowns, a hydraulic expander is used to produce work from the reduction in liquid pressure and coupled with a turbine to generate electricity. A suitable application of hydraulic expander technology could occur at sour gas processing plants where the pressurized rich-amine stream used in gas separation processes is normally letdown using a control valve, resulting in wasted energy.

No modification of the quantification section of the protocol is necessary to accommodate pressure letdown projects as the waste heat recovery protocol already requires measurement of supplemental fossil fuels (e.g. for drying a gas stream) under SSRs P5, P6, P7 and P11 and it already requires the measurement of electricity output from the energy recovery unit under SSR B11.

The second change to improve the clarity of the protocol under SS B4 around the issue of measurement and monitoring of heat output does not impact the waste heat recovery project type in any way as it simply improves the wording around the monitoring of heat output.

Description of how real reductions or removals will be achieved with this modification: (The Protocol Developer must ensure the GHG(s) that will be reduced by the activities for this project type are within the scope and criteria of the Alberta Offset System and the Specified Gas Emitters Regulation.)

Typically, gas pressure in piping systems is let down with a valve. This process wastes the pressure energy from the gas. In the project condition, the pressure is used to turn a turbine. This reduces the pressure of the gas while generating electricity. Some of the energy used to initially pressurize the gas is recovered in the form of electricity; indirect emission reductions are realized through the displacement of grid electricity or electricity generated on-site.

No changes in how reductions are achieved will occur because of the inclusion of monitoring and quantification methods for the volume of fuel combusted in SSR B4. Rather this change will increase clarity around expected measurement for the project proponent.

B.2. Demonstration of Additionality: (The Protocol Developer must demonstrate how real reductions or removals are beyond business as usual. Please provide a summary of how your protocol ensures additionality of offset projects. Also include a discussion of whether your project type additionality is impacted by input and/or activity mobility, and/or management decisions influenced by market or social forces.)

In the original waste heat recovery protocol, project proponents must demonstrate that prior to project initiation, the “waste” heat was truly wasted and not used to do useful work. Correspondingly, the proposed project type must demonstrate that the waste pressure was not used to do useful work in the pre-project condition. Additionality is only impacted by the pre-project condition of the pressure letdown system: as long as the gas pressure was reduced without re-capturing energy, the project condition is above and beyond business-as-usual activity since no prior waste pressure to energy projects have been implemented in Alberta before. Turbo-expanders and hydraulic expanders are relatively new technologies that have not been commercially implemented anywhere in Alberta. The first demonstration projects are expected to be implemented in

Currently, there are no pressure letdown electricity generation projects in Alberta. At least one project developer is planning several projects at gas processing and chemical production facilities. At present, it is common practice to letdown pressure with a valve. Only one demonstration project has been completed in Canada to date, which was implemented by Enbridge in Ontario[1] and involved coupling a natural gas fuel cell with a pressure letdown project to develop a hybrid power generation system.

The change to the monitoring of heat output under SS B4 does not affect additionality.

B.3. Description of Background Information/Best Practice Guidance Used for Modification:

1. Document Title	**2. Publishing Body/Date**	**3. Description**
Eg. Canada's National Inventory	*Government of Canada, 2006*	*Description of IPCC tier 2 and 3 applications for quantifying GHGs from sectors at a national level.*
ISO 14064-2	*International Organization for Standardization*	*Details the principles and requirements for determining project and baseline scenarios, as well as monitoring, quantifying, and reporting GHG emissions reductions at the project level.*
Turbo-expanders and Process Applications	*Butterworth-Heinemann*	*Explores turbo-expanders as a method of conserving operational costs and the environment.*
Fuel switch from fossil fuels to biomass residues in heat generation equipment (AM0036)	*Clean Development Mechanism*	*This quantification methodology is applicable to project activities that switch from use of fossil fuels to biomass residues in heat generation equipment. It specifically outlines a method to determine the volume of fuel combusted for a heat generation in the baseline which is replaced by an alternate source of energy in the project condition.*

B.4. Regulatory, Legal Requirements and/or Government Incentive/Grant Programs:

List of potentially relevant regulations/legal requirements:

N/A

List of potentially relevant climate change incentives:

Climate Change and Emissions Management Fund for energy efficiency projects

[1] http://www.enbridge.com/DeliveringEnergy/AlternativeTechnologies/FuelCell.aspx

B.5. Barriers to Implementation of Existing Protocol: (Review and discuss the barriers impeding the projects outlined in the protocol from being implemented)

As with energy recovery from pressure letdown projects, energy recovery from waste heat sources is not common practice. In addition, waste heat recovery is most economical in large applications where projects are likely regulated under the *Specified Gas Emitters Regulation*. Projects eligible for carbon offsets would face financial barriers due to their small size. Many waste heat to power generation projects do not generate returns on investments that would meet the requirements (hurdle rates) of most oil and gas producers and are thus only pursued at a demonstration level.

Many of the best waste heat recovery projects are limited by burdens associated with connecting to the electricity grid to distribute and sell power or by the uncertain price of power in Alberta's privatized power market. Other provinces, such as BC and Ontario offer streamlined approval processes and standard offer contracts for 20 years for small renewable power projects to eliminate such barriers, but Alberta does not offer any such programs for waste heat to power projects. Several waste heat to power generation projects have been developed along the Alliance pipeline in Saskatchewan because of longer term power off take contracts, while projects on the Alberta section of the pipeline have been stalled due to questionable economic returns from uncertain power prices. A similar situation exists in BC, where EnPower has developed two 5.2MW waste heat to power projects along the Spectra mainline. The majority of waste heat to power projects opportunities are smaller than those mentioned above and face greater barriers, some of which could be partially overcome through offset revenues.

For projects that recover waste heat for thermal energy distribution and use, the main barrier is low natural gas prices that discourage energy efficiency projects and reduce rates of return relative to other investment opportunities.

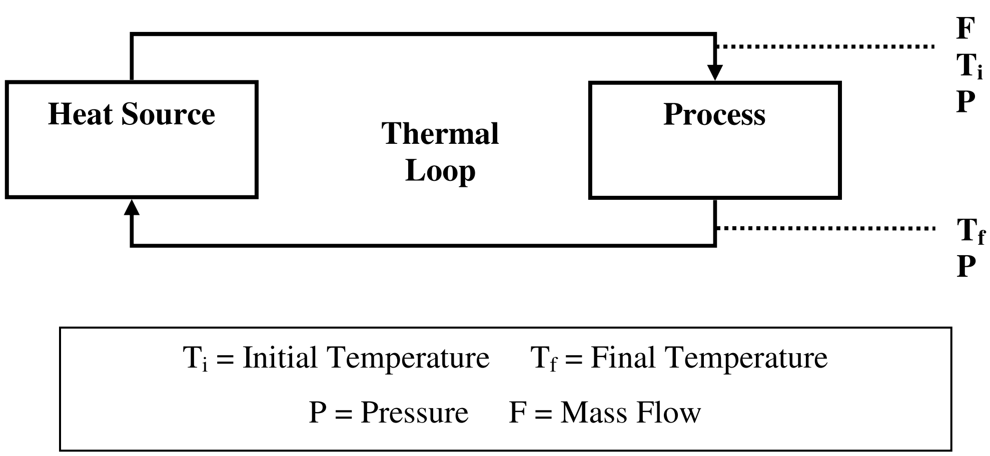
Not applicable to the inclusion of monitoring and quantification methods for the volume of fuel combusted in B4.

B.6. Risks to Implementation: (Review and discuss the risks associated with the protocols project-type and how these risks are being addressed / mitigated)	
When the pressure of a gas system is rapidly reduced, the temperature is also reduced. There is a risk of liquid condensation and freezing in the pipeline or turbine which could cause equipment malfunction or failure. To avoid the risk of an emergency shutdown, air dryers and/or heaters may be included in the project configuration. (Note that these devices may also be included in the baseline condition, as pressure letdowns via valves have the same cooling effect.). Incremental fossil fuel consumption is quantified according to the same approach as originally outlined in the waste heat recovery protocol. Not risks are applicable to the inclusion of monitoring and quantification methods for the volume of fuel combusted in B4.	
B.7. Review of Technology/Scientific Knowledge: (Describe the applicable practice(s) or technology producing the GHG emission reductions and the scope of activities considered)	
Energy from pressure letdowns is captured by turbo-expanders or hydraulic expanders. These expansion turbines convert the energy from pressurized gas or liquids into mechanical energy which can be used to generate electricity. In turbo-expanders, the loss of pressure in the expander results in rapid cooling of the gas. Liquid separators, gas dryers, or heaters may be required to prevent condensation of fluid in the expander. This can cause damage by corrosion or freezing in certain types of turbo-expanders. Energy inputs/outputs from each of these technologies should be considered in the quantification of GHG emission reduction technologies. Not applicable to the inclusion of monitoring and quantification methods for the volume of fuel combusted in B4.	
B.8. Review of Existing Projects: (Review of trends and statistics on existing practices/projects in the Alberta and Canadian context.)	
Enbridge and Fuel Cell Energy Inc were funded in part by the Government of Canada and Ontario to recovery lost energy from pressure letdown at a natural gas distribution plant in Toronto. Turbines let down the pressure while generating electricity. Waste heat from a natural gas fuel cell is used to warm the gas during pressure letdown. No projects which generate electricity from pressure letdowns exist in Alberta yet. Not applicable to the inclusion of monitoring and quantification methods for the volume of fuel combusted in B4.	
B.9. Summary of Quantification Approach Modifications: (Include a summary of any modifications to the GHG quantification approaches and methodologies. Include a justification for the inclusion of the “New Source or Sink” specifying where the proposed approach deviates from the existing protocol and reference Best Practice Guidance for the proposed alterations in quantification approach(es).)	

No modifications need to be made to include pressure letdowns in the scope of the protocol. Project proponents should monitor the volume of any incremental fossil fuel used to prepare/heat/condition the waste gas or liquid stream for the turbo-expander/hydraulic expander, and electricity output must be tracked in kWh in the same manner as a conventional waste heat to power project. GHG emissions from fuel use are quantified under P1 Fuel Extraction and Processing, P5 Distribution of Waste Heat, P6 Generation of Heat and Power, P7 Heat Transfer or Power Conversion and P11 Electricity Generation. Electricity output is quantified under B11 Electricity Usage.

The parameter "volume of fuel combusted" in SS B4 advises that the volume of fuel should be "based on the equivalent heat and power demand with the most likely fuel", without giving guidance on how this is to be accomplished. The following summarizes best practice guidance to determine the volume of fuel combusted in the baseline for waste heat recovery projects that generate thermal energy. This guidance has been adapted from CDM Methodology AM0036, "Fuel switch from fossil fuels to biomass residues in heat generation equipment".

The volume of fuel combusted for SS B4 is calculated based on the amount of heat energy delivered to the project site in the project condition. Heat energy is delivered via a thermal loop or coil containing a heat transfer medium. Heat generation is determined as the difference of the enthalpy of the heat transfer medium leaving the waste heat recovery unit(s) and entering the process that is utilizing the waste heat (hot side) minus the enthalpy of the colder fluid entering the WHR unit to be heated up (cold side). In the case of steam based systems, the blow-down and any condensate return should be considered (as applicable). The respective enthalpies should be determined based on the measured mass flow rates and fluid temperatures (e.g. supply and return temperatures), and in case of superheated steam, the pressure. The figure below demonstrates monitoring requirements for an example project configuration.



The efficiency of the baseline heater/boiler and the higher heating value of the fossil fuel used in the baseline are used to calculated the volume of fuel combusted in the following equation:

$$\textbf{Vol. Fuel}_i = \textbf{Heat Output / Efficiency / HHV}$$

B.10. Other Impacts and Co-Benefits: (Include other air emissions, odours, risks, environmental impacts on vegetation, wildlife, water resources etc.)

This is a source of zero-emissions clean electricity and therefore displaces grid electricity or other fossil fuel derived sources of electricity, which reduces air pollution, water pollution and natural resource consumption in Alberta.

B.11. Assessment of Baseline Scenarios (if suggesting modification)

Evaluate all possible Baseline Approaches in the list below, and identify which ones are appropriate for the proposed protocol. Justify why each selected Baseline Scenarios is appropriate. Justification should relate to why each appropriate Baseline Scenarios conservatively and accurately represents "business as usual". Also, justify why the other Baseline Scenarios are not appropriate and are excluded from the Protocol. Must explain why the Baseline approach is static or dynamic, justify the selection of the most appropriate baseline scenario(s) including references and any assumptions.

No modification of the baseline scenario is suggested.

TABLE 1.2: Re-Assessment of Possible Baseline Scenarios

1. Baseline Options	2. Description	3. Static / Dynamic Baseline	4. Accept or Reject and Justify
Historic Benchmark:	*(Typically site-specific and can be constructed to reflect reductions in a base period (such as the average emissions of the previous three years).)*		
Performance Standard:	*(Assumes the typical emissions profile for the industry or sector is a reasonable representation of the baseline.)*		
Comparison-based:	*(Actual measurements of parameters from a control group to compare with the project.)*		
Projection-Based:	*(Projections of reductions in the future can use a variety of techniques, from simple straight-line growth assumptions to complex models.)*		

Adjusted Baseline:	*(Takes into account current practice levels of a particular project and specified that the same baseline is used for all projects of a certain type, regardless of historical practices.)*		
Other (Explain):			

B.12. Re-definition of the Project Condition: (Define the project condition and justification for the scope of the activity considered.)

The project condition is the use of previously wasted pressure to generate electricity. Mechanical energy is extracted from the high-pressure gas stream or high pressure liquid with a turbo-expander or similar equipment and used to create electricity via a generator. To prevent hydrate formation or condensation which could result in freezing or corrosion, air dryers, heaters, or liquid separators may be required, which would have some supplemental energy requirements (e.g. direct fossil fuel consumption and/or reduced electricity output if some parasitic loads exist that consume a little bit of the produced electricity).

The scope of activity includes all material incremental sinks and sources of emissions in the project condition, as required by ISO 14064-2. No new SSRs are proposed as the existing SSRs under the waste heat recovery protocol are adequate to fully characterize pressure letdown projects due to the similarities between project types. Immaterial GHG sinks and sources, such as equipment construction and testing, were excluded for consistency with the original waste heat recovery protocol and ease of calculations.

Not applicable to the inclusion of monitoring and quantification methods for the volume of fuel combusted in B4.

B. 13. Functional Equivalence (if suggesting modifications): (Explain and justify how the project and the baseline are comparable in terms of products and/or activity level. This type of comparison requires a common metric or unit of measurement (such as the mass of beef produced, tonne-kilometers traveled, or energy content of fuel volumes in the case of displacing fossil fuels with biofuels).)

No modifications to functional equivalence are suggested. The project proponent must still measure the energy output (in this case electricity) to back calculate the equivalent amount of fossil fuels that would have been consumed if the waste pressure source had not been converted into electricity in the project condition. Therefore the kWh of net electricity output to the grid or to direct connected users would be the main variable to calculate the baseline emissions in conjunction with the grid electricity factor for Alberta or another emission factor for direct connected facilities.

B.14. Flexibility Mechanisms (if suggesting modification): (Explain optional approaches for quantifying

the reductions to be achieved from the project type.)
It is suggested that the above described flexibility mechanism be added to the Waste Heat Recovery Protocol to include pressure letdown projects provided that appropriate measurements are taken of the net electricity output and any volumes of supplemental fossil fuels consumed to operate the pressure letdown project.