

CLEAN INFRASTRUCTURE
ROYALTY CREDIT PROGRAM

GUIDANCE DOCUMENT

2018 REQUEST FOR APPLICATIONS (RFA) PROCESS

Regulatory and Infrastructure Branch
Oil and Gas Division
Ministry of Energy, Mines and Petroleum Resources

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A. Introduction

Through the Clean Infrastructure Royalty Credit Program (CIRCP), upstream oil and gas producers, regardless of their size, can apply for a deduction from the royalties they pay to the Province. The purpose of the CIRCP is to advance clean technologies and solutions to reduce the environmental impact of oil and natural gas development in British Columbia. This deduction can be as much as 50 percent of the eligible project costs.

This document is intended to provide guidance to oil and gas producer and pipeline companies interested in submitting an application(s) under the on the 2018 CIRCP Request for Applications (RFA).

B. CIRCP Overview

Application and Evaluation Process

The 2018 installment of the CIRCP has been allocated $19.3 million in royalty deductions to be competed through a RFA. The royalty deductions have been evenly allocated to each of the two project categories: vented sources and electrification. Companies can submit one or more project applications under the RFA. Each application is evaluated and ranked based on the criteria noted in Section F of the 2018 RFA. Projects are approved in rank order until the available royalty deductions have been allocated. The Province will advise each company in writing whether or not their project application(s) was successful in the RFA process.

The information provided by the Applicant in response to this RFA will be subject to the *Freedom of Information and Protection of Privacy Act.*

Approved Projects

Royalty deductions are assigned to an approved project, not a company. Each project approved under the CIRCP is assigned a maximum project royalty deduction based on the estimated project completion cost provided in the project application, and the requested royalty deduction percentage. Approved projects must be completed within 5 years.

Release of Royalty Deduction

An approval of a project that results from the CIRCP RFA application does not result in royalty deductions being immediately applied to the producer company's royalty payable account. Once a project is complete, and all associated eligible costs have been paid, the Producer company must send a written request to the Ministry requesting the release of the royalty deduction. Schedule B of the Project Agreement lists the required documents that must be completed and submitted as part of the request for release of a royalty deduction. These documents are used to determine the eligible royalty deduction. The eligible royalty deduction is based on the equivalent deduction percentage of either the estimated project completion cost or the final as-built cost, whichever is less.

One half (50%) of the approved royalty deduction associated with Step 1 (Project Construction) may be released within 6 months of construction completion once an Producer requests the release as per the requirements of the Project Agreement. The second half (50%) of the approved royalty deduction associated with Step 1, and 100% of the approved royalty deduction associated with Step 2 (Post-Project Verification), may be released within 6 months of completion of Step 2 once requested by an Producer.

Once a royalty deduction is approved by the Royalty Administrator, the Producer and the Ministry of Finance are notified in writing of the released royalty deduction amount that can be deducted from oil and gas royalty payments due to the Province. The Producer must then complete and submit a BC-15 Remittance Advice entry form to the Ministry of Finance in order to claim all or some portion of the royalty deduction.

Note the royalty deduction is not transferable between related or unrelated companies, persons or other entities.

Audit Reviews

The Ministry has the discretion to access any CIRCP approved project site or company site with records relating to the project to carry out inspections, monitor progress and conduct audit reviews with reasonable notice.

An audit review may be carried out on any completed Project, or completed Step of a Project under the CIRCP. It is typically conducted by a third party accounting firm contracted by the Ministry. Based on the results of the audit, the Ministry reserves the right to reassess and adjust the royalty deduction entitlement if it is found that any of the claimed project costs are ineligible, or where unclaimed eligible costs are identified.

Program Flow Chart

It is expected that eligible projects that apply to the RFA, and if approved under the RFA, will follow a similar pathway as outlined in the figure below:

*as outlined in the Agreement

C. Application Considerations

Selecting an Eligible Project

The CIRCP is NOT intended to share costs of building infrastructure (greenfield or retrofit) that has already been built or is under construction, nor is it intended to support the deployment of technologies that may be required to meet regulatory requirements, or in the case of "business as usual" retrofits.

The following points should also be considered when selecting a project:

- Companies can submit one or more project applications, and applications can include any combination of eligible project types, however each application will only be evaluated under one project category.
- The Province does not have a preference for approving smaller projects over larger projects.
- All projects must be located within British Columbia;

- Projects that were completed or substantially underway before the RFA closes are not Eligible Projects;
- Leak detection and repair projects concerning fugitive emissions are not eligible projects for the 2018 CIRCP; and
- There is no minimum GHG reduction required.

Selecting a Royalty Deduction Percentage

The maximum project royalty deduction is 50% of the estimated project completion cost, however Producers can request less than 50% in their application, as per the Regulation. As a higher point score will be assigned to projects that demonstrate a lower RCERR, the amount of royalty deduction requested will affect an application's evaluation scoring.

The following example illustrates where an Applicant may choose to request less than the maximum 50% royalty deduction in their project application.

Example: Calculating the RCERR with a 50% or 35% Royalty Deduction Request

Consider the following example project that includes the deployment of different GHG emission reductions technologies applicable under the CIRCP:

- Replace 100 Fisher 4150 high-bleed pneumatic devices with 100 Fisher C1 low-bleed pneumatic devices
- Replace 40 generic diaphragm pumps with solar-powered pumps
- Upgrade 10 vent gas capture systems
- Replace 5 gas-driven instrument air systems with electric-driven
- Assume a project start date of July 1, 2019.
- Project emissions will be estimated over ten years.

The total costs provided are estimates of eligible costs as defined in the RFA. As shown in the tables below, the total project costs are $2,960,000 and the project is expected to achieve approximately 397,328 tonnes of carbon dioxide equivalent (CO_2e) reductions over the project period, defined as January 1, 2019 – December 31, 2028. By reducing the amount of royalty deduction requested from 50% to 35%, the RCERR is reduced from 3.72 to 2.61. A lower RCERR will be scored more favourably during evaluation.

Table 1: Example Project – Summary of Estimated Costs and GHG Reductions

Project Activities	Number of Activities	Total Estimated Cost	GHG Reductions over 10 years (tCO_2e)
Replace 100 Fisher 4150 high-bleed pneumatic devices with 100 Fisher C1 low-bleed pneumatic devices.	100	$250,000	48,820.5
Replace 40 generic diaphragm pumps with solar-powered pumps	40	$360,000	46,265
Install 10 vent gas capture systems	10	$1,100,000	137,949.5
Install 5 instrument air systems to replace gas-driven systems	5	$1,250,000	164,293
Total		**$2,960,000**	**397,328**

Table 2: Example Project – RCERR Calculations

Case 1:	An applicant requests **50%** of the total project costs.	**Case 2:**	An applicant requests **35%** of the total project costs.
Estimated Project Cost	$2,960,000	Estimated Project Cost	$2,960,000
Estimated GHG reductions	397,328 tCO_2e	Estimated GHG reductions	397,328 tCO_2e
Royalty Credit request (50%)	$1,480,000	Royalty Credit request (35%)	$1,036,000
Calculated RCERR	**3.72**	**Calculated RCERR**	**2.61**

GHG Emissions Quantification

GHG quantification for emissions reduction projects can be complex as calculations are often based on estimations and hypothetical situations. Applicants are required to use relevant Western Climate Initiative (WCI) quantification methods as noted in Appendix A of the RFA. Information provided by an Applicant must match the equipment and associated information reported by Producers under the *Greenhouse Gas Emission Reporting Regulation* (if applicable).

The baseline is considered to be a reasonable representation of what likely would have occurred during the Project period had the Project not been implemented. It is considered to be best represented by historical operating conditions of the specific equipment to be modified during the proposed project. The implementation of a Project represents a change from this practice, and corresponding GHG reductions are estimated by comparing GHG emissions generated during the project to those estimated in the baseline.

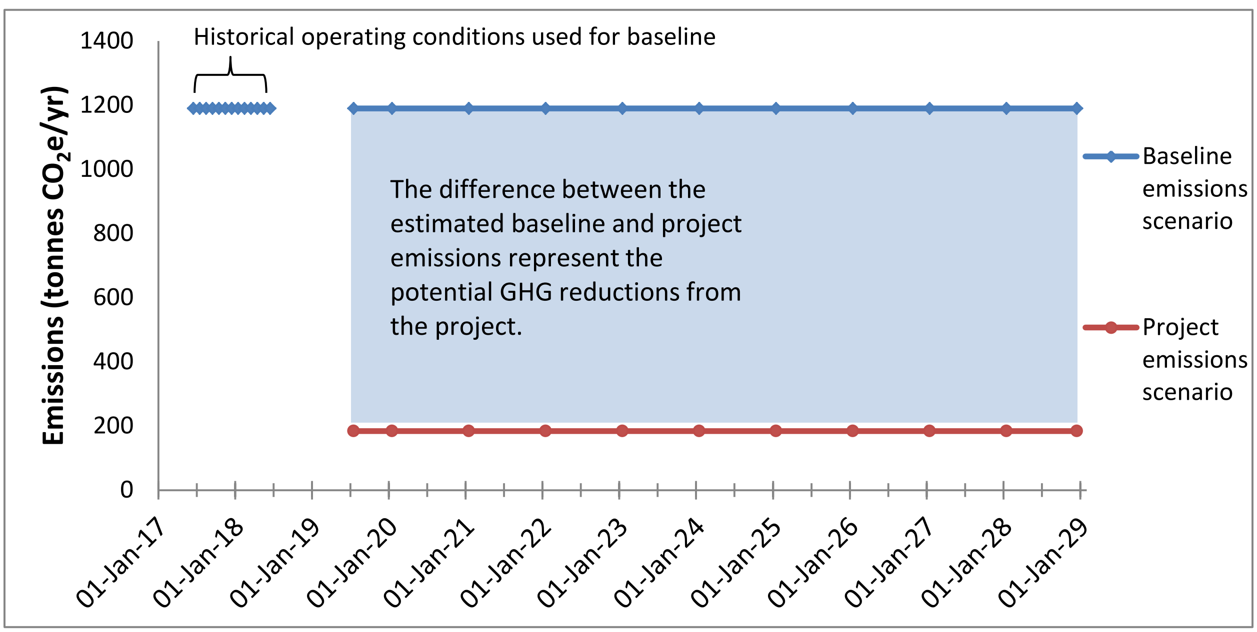
Using the historical operating information, the baseline scenario should be developed by forecasting emissions (from the previous 12 months), over the proposed project period.

- The project period is the time between the completion date of project construction for the specific equipment and December 31, 2028.
- If the completion date for project construction is prior to January 1, 2019, then January 1, 2019 should be used as the starting period for the purposes of this calculation.
- If the previous year's information is not available for the specified equipment, other approaches may be considered, such as a comparison-based approach using measurements from a representative sample group or a hybrid-based approach. Alternative approaches must be confirmed with the Province to ensure their appropriateness for the purposes of the CIRCP application.

The project scenario must be calculated using the appropriate WCI equations and the same project period as above, using the appropriate emissions factors and operating conditions for the equipment subject.

- Emissions reductions from the proposed project must be reported for a ten-year period, between January 1, 2019 and December 31, 2028.
- Projects that start after January 1, 2019 must use the equipment in-service date for estimating GHG emissions from the project.

The figure below displays how the baseline and project emissions should be estimated.



It is expected that any proposed project will provide an equal level of service or product (i.e. that functional equivalence is maintained) when compared to the baseline.

The accepted unit of measure for reporting GHGs in the RFA is tonnes of carbon dioxide equivalent.

Global warming potentials for various GHGs should be consistent with those specified in the Schedule of the *Carbon Neutral Government Regulation*.

Further details on estimation methods are provided in **Appendix A.** Detailed examples of estimated GHG emissions reduction calculations for two projects are provided in **Appendix B**.

Identifying Project Barriers

Applicants should use the business case to identify and define the potential barriers that may exist such that the project would not proceed without the CIRCP. The following examples of barriers are provided for informational purposes; it is expected that Applicants will provide an inclusive list specific to the project being proposed.

- Financial Barriers:
    - Natural gas prices may not support project economics to implement the initiative (project capital and operating expenditures result in a rate of return that is below typical industry hurdle rates or payback periods).
    - Insufficient resources may be available to allocate funds for the Project, as these projects have to compete for the same resources as potentially higher return drilling and exploration projects.
- Technological Barriers:
    - Project monitoring requires adaptation of common practice (e.g., typical practice of measuring total plant natural gas consumption, rather than individual engine consumption).
    - Risk or perceived risk of increased shutdowns/operational problems from use of less proven technology.
- Other Barriers:
    - Limited access to infrastructure (e.g., instrument air systems and electrification projects require access to electricity, which is often not available at many remote sites).
    - Multiple working interests in an operating facility could easily thwart efforts to change to a more environmentally-minded system.

Calculating the Industry Payback Period

A payback period for the project should be estimated based on total project costs as estimated by the Applicant. Costs should be input in the year they will be incurred, and estimated gas savings (in thousand cubic meters per year, e3m3/year) should be based on the amount of methane (CH^4) that would not be vented/used due to the project.

For projects involving multiple equipment types, the total estimated project costs and total estimated gas savings for all equipment and project types, should be reported in the table. It is not necessary to complete the table for each equipment type.

The 'Producer value of gas' ($/e3m3) is provided based on forecasts developed by the Province and should not be modified.

Table 3 presents an example of an industry payback calculation for a project that converts a series of high-bleed pneumatic devices to low-bleed devices. The estimated gas savings is based on the amount of gas saved as estimated and reported in the application. In this case, the requested royalty deduction is 50%, and the payback period would be reduced from 10.5 years to 6.1 years if the project was approved under the CIRCP.

Common Submission Errors

Table 4 below highlights some common errors found in applications received from prior years. The Ministry encourages Applicants to review these issues prior to submission to ensure their applications are complete.

Table 4: Summary of RFA Application Issues Observed

DOCUMENT	ISSUE
Authorization	• Missing • Not fully completed
Cover Letter	• Missing • Lack of information about the project provided • Not on company letterhead
Supporting Letter(s) (if a partner application)	• Missing or only one letter from one partner received • Letter not signed • Letter does not indicate each partner agrees to the joint project • No royalty deduction percentage split for partners assigned

DOCUMENT	ISSUE
RFA Response Template	• Template not used/altered • Questions unanswered • Legal company name not provided • Partner company name not provided • Vague description of project • Response only provided in PDF format (must be in PDF and Word) • Separate electronic files for attachments not provided (Estimated Project and Equipment Cost Breakdown Tables, Estimated GHG Reductions Calculation, Estimated Industry Payback Calculation).
Proposed Project Schedule	• Missing • Not fully completed • Format of spreadsheet changed (format must remain unchanged and in Excel)
Mapping Requirements	• Missing • Map not in colour • Map not printed on 8.5x11 paper • Map not legible
Flash Drive	• Not provided • Files missing/blank

Table 3: Example Industry Payback Calculation

Estimated Industry Payback Calculation - CIRCP RFA 2018																
Company Name:	Example											**Note:** Government Fiscal Year is April 1 - March 31				
Project Name:	Example															
Without Royalty Deduction	**Fiscal Year:**	**2018/19**	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**2025/26**	**2026/27**	**2027/28**	**2028/29**	**2029/30**	**2030/31**	**2031/32**	**2032/33**
Total Equipment Cost, all types ($C)		-$ 800.00														
Labour and other costs ($C)		-$ 1,500.00														
Estimated Gas Savings (e3m3/yr)		3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Producer value of Gas ($C/e3m3)		44.70	48.14	57.21	63.31	67.64	70.86	74.20	77.46	80.18	90.76	92.58	94.43	96.32	98.25	100.21
Estimated Value of Gas Savings ($C/yr)		143.05	154.06	183.07	202.61	216.44	226.75	237.45	247.88	256.58	290.44	296.25	302.18	308.22	314.39	320.67
Discount Rate	12%															
Cash Flow - annual ($C)		-$2,156.95	$154.06	$183.07	$202.61	$216.44	$226.75	$237.45	$247.88	$256.58	$290.44	$296.25	$302.18	$308.22	$314.39	$320.67
Cash Flow - cumulative ($C)		-$2,156.95	-$2,002.88	-$1,819.81	-$1,617.20	-$1,400.77	-$1,174.02	-$936.57	-$688.69	-$432.12	-$141.67	$154.58	$456.76	$764.98	$1,079.36	$1,400.04
Net Present Value ($C):	-$556.43															
Industry Payback (years):	10.5															
Industry Payback (months):	126															
With Royalty Deduction	**Fiscal Year:**	**2018/19**	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**2025/26**	**2026/27**	**2027/28**	**2028/29**	**2029/30**	**2030/31**	**2031/32**	**2032/33**
Royalty Deduction Request:	50 %															
Equipment Cost ($C)		-$400.00	$0.00	$0.00	$0.00	$0.00										
Labour and other costs ($C)		-$750.00	$0.00	$0.00	$0.00	$0.00										
Estimated Gas Savings (e3m3/yr)		3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Producer value of Gas ($C/e3m3)		44.70	48.14	57.21	63.31	67.64	70.86	74.20	77.46	80.18	90.76	92.58	94.43	96.32	98.25	100.21
Estimated Value of Gas Savings ($C/yr)		143.05	154.06	183.07	202.61	216.44	226.75	237.45	247.88	256.58	290.44	296.25	302.18	308.22	314.39	320.67
Discount Rate	12%															
Cash Flow - annual ($C)		-$1,006.95	$154.06	$183.07	$202.61	$216.44	$226.75	$237.45	$247.88	$256.58	$290.44	$296.25	$302.18	$308.22	$314.39	$320.67
Cash Flow - cumulative ($C)		-$1,006.95	-$852.88	-$669.81	-$467.20	-$250.77	-$24.02	$213.43	$461.31	$717.88	$1,008.33	$1,304.58	$1,606.76	$1,914.98	$2,229.36	$2,550.04
Net Present Value ($C):	$470.36															
Industry Payback (years):	6.1															
Industry Payback (months):	73															

D. Frequently Asked Questions

The following questions and responses have been provided to Applicants during the previous CIRCP installment and some have been added for guidance for the 2018 CIRCP. Any new questions received during the 2018 RFA will be posted to the CIRCP Website along with the answer.

Q. In a joint application between two or more Producers, or one or more producers and a pipeline partner, how will the royalty deduction be split between producers and who decides?

A. The Province has no involvement in the decision of the percentage split of the requested deduction between Producers. This information is specified by the Applicant when responding to the RFA. See the Petroleum and Natural Gas Royalty and Freehold Production Tax Regulation for more information.

Q. Since innovative technologies or technologies that are not commercialized generally cost more to implement (therefore increasing the Royalty Credit Emission Reduction Ratio), is there additional weighting allocated to projects that incorporate innovative technologies?

A. The 2018 CIRCP allocates 30% of evaluation points to the Business Case which includes an opportunity to describe the use of innovative technologies for the project.

Q. The emission baseline calculation may be underestimated given current production levels. Must the most recent 12 months of baseline data be used in this calculation, or is there an opportunity to use data which more accurately reflects current production?

A. The use of the most recent 12 months of data will result in consistent assessment of the relative merits of different projects based on the CIRCP evaluation criteria. Actual emissions reductions from the approved projects will be detailed in the GHG emissions reduction report during Post-Project Verification.

Q. Where is the price forecast in the 'Industry Payback Period' spreadsheet from? Are we able to use other price forecasts?

A. The Ministry periodically develops internal forecasts for royalty program purposes, and these are used for our royalty deduction programs. Applicants must use the price forecast provided.

Q. Will it be difficult to find third party verification bodies for Step 2 (Post-Project Verification)?

A. We do not anticipate challenges in terms of the lack of suitable verifiers for the purpose of the CIRCP given the staggered nature of project timelines for potentially approved projects. The BC Climate Action Secretariat website for the GHG Reporting Regulation provides a link to the Standards Council of Canada and the American National Standards Institute which list accredited verification bodies.

Q. Are both the physical completion of the verification and the development of the associated documentation considered eligible project costs?

A. Yes, all costs associated with development of verification documentation (including field activities) are considered eligible project costs.

Q. Should verification be completed to a limited or reasonable level of assurance?

A. A limited level of assurance is required at a minimum for the verification reports of approved projects.

Appendix A. GHG Emissions Estimation Methods

This appendix provides additional details on how greenhouse gases (GHGs) should be estimated for different eligible project types for the CIRCP.

Eligible Project Types

The projects types noted in the table below are considered eligible projects under the 2018 CIRCP which focuses on GHG emissions reductions projects (in particular methane). Other projects focus on reducing methane emissions in the upstream may be considered, however applicants must discuss project types not listed below with the Ministry prior to submission of their application.

Table A.1: CIRCP 2018 Eligible Project Types

Eligible Project Type	Description/Example
High-to-low bleed instrument conversions	High bleed pneumatic instruments are converted to low bleed devices.
Pump system conversions	Pumps (normally gas-driven) are converted to solar powered pumps or are 'right-sized' for appropriate use.
Vent gas capture	Gas that would normally be vented is captured and combusted on site.
Instrument gas to instrument air conversions	Air compressors (instead of on-site gas) are used to supply pneumatic power to devices.
Electrification	Electrification of new oil and gas equipment and facilities such as wellpads, wellsite compressors and other equipment; or retrofitting existing equipment/facilities for electrification.

High-to-Low Bleed Instrument Conversions

Oil and natural gas facilities often use pneumatic power for operational needs. Pressurized natural gas is readily available on site and is the most common pneumatic power source for a variety of devices (e.g. pressure controllers, temperature controllers, transducers, regulators, and chemical injection pumps). Typically, pneumatic devices can be considered as either high-bleed or low-bleed based on the bleed rate of the device. The Western Climate Initiative **(**WCI) defines high-bleed devices as those "which continuously bleed at a rate greater than 0.17 m^3/hr". Replacing or retrofitting high-bleed pneumatic devices with low-bleed (or no-bleed) equivalents will result in lower GHG emissions from the device.

Pump System Conversions

Chemical injection pumps and circulation pumps in glycol dehydration units vent GHGs during normal operations. The conversion of a gas-driven pump to one powered by electricity (either on or off-grid) and/or the 'right-sizing' of pumps for current operating conditions can result in significant reductions of GHGs. If the proposed project is to convert gas-powered pumps to ones that are powered by solar power, the expected emissions in the project case are zero.

Vent Gas Capture

Certain process control instrumentation and pumps commonly vent natural gas or fuel gas during normal operations. It is possible to capture vented gas from these sources to be combusted in a flare or incinerator. If the destruction of this vented gas is not required by applicable gas conservation directives (such as the BC Oil and Gas Commission's *Flaring and Venting Reduction Guideline*), a project that captures these gases and combusts them would be considered an eligible project type under the CIRCP.

Instrument Gas to Instrument Air Conversions

Various process control devices in the sector, including pressure, temperature, liquid level, and flow rate regulation are powered by natural gas. It is possible to convert these instrument systems from using gas to using compressed air, which maintains the functionality of the system while reducing GHGs. Compressed air systems require on-site electricity, which could be supplied by the grid or from an off-grid source. The gas that has been conserved because of the conversion to an instrument air system is assumed to be combusted downstream of the operation by an end-user.

Electrification

An electrification project uses electricity to power equipment at oil and gas facilities, thereby reducing GHG emissions. Electrification can occur at greenfield sites through installation of new electric-power equipment, or by retrofitting existing equipment/facilities to use electricity supplied by an integrated grid or on-site isolated grid.

Estimation Methods for Eligible Project Types

A summary of the equations used to calculate emissions reductions for each eligible project type is provided in Table A.2. When using the WCI equations, please note the following:

- The referenced equations will provide estimates of volumetric emissions. To convert to mass emissions (in tonnes CO_2e), use equations 360-41 and 360-42 in the WCI methods documents.

- Both methane (CH_4) and Carbon dioxide (CO_2) emissions should be estimated. Nitrous oxide (N_2O) emissions should also be estimated for project-related emissions from flaring).
- Note the Global Warming Potential forCH_4 should be 25 and N_2O is 298, as listed in the Schedule of the *Carbon Neutral Government Regulation*.
- Emission factors and relevant coefficients for various devices are provided in the WCI documents (Tables 360-5 and 360-6).
- If the device, or equivalent device, is not listed in Table 360-6, the generic high bleed emission factor must be used. If a generic emission factor is used, a discount factor of 20% must be applied to the estimated GHG emissions reductions.

Applicants should make the following assumptions when calculating all estimated GHG emissions reductions:

- **Make and model of the high-bleed and low-bleed pneumatic devices are available.**
  - Applicants are required to provide information on which types of devices will be subject to retrofit or conversion during the Project.
- **Make and model of the pneumatic pumps are not known.**
  - In the case where the make and model of equipment is unknown, applicants are required to use the generic WCI emission factors for that equipment type. If generic emission factors are used, a 20% discount factor must be applied to those emission estimates for the purpose of the CIRCP Application.
- **Metered information is available to determine the amount of natural gas subject to the vent gas capture projects.**
  - Applicants are required to provide information on which types of devices will be subject to retrofit or conversion during the Project, which may be confirmed through auditing procedures.
- **Metered information is available to determine the amount of natural gas used by the current operating equipment that will be converted to instrument air systems.**
  - Applicants are required to provide information on which types of devices will be subject to retrofit or conversion during the Project.
- **A gas analysis has been conducted to determine the constituents of the natural gas stream currently used by the pneumatic device**
  - Applicants are required to provide accurate gas analysis percentage breakdowns for the different gas streams associated with the Project if known, or based on historical operating data or operating data of other operators in the same region.

- **Baseline Conditions**
  - Applicants need to simulate the baseline based on the historical operating characteristics of the project opponent or other operators in the same region, while the project assumes the equipment will be powered by electricity (integrated grid or on-site isolated grid).
- **Electricity Supply**
  - Integrated grid is an electrical distribution system that is operated by BC Hydro. Isolated grid is an electrical distribution system with on-site generated electricity using natural gas.

Additional information for calculating $Emissions_{Project}$ for instrument gas to instrument air projects and electrification projects are noted below.

Project Emissions for Instrument Gas to Instrument Air Projects

For instrument gas to instrument air projects, $Emissions_{Project}$, the emissions from the air management system (measured in kg of CO_2e) should be calculated based on the following equation:

$$\mathbf{Emissions_{Project}} = \sum(\mathbf{EC_i} \times \mathbf{EF_{Elec}} \times \mathbf{Managed\ Air_i}) \div \sum \mathbf{Total\ Managed\ Air_i}\text{ , where}$$

Variable	Description	Units	Measurement Method
EC_i	Electricity consumed by the air management system	kWh	Direct measurement or use of manufacturer specifications.
EF_{Elec}	Emission Factor for electricity generation	kg CO_2e/kWh	Site specific emission factor based on gas composition analysis. If gas composition is not available, the established emission factor for Producer Consumption may be used. Emission Factor for electricity generation from BC Hydro grid is 0.011 kg CO_2e/kWh
Managed Air_i	The amount of air used in the system for related control systems and in engine starters	m^3	Direct measurement or use of manufacturer specifications.
Total Managed Air_i	The total amount of air being managed by the system	m^3	Direct measurement or use of manufacturer specifications.

Project Emissions for Electrification Projects

If the proposed project is to convert gas-powered equipment to ones that are powered by on-site renewable electricity (e.g. solar power), the expected emissions, $Emissions_{Project}$, are zero.

For greenfield electrification projects, $Emissions_{Project}$, the emissions from the air management system (measured in kg of CO_2e) is calculated based on the following equation:

$$\mathbf{Emissions_{Project}} = \sum(\mathbf{EC_i} \times \mathbf{EF_{Elec}}), \quad \text{where}$$

Variable	Description	Units	Measurement Method
EC_i	Electricity consumed by the electric-driven wellsite equipment	kWh	Direct measurement or use of manufacturer specifications.
EF_{Elec}	Emission Factor for electricity generation	kg CO_2e/kWh	Site specific emission factor based on gas composition analysis. If gas composition is not available, the established emission factor for Producer Consumption may be used. • Emission Factor for electricity generation from BC Hydro grid is 0.011 kg CO_2e/kWh. • Emission Factor for on-site renewable electricity is zero (e.g. solar power). • Emission Factor for electricity supplied by an isolated grid, generated using a non-electricity fuel in project report period. Quantification of CO_2 emissions must use WCI.23(b), (c) or (e), and, if applicable, WCI.23(f). Quantification of CH_4 and N_2O emissions must use WCI.24.

Table A.2: CIRCP 2018 GHG Emissions Reductions Calculations

Project Type	Baseline Scenario	Project Scenario	$Emissions_{Baseline}$	$Emissions_{Project}$
High-to-low bleed instrument conversions	Emissions estimated for a set of high-bleed pneumatic devices based on historical operating characteristics	Conversion to a low-bleed pneumatic device	Eqn 360-1 (for metered devices) Eqn 360-2, 360-2a, 360-5, 360-5a (for unmetered devices)	Eqn 360-4
Pump system conversions	Emissions estimated for a set of pneumatic pumps based on historical operating characteristic	Pumps have been modified to be powered by on-site electricity	Eqn 360-1 (for metered devices) Eqn 360-3, 360-3a, 360-3b (for unmetered devices)	Eqn 360-3, 360-3a, 360-3b (for unmetered devices)
Vent gas capture	Emissions estimated for a generic set of pneumatic devices that vent gas, based on historical operating characteristics	Gas that was previously vented is now captured and combusted on-site	Eqn 360-1 (for metered devices) Eqn 360-2, 360-2a, 360-3, 360-3a, 360-3b, 360-5, 360-5a or others that may be applicable (for unmetered devices)	Eqn 360-27, 360-28, 360-29, 360-30 (for vent capture projects sent to a flare, or if emissions are sent to an incinerator). For other uses of uses of the vented gas (such as general combustion), use Eqn 20-1, 20-1a, 20-2
Instrument gas to instrument air conversions	Emissions estimated for a set of gas-powered control devices based on historical operating characteristics	Conversion to a compressed air system operated by electricity	Eqn 360-1 (for metered devices) Eqn 360-2, 360-2a, 360-3, 360-3a, 360-3b, 360-5, 360-5a or others that may be applicable (for unmetered	Eqn as noted in CIRCP Guidance Document Appendix A.
Electrification	Emissions estimated for a simulated set of equipment based on historical operating characteristics by the applicant or other operators in the same region	Equipment has been installed to be powered by electricity (grid or on-site)	Eqn 360-1 (for metered devices) Eqn 360-3, 360-3a, 360-3b (for unmetered devices)	Eqn 360-3, 360-3a, 360-3b (for unmetered devices) Eqn as noted in CIRCP Guidance Document Appendix A.

Appendix B. Example GHG Emissions Reduction Calculations

Category 1 Example (Retrofit Project):

- Component A: Replacing 100 Fisher 4150 high-bleed pneumatic devices with 100 Fisher C1 low-bleed pneumatic devices
- Component B: Replacing 40 generic diaphragm pumps with solar-powered pumps
- Component C: Upgrading 10 vent gas capture systems
- Component D: Replacing 5 instrument gas to instrument air systems.
- Project period: July, 1 2019 – December 31, 2028 (9.5 years)

The assumptions/values used for this example calculation are noted in Table B.1.

Table B.1: Parameters used in Category 1 Example

Parameter	Description	Value/Assumption
Operating Hours,$_i$	Operating hours of device *i* each year, based on historical operating information	Assume 8760 hours per year for each device
$\%CH_4$	Percentage of CH_4 in vent gas by volume, based on gas analysis	Assume 97%
$\%CO_2$	Percentage of CO_2 in vent gas by volume, based on gas analysis	Assume 2%
ρCH_4	Density of CH_4	0.678 kg/m^3
ρCO_2	Density of CO_2	1.86 kg/m^3
GWP_{CH4}	Global warming potential of CH_4	25
GWP_{N2O}	Global warming potential of N_2O	298
$EF_{High\text{-}bleed,i}$	Bleed rate of High-bleed device *i*	Assume all devices are Fisher 4150 pressure controllers with a bleed rate of 0.4209 m^3/hr, as listed in Table 360-6 of WCI.367
$EF_{Low\text{-}bleed,i}$	Bleed rate of Low-bleed device *i*	Assume all devices are Fisher C1 pressure controllers, with a bleed rate of 0.0649 m^3/hr, as listed in Table 360-6 of WCI.367
$EF_{Pump,\ i}$	Emission factor for pneumatic pump *i*	Assume the specific devices are unknown. In this case, use the attributes for a generic diaphragm pump and a bleed rate of 1.0542 m^3/hr, as listed in Table 360-6 of WCI.367. Apply a discount factor of 20% for using the generic emission factor.
$EF_{SolarPump,\ i}$	Emission factor for pneumatic solar pump *i*	For this project, assume solar pump, 0 m^3/hr

Parameter	Description	Value/Assumption
$Vented_i$	Natural gas vented by device *i*	Based on metered readings of applicable devices: <u>For Component C:</u> System 1 – 80,000 m3/yr System 2 – 100,000 m3/yr System 3 – 120,000 m3/yr System 4 – 60,000 m3/yr System 5 – 90,000 m3/yr System 6 – 110,000 m3/yr System 7 – 75,000 m3/yr System 8 – 60,000 m3/yr System 9 – 115,000 m3/yr System 10 – 85,000 m3/yr <u>For Component D:</u> System 1 – 150,000 m3/yr System 2 – 200,000 m3/yr System 3 – 220,000 m3/yr System 4 – 180,000 m3/yr System 5 – 300,000 m3/yr
$Captured_i$	Natural gas by device *i* captured	From baseline calculation = 895,000 m^3/yr.
DE	Destruction efficiency	Assume 98.5% as captured gas will be sent to a flare.
$EF_{CO2,\ i}$	Emission Factor for device *i*	Assume 0.0065 kg/m^3
$EF_{N2O,\ i}$	Emission Factor for device *i*	Assume 0.00006 kg/m^3
EC_i	Electricity consumed by the air management system.	For this example, assume a 50 HP compressor for each site that operates 50% of the time per year. This amounts to: 50 HP x 4,380 hr x 0.75 kW/HP x 5 sites = 821,250 kWh per year
EF_{Elec}	Emission Factor for electricity generation from integrated grid	0.011 kg/kWh
Managed Air_i	The amount of air used in the system for related control systems and in engine starters	Assume 100% of air is used for this example
Total Managed Air_i	The total amount of air being managed by the system	Assume 100% of air is used for this example
Project Period	Applicants are required to estimate when the equipment will be in service and use this date as the start date for the purpose of estimating emissions. This may be different for each activity.	9.5 years, assuming an equipment start date of July 1, 2019 and end date of December 31, 2028

Solution:

1. For each Component:
   - o Calculate the $Emissions_{Baseline}$
   - o Calculate the $Emissions_{Project}$
   - o Calculate the $Emissions_{Reduction}$
2. Calculate the Project $Emissions_{Reduction}$ by adding together the $Emissions_{Reduction}$ for each component.

Component A: Replacing 100 Fisher 4150 high-bleed pneumatic devices with 100 Fisher C1 low-bleed pneumatic devices

$$\mathbf{Emissions_{Baseline}} = \sum \left(\mathbf{EF_{High-bleed,i}} \times \mathbf{Operating\ Hours_i} \times \%\mathbf{CH_4} \times \boldsymbol{\rho}\mathbf{CH_4} \times \mathbf{GWP_{CH4}}\right) + \left(\mathbf{EF_{High-bleed,i}} \times \mathbf{Operating\ Hours_i} \times \%\mathbf{CO_2} \times \boldsymbol{\rho}\mathbf{CO_2}\right)$$

= 100 x [(0.4209 m^3/hr x 8760 hr x 97% x 0.678 kg/m^3 x 25) + (0.4209 m^3/hr x 8760 hr x 2% x 1.86kg/m^3)]

= 6,075,835 kg CO_2e/yr x 1 tonne/1,000 kg

= 6,076 tonnes CO_2e/yr

$$\mathbf{Emissions_{Project}} = \sum \left(\mathbf{EF_{Low-bleed,i}} \times \mathbf{Operating\ Hours_i} \times \%\mathbf{CH_4} \times \boldsymbol{\rho}\mathbf{CH_4} \times \mathbf{GWP_{CH4}}\right) + \left(\mathbf{EF_{Low-bleed,i}} \times \mathbf{Operating\ Hours_i} \times \%\mathbf{CO_2} \times \boldsymbol{\rho}\mathbf{CO_2}\right)$$

= 100 x [(0.0649 m^3/hr x 8760 hr x 97% x 0.678 kg/m^3 x 25) + (0.0649 m^3/hr x 8760 hr x 2% x 1.86kg/m^3)]

= 936,854 kg CO2e/yr x 1 tonne/1,000 kg

= 937 tonnes CO2e/yr

$$\mathbf{Emissions_{Reduction}} = \mathbf{Emissions_{Baseline}} - \mathbf{Emissions_{Project}}$$

= 6,076 tonnes CO_2e - 937 tonnes CO_2e

= 5,139 tonnes CO_2e/yr

Component B: Replacing 40 generic diaphragm pumps with solar-powered pumps

$$\mathbf{Emissions_{Baseline}} = \sum \left(\mathbf{EF_{Pump,i}} \times \mathbf{Operating\ Hours_i} \times \%\mathbf{CH_4} \times \boldsymbol{\rho}\mathbf{CH_4} \times \mathbf{GWP_{CH4}}\right) + \left(\mathbf{EF_{Pump,i}} \times \mathbf{Operating\ Hours_i} \times \%\mathbf{CO_2} \times \boldsymbol{\rho}\mathbf{CO_2}\right)$$

= 40 x [(1.0542 m^3/hr x 8760 hr x 97% x 0.678 kg/m^3 x 25) + (1.0542 m^3/hr x 8760 hr x 2% x 1.86kg/m^3)]

= 6,087,095 kg CO_2e/yr x 1 tonne/1,000 kg

= 6,087 tonnes CO_2e/yr

= 4,870 tonnes CO_2e/yr (**including discount factor of 20% for using generic emission factor**)

$$\mathbf{Emissions_{Project}} = \sum \left(\mathbf{EF_{SolarPump,i}} \times \mathbf{Operating\ Hours_i} \times \%\mathbf{CH_4} \times \boldsymbol{\rho}\mathbf{CH_4} \times \mathbf{GWP_{CH4}}\right) + \left(\mathbf{EF_{SolarPump,i}} \times \mathbf{Operating\ Hours_i} \times \%\mathbf{CO_2} \times \boldsymbol{\rho}\mathbf{CO_2}\right)$$

= 40 x [(0 m^3/hr x 8760 hr x 97% x 0.678 kg/m^3 x 25) + (0 m^3/hr x 8760 hr x 2% x 1.86kg/m^3)]

= 0 tonnes CO_2e/yr

$$\mathbf{Emissions_{Reduction}} = \mathbf{Emissions_{Baseline}} - \mathbf{Emissions_{Project}}$$

= 4,870 tonnes CO_2e/yr - 0 tonnes CO_2e/yr

= 4,870 tonnes CO_2e/yr

Component C: Upgrading 10 vent gas capture systems

$Vented_i$ for Systems 1 – 10

= 80,000+100,000+120,000+60,000+90,000+110,000+75,000+60,000+115,000+85,000

= 895,000 m^3/yr

$$\mathbf{Emissions_{Baseline}} = \sum (\mathbf{Vented}_{\mathbf{i}} \times \%\mathbf{CH_4} \times \boldsymbol{\rho}\mathbf{CH_4} \times \mathbf{GWP_{CH4}}) + (\mathbf{Vented_i} \times \%\mathbf{CO_2} \times \boldsymbol{\rho}\mathbf{CO_2})$$

= [(895,000 m^3/yr x 97% x 0.678 kg/m^3 x 25) + (895,000 m^3/yr x 2% x 1.86kg/ m^3)]

= 14,748,437 kg CO_2e/yr x 1 tonne/1,000 kg

= 14,748 tonnes CO_2e/yr

$$\mathbf{Emissions_{Project}} = \sum [\mathbf{Captured}_{\mathbf{i}} \times \%\mathbf{CH_4} \times \boldsymbol{\rho}\mathbf{CH_4} \times (\mathbf{1} - \mathbf{DE}) \times \mathbf{GWP_{CH4}}] + \left(\mathbf{Captured_i} \times \mathbf{EF_{CO2,i}}\right) + \left(\mathbf{Captured_i} \times \mathbf{EF_{N2O,i}} \times \mathbf{GWP_{N2O}}\right)$$

= [895,000 m^3/yr x 97% x 0.678 kg/m^3 x (1-0.985) x 25] + (895,000 m^3/yr x 0.0065 kg/ m^3) + (895,000 m^3/yr x 0.00006 kg/ m^3 x 298)

= 242,547 kg CO_2e/yr x 1 tonne/1,000 kg

= 243 tonnes CO_2e/yr

$$\mathbf{Emissions_{Reduction}} = \mathbf{Emissions_{Baseline}} - \mathbf{Emissions_{Project}}$$

= 14748 tonnes CO_2e/yr – 243 tonnes CO_2e/yr

= 14,505 tonnes CO_2e/yr

Component D: Replacing 5 instrument gas to instrument air systems

$Vented_i$ for Systems 1 – 5

= (150,000 + 200,000 + 220,000 + 180,000 + 300,000)

= 1,050,000 m^3/yr

$$\mathbf{Emissions_{Baseline}} = \sum(\mathbf{Vented_i} \times \%\mathbf{CH_4} \times \boldsymbol{\rho}\mathbf{CH_4} \times \mathbf{GWP_{CH4}}) + (\mathbf{Vented_i} \times \%\mathbf{CO_2} \times \boldsymbol{\rho}\mathbf{CO_2})$$

= (1,050,000 m^3/yr x 97% x 0.678 kg/m^3 x 25) + (1,050,000 m^3/yr x 2% x 1.86kg/ m^3)

= 17,302,635 kg CO_2e/yr x 1 tonne/1,000 kg

= 17,303 tonnes CO_2e/yr

$$\mathbf{Emissions_{Project}} = \sum(\mathbf{EC_i} \times \mathbf{EF_{Elec}} \times \mathbf{Managed\ Air_i}) \div \sum \mathbf{Total\ Managed\ Air_i}$$

= (821,250 kWh x 0.011 kg/kWh x 100%) / 100%

= 9,034 kg CO_2e/yr x 1 tonne/1,000 kg

= 9 tonnes CO_2e/yr

$$\mathbf{Emissions_{Reduction}} = \mathbf{Emissions_{Baseline}} - \mathbf{Emissions_{Project}}$$

= 17,303 tonnes CO_2e – 9 tonnes CO_2e

= 17,294 tonnes CO_2e

Final Result:

$$\mathbf{Project\ Emissions_{Reduction}} = \sum \mathbf{Emissions_{Reductions, components\ A-D}} \times \mathbf{Project\ Period}$$

= (5,139 tonnes CO_2e/yr +4,870 tonnes CO_2e/yr +14,505 tonnes CO_2e/yr +17,294 tonnes CO_2e/yr) x 9.5yr

= 397,176 tonnes CO_2e

Category 2 Example (Electrification Project):

- Greenfield wellsite electrification (connected to integrated grid or isolated grid)
- Component A: Installing 10 electric-driven pneumatic devices
- Component B: Installing 5 electric-driven chemical injection pumps
- Component C: Installing one 50 HP electric-driven reciprocating compressor.
- Project period: July, 1 2019 – December 31, 2028 (9.5 years)

The assumptions/values used for this example calculation are noted in Table B.2.

Table B.2: Parameters used in Category 2 Example

Parameter	Description	Value/Assumption
Operating Hours,$_i$	Operating hours of device *i* each year, based on historical operating information	Assume 8760 hours per year for each device
$\%CH_4$	Percentage of CH_4 in vent gas by volume, based on gas analysis	Assume 97%
$\%CO_2$	Percentage of CO_2 in vent gas by volume, based on gas analysis	Assume 2%
ρCH_4	Density of CH_4	0.678 kg/m^3
ρCO_2	Density of CO_2	1.86 kg/m^3
GWP_{CH4}	Global warming potential of CH_4	25
GWP_{N2O}	Global warming potential of N_2O	298
$EF_{High\text{-}bleed,i}$	Bleed rate of High-bleed device *i*	Assume all devices are Fisher C4150 pressure controllers with a bleed rate of 0.4209 m^3/hr, as listed in Table 360-6 of WCI.367
$EF_{Pump,\ i}$	Emission factor for pneumatic pump *i*	Assume the specific devices are unknown. In this case, use the attributes for a generic diaphragm pump and a bleed rate of 1.0542 m^3/hr, as listed in Table 360-6 of WCI.367. A discount factor of 20% will be applied for using the generic emission factor.
$EF_{Compressor,\ i}$	Emission factor for reciprocating compressor *i*	Assume the specific devices are unknown. In this case, use the Equation 360-22 with emission factor 267.9 Sm^3/yr per compressor for CH_4 and 14.9 Sm^3/yr per compressor for CO_2 at 15^{o}C and 1 atmosphere to estimate the simulated emission. A discount factor of 20% will be applied for using the generic emission factor.

Parameter	Description	Value/Assumption
$EC_{Int\text{-}grid}$	Electricity consumed by all equipment in the wellsite (Integrated Grid)	Assume the transmission line connected to BC Hydro grid runs pneumatic devices, chemical injection pumps, the reciprocating compressor, and other equipment. Based on the engineering design, the monthly electricity usage will be 50,000 kWh, or 600,000 kWh/yr
$EF_{Int\text{-}grid}$	Emission Factor for electricity generation (Integrated Grid)	0.011 kg/kWh (for BC Hydro grid)
$EC_{Iso\text{-}grid}$	Electricity consumed by all equipment in the wellsite (Isolated Grid)	Assume electricity is supplied by the isolated grid generated using a non-electricity fuel (natural gas) to run pneumatic devices, chemical injection pumps, and the reciprocating compressor. Based on engineering design, the monthly electricity usage will be 50,000 kWh, or 600,000 kWh/yr
$EF_{Iso\text{-}grid}$	Emission Factor for electricity generation, ie.GHG emissions associated with the electricity supplied by an isolated grid, generated using natural gas	Quantification of CO_2 emissions must use WCI.23(b), (c) or (e), and, if applicable, WCI.23(f). Quantification of CH_4 and N_2O emissions must use WCI.24.
EF_{CO2}	Emission Factor for natural gas	56.13 kg/GJ
EF_{CH4}	Emission Factor for natural gas	0.01279 kg/GJ
EF_{N2O}	Emission Factor for natural gas	0.001279 kg/GJ
Project Period	Applicants are required to estimate when the equipment will be in service and use this date as the start date for the purpose of estimating emissions. This may be different for each activity	9.5 years, assuming an equipment start date of July 1, 2019 and end date of December 31, 2028

Solution:

1. Calculate the $\text{Emissions}_{\text{Baseline}}$ for each component
2. Calculate the $\text{Emissions}_{\text{Project}}$ for each scenario (Integrated Grid & Isolated Grid)
3. Calculate the $\text{Emissions}_{\text{Reduction}}$ for each scenario (Integrated Grid & Isolated Grid)

Component A: **Estimating simulated baseline emissions from 10 gas-driven high-bleed pneumatic devices**

$$\mathbf{Emissions_{Baseline}} = \sum(\mathbf{EF_{High-bleed,i}} \times \mathbf{Operating\ Hours_i} \times \%\mathbf{CH_4} \times \mathbf{\rho CH_4} \times \mathbf{GWP_{CH4}}) + (\mathbf{EF_{High-bleed,i}} \times \mathbf{Operating\ Hours_i} \times \%\mathbf{CO_2} \times \mathbf{\rho CO_2})$$

= 10 x [(0.4209 m^3/hr x 8760 hr x 97% x 0.678 kg/m^3 x 25) + (0.4209 m^3/hr x 8760 hr x 2% x 1.86kg/m^3)]

= 607,584 kg CO_2e/yr x 1 tonne/1,000 kg

= 608 tonnes CO_2e /yr

Component B: **Estimating simulated baseline emissions from 5 gas-driven pneumatic chemical injection pumps**

$$\boldsymbol{Emissions_{Baseline}} = \sum(\mathbf{EF_{Pump,i}} \times \mathbf{Operating\ Hours_i} \times \%\mathbf{CH_4} \times \mathbf{\rho CH_4} \times \mathbf{GWP_{CH4}}) + (\mathbf{EF_{Pump,i}} \times \mathbf{Operating\ Hours_i} \times \%\mathbf{CO_2} \times \mathbf{\rho CO_2})$$

= 5 x [(1.0542 m^3/hr x 8760 hr x 97% x 0.678 kg/m^3 x 25) + (1.0542 m^3/hr x 8760 hr x 2% x 1.86kg/m^3)]

= 760,887 kg CO_2e/yr x 1 tonne/1,000 kg

= 760 tonnes CO_2e /yr

= 609 tonnes CO_2e/yr (**including discount factor of 20% for using generic emission factor**)

Component C: **Estimating simulated baseline venting emissions from gas-driven reciprocating compressor**

$$\mathbf{Emissions_{Baseline}} = \sum(\mathbf{EF_{Compressor,i}} \times \%\mathbf{CH_4} \times \mathbf{\rho CH_4} \times \mathbf{GWP_{CH4}}) + (\mathbf{EF_{Compressor,i}} \times \%\mathbf{CO_2} \times \mathbf{\rho CO_2})$$

= [(267.9 m^3/yr x 97% x0.678 kg/m^3 x 25) + (14.9 m^3/yr x 2% x 1.86kg/m^3)]

= 4,405 kg CO_2e/yr x 1 tonne/1,000 kg

= 4.405 tonnes CO_2e /yr

= 3.5 tonnes CO_2e /yr (**including discount factor of 20% for using generic emission factor**)

Estimating Emissions Reductions - Option 1 (Integrated Grid)

$$\mathbf{Emissions_{Project,Int} = EC_{Int-grid} \times EF_{Int-grid}}$$

= 600,000 kWh x 0.011 kg/kWh

= 6,600 kg CO_2e/yr x 1 tonne/1,000 kg

= 6.6 tonnes CO_2e/yr

$$\mathbf{Emissions_{Reduction,Int} = \left(\sum Emissions_{Baseline,components\ A-C} - Emissions_{Project,Int}\right) \times Project\ Period}$$

= (608 tonnes CO_2e/yr + 609 tonnes CO_2e/yr + 3.5 tonnes CO_2e/yr – 6.6 tonnes CO_2e/yr) x 9.5 yr

= 11,532 tonnes CO_2e

Estimating Emissions Reduction - Option 2 (Isolated Grid)

$$\mathbf{Emissions_{Project,Iso} = EC_{Iso-grid} \times EF_{Iso-grid}}$$
$$\mathbf{= EC_{Iso-grid} \times [(EF_{CO2} + EF_{CH4}) \times GWP_{CH4} + EF_{N20} \times GWP_{N20}]}$$

= 600,000 kWh x [(56.13 kg/GJ + 0.01279 kg/GJ) x 25 + 0.001279 kg/GJ x 298] x 0.0036 GJ/kWh

= 122,755 kg CO_2e/yr x 1 tonne/1,000 kg

= 122.8 tonnes CO_2e/yr

$$\mathbf{Emissions_{Reduction,Iso} = \left(\sum Emissions_{Baseline,components\ A-C} - Emissions_{Project,Iso}\right) \times Project\ Period}$$

= (608 tonnes CO_2e/yr + 609 tonnes CO_2e/yr + 3.5 tonnes CO_2e/yr – 122.8 tonnes CO_2e/yr) x 9.5 yr

= 10,428 tonnes CO_2e