INTRODUCTION TO
DE-CARBONIZATION AND
ENERGY EFFICIENCY TECHNOLOGY

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ENERGY EFFICIENCIES/REDUCING GHG EMISSION PROJECTS

Proposed Project:

The proposed project is comprised of a portfolio of various alternative technologies, which involves the assessment of existing operations to identify inefficient processes and suggest a modified way or revamp to achieve energy efficiency.

This project will need to perform a detailed technical study to propose the solution.

Technology:

The proposed technology is a portfolio of various small to medium scale processes mainly targeting utility consumption when implemented will result in significant cost benefits and reduced GHG emission.
This technology will help in reduced use of utilities, such as:

- Optimize water usage
- Optimize usage of steam and power
- Eliminating process gas/instrument air for control valve actuators –Pneumatic Retrofits
- Efficient operation of HVAC system/ alternative HVAC solutions
- Heat integration, which translates into significant reduction of GHG emission
- Remote locations emission mitigations and power availability

The existing process configuration may need to be revamped to integrate the latest technologies and could lead to additional investments in terms of equipment and control system changes. However, the net effect will result in carbon negative and net reduction in GHG emission.

Opportunity:

This proposed process/technology as a result of an existing operational assessment could offer an opportunity to utilize the resources wisely and efficiently. Revamp where necessary to benefit from the integration of advanced technologies to achieve energy efficiencies and reduced GHG emissions.

It offers the benefit of the expansion of production capacity and decarbonizing the facility operations.

Environmental Benefits: Significant reduction in GHG emission can be achieved.

Area of application:

- *OilSands (minable, thermal)*
- *Upgrader*
- *Petrochemicals*
- *Refinery*
- *Fertilizers*
- *Gas Processing*
- *LNG*

1. Innovation Opportunity

Figure 1 is a process flow diagram that presents two stages of Air Compression with After Coolers facilitating recovery of heat of compression by circulating treated water, Turbo Expander applications for compression power recovery and production of expanded chilled air for further process use according to an embodiment of the present invention.

Figure 2 is a process flow diagram that presents a Closed Loop Cooling Water (CLCW) system including a storage tank, circulation pumps accommodating cooling water circulation through the process sections, cooling water supply and return headers, and a Chilled Air Heat Exchanger. The heat gained by the cooling water return stream is dissipated by exchanging heat with the chilled air, produced due to isentropic expansion of the compressed air through Turbo Expander according to an embodiment of the present invention.

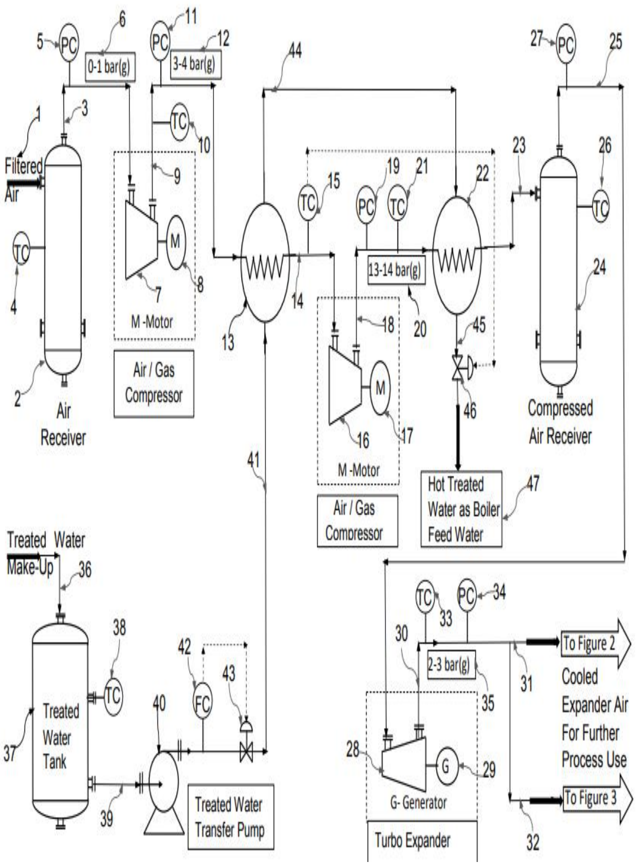

FIGURE 1*

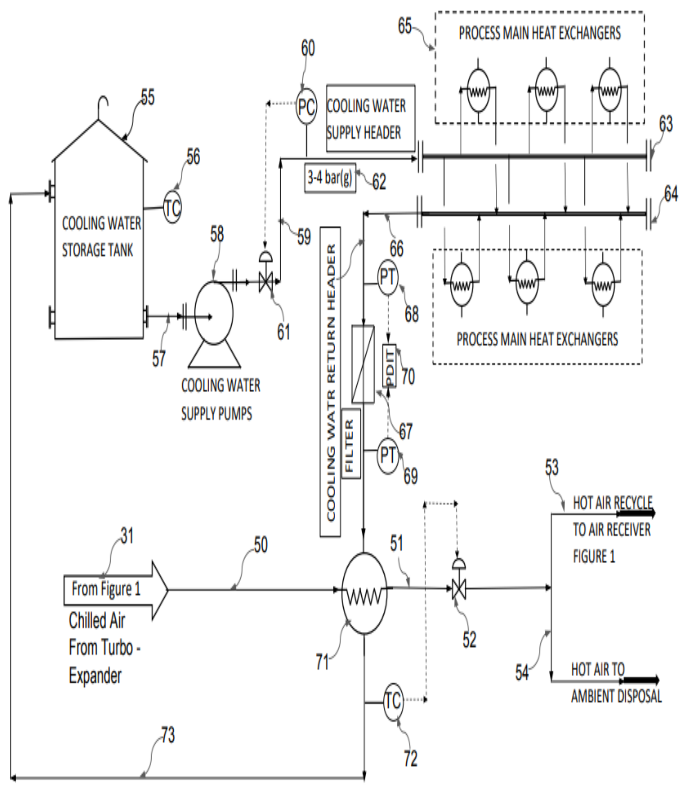

FIGURE 2*

* - Patent under Progress.

Figure 1 shows two stage compression of the ambient air and then expansion through the turbo-expander. The Compressed Air Pressure lets down from 13-14 bar (g) to 2-3 bar (g) across the Turbo

Expander. The temperature and pressure of the exhaust from the Turbo Expander is controlled and provided to Figure 2 process for further process use. The close loop or once-through cooling water system is provided to capture the compressed air heat energy after each stage of the air compression to produce the Hot Process Water (HPW) or Boiler Feed Water (BFW) at a temperature specification of 80 ^{0}C or greater. A temperature controller is provided to record the temperature of the Treated Water. The Treated Water Transfer Pump circulates water through the first stage discharge and the second stage discharge compression cooler for recovering the heat of compression and to produce hot process water at specifications of 80 ^{0}C.

Figure 2 shows an application of the chilled air produced from the turbo-expander to dissipate the heat gained by the cooling water stream from the process heat exchangers. Basically, this process allows the replacement of the cooling tower in the process industry. The chilled air is produced at a temperature specification of 0 ^{0}C or lower in a cost-effective and energy-efficient manner which provides a further thermal duty to enhance the overall system performance. The cooling water supply header runs within the battery limits of the process plant and receives the cold cooling water from the utility section. The cooling water is circulated through the process section heat exchangers and returned to the cooling water return header. The cooling water return header receives the warm cooling water and flows out from the process plant battery limits to the utility section. The chilled air is fed to the Heat Exchanger for providing cooling duty by heat exchanging with warm cooling water return stream. The Heat Exchanger is located within the utility section, which is a shell and tube or plate and frame type of heat exchanger which receives the chilled air as a cold stream and discharges gaining heat through the outlet line which is either recycled back to the compression section or disposed of in atmosphere. The cold cooling water stream discharged through the heat exchanger is recycled to the Close Loop Cooling Water Storage Tank.

-The technology is developed to solve the problem- known as GHG and water conservation.
The current practices employ the fossil fuel-based process heaters to produce the Hot Process Water or Boiler Feed Water. This practice consumes significant fossil fuel since the efficiency and heat losses involved are very high. Therefore, it is imperative to find alternative solution which provides higher efficiencies and processes are integrated such that it provides cost-effective solution at a significantly lower emission rate. This technology employs heat pump which provides significantly higher efficiencies for production of Hot Process Water. It addresses the market need as the industry needs either hot process water or boiler feed water on a continuous basis.

It is transformative solution as various processes are integrated to make the process 100% energy efficient. The compressed air from heat pump is expanded and used to cool the process cooling water. This process eliminates the need of the cooling tower and results into significant saving of the cooling water and also controls the fouling within the process heat exchangers. It also eliminates emission of VOCs as cooling water contains significant number of additives which are usually lost into atmosphere with water evaporation.

-There is no known competitor exist in the market who is actively working to find a solution to the given problem. This is an out-of-the-box kind of solution proposed by 2127187 Alberta Ltd.

- The very first thing which makes the proposed process novel and innovative is conceptualizing process of electrification and designing a mechanical arrangement which can be practically commercialized.
- The prosed technology will allow the facility to use renewable energy for operating proposed processes which will result into reduced GHG footprint and significant reduction in water consumption.
- It is novel in its kind of as no such solution is yet implemented by industry.

The project is at conceptual and design development stage. The next step towards the commercialization would be pilot plant set up, testing, validation, data collection and safety and reliability analysis. It will also include the carbon emission accounting and cost-benefit analysis.

Upon successful completion of laboratory or facility based pilot evaluation, the engineering design and procurement can be performed further for the commercialization of the project.

The requested funding from the ERA will help in performing preliminary engineering work and setting up pilot scale facility and construction to accommodate testing and mitigate other expenses.

2. Project Implementation Plan

The objectives of the project are to set-up a pilot scale facility for testing and validation of the proposed technology and claimed benefits.
Project scope includes preliminary studies as outlined below, Design development and engineering work and involvement of procurement and construction for the successful set-up of the pilot plant.

- Conceptual study, Feasibility study, Cost benefit analysis, Emission reduction and accounting analysis, risk management workshops, etc.
- Engineering deliverables such as process simulation, heat and material balance, project design criteria, process control documentation, process flow diagrams, process and instrumentation diagrams, equipment design specifications, equipment datasheets, line lists, process calculations, control and shutdown narratives, risk and process safety assessment, electrical load analysis, utility summary, etc.

The scale, nature, type of prototype, either facility based or laboratory based, depends on multiple factors and the same shall be disclosed later date.

3. GHG Benefits

- The proposed solution leading to the electrification of the existing operations. The electrification is usually possesses higher GHG potential. However, electrification would lead to GHG emission reduction by deployment of energy sourced from the renewable resources.
- The realistic time frame of achieving net-zero solution is anticipated at an immediate basis, subject to the industry deploys the renewable energy at work. The time line does not extend to 2030 or beyond that until 2050; rather the benefits could be realized upon implementation of this technology.

i.

GHG Estimations:

Referred to the Department of Energy (DOE) guidelines,

- Emission potential for Electricity = 158.06 kg CO_2e / MMBtu = 0.539 kg CO_2e / kwh
- Emission potential for Steam = 73.78 kg CO_2e / MMBtu = 0.252 kg CO_2e / kwh
- Emission potential for Electricity from Renewable Sources = 0.041 kg CO_2e / kwh

EXAMPLE:

Water flowing at the flowrate of 216 m^3/h, inlet temperature of 15 ^{0}C and outlet temperature of 80 ^{0}C., air flowrate of 175,000 kg/h and at a temperature of 25 ^{0}C inlet to the 1st stage compressor, Air compressed from 101 kPaa to 1490 kPaa.

-Power consumed by 1st stage of compression: 9370 kw

-Power consumed by 2nd stage of compression: 9587 kw

-Power recovered through the turbo-expander: 4636 kw

- Thermal Energy recovered by hot process water: 13000 kw

- Heat duty provided by the chilled air by cooling the warm process water: 1808 kw (warm cooling water @ 60 m^3/h cooled from 45 ^{0}C to 20 ^{0}C with the chilled turbo-expander air)

Therefore: Total energy expended – total energy recovered = -487 kw of energy conserved.

- NEGATIVE GHG emission associated with the energy expended = -0.539 kg CO_2e / kwh X 487 KW

= -262 Kg/h of emission = -2,299,438 Kg CO2e /Annum REDUCED by this process.

It is to be noted that above numbers are estimated based on conservative approach, when used higher efficiencies, the emission numbers are reduced significantly.

- The estimated REDUCTION in emission can be further benefited by deploying electricity produced form the renewable resources.

4. CONCLUSION:

It is worth mentioning again that the electrification of the processes to generate hot process water and elimination of the cooling tower for water conservation is supported by the emission estimation numbers, since, electrification is the preferred route which could lead to the partial or complete elimination of the emission with the deployment of the renewable resources.

Although grid based electricity involves higher emission potential than the steam produced from the boiler or direct fired heaters, the proposed technology allows the industry to deploy the energy sourced from the renewable sources immediately and subsidizing the emission footprint from day one and not to enough emphasize that it significantly benefits from water conservation perspective.

- For the comprehensive GHG estimates associated with the mechanically cooled cooling water plus heat pump Process, each and every element of the process would need to be evaluated and then the final conclusion can be drawn, which is complex process. However, what is obvious is that with the electrification of the process and especially sourcing electricity from the renewable sources (completely or in proportion) would definitely lead toward the net-zero solution.

- The realistic time frame of achieving net-zero solution is anticipated at an immediate basis, subject to the industry deploys the renewable energy at work. The time line does not extend to 2030 or beyond that until 2050; rather the benefits could be realized upon implementation of this technology.

The proposed technology/solution would definitely help with the chemical processing industry corporate's net-zero commitments. The way existing operation is carried out have slim chances that the processing industry would be able to cut emission associated with the cooling water system and production of hot process water.

The proposed solution involves application of the heat pump for the generation of hot process water and mechanical cooling of the cooling water which will allow the industry to employ and gradually increase the share of the renewable energy to achieve net-zero targets. Although grid based electricity involves higher emission potential so the proposed technology allows the industry to deploy the energy sourced from the renewable sources immediately and subsidizing the emission footprint from day one and not to enough emphasize that it significantly benefits from water conservation perspective.

5. Non-GHG Benefits

- Yes, the greatest advantage shall be realized in the form of Water Conservation and reduced VOCs emissions.

There are economic benefits associated with the project and commercialization of proposed technology. Implementation of this technology would enable the operations lowering the operations cost, better control over the operations against climatic conditions and would allow expansion in production capacity. As it has got wide range of applicability, quantification of the economic benefits would vary from industry to industry.