Mexico Boiler Efficiency Project Protocol Draft

Energy Efficiency Improvements for Mexican Boilers

Workgroup Discussion Draft #2

As of: 1 June 2016

NOTE: This is a Workgroup Discussion Draft, and as such, is subject to change. This draft reflects the Reserve's current thinking and recommendations for various protocol elements, including text boxes addressed to the workgroup in a number of sections where we have specific questions and/or seek specific feedback. **Workgroup members are encouraged to submit written comments to the Climate Action Reserve by Thursday, June 16th, 2016 to ensure those comments are reflected with changes in the document.**

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This protocol development effort was supported by funding from the Secretaría de Energía (SENER) through the Fund for Energy Transition and Sustainable Use of Energy (Fondo para la Transición Energética y el Aprovechamiento Sustentable de la Energía (FOTEASE)), as well as the U.S. Agency for International Development (USAID), who provided funding through their Mexico Low Emission Development Program (MLED).

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Abbreviations and Acronyms

BHP	Boiler horsepower
Btu	British Thermal Unit
CO_2	Carbon dioxide
CH_4	Methane
CONUEE	Comisión Nacional Para El Uso Eficiente de la Energía
CRE	Comisión Reguladora de Energía
CRT	Climate Reserve Tonne
EPA	U.S. Environmental Protection Agency
GHG	Greenhouse gas
ISO	International Organization for Standardization
kg	Kilogram
MMBtu	Million British Thermal Unit
NOM	Norma Oficial Mexicana (Mexican Official Standard)
N_2O	Nitrous oxide
Reserve	Climate Action Reserve
SEMARNAT	Secretaría de Medio Ambiente y Recursos Naturales (Secretariat of Environment and Natural Resources)
SENER	Secretaría de Energía (Secretariat of Energy)
SSR	Source, sink, and reservoir
t	Metric ton (or tonne)

1 Introduction

The Climate Action Reserve (Reserve) Mexico Boiler Efficiency Project Protocol provides guidance to account for, report, and verify greenhouse gas (GHG) emission reductions associated with boiler efficiency improvements in Mexico.

The Reserve is an offset registry serving the California cap-and-trade program and the North American voluntary carbon market. The Reserve encourages actions to reduce GHG emissions and works to ensure environmental benefit, integrity, and transparency in market-based solutions to address global climate change. It operates the largest accredited registry for the California compliance market and has played an integral role in the development and administration of the state's GHG offset program. For the voluntary market, the Reserve establishes high quality standards for carbon offset projects, oversees independent third-party verification bodies, and issues and tracks the transaction of carbon credits (Climate Reserve Tonnes or CRTs) generated from such projects in a transparent, publicly-accessible system. The Reserve is a private 501(c)(3) nonprofit organization based in Los Angeles, California.

Project developers that initiate Mexico Boiler Efficiency projects use this document to quantify and register GHG reductions with the Reserve. The protocol provides eligibility rules, methods to calculate reductions, performance-monitoring instructions, and procedures for reporting project information to the Reserve. Additionally, all project reports receive annual, independent verification by ISO-accredited and Reserve-approved verification bodies. Guidance for verification bodies to verify reductions is provided in the Reserve Verification Program Manual and Section 8 of this protocol.

This protocol is designed to ensure the complete, consistent, transparent, accurate, and conservative quantification and verification of GHG emission reductions associated with a Mexico Boiler Efficiency project.[1]

[1] See the WRI/WBCSD GHG Protocol for Project Accounting (Part I, Chapter 4) for a description of GHG reduction project accounting principles.

2 The GHG Reduction Project

2.1 Background

The government of Mexico acknowledges that climate change represents the primary global environmental challenge of this century and has been a leader amongst developing nations with its progressive goals, targets and regulatory action at both the national and international level.

Internationally, Mexico has presented five National Communications of Mexico's greenhouse gas inventories to the United Nations Framework Convention on Climate Change (UNFCCC), was the first developing country (and one of the first countries overall) to release its post-2020 climate action plan, or "intended nationally determined contribution" (INDC), to the UNFCCC leading up to the Conference of Parties in Paris,[2] and was a leader in expressing its willingness to achieve a legally binding agreement with the participation of all Parties to the UNFCCC in the lead up to Paris.

Domestically, Mexico has published two National Strategies on Climate Change (ENCC), with the most recent in 2013, establishing 10, 20, and 40 year visionary goals for addressing climate change, focusing on adaptation and low emission development. Then in 2009, Mexico adopted a Special Program on Climate Change (PECC), which outlines policy planning instruments, strategies, specific action items and an annex of the complementary activities; PECC includes developing infrastructure for current and future carbon markets, an emphasis on the country's NAMAs, and prioritizes GHG mitigation actions[3].

In 2012, the Mexican Congress unanimously passed a General Law on Climate Change (LGCC), making Mexico the first developing country to pass a comprehensive law on climate change.[4] The LGCC mandates a 30% reduction in emissions below "business as usual" by 2020 and a 50% reduction below 2000 levels by 2050.[5] It also establishes a number of clean energy goals, such as the "promotion of energy efficiency practices, the development and use of renewable energy sources and the transfer and development of low carbon technologies"[6] and establishes a number of public policy instruments, such as the mandatory GHG reporting system, the National Emission Register (RENE).[7] RENE imposes a reporting obligation on companies or facilities emitting more than 25,000 tCO_2e/year, covering some 3000 companies from a variety of sectors, with 2015 being the first year all of these companies will have been required to report on their emissions from the previous year.[8] The RENE system is intended to be expanded in the future to include the voluntary registration of carbon offset projects based in Mexico, and later expanded further to the certification of such projects by SEMARNAT.[9]

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[2] WRI article: http://www.wri.org/blog/2015/03/mexico-becomes-first-developing-country-release-new-climate-plan-indc

[3] "Mexico: National Context," The Partnership for Market Readiness, World Bank, Accessed 23 December 2015. Available: https://www.thepmr.org/country/mexico-0#National Context

[4] Mexico INDC. Available at: http://www4.unfccc.int/submissions/INDC/Published%20Documents/Mexico/1/MEXICO%20INDC%2003.30.2015.pdf

[5] Camara de Diputados del H. Congresso de la Union (June 2012). "Ley General de Cambio Climatico." Estados Unidos Mexicanos. Available at: http://www.diputados.gob.mx/LeyesBiblio/pdf/LGCC_130515.pdf

[6] Camara de Diputados del H. Congresso de la Union (2012). "Ley General de Cambio Climatico."

[7] Camara de Diputados del H. Congresso de la Union (2012). "Ley General de Cambio Climatico."

[8] IETA (2015) Mexico: The Worlds Carbon Markets: A Case Study Guide to Emissions Trading, downloaded on 12/02/2015 from: https://www.edf.org/sites/default/files/mexico-case-study-may2015.pdf

[9] SEMARNAT 2015, *National Emissions Register: Mitigation Component*, downloaded on Nov 16th from: https://www.thepmr.org/sites/wbpmr/files/Mexico_RENE_PMR_240915.pdf.

Mexico has had a carbon tax on fossil fuels since it was passed by Congress in 2013. The amount of tax to be paid varies by the emissions intensity of the fossil fuel in question, relative to natural gas, with natural gas itself exempt from the tax. This carbon tax theoretically allows the use of carbon offset credits generated from CDM projects (CERs) in Mexico to help meet carbon tax liabilities, yet. Market participants anticipate the need for further refinement to the carbon tax regulation to fully operationalize how the CERs are applied.

In addition to the General Law on Climate Change and the Carbon Tax, on December 2013, Mexico's Congress voted to modify the Constitution to allow both domestic and foreign private investment in the energy sector.[10] This change effectively ended the monopolies held by state-owned PEMEX and CFE, in the oil and gas sector and electricity sector, respectively. All of these factors have combined to facilitate and provide incentive for comprehensive reform in the energy sector. Most recently, in December 2015, the Energy Transition Act was published, describing the new legal order related to renewable technologies for electric generation.[11]

Appendix C contains further detailed information on this regulatory framework in Mexico.

2.1.1 Background on Industrial & Power Generation Sectors

Within this legal framework, Mexico's industrial and power generation sectors represent a significant opportunity to achieve emissions reductions through boiler efficiency improvements.

Fossil fuels used for power generation in Pemex, CFE and for power generation by independent producers for power sales or self-consumption amounted to 2,101 Petajoules (PJ) in 2014[12] and produced GHG emissions amounting to nearly 135 million tonnes of CO_2, or 32% of the country's total fossil combustion related CO_2 emissions[13].

Meanwhile, Mexico's industrial sector used 1,568 PJ of energy total in 2014.[14] Excluding indirect emissions from electricity use and energy used for transformation (548.8 PJ), one can estimate that the industrial sector in Mexico produces approximately 67 million tonnes CO_2 per year, resulting from fossil fuel consumption of 982 PJ.[15] The table below indicates the consumption of secondary energy from fossil sources used in Mexico's industrial sector, excluding the power sector, for 2014.

[10] Camara de Diputados del H. Congresso de la Union (December 2013). "Decreto por el que se reforman y adicionan diversas disposiciones de la Constitución Política de los Estados Unidos Mexicanos, en Materia de Energía." Available at: http://www.diputados.gob.mx/LeyesBiblio/ref/dof/CPEUM_ref_212_20dic13.pdf

[11] Camara de Diputados del H. Congresso de la Union (December 2015). "Ley de Transición Energética." Estados Unidos Mexicanos. Available at: http://www.diputados.gob.mx/LeyesBiblio/pdf/LTE.pdf

[12] SENER, Balance Nacional de Energía 2014, Secretaría de Energía, 2015

[13] Based on data as per in "Inventario Nacional de Gases y Compuestos de Efecto Invernadero – Sectores Interés Nacional (2014) Emisiones por Combustión por Quema de Combustibles Fósiles" (INECC estimation, 2015). Available at:

[14] SENER, Balance Nacional de Energía 2014, Secretaría de Energía, Published 2015.

[15] *Ibid.*

Table 2.1. Industrial Energy Use and Estimated Emissions from Fossil Fuel Consumption in the Industrial Sector in Mexico for 2014

	Petajoules[16]	EF ($kgCO_2/TJ$)[17]	tCO_2
TOTAL	**1,019.7**		**67,136,303**
Dry gas	603.3	56,100	33,844,008
Petroleum coke	113.5	97,500	11,067,225
Residual fuel oil	14.9	77,400	1,155,582
Coal	77.4	94,600	7,325,824
Coke of coal	68.9	94,600	6,516,994
Diesel	60.4	74,100	4,473,417
Liquefied petroleum gas	42.5	63,100	2,680,488
Gasoline and naphtha	1.1	69,300	72,765
Bagasse	37.7	0[18]	0

It is also worth noting the table above does not consider energy used for steam production in refineries, gas processing plants or thermal power plants. According to this same energy balance data, coal and heavy fuel oil use by CFE amount to some 612 PJ, with combined GHG emissions estimated at 53.5 $MtCO_2$. Given that these fuels cannot be used in gas turbines or combined cycle gas plants, and given heavy fuel oil internal combustion engine power plants represent a small fraction of the total, it is estimated that some 580 PJ and 51 $MtCO_2$ can be attributed to steam generation from those types of fuels alone. [19] These numbers are likely to be very conservative, given that 23 boilers utilized by CFE are fueled by natural gas (6), or a combination of heavy fuel oil and natural gas (17). This is not considered in the previous discussion as data in the 2014 National Energy Balance do not allow for a precise identification of the natural gas fraction consumed by those boilers. It must also be considered that that these figures do not include PEMEX boilers.

Note for Workgroup: Additional background data on PEMEX and CFE still to be added here (including tables similar to Table 2.1).

2.1.2 Background on Energy Efficiency and Boilers

According to the International Energy Agency (IEA), based on a study of industrial systems globally, steam systems account for approximately 38% of total energy usage of industrial systems, while motor systems account for approximately 15%.[20] Based on the figures in Table 2.1, therefore, just over a third of the 67 million tCO_2e may be attributable to generating steam in the industry, or roughly 22.3 million tCO_2e. IEA further estimates that globally the energy efficiency of steam production can be increased by at least 10%, estimating that in Mexico such an improvement could reduce energy use for industrial processes by approximately 31 PJ per

[16] *Ibid.*
[17] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Table 2.2
[18] As bagasse is biomass, according to major GHG accountability and reporting standards it is considered CO_2 neutral
[19] SENER, Balance Nacional de Energía 2014, Secretaría de Energía, Published 2015.
[20] International Energy Agency. "Tracking Industrial Energy Efficiency and CO2 Emissions." 2007. Available at: http://www.iea.org/publications/freepublications/publication/tracking_emissions.pdf

year.[21] Based on the emissions estimates in Table 2.1, such a 10% improvement in efficiency could reduce industrial steam boiler emissions by as much as 2 million tCO_2per year in Mexico.

The former figures are in addition to the effects of energy efficiency improvements in CFE and PEMEX boilers.

There is significant opportunity for emissions reductions due to improved energy efficiency and improved steam distribution efficiency at boilers used in the industrial and power generating sectors.

Appendix C contains further information, specifically in sections C1.1 and C1.2, on laws relevant to the project activities and regulatory compliance requirements.

2.2 Project Definition *[significant revisions]*

For the purpose of this protocol, the GHG reduction project is defined as the implementation of eligible project activities at an eligible boiler or group of eligible boilers, located at a single facility or project site. Eligible boiler equipment is defined in Section 2.2.1, and eligible project activities are defined in Section 2.2.2.

For projects comprised of more than one boiler, all boilers in the project must share the same start date, as defined in Section 3.2, independently pass the Performance Standard Test, as defined in Section 3.4.1, must be quantified separately, according to Section 5, and meet all protocol monitoring and reporting requirements. More than one boiler project may be implemented at a single facility concurrently, so long as each individual project is clearly defined and has its own start date and crediting period, and meets protocol monitoring and reporting requirements. Joint verifications for facilities with multiple projects are also possible, as described in more detail in Section 8.

2.2.1 Eligible Equipment Types *[significant revisions]*

For the purpose of this protocol, project activities shall be implemented at an eligible boiler or group of boilers. A boiler is defined as a closed vessel or arrangement of vessels and tubes and a heat source, in which water is heated to produce steam to drive turbines or engines, generate power, or drive other industrial process applications. This definition of "boiler" includes components of the boiler unit which are most relevant for determining its rated thermal efficiency, particularly the burner, flue stack, blowdown system, deaerator, feed water preheater, air preheater and economizer, in addition to the boiler unit itself. These subcomponents may not be common to all categories of boilers, but when present, either pre-existing in the baseline scenario or installed as part of the project activities, these components will be included within the project boundary (see Figure 2.1 in Section 2.2.2 below).

A boiler must have a rated capacity of 9.8 MW (33.5 MMBtu/h) or greater to be eligible under this protocol. As discussed further in Section 3.4.1, eligible boilers must also meet or exceed the Performance Standard, which varies based on boiler capacities, as follows:

- Boilers 9.8 to 30 MW (33.5 – 102.5 MMBtu/h)
- Boilers > 30 MW to 100 MW (>102.5 – 341.4 MMBtu/h)
- Boilers > 100 MW (>341.4 MMBtu/h)

[21] International Energy Agency. "Tracking Industrial Energy Efficiency and CO2 Emissions." 2007. Available at: http://www.iea.org/publications/freepublications/publication/tracking_emissions.pdf

Equipment ineligible under this protocol includes boilers with nominal heat transfer capacity below 9.8 MW (<33.5 MMBtu/h), hot water heaters,[22] furnaces, and process heaters.[23]

2.2.2 Eligible Project Activities *[significant revisions]*

Note for Workgroup: Please review the two eligible project type definitions closely.

Are both definitions sufficiently precise and clear as to what is included / excluded in an activity? If not, what type of specificity is missing?

Installing new high-efficiency boilers (as a project activity)
This project type is a hybrid of installing new-boilers and early retirement of old boilers. For these projects, the existing (baseline) boiler must be no older than 35 years to be eligible for replacement under this protocol (subject to further discussion), and the new boiler will be required to *exceed* the new boiler performance threshold (to be determined). These projects will be eligible for a single 5-year crediting period. Additional details are included in Sections 3.3 and 3.4.1 on eligibility requirements.

For these new high-efficiency boilers, we propose to allow old existing boilers (that were removed and replaced) to be reused, as we believe that is most practical and representative of reality in Mexico (and that the old boiler parts are likely replacing a less efficient or older boiler). However, this reuse will only be allowed under this protocol if the project developer can demonstrate that the boiler and/or boiler parts are not reused at the same plant / facility and is not being used to increase capacity at that plant / facility. We believe this will minimize risk that the life of lower-efficiency equipment is prolonged, and that efficiency becomes worse at other equipment. Do any WG members feel this is not appropriate?

For the purpose of this protocol, the GHG reduction project is defined as a project that implements one or more of the following technologies and practices ("project activities") at an eligible boiler (as defined in Section 2.2.1):

1. **Retrofitting existing boilers.** The project retrofits an existing boiler, installing one or more new efficiency improvement technologies to the existing boiler.

2. **Installing new high-efficiency boilers.** The project installs a new boiler that demonstrates greater efficiency than conventional alternatives. The existing boiler (that is replaced) may be retired or dismantled and sold for parts; however, this project type may not be used to facilitate a capacity expansion at the project site or facility. The project developer must demonstrate to the verifier that the old boiler is not still in use elsewhere at the same plant or facility and is not being used to expand capacity.

[22] Given their energy consumption levels, boilers smaller than 9.8 MW and hot water heaters would likely need additional incentives to make verification of emission reductions under this protocol cost-effective.
[23] For each of these equipment categories, there is no comprehensive data set or sources to allow for proper analysis of performance efficiencies needed to establish sound efficiency thresholds. This is necessary to make a protocol application practical. Nevertheless, a dedicated protocol or future inclusion of these additional devices in this protocol could be discussed at a future date.

For all projects, this protocol allows for boilers (both new and retrofitted) to switch from a higher carbon-intensity fuel to a lower carbon-intensity fuel (e.g. from coal to natural gas) over the course of the project. However, while this protocol allows for and encourages such a fuel switch in projects, fuel switching itself is not an eligible project activity. The nationwide trend in Mexico to switch to lower carbon intensity fuels, particularly natural gas, and the regulatory incentive provided by the carbon tax make this activity "business-as-usual."

As such, emission reductions resulting from a fuel switch will not generate credits under this protocol; only emission reductions from the project activities listed above are creditable.

Section 5.1.1 provides guidance on quantification for projects that include a fuel switch, while Appendix A provides additional context on why fuel switching was generally deemed non-additional.

2.2.3 The Physical Project Boundary *[significant revisions]*

The physical boundary of a project includes any components of one or more boilers and each boiler's associated steam generation system that will change between the baseline and project scenarios. The physical boundary will typically be limited to the components of the boiler unit which are most relevant for determining its rated thermal efficiency, namely the boiler, burner, flue stack, blowdown system, air preheater and economizer. The physical project boundary does not include steam distribution and condensate return systems, due to complexity involved in accounting for such improvements. See Figure 2.1.[24]

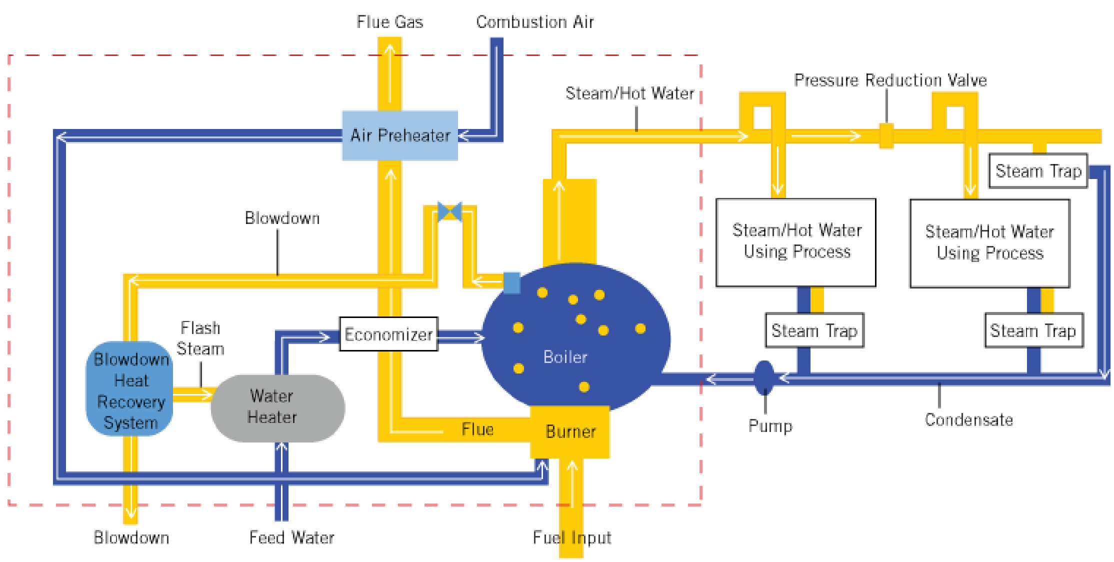

Figure 2.1. Physical Boundary for Industrial Boiler Projects[25]

2.3 The Project Developer

The "project developer" is an entity that has an active account with the Reserve, develops and submits a project for listing and registration with the Reserve, and is ultimately responsible for all project reporting and verification. Project developers may be energy service companies, facility owners, facility operators, or GHG project financiers, and may include entities wholly or

[24] Adapted from CDM methodology AM0056 / Version 01
[25] Diagram adapted from unpublished background research conducted for the US EPA's Climate Leaders Program.

partly controlled by government. In all cases, the project developer must attest to the Reserve that they have exclusive claim to the GHG reductions resulting from the project. Each time a project is verified, the project developer must attest that no other entities are reporting or claiming (e.g., for voluntary reporting or regulatory compliance purposes) the GHG reductions caused by the project.[26]

Under this protocol, the project developer is the only party required to hold an account with the Reserve and be involved with project implementation.

[26] This is done by signing the Reserve's Attestation of Title form, available at: http://www.climateactionreserve.org/how/program/documents/

3 Eligibility Rules *[significant revisions]*

Projects must fully satisfy the following eligibility rules in order to register with the Reserve. The criteria only apply to projects that meet the definition of a GHG reduction project (Section 2).

Eligibility Rule I:	Location	→	*Mexico*
Eligibility Rule II:	Project Start Date	→	*The date the system resumes or enters regular operation, following an initial start-up period of up to 6 months after project activities are implemented.* *No more than six months prior to project submission*
Eligibility Rule III:	Additionality	→	*Meet performance standard*
		→	*Exceeds any legally mandated efficiency improvements*
Eligibility Rule IV:	Regulatory Compliance	→	*Meet regulatory requirements*

3.1 Location

Only projects located in Mexico are eligible to register reductions with the Reserve under this protocol. All components of the physical boundary of each project, as described in Section 2, must be located in Mexico for the project to be eligible. Under this protocol, reductions from projects located outside of Mexico are not eligible to register with the Reserve.

3.2 Project Start Date *[significant revisions]*

The project start date is defined as the date on which an improved-efficiency boiler and the associated steam generation system becomes operational. For the purposes of this protocol, a boiler and its steam generation system is considered operational on the date the system resumes or enters regular operation generating relevant energy outputs (i.e., steam, heat, electricity, or a combination thereof), following an initial start-up period of up to 6 months. This operational date, or "start date," shall be selected by the project developer within the 6 month start-up period following the date on which the system first begins consuming energy inputs following the implementation of project activities, as defined in Section 2.2.2, (e.g. after a retrofit or installation of a new boiler).[27]

To be eligible, the project must be submitted to the Reserve[28] no more than six months after the project start date, unless the project is submitted during the first 12 months following the date of adoption of this protocol by the Reserve board (the Effective Date).[29] For a period of 12 months

[27] If the contract for commissioning boiler efficiency improvements includes operational performance guarantees, then the date the owner takes over operations could be used as the start date, provided that date is within 6 months of the date on which the system first begins consuming energy inputs following the commissioning of efficiency improvements.

[28] Projects are considered submitted when the project developer has fully completed and filed the appropriate project Submittal Form, available at http://www.climateactionreserve.org/how/program/documents/.

[29] The Effective Date for this protocol will be October 19, 2016

from the Effective Date of this protocol (Version 1.0), projects with start dates no more than 24 months prior to the Effective Date of this protocol are eligible. Specifically, projects with start dates on or after October 19, 2014 are eligible to register with the Reserve if submitted by June 29, 2017. Projects with start dates prior to June 29, 2014 are not eligible under this protocol. All of these dates assume an effective date of October 19, 2016 for this protocol (to be updated if a different effective date occurs). Projects may always be submitted for listing by the Reserve prior to their start date.

3.3 Project Crediting Period *[revisions]*

Note for Workgroup: The Reserve is proposing a single 10-year crediting period for retrofit projects, as this is considered a reasonable average lifetime for many boiler retrofits before additional retrofits are needed for the relevant boiler. The Reserve is also proposing a single 5-year crediting period for new boiler projects. From initial data analysis it appears that 38.5 years of age is an average age of retirement for boilers, and as such, this protocol assumes that replacement of boilers older than 40 years of age should be considered “business as usual”. New boilers may replace existing boilers 35 years old or younger (threshold subject to further discussion), and these projects will have a 5-year crediting period. The 5 year crediting period, together with the performance standard, help ensure that this protocol only credits truly additional emission reductions, as opposed to emission reductions from activities that may have occurred under business-as-usual. These assumptions and the two key thresholds of maximum fleet age and expected lifetime of retrofitted boilers, will be revisited as the data analysis is further refined. WG discussion of and feedback on this section is encouraged.

The crediting period for retrofit projects under this protocol is ten years. The crediting period for new boiler projects is five years. This is a one-time crediting period and cannot be renewed.

The Reserve will cease to issue CRTs for GHG reductions if at any point in the future, the efficiency levels achieved by project equipment become legally required. For further details on the effects of legal requirements, see the terms of the Legal Requirement Test (Section 3.4.2). Thus, the Reserve will issue CRTs for GHG reductions quantified and verified according to this protocol for a maximum of one ten year crediting period after the project start date, or until the project activity is required by law. At the end of the crediting period new projects may be initiated at the same boiler units at the same facility, through the implementation of new project activities.

3.4 Additionality *[significant revisions]*

The Reserve registers only projects that yield surplus GHG reductions that are additional to what would have occurred in the absence of a carbon offset market.

Projects must satisfy the following tests to be considered additional:

1. The Performance Standard Test
2. The Legal Requirement Test

3.4.1 The Performance Standard Test *[significant revisions]*

Note to the Workgroup: Please review the proposed structure, as the Performance Standard has been refined significantly over the past few months. However, please note, the actual performance thresholds are still "to be determined" and will be the focus of some significant discussion during the Workgroup Meeting.

Due to delays in receiving the data, however, analysis of data is ongoing. As such, the final performance threshold and underlying data analysis are not included in this draft. However, we plan to discuss preliminary results of the data analysis during the workgroup meeting and ask that you please review the proposed structure of the Performance Standard, envisioning at what level the threshold should be set (i.e., mean, median, 75th percentile), so that it conservatively excludes any business-as-usual projects.

As mentioned in the section 2.2 and 3.3 discussion boxes, there is an additional element of the performance standard / eligibility test for new boiler projects. Once installed boilers reach 35-40 years of age they are subject to being replaced as part of Business As Usual. Thus a new boiler project (replacement of an existing boiler) will only be an eligible project activity if the existing boiler being replaced is no older than 35 years of age.

This threshold will be revisited as the data analysis is further refined. WG discussion of and feedback on this section is encouraged.

Projects pass the Performance Standard Test (PST) by meeting a performance threshold, i.e. a standard of performance applicable to all boiler efficiency projects, established by this protocol. The performance threshold represents a level of energy efficiency that is beyond business-as-usual compared to existing boilers of the same fuel-type. A full discussion of the analysis on data from existing boilers in Mexico used to inform the performance standard can be found in Appendix A of this protocol.

To meet the performance standard, all project types are required to improve energy efficiency beyond the energy efficiency performance threshold in Table XX. More specifically, project boiler fuel efficiency ($\eta_{P,y}$), as calculated according to guidance in Section 5, must exceed the energy efficiency performance threshold in Table XX that corresponds to the project type and the fuel-type used in the project boiler during the reporting period. Project boilers that were retrofitted for a new fuel-type (i.e., uses a different fuel in the baseline than the project shall use the performance threshold specific to the new fuel-type, as used during the project reporting period.

For new boiler projects, there is an additional component of the performance standard. For these new boiler projects, the old existing boiler (that is replaced as the project activity) may be no older than 35 years at the time of the project start date (as defined in Section 3.2). Boilers older than 35 years are assumed to be old enough that it is business-as-usual to be replaced with newer, more efficient boilers.

The Performance Standard Test is applied at the time a project applies for registration with the Reserve.

3.4.2 The Legal Requirement Test *[revisions]*

All projects are subject to a Legal Requirement Test to ensure that the GHG reductions achieved by a project would not otherwise have occurred due to federal, state, or local regulations, or other legally binding mandates. To satisfy the Legal Requirement Test, project developers must submit a signed Attestation of Voluntary Implementation form[30] prior to the commencement of verification activities each time the project is verified (see Section 8). In addition, the project's Monitoring Plan (Section 6) must include procedures that the project developer will follow to ascertain and demonstrate that the project at all times passes the Legal Requirement Test.

The Reserve did not identify any existing federal, state, or local regulations that obligate existing boilers to operate at a minimum level of efficiency.

As noted in Section 2.1, Mexico has been mitigating carbon emissions at the national level with a carbon tax on fossil fuels since 2013. While the carbon tax does provide incentive for regulated entities (namely fuel importers and processors) to improve energy efficiency, it does not require improved efficiency at boilers, and therefore does not impact additionality. Further, this protocol does not include "fuel switching" from a higher carbon-intensity fuel to a lower carbon-intensity fuel as a separate project activity. The protocol permits fuel switching but does not credit emission reductions from fuel switching. If Mexico develops and implements an Emission Trading System in the future, it is possible that facilities implementing projects under this protocol may be included under an emissions cap. In that case, emission reductions may be reported to the Reserve up until the date that the emissions cap takes effect, as it is standard international best practice for offset projects to not credit emission reductions that occur at facilities covered by an emissions trading system cap.

3.5 Regulatory Compliance *[revisions]*

Projects must be in material compliance with all applicable laws (e.g., air, water quality, and safety), including environmental regulations, in order to be credited for GHG reductions. Project developers are required to disclose to the verifier all instances of non-compliance of the project with any law. Whether a violation has an impact on the issuance of CRTs to a project will depend upon whether 1) the violation is related to the project or project activities, and 2) whether the violation is material. The verifier will assess whether a violation is related to the project or project activities. There may be many activities occurring at a facility at which the boiler is located that are unrelated to the project. Once the verifier has determined that the violation is related to the project activities and the reporting period being verified, they shall then assess the materiality of the violation. Violations that are administrative (such as an expired permit without any other associated violations or tardiness in filing documentation) are not considered material and do not affect CRT crediting. Any other type of violation that is project-related is generally considered material.

If a material violation is found to have occurred at the project facility, then the project would not be issued CRTs from the point in time when the violation occurred, until the point at which the violation was remedied to the satisfaction of the relevant regulatory authority. The project developer must carefully document all instances of non-compliance and relevant communications with regulators and provide such information to their verifier.

[30] Attestation forms are available at http://www.climateactionreserve.org/how/program/documents/.

Project developers must attest that project activities do not cause violations of applicable laws (e.g. air, water quality, safety, etc.). To satisfy this requirement, project developers must submit a signed Attestation of Regulatory Compliance form[31] prior to the commencement of verification activities each time the project is verified.

[31] Attestation forms are available at http://www.climateactionreserve.org/how/program/documents/.

4 The GHG Assessment Boundary *[significant revisions]*

The GHG Assessment Boundary delineates the GHG sources, sinks, and reservoirs (SSRs) that must be assessed by project developers in order to determine the net change in emissions caused by a boiler efficiency project.[32]

Figure 4.1 illustrates all relevant GHG SSRs associated with project activities and delineates the GHG Assessment Boundary.

Table 4.1 provides greater detail on each SSR and justification for the inclusion or exclusion of certain SSRs from the GHG Assessment Boundary.

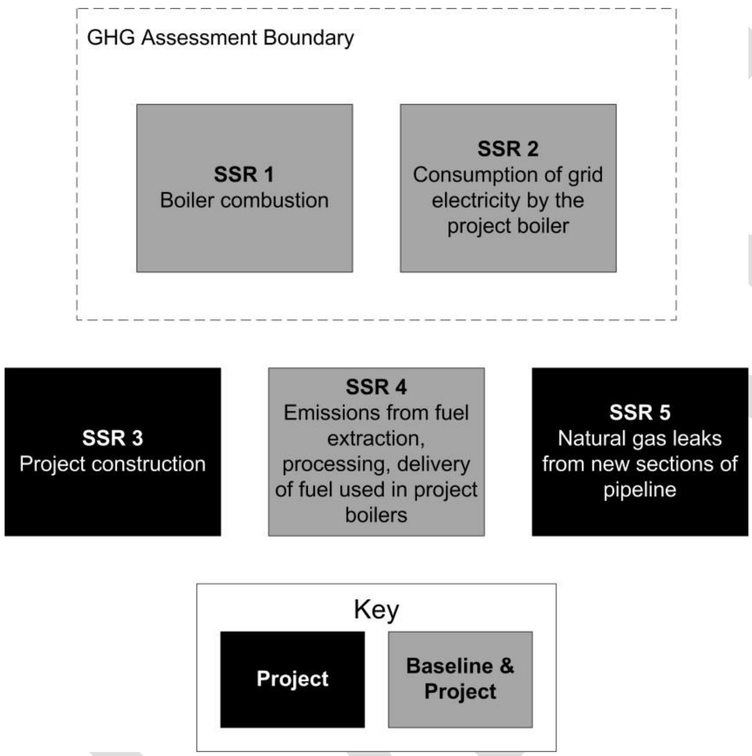

Figure 4.1. General Illustration of the GHG Assessment Boundary

[32] The definition and assessment of SSRs is consistent with ISO 14064-2 guidance.

Table 4.1. Description of all Sources, Sinks, and Reservoirs

SSR	Source Description	GHG	Included (I) or Excluded (E)	Baseline (B) or Project (P)	Justification/Explanation
1 Boiler combustion	Emissions from fuel combustion at boiler, including all eligible subcomponents in the boiler project boundary, including emissions from incomplete combustion of fuels	CO_2	I	**B, P**	CO_2 - Primary emission reductions opportunity for the project activities CH_4/N_2O – Excluded for simplification and because emissions are expected to be very small. Conservative to exclude.
		CH_4	E		
		N_2O	E		
2 Consumption of grid electricity by the project boiler	Indirect emissions associated with changes in consumption of electricity from the grid by the project boiler, including all eligible subcomponents in the project boundary	CO_2	I	**B, P**	While electricity consumption is expected to make up a small portion of total emissions from a single boiler, it is expected that emission reductions from reduced grid electricity consumption could be significant for a given project.
3 Project construction	Project construction and emissions from decommissioning an old boiler, installation of a new boiler, or retrofitting an existing boiler	CO_2 CH_4 N_2O	E	**P**	Project emissions for such changes should be negligible and therefore are excluded.
4 Emissions from fuel extraction, processing, delivery of fuel used in project boilers	Facilities where fuel used undergoes extraction, processing and delivery	CO_2 CH_4 N_2O	E	**B, P**	The difference between baseline and project emissions for such changes should be negligible and therefore are excluded.
5 Natural gas leaks from new sections of pipeline	Natural gas leaks from new sections of natural gas distribution pipeline installed due to the project to service the project boiler.	CH_4	E	**P**	This protocol does not credit emission reductions associated with the fuel switch to natural gas, as such this project will not directly lead to the construction of new sections of pipeline.

5 Quantifying GHG Emission Reductions *[very significant revisions – UPDATED JUNE 3, 2016]*

Note for Workgroup: This section is a highly technical section, but is intended to be straightforward enough for someone who is not an engineer to read and understand. The Reserve has provided some explanation of the equations throughout, but is considering adding additional explanation if needed. Please consider whether the quantification methodology was easy enough to understand and follow, and whether further explanation of any specific areas would help.

Please also note, upon further consideration, the Reserve no longer believes that including "for boiler *k*" in each parameter and equation (as they currently are) is necessary. We believe it is messy and confusing. Instead, the Reserve proposes to remove all "*k*"s from these parameters and will add a line to the protocol (in the section immediately below this text box) that all boilers must be quantified separately and emission reductions summed at the end. Please let us know if you disagree with this decision.

GHG emission reductions from a boiler efficiency project are quantified by subtracting actual project emissions from the calculated baseline emissions. Baseline emissions are an estimate of the GHG emissions from sources within the GHG Assessment Boundary (see Section 4) that would have occurred in the absence of the project. Project emissions are actual GHG emissions that occur at sources within the GHG Assessment Boundary. Project emissions must be subtracted from the baseline emissions to quantify the project boiler's total net GHG emission reductions (Equation 5.1).

Quantification of both boiler retrofit projects and new boiler projects will follow the same quantification methodology, as discussed below.

If the project is comprised of more than one eligible boiler, the emissions and emission reductions of each boiler *k* must be quantified separately and summed, as described in Equation 5.1. Similarly, the boiler fuel efficiency must be calculated separately for each individual boiler *k,* for use in both the quantification of emission reductions for Equation 5.1, as well as for demonstrating that each project boiler has met the Performance Standard Threshold, as described in Section 3.4.1.

GHG emission reductions must be quantified and verified on at least an annual basis. Project developers may choose to quantify and verify GHG emission reductions on a more frequent basis if they desire. The length of time over which GHG emission reductions are periodically quantified and verified is called the "reporting period."

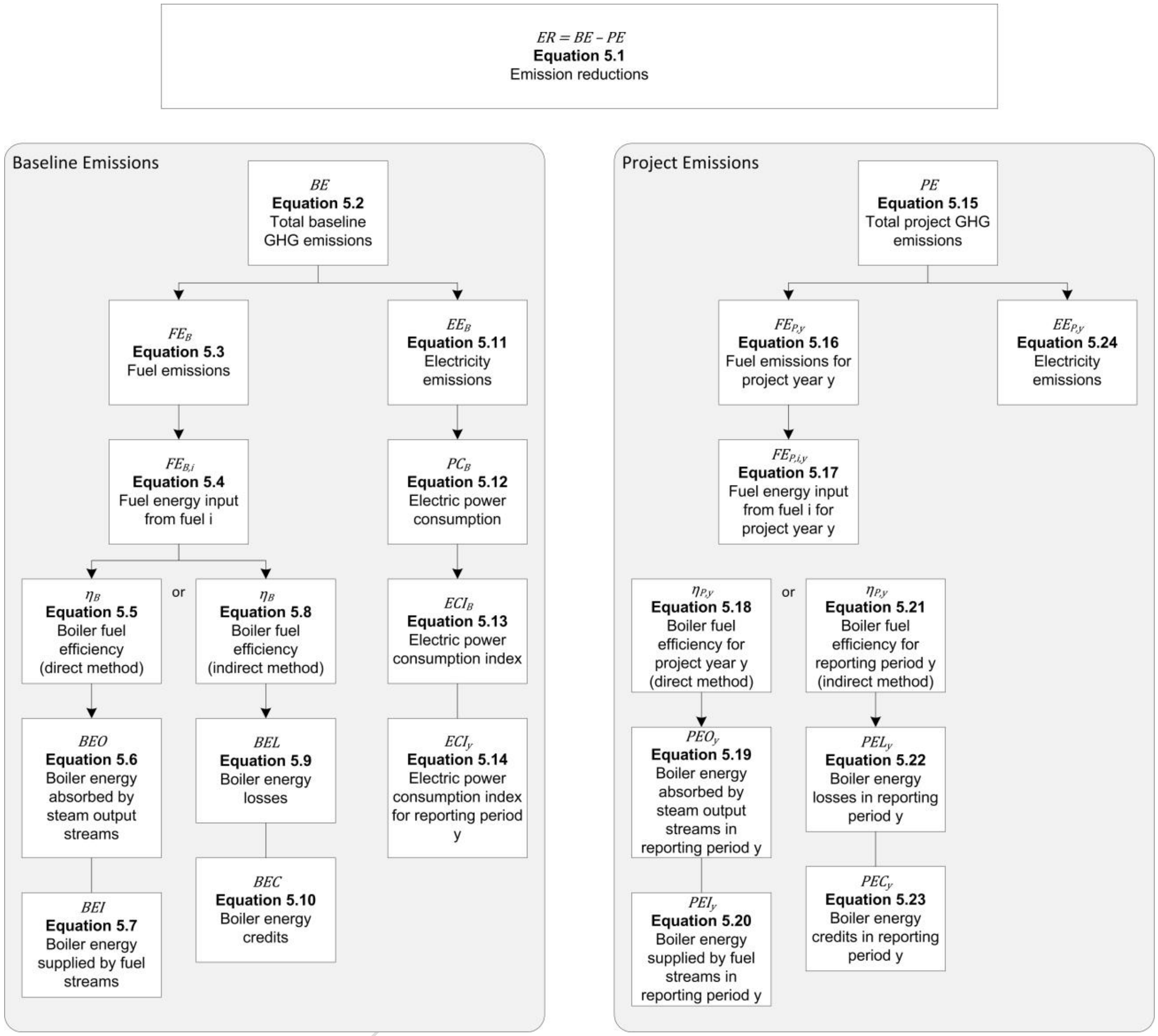

Figure 5.1. Equation Map for Mexico Boiler Efficiency Projects

Equation 5.1. Calculating GHG Emission Reductions

$$ER = \sum_{k} [BE_k - PE_k]$$

Where, Units

ER	=	Total emission reductions for the reporting period, for all boilers	tCO_2e
BE_k	=	Total baseline emissions for the reporting period, for boiler k, from all SSRs in the GHG Assessment Boundary (as calculated in Section 5.1)	tCO_2e
PE_k	=	Total project emissions for the reporting period, for boiler k, from all SSRs in the GHG Assessment Boundary (as calculated in Section 5.2)	tCO_2e

5.1 Quantifying Baseline Emissions

Total baseline emissions for the reporting period are estimated by calculating and summing the emissions from all relevant baseline SSRs that are included in the GHG Assessment Boundary (as indicated in Table 4.1).

In order to ensure that any changes in the operating regime of the boiler between the baseline and project scenarios do not affect the comparability of the emissions profiles of the baseline and project scenarios , data on the useful energy transferred from the project reporting period will be applied to the baseline period. The baseline and project boiler efficiencies should then be calculated and reported separately.

Calculate total baseline emissions using Equation 5.2.

Equation 5.2. Quantifying Total Baseline GHG Emissions

$$BE_k = FE_{B,k} + EE_{B,k}$$

Where, Units

BE_k	=	Total baseline emissions for the reporting period, for boiler k, from all SSRs in the GHG Assessment Boundary	tCO_2e
$FE_{B,k}$	=	Baseline fuel emissions for boiler k (as calculated in Equation 5.3)	tCO_2e
$EE_{B,k}$	=	Baseline electricity emissions for boiler k (as calculated in Equation 5.11)	tCO_2e

5.1.1 Quantifying Baseline Fuel Emissions

Baseline fuel emissions are estimated by using Equation 5.3. As the baseline is the continuation of “business as usual” (BAU) conditions if the project had not occurred, it is a counter-factual claim regarding what the baseline fuel emissions would have been; therefore, these emissions must be estimated.

Note to Workgroup: For projects that include a fuel switch, which is allowable under this protocol but will not receive credits for the switch as it is assumed to be occurring simultaneously with the project activity, the Reserve has proposed using the project emission factor (EF) of the lower carbon-intensity fuel in both the baseline and project calculations, as a means of excluding emission reductions from the fuel switch from crediting. The alternative would be to use the higher carbon intensity baseline EF in both calculations, which would likely yield more calculated emission reductions.

The Reserve prefers using the project EF as it is the more conservative option, thereby consistent with best practices in carbon accounting. It also allows reporting period calculations to be representative of the total actual emissions in the reporting period, as opposed to modeling those emissions (a practice typically only used in the baseline scenario, which always must be estimated, due to the fact that the baseline is a counterfactual).

However, the argument could be made that this potentially disincentives a fuel switch, which we've assumed is business as usual. Using the project EF in both scenarios could be argued to give two advantages to non-fuel switching projects (a higher efficiency level in the project reporting period and a larger overall pool of emissions, with resulting higher potential for emission reductions), whereas we potentially punish twice the fuel switch projects, which have more real emission reductions.

Please consider these arguments for and against using the project EF for both baseline and project calculations for fuel-switch projects.

For all projects that involve the switching of fuels from a higher to a lower carbon-intensive fuel, baseline emissions will be calculated using an emission factor for fuel consumed in the project scenario. This will ensure that no emission reductions are credited for the switching of fuels itself, but will still allow for emission reductions to be credited for other efficiency gains associated with the new equipment.

In order to ensure that changes in the operating regime of the boiler between the baseline and project scenarios do not affect the comparability of the emissions profiles of the baseline and project scenarios, fuel emissions must be calculated using an estimate of fuel energy inputs, rather than simply the volume of fuel used in the baseline. If fuel emissions were calculated simply using the volume of fuel used in the baseline, then changes in operational regime could give rise to an overestimation or underestimation of emission reductions, without any change in efficiency, i.e., if the facility temporarily slowed down its demand for steam, it would be credited for associated emission reductions due to lower fuel consumption.

Equation 5.3. Quantifying Baseline Fuel Emissions

$$\boldsymbol{FE_{B,k} = \sum_{i}(FE_{B,k,i} \times EF_{Fuel_{CO_2,B,k,i}})}$$

Where,			Units
$FE_{B,k}$	=	Baseline fuel emissions for boiler k	$kgCO_2$
$FE_{B,k,i}$	=	Baseline fuel energy input for boiler k, from fuel i (as calculated in Equation 5.4)	TJ
$EF_{Fuel,CO2,B,k,i}$	=	Baseline CO_2 emission factor for boiler k, from fuel i, as provided in Appendix B. (Projects that switch from a higher to lower carbon-intensive fuel over the course of the project must use the fuel emission factor for the fuel used in the project scenario here)[33]	$kgCO_2/TJ$

The baseline fuel energy input from fuel i, $FE_{B,k,i}$, is calculated based on measured, estimated, or default higher heating value and measured project reporting period consumption for fuel i and an efficiency ratio of baseline fuel efficiency to project fuel efficiency as per Equation 5.4.

Calculating the fuel efficiency ratio allows us to represent a hypothetical fuel consumption in the baseline (higher) that would be needed to supply the same useful energy as required for operational demands in the project reporting period *y*, provided the baseline efficiency of the project boiler was lower.

Equation 5.4. Quantifying Baseline Fuel Energy Input from Fuel i

$$\boldsymbol{FE_{B,k,i} = HHV_{B,k,i} \times QF_{P,k,i,y} \times \frac{\eta_B}{\eta_{P,y}}}$$

Where,			Units
$FE_{B,k,i}$	=	Baseline i fuel energy input for boiler k, from fuel i	TJ
$HHV_{B,k,i}$	=	Baseline higher heating value for boiler k, from fuel i	TJ/kg or TJ/m^3
$QF_{P,k,i,y}$	=	Consumption of fuel i, for boiler k, from project reporting period y	kg or m^3
η_B	=	Baseline boiler fuel efficiency (as calculated in Section 5.1.2)	%
$\eta_{P,y}$	=	Project boiler fuel efficiency for project reporting period y (as calculated in Section 5.2.2)	%

5.1.2 Calculating Baseline Boiler Efficiency

When one talks about boiler efficiency, boiler fuel efficiency is what is being evaluated: the efficiency with which the boiler converts the energy supplied by fuel to steam.

It is common practice internationally to calculate boiler fuel efficiency via one of two methods: the direct method (also known as the input-output method) and the indirect method (also known as the energy balance method). The direct method is described in Equation 5.5 for the baseline and Equation 5.18 for the project reporting period, while the indirect method is described in Equation 5.8 for the baseline and Equation 2.1 for the project reporting period.

[33] If project developers have verifiable records on fuel *i* to calculate the emission factor for fuel *i* (EF, $Fuel_{CO2,BL,k,i}$), they may use the calculated EF instead of the default provided in Appendix B.

These equations are consistent with two of the most widely recognized methodologies: the American Society of Mechanical Engineers *Fired Steam Generators Performance Test Code* , known as ASME PTC 4-2013,[34] and the British Standard 845[35] (BS 845). These underlying methodologies provide additional calculations for how the various input parameters used in Equation 5.5, Equation 5.8, Equation 5.18, and Equation 5.21 are calculated. For the implementation of this protocol, boiler fuel efficiency must be calculated by using either of these methodologies (ASME PTC 4-2013[36] or the BS 845[37]) or the CONUEE Boiler Efficiency Tool.

The Reserve strongly encourages use of the CONUEE Boiler Efficiency Tool to streamline the boiler efficiency calculations. The CONUEE Boiler Efficiency Tool follows the ASME PTC 4-2013[38] method and was re-designed in parallel with this protocol to support project developers. This CONUEE Boiler Efficiency Tool allows users to calculate efficiencies using either the energy balance method or the input-output method.

Note to the Workgroup: The CONUEE Boiler Efficiency Tool is currently undergoing final stages of revision and review by CONUEE. The Reserve is working with CONUEE to finalize this tool and make it available on CONUEE's and the Reserve's websites in time for publication of this protocol. This section will be further updated with guidance on where to find the tool, as that information becomes available.

Additional guidance on how to use the tool will be provided in Appendix E (not currently included) that will be finalized once the tool is finalized.

The same method for calculating boiler fuel efficiency in the baseline (Section 5.1.2) must be applied for calculating boiler fuel efficiency for the project reporting period (Section 5.2.2). More specifically, if a project developer chooses to use the ASME energy balance method for the baseline, they must use the ASME energy balance method for the project reporting period; they cannot then apply the BS energy balance method or the ASME input-output method for the project reporting period.

Almost universally, the indirect method is preferable for calculating boiler fuel efficiency, due to lower uncertainty associated with the higher number of measured input parameters, and the difficulty associated with achieving accurate measurements for inputs in the direct method. However, when accurate measurements for the inputs necessary for the direct method are possible, the direct method is typically preferable.

Baseline boiler fuel efficiency, $\eta_{B,k}$, shall be calculated using any of the methods above, so long as the project developer is able to demonstrate sufficient accuracy of measurements, which is often challenging when using the input-output (or direct) method.

5.1.2.1 Direct (Input-Output) Method for Calculating Baseline Boiler Fuel Efficiency

The ASME PTC 4-2013 describes the Input-Output method as a method of determining steam generator efficiency by direct measurement of output (all energy absorbed by the working fluid

[34] ASME PTC 4-2013, *Fired Steam Generators Performance Test Code*, The American Society of Mechanical Engineers, New York, 2014.
[35] BS 845, "Methods for Assessing thermal performance of boilers for steam, hot water and high temperature heat transfer fluids," British Standard .
[36] ASME PTC 4-2013.
[37] BS 845.
[38] ASME PTC 4-2013

that is not recovered within the steam generator envelope) and input (the total chemical energy available from the fuel).[39] It is also called the “direct method.”

Equation 5.5. Calculating Baseline Boiler Fuel Efficiency (Direct / Input-Output Method)

$$\eta_{B,k} = \frac{BEO_k}{BEI_k} \times 100$$

Where, Units

$\eta_{B,k}$	=	Baseline boiler fuel efficiency for boiler k	%
BEO_k	=	Baseline boiler energy absorbed by steam output streams for boiler k (as calculated in Equation 5.6)	TJ
BEI_k	=	Baseline boiler energy supplied by fuel streams for boiler k (as calculated in Equation 5.7)	TJ

Baseline boiler energy absorbed by steam output streams, $BEO_{,k}$, is calculated as per Equation 5.6.

Equation 5.6. Calculating Baseline Boiler Energy Absorbed by Steam Output Streams

$$BEO_k = \sum_j QS_{B,k,j} \times \frac{(h_{k,j,out} - h_{k,j,in})}{10^9}$$

Where, Units

BEO_k	=	Baseline boiler energy absorbed by steam output streams for boiler k	TJ
$QS_{B,k,j}$	=	Total baseline flow of fluid stream j leaving boiler k boundary	kg
$h_{k,j,out}$	=	Enthalpy of fluid in stream j leaving boiler k boundary	kJ/kg
$h_{k,j,in}$	=	Enthalpy of fluid entering boiler k boundary, feeding stream j	kJ/kg
10^9	=	Unit conversion factor (kJ to TJ)	

Baseline boiler energy supplied by fuel streams, BEI_k, is calculated as per Equation 5.7.

Equation 5.7. Calculating Baseline Boiler Energy Supplied by Fuel Streams

$$BEI_k = \sum_i (HHV_{B,k,i} \times QF_{B,k,i})$$

Where, Units

BEI_k	=	Baseline boiler energy supplied by fuel streams to boiler k	TJ
$HHV_{B,k,i}$	=	Baseline higher heating value for fuel i for boiler k	TJ/kg or TJ/m^3
$QF_{B,k,i}$	=	Baseline boiler fuel i consumption for boiler k	kg or m^3

[39] ASME PTC 4-2013

5.1.2.2 Indirect (Energy Balance) Method for Calculating Baseline Boiler Fuel Efficiency

The ASME PTC 4-2013 describes the energy balance method as a method of determining steam generator efficiency by a detailed accounting of all energy entering and leaving the steam generator envelope. It is also sometimes called the “heat balance method” or the “indirect method.” The Reserve expects most project developers will prefer this energy balance method as it entails the lowest total uncertainty.

In the energy balance method, all energy is described in terms of net ‘losses’ and ‘credits’ to the overall energy balance. Energy losses are defined as the energy that exits the steam generator envelope other than the energy in the output stream(s).[40] Energy credits are defined as the energy entering the steam generator envelope other than the chemical energy in the as-fired fuel. These credits include sensible heat in the fuel, entering air, and atomizing steam; energy from power conversion in coal pulverizers, circulating pumps, primary air fans, and gas recirculation fans; and chemical reactions such as sulfation, amongst others. Credits can be negative, such as when the air temperature is below the reference temperature.[41]

Equation 5.8. Calculating Baseline Boiler Fuel Efficiency (Indirect / Energy Balance Method)

$$\eta_{B,k} = \frac{(BEI_k - BEL_k + BEC_k)}{BEI_k} \times 100$$

Where,			Units
$\eta_{B,k}$	=	Baseline boiler fuel efficiency for boiler k	%
BEI_k	=	Baseline boiler energy supplied by fuel streams for boiler k (as calculated in Equation 5.7)	TJ
BEL_k	=	Baseline boiler energy losses for boiler k (as calculated in Equation 5.9)	TJ
BEC_k	=	Baseline boiler energy credits for boiler k (as calculated in Equation 5.10)	TJ

As noted above, energy losses are defined as the energy that exits the steam generator envelope other than the energy in the output stream(s). Baseline boiler energy losses are calculated as per Equation 5.9.

Equation 5.9. Calculating Baseline Boiler Energy Losses

$$BEL_k = \sum_m BEL_{k,m}$$

Where,			Units
BEL_k	=	Baseline boiler energy losses for boiler k	TJ
$BEL_{k,m}$	=	Baseline boiler energy loss item m for boiler k	TJ

Further guidance on boiler energy losses to be considered is presented in Appendix E.

[40] ASME PTC 4-2013
[41] ASME PTC 4-2013

As noted above, energy credits are defined as the energy entering the steam generator envelope other than the chemical energy in the as-fired fuel. Baseline boiler energy credits are calculated as per Equation 5.10.

Equation 5.10. Calculating Baseline Boiler Energy Credits

$$BEC_k = \sum_n BEC_{k,n}$$

Where, Units

BEC_k	=	Baseline boiler energy credits for boiler k	TJ
$BEC_{k,n}$	=	Baseline boiler energy credit item n for boiler k	TJ

5.1.3 Quantifying Baseline Electricity Emissions

Note for Workgroup: At present, we have included both increases and decreases in electricity use (and electricity emissions) in the project GHG boundary. However, this determination is dependent on the ability to measure or accurately estimate electricity use, which we believe will be challenging. This SSR is excluded in the CDM methodology that is most similar to this one, and the ASME standard allows you to discard them from efficiency calculations due to the fact that these are often not measured.

The Reserve is considering excluding this SSR entirely and allowing project developers to assume power consumption is the same in baseline and project scenarios, unless there is a good reason to think consumption (and emissions) increase in the project scenario, and/or allowing this to be an optional source which project developers may quantify (both increases and decreases) if they install a meter.

There is a vast array of projects where you would not expect any power consumption changes, so it seems unnecessary to require metering of this SSR for all projects. However, even if we don't require metering for all projects, we must still consider a method for estimating an emissions increase, when those do occur.

Equation 5.11. Quantifying Baseline Electricity Emissions

$$EE_{B,k} = PC_{B,k} \times EF_{Grid,y}$$

Where, Units

$EE_{B,k}$	=	Baseline electricity emissions for boiler k (reported in CO_2e emissions from consumed electricity)	$kgCO_2e$
$PC_{B,k}$	=	Baseline electric power consumption for boiler k	MWh
$EF_{Grid,y}$	=	National electricity grid emission factor in Mexico for reporting period y[42]	$kgCO_2e/MWh$

[42] Project developers should use the national electricity grid emission factor most closely corresponding to the time period during which the electricity was used, which can be sourced from XXX.[to be determined – recommendations welcome]

As previously noted, in order to ensure that changes in the operating time and regime of the boiler between the baseline and project scenarios do not affect the comparability of the two, emissions from the consumption of grid electricity must not be calculated simply using electricity consumed in each relevant baseline or project scenario. If electricity emissions were calculated simply using electricity consumed in each relevant period, then changes in operational time or regime could lead to an overestimation or underestimation of emission reductions without any change in efficiency, i.e., if the factory temporarily slowed down the demand for steam, they would be credited for associated emission reductions for the reduction in electricity consumed.

Instead, baseline electric power consumption must be based on the relationship between power consumption in the reporting period y, as well as to the relative power consumption to steam absorbed energy in both the baseline and project scenarios.

Equation 5.12. Quantifying Baseline Electric Power Consumption

$$PC_{B,k} = PC_{P,k,y} \times \frac{ECI_{B,k}}{ECI_{P,k,y}}$$

Where, Units

$PC_{B,k}$	=	Baseline electric power consumption for boiler k	MWh
$PC_{P,k,y}$	=	Project electric power consumption for boiler k for reporting period y	MWh
$ECI_{B,k}$	=	Baseline electric power consumption index for boiler k	MWh/TJ
$ECI_{P,k,y}$	=	Electric power consumption index for boiler k for reporting period y	MWh/TJ

Equation 5.13. Quantifying Baseline Electric Power Consumption Index

$$ECI_{B,k} = \frac{PC_{H,k}}{\sum_i (HHV_{B,k,i} \times QF_{H,k,i}) \times \eta_{B,k}}$$

Where, Units

$ECI_{B,k}$	=	Baseline electric power consumption index for boiler k	MWh/TJ
$PC_{H,k}$	=	Historical electric power consumption for boiler k (use the average annual consumption for the past three years)	MWh
$HHV_{B,k,i}$	=	Baseline higher heating value for fuel i for boiler k	TJ/kg or TJ/m^3
$QF_{H,k,i}$	=	Historical boiler fuel i consumption at boiler k (use the average annual consumption for the past three years)	kg or m^3
$\eta_{B,k}$	=	Boiler fuel efficiency for baseline	%

Equation 5.14. Quantifying Electric Power Consumption Index for Reporting Period y

$$ECI_{k,y} = \frac{PC_{P,k,y}}{\sum_i (HHV_{k,i,y} \times QF_{P,k,i,y}) \times \eta_{P,k,y}}$$

Where, Units

$ECI_{k,y}$	=	Electric power consumption index for boiler k for reporting period y	MWh/TJ
$PC_{P,k,y}$	=	Project electric power consumption for boiler k for reporting period y	MWh
$HHV_{k,i,y}$	=	Baseline higher heating value for fuel i for boiler k	TJ/kg or TJ/m^3
$QF_{P,k,i,y}$	=	Project boiler fuel i consumption at boiler k for reporting period y	kg or m^3
$\eta_{P,k,y}$	=	Project boiler fuel efficiency for boiler k for reporting period y	%

5.2 Quantifying Project Emissions

Project emissions are actual GHG emissions that occur within the GHG Assessment Boundary as a result of the project activity. Project emissions must be quantified every reporting period on an *ex post* basis.

Equation 5.15. Quantifying Total Project GHG Emissions

$$PE_{k,y} = FE_{P,k,y} + EE_{k,y}$$

Where,

			Units
$PE_{k,y}$	=	Total project emissions for boiler k, from reporting period y, from all SSRs in the GHG Assessment Boundary	tCO_2e
$FE_{P,k,y}$	=	Project Fuel Emissions for boiler k (as calculated in Equation 5.16)	tCO_2e
$EE_{k,y}$	=	Project Electricity Emissions for boiler k for reporting period y (as calculated in Equation 5.24)	tCO_2e

5.2.1 Quantifying Project Fuel Emissions

Project fuel emissions for project reporting period y are estimated by using Equation 5.16.

Equation 5.16. Quantifying Project Fuel Emissions for Project Year y

$$FE_{P,k,y} = \sum_i (FE_{P,k,i,y} \times EF_{Fuel_{CO_2},P,k,i,y})$$

Where,

			Units
$FE_{P,k,y}$	=	Project fuel emissions for project boiler k in project year y	$kgCO_2$
$FE_{P,k,i,y}$	=	Project fuel energy input for boiler k from fuel i in project year y	TJ
$EF_{Fuel,CO2,P,k,i,y}$	=	Project CO_2 emission factor for fuel i for boiler k in project year y, as provided in Appendix B.[43]	$kgCO_2$/TJ

The project fuel energy input from fuel i for project year y, $FE_{P,k,y}$, is calculated based on measured, estimated or default higher heating value and measured project year y consumption for fuel i.

Equation 5.17. Quantifying Project Fuel Energy Input from Fuel i for Project Year y

$$FE_{P,k,i,y} = HHV_{k,i,y} \times QF_{P,k,i,y}$$

Where,

			Units
$FE_{P,k,i,y}$	=	Project fuel energy input from fuel i for boiler k in project year y	TJ
$HHV_{k,i,y}$	=	Project higher heating value for fuel i for boiler k in project year y	TJ/kg or TJ/m^3
$QF_{P,k,i,y}$	=	Project boiler k consumption of fuel i for project year y	kg or m^3

[43] If project developers have verifiable records on fuel *i* to calculate the emission factor for fuel *i* (EF, $Fuel_{CO2,BL,k,i}$), they may use the calculated EF instead of the default provided in Appendix B.

5.2.2 Calculating Project Boiler Fuel Efficiency

As discussed in Section 5.1.2, boiler fuel efficiency for the project reporting period y, $\eta_{P,y}$, can be calculated by the direct method (input-output method) or by the indirect method (energy balance method), as per Equation 5.18 and Equation 5.21, which are consistent with ASME PTC 4-2013[44] and BS 845[45]. These underlying methodologies provide additional calculations for how the various input parameters used in Equation 5.18 and Equation 5.21 are calculated. For the implementation of this protocol, boiler fuel efficiency must be calculated by using either of these methodologies (ASME PTC 4-2013[46] or the BS 845[47]) or the CONUEE Boiler Efficiency Tool.

As noted above, the Reserve strongly encourages use of the CONUEE Boiler Efficiency Tool to streamline these boiler efficiency calculations. The CONUEE Boiler Efficiency Tool follows the ASME PTC 4-2013[48]method and was re-designed in parallel with this protocol to support project developers. This CONUEE Boiler Efficiency Tool allows users to calculate efficiencies using either the energy balance method or the input-output method.

The same method for calculating boiler fuel efficiency in the baseline (per Section 5.1.2) must be applied for calculating boiler fuel efficiency for the project reporting period (in Section 5.2.2).

5.2.2.1 Direct (Input-Output) Method for Calculating Project Boiler Fuel Efficiency

Equation 5.18. Calculating Boiler Fuel Efficiency (Direct / Input-Output Method) for Project Reporting Period y

$$\boldsymbol{\eta_{P,k,y} = \frac{PEO_{k,y}}{PEI_{k,y}} \times 100}$$

Where,			Units
$\eta_{P,k,y}$	=	Project boiler fuel efficiency for boiler k for project reporting period y	%
$PEO_{k,y}$	=	Project boiler energy absorbed by steam output streams in boiler k in project reporting period y (as calculated in Equation 5.19)	TJ
$PEI_{k,y}$	=	Project boiler energy supplied by fuel streams for boiler k in project reporting period y (as calculated in Equation 5.20)	TJ

Project boiler energy absorbed by steam output streams in project reporting period y, $PEO_{k,y}$, is calculated as per Equation 5.19.

[44] ASME PTC 4-2013.
[45] BS 845.
[46] ASME PTC 4-2013.
[47] BS 845.
[48] ASME PTC 4-2013.

Equation 5.19. Calculating Project Boiler Energy Absorbed by Steam Output Streams in Project Reporting Period y

$$PEO_{k,y} = \sum_{j} \left[QS_{P,j,y} \times \frac{(h_{k,j,out} - h_{k,j,in})}{10^9} \right]$$

Where, Units

$PEO_{k,y}$	=	Project boiler energy absorbed by steam output streams for boiler k in project reporting period y	TJ
$QS_{P.k,j,y}$	=	Total project flow of fluid stream j leaving boiler boundary for boiler k in project reporting period y	kg
$h_{k,j,out}$	=	Enthalpy of fluid in stream j leaving boiler boundary k	kJ/kg
$h_{k,j,in}$	=	Enthalpy of fluid entering boiler boundary k, feeding stream j	kJ/kg
10^9	=	Unit conversion factor (kJ to TJ)	Dimensionless

Project boiler energy supplied by fuel streams in project reporting period *y*, $PEI_{k,y}$, is calculated by using Equation 5.20.

Equation 5.20. Calculating Project Boiler Energy Supplied by Fuel Streams in Project Reporting Period y

$$PEI_{k,y} = \sum_{i} (HHV_{k,i,y} \times QF_{P,k,i,y})$$

Where, Units

$PEI_{k,y}$	=	Project boiler energy supplied by fuel streams for boiler k in project reporting period y	TJ
$HHV_{k,i,y}$	=	Project higher heating value for fuel i for boiler k for reporting period y	TJ/kg or TJ/m^3
$QF_{P,k,i,y}$	=	Project boiler fuel i consumption for boiler k for reporting period y	kg or m^3

5.2.2.2 Indirect (Energy Balance) Method for Calculating Project Boiler Fuel Efficiency

In the energy balance method, all energy is described in terms of net ‘losses’ and ‘credits’ to the overall energy balance. Energy losses are defined (by the ASME PTC 4-2013) as the energy that exits the steam generator envelope other than the energy in the output stream(s). Energy credits are defined (by the ASME PTC 4-2013) as the energy entering the steam generator envelope other than the chemical energy in the as-fired fuel. These credits include sensible heat in the fuel, entering air, and atomizing steam; energy from power conversion in coal pulverizers, circulating pumps, primary air fans, and gas recirculation fans; and chemical reactions such as sulfation, amongst others. Credits can be negative, such as when the air temperature is below the reference temperature.

Equation 5.21. Calculating Project Boiler Fuel Efficiency (Indirect / Energy Balance Method) for Project Reporting Period y

$$\eta_{P,k,y} = \frac{(PEI_{k,y} - PEL_{k,y} + PEC_{k,y})}{PEI_{k,y}} \times 100$$

Where, Units

$\eta_{P,k,y}$	=	Project boiler fuel efficiency for boiler k for project reporting period y	%
$PEI_{k,y}$	=	Project boiler energy supplied by fuel streams for boiler k in project reporting period y	TJ
$PEL_{k,y}$	=	Project boiler energy losses for boiler k in project reporting period y	TJ
$PEC_{k,y}$	=	Project boiler energy credits for boiler k in project reporting period y	TJ

Project boiler energy losses in project reporting period y are calculated as per Equation 5.22.

Equation 5.22. Calculating Project Boiler Energy Losses in Project Reporting Period y

$$PEL_{k,y} = \sum_{m} PEL_{k,m,y}$$

Where, Units

$PEL_{k,y}$	=	Project boiler energy losses in project reporting period y	TJ
$PEL_{k,m,y}$	=	Project boiler energy loss item m for the Project Boiler k in reporting period y[49]	TJ

Further guidance on boiler energy losses to be considered is presented in Appendix E.

Project boiler energy credits in project reporting period y are calculated as per Equation 5.23.

Equation 5.23. Calculating Project Boiler Energy Credits in Project Reporting Period y

$$PEC_{k,y} = \sum_{n} PEC_{k,n,y}$$

Where, Units

$PEC_{k,y}$	=	Project boiler energy credits for boiler k in project reporting period y	TJ
$PEC_{k,n,y}$	=	Project boiler energy credit item n for boiler k in reporting period y[50]	TJ

[49] The energy loss parameter refers to each applicable energy loss category used to assess boiler efficiency. Categories should be included if there is expected to be a change in associated energy loss between the baseline and project.
[50] The energy credit parameter refers to each applicable energy credit category used to assess boiler efficiency. Categories should be included if there is expected to be a change in associated energy credit between the baseline and project.

5.2.3 Quantifying Project Electricity Emissions

Equation 5.24. Quantifying Project Electricity Emissions

$$EE_{P,k,y} = PC_{P,k,y} \times EF_{Grid,y}$$

Where,

			Units
$EE_{P,k,y}$	=	Project Electricity Emissions from boiler k (CO_2 emissions from consumed electricity)	$kgCO_2$
$PC_{P,k,y}$	=	Quantity of electricity consumed by boiler k during the reporting period y	MWh
$EF_{Grid,y}$	=	National electricity grid emission factor in Mexico for reporting period y[51]	$kgCO_2e$/MWh

[51] Project developers should use the national electricity grid emission factor most closely corresponding to the time period during which the electricity was used, which can be sourced from [to be determined].

6 Project Monitoring *[minimal revisions, Section 6.1 only]*

The Reserve requires a Monitoring Plan to be established for all monitoring and reporting activities associated with the project. The Monitoring Plan will serve as the basis for verifiers to confirm that the monitoring and reporting requirements in this section and Section 7 have been and will continue to be met, and that consistent, rigorous monitoring and record keeping is ongoing at the project site. The Monitoring Plan must cover all aspects of monitoring and reporting contained in this protocol and must specify how data for all relevant parameters in Table 6.1 will be collected and recorded.

At a minimum, the Monitoring Plan shall include the frequency of data acquisition; a record keeping plan (see Section 7.2 for minimum record keeping requirements); the frequency of instrument cleaning, inspection, field check, and calibration activities; the role of individuals performing each specific monitoring activity; and a detailed project diagram. The Monitoring Plan should include QA/QC provisions to ensure that data acquisition and meter calibration are carried out consistently and with precision.

Finally, the Monitoring Plan must include procedures that the project developer will follow to ascertain and demonstrate that the project at all times passes the Legal Requirement Test and the Regulatory Compliance Test (Section 3.4.2 and 3.5, respectively).

Project developers are responsible for monitoring the performance of the project and ensuring that the operation of all project-related equipment is consistent with the manufacturer's recommendations.

6.1 Monitoring Requirements

Note for Workgroup: Once completed the following sections will contain the information summarized in Table 6.1, along with additional expanded guidance on system installation and certification, initial calibration, quality control / quality assurance (QA/QC) requirements, frequency of sampling, data substitution methods, etc.

The WG should consider issues such as how projects should be required to measure / record key parameters such as fuel consumption. Estimation of emissions based on fuel receipts should be possible in most instances; however this is not typically a sufficiently accurate and verifiable method for estimating emissions from an included SSR. Some example requirements could include: For liquid or gaseous fuels, the protocol could require a flow meter. For solid fuels a method for measuring consumption, other than using receipts, would be useful.

When considering these requirements, please remember that the baseline is representative of pre-project activities, so there may need to be alternatives to flow meters or a required baseline sampling period (if we decide flow meters are truly the best option for a given parameter).

6.2 Monitoring Parameters *[significant revisions]*

Prescribed monitoring parameters necessary to calculate baseline and project emissions are provided in Table 6.1.

Table 6.1. Project Monitoring Parameters

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
General Project Parameters						
	Regulations	Project developer attestation of compliance with regulatory requirements relating to the project	Environmental regulations	n/a	Each verification cycle	Information used to: 1) To demonstrate ability to meet the Legal Requirement Test – where regulation would require boiler efficiencies commensurate with project boiler efficiencies. 2) To demonstrate compliance with associated environmental rules, e.g. criteria pollutant limits.
Equation 5.1	ER	Total emission reductions for the reporting period, for all boilers	tCO_2e	C	Each verification cycle	
Equation 5.1 Equation 5.2	BE_k	Total baseline emissions for the reporting period, from boiler k, from all SSRs in the GHG Assessment Boundary	tCO_2e	C	Each verification cycle	
Equation 5.1 Equation 5.15	PE_k	Total project emissions for the reporting period, for boiler k	tCO_2e	C	Each verification cycle	
Baseline Calculation Parameters						
Equation 5.2 Equation 5.3	$FE_{B,k}$	Baseline fuel emissions for boiler k	tCO_2e or $kgCO_2$	C	Each verification cycle	
Equation 5.2 Equation 5.11	$EE_{B,k}$	Baseline electricity emissions from boiler k	tCO_2e	C	Each verification cycle	

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
Equation 5.3 Equation 5.4	$FE_{B,k,i}$	Baseline fuel energy input for boiler k from fuel i	TJ	C	Each verification cycle	
Equation 5.3	$EF_{Fuel,CO2,B,k,i}$	Baseline CO_2 emission factor for fuel i for boiler k as provided in Appendix B. (Projects that switch from a higher to lower carbon-intensive fossil fuel over the course of the project must use the fuel emission factor for the fuel used in the project scenario.)	$kgCO_2/TJ$	C or R	Each verification cycle	If project developers have verifiable records on fuel *i* to calculate the emission factor for fuel *i* (EF, $Fuel_{CO2,BL,k,i}$), they may use the calculated EF instead of the default provided in Appendix B.
Equation 5.4 Equation 5.7 Equation 5.13 Equation 5.14	$HHV_{B,k,i}$	Baseline higher heating value for boiler k from fuel i	TJ/kg or TJ/m^3	C or R	Once	Supplier information or determined by composition. For fuel switch to a lower carbon intensity fuel in the project boiler during crediting period, this value must be used as project higher heating value
Equation 5.4	$QF_{P,k,i,y}$	Consumption of fuel i, for boiler k, from project reporting period y	kg or m^3	M or O	Continuous, or according to fuel invoicing frequency	Continuous measurement must be integrated at least monthly
Equation 5.4 Equation 5.5 Equation 5.8 Equation 5.13	η_B $\eta_{B,k}$	Baseline boiler fuel efficiency Baseline boiler fuel efficiency, for boiler k	%	C or O	Once	To be determined according to adequate methodology or tools for baseline calculations.

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
Equation 5.4	$\eta_{P,y}$	Project boiler fuel efficiency for project reporting period y	%	C	Each verification cycle	To be determined according to adequate methodology or tools (PTC 4, BS845 or CONUEE tool) for baseline calculations
Equation 5.5 Equation 5.6	BEO_k	Baseline boiler energy absorbed by steam output streams for boiler k	TJ	C	Once	To be determined according to adequate methodology or tools (PTC 4, BS845 or CONUEE tool) for baseline calculations
Equation 5.5 Equation 5.7 Equation 5.8	BEI_k	Baseline boiler energy supplied by fuel streams for boiler k	TJ	C	Once	Use average fuel consumption for past 3 years for calculation
Equation 5.6	$QS_{B,k,j}$	Total baseline consumption of fluid stream j leaving boiler k boundary	kg	M or O	Once	Continuous, or according to fuel invoicing frequency Alternative options could be proposed, according to current practice if not affecting measurement quality
Equation 5.6	$h_{k,j,out}$	Enthalpy of fluid in stream j leaving boiler k boundary	kJ/kg	R	Default	From steam tables or steam properties software
Equation 5.6	$h_{k,j,in}$	Enthalpy of fluid entering boiler k boundary, feeding stream j	kJ/kg	R	Default	From steam tables or steam properties software
Equation 5.4 Equation 5.7	$QF_{B,k,i}$	Baseline boiler fuel i consumption for boiler k	kg or m^3	M or O	Once	Continuous, or according to fuel invoicing frequency

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
Equation 5.8 Equation 5.9	$BEL_{,k}$ $BEL_{k,m}$	Baseline boiler energy losses for boiler k Baseline boiler energy losses for item m for boiler k	TJ	C	Once	To be determined according to adequate methodology or tools for baseline calculations
Equation 5.8 Equation 5.10	$BEC_{,k}$ $BEC_{k,n}$	Baseline boiler energy credits for boiler k Baseline boiler energy credits for item n for boiler k	TJ	C	Once	To be determined according to adequate methodology or tools for baseline calculations
Equation 5.11 Equation 5.12	$PC_{B,k}$	Baseline electric power consumption for boiler k	MWh	C	Once	Continuous, or according to power supplier invoicing frequency Continuous measurement must be integrated at least monthly
Equation 5.11	$EF_{Grid,y}$	National electricity grid emission factor in Mexico for reporting period y[52]	$kgCO_2e/MWh$	R		Project developers should use the national electricity grid emission factor most closely corresponding to the time period during which the electricity was used, which can be sourced from XXX, found www.HERE.MX.

[52] Project developers should use the national electricity grid emission factor most closely corresponding to the time period during which the electricity was used, which can be sourced from [to be determined].

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
Equation 5.12 Equation 5.14 Equation 5.24	$PC_{P,k,y}$	Project electric power consumption for boiler k for reporting period y	MWh	C	Monthly	Continuous, or according to power supplier invoicing frequency. Continuous measurement must be integrated at least monthly
Equation 5.12 Equation 5.13	$ECI_{B,k}$	Baseline electric power consumption index for boiler k	MWh/TJ	C	Once	To be determined for baseline period
Equation 5.12 Equation 5.14	$ECI_{P,k,y}$ $ECI_{k,y}$	Electric power consumption index for boiler k for reporting period y	MWh/TJ	C	Each verification cycle	
Equation 5.13	$PC_{H,k}$	Historical electric power consumption for boiler k	MWh	C	Once	To be determined for baseline period from operation records
Equation 5.13	$QF_{H,k,i}$	Historical boiler fuel i consumption at boiler k	kg or m^3	M or O	Once	Continuous measurement must be integrated at least monthly
Equation 5.14	$HHV_{k,i,y}$	Project higher heating value for fuel i for boiler k for reporting period y	TJ/kg or TJ/m^3	C or R	Each verification cycle	Supplier information or determined by composition. For fuel switch to a lower carbon intensity fuel in the project boiler during crediting period, baseline higher heating value must be used as higher heating value from then on
Equation 5.14	$QF_{P,k,i,y}$	Project boiler fuel i consumption at boiler k for project year y	kg or m^3	M or O	Continuous, or according to fuel invoicing frequency	Continuous measurement must be integrated at least monthly
Equation 5.14	$\eta_{P,k,y}$	Project boiler fuel efficiency for project reporting period y	%	C	Each verification cycle	To be determined according to adequate methodology or tools for baseline calculations

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
Project Calculation Parameters						
Equation 5.15 Equation 5.16	$FE_{P,k,y}$	Project fuel emissions from boiler k	tCO_2e	C	Each verification cycle	
Equation 5.15 Equation 5.24	$EE_{P,k,y}$	Project electricity emissions from boiler k for reporting period y	tCO_2e	C	Each verification cycle	
Equation 5.16 Equation 5.17	$FE_{P,k,i,y}$	Project fuel energy input for boiler k from fuel i in project year y	TJ	c	Each verification cycle	
Equation 5.16	$EF_{Fuel,CO2,P,k,i,y}$	Project CO_2 emission factor for fuel i for boiler k in project year y	$kgCO_2/TJ$	C or R	N/A	
Equation 5.17 Equation 5.20	$HHV_{k,i,y}$	Project higher heating value for fuel i for boiler k for reporting period y	TJ/kg or TJ/m^3	C or R	Each verification cycle	Supplier information or determined by composition. For fuel switch to a lower carbon intensity fuel in the project boiler during crediting period, baseline higher heating value must be used as higher heating value from then on
Equation 5.17 Equation 5.20	$QF_{P,k,i,y}$	Project boiler fuel i consumption at boiler k for project year y	kg or m^3	M or O	Continuous, or according to fuel invoicing frequency	Continuous measurement must be integrated at least monthly
Equation 5.18 Equation 5.21	$\eta_{P,k,y}$	Project boiler fuel efficiency for project reporting period y	%	C	Each verification cycle	To be determined according to adequate methodology or tools for baseline calculations

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
Equation 5.18 Equation 5.19	$PEO_{k,y}$	Project boiler energy absorbed by steam output streams in boiler k in project reporting period y	TJ	C	Each verification cycle	To be determined according to adequate methodology or tools for baseline calculations
Equation 5.18 Equation 5.20 Equation 5.21	$PEI_{k,y}$	Project boiler energy supplied by fuel streams for boiler k in project reporting period y	TJ	C	Each verification cycle	Calculated from project fuel consumption and HHV data
Equation 5.19	$QS_{P.k,j,y}$	Total project consumption of fluid stream j leaving boiler boundary for boiler k in project reporting period y				
Equation 5.19	$h_{k,j,out}$	Enthalpy of fluid in stream j leaving boiler boundary k	kJ/kg	R	Default	From steam tables or steam properties software
Equation 5.19	$h_{k,j,in}$	Enthalpy of fluid entering boiler boundary k, feeding stream j	kJ/kg	R	Default	From steam tables or steam properties software
Equation 5.21 Equation 5.22	$PEL_{k,y}$ $PEL_{k,m,y}$	Project boiler energy losses for boiler k in project reporting period y Project boiler energy loss item m in reporting period y	TJ	C	Each verification cycle	To be determined according to adequate methodology or tools for baseline calculations.

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
Equation 5.21 Equation 5.23	$PEC_{k,y}$ $PEC_{k,n,y}$	Project boiler energy credits for boiler k in project reporting period y Project boiler energy credit item n for boiler k in reporting period y	TJ	C	Each verification cycle	To be determined according to adequate methodology or tools for baseline calculations.
Equation 5.24	$PC_{P,k,y}$	Project electric power consumption for boiler k for reporting period y	MWh	C	Monthly	Continuous, or according to power supplier invoicing frequency. Continuous measurement must be integrated at least monthly
Equation 5.24	$EF_{Grid,y}$	National electricity grid emission factor in Mexico for reporting period y	$kgCO_2e/MWh$	C or R	Each verification cycle	Project developers should use the national electricity grid emission factor most closely corresponding to the time period during which the electricity was used, which can be sourced from [to be determined].

7 Reporting Parameters *[minimal revisions, Section 7.2 only]*

This section provides requirements and guidance on reporting rules and procedures. A priority of the Reserve is to facilitate consistent and transparent information disclosure among project developers. Project developers must submit verified emission reduction reports to the Reserve annually at a minimum.

7.1 Project Submittal Documentation

Project developers must provide the following documentation to the Reserve in order to register a boiler efficiency project:

- Project Submittal form
- Project diagram
- Signed Attestation of Title form
- Signed Attestation of Voluntary Implementation form
- Signed Attestation of Regulatory Compliance form
- Verification Report
- Verification Statement

Project developers must provide the following documentation each reporting period in order for the Reserve to issue CRTs for quantified GHG reductions:

- Verification Report
- Verification Statement
- Project diagram (if changed from previous reporting period)
- Signed Attestation of Title form
- Signed Attestation of Voluntary Implementation form
- Signed Attestation of Regulatory Compliance form

At a minimum, the above project documentation (except for the project diagram) will be available to the public via the Reserve's online registry. Further disclosure and other documentation may be made available on a voluntary basis through the Reserve. Project submittal forms can be found at http://www.climateactionreserve.org/how/program/documents/.

7.2 Joint Project Verification *[new section]*

Because the protocol allows for multiple projects at a single project site or facility, project developers have the option to hire a single verification body to verify multiple projects at a facility through a "joint project verification." This may provide economies of scale for the project verifications and improve the efficiency of the verification process.

Under joint project verification, each project, as defined by the protocol, is submitted for listing, listed, and registered separately in the Reserve system. Furthermore, each project requires its own separate verification process and Verification Statement (i.e. each project is assessed by the verification body separately as if it were the only project at the facility). However, all projects may be verified together by a single site visit to the facility. Furthermore, a single Verification Report may be filed with the Reserve that summarizes the findings from multiple project verifications.

7.3 Record Keeping

For purposes of independent verification and historical documentation, project developers are required to keep all information outlined in this protocol for a period of 10 years after the information is generated or 7 years after the last verification. This information will not be publicly available, but may be requested by the verifier or the Reserve.

System information the project developer should retain includes:

- All data inputs for the calculation of the project emission reductions, including all required sampled data
- Copies of all permits, Notices of Violations (NOVs), and any relevant administrative or legal consent orders dating back at least 3 years prior to the project start date
- Executed Attestation of Title, Attestation of Regulatory Compliance, and Attestation of Voluntary Implementation forms
- Onsite fuel use records
- Onsite grid electricity use records
- Results of CO_2e annual reduction calculations
- Initial and annual verification records and results
- All maintenance records relevant to the monitoring equipment

7.4 Reporting Period and Verification Cycle

Project developers must report GHG reductions resulting from project activities during each reporting period. Although projects must be verified annually at a minimum, the Reserve will accept verified emission reduction reports on a sub-annual basis, should the project developer choose to have a sub-annual reporting period and verification schedule (e.g. monthly, quarterly, or semi-annually).

To meet the annual verification deadline, the project developer must have the required verification documentation (see Section 7.1) submitted within 12 months of the end of each reporting period. A reporting period cannot exceed 12 months, and no more than 12 months of emission reductions can be verified at once, except during a project's initial verification. Although there is some flexibility in the length of the initial reporting period, the project developer must still meet the 12-month verification deadline.

8 Verification Guidance *[minimal revisions, Section 8.1 only]*

This section provides verification bodies with guidance on verifying GHG emission reductions associated with the project activity. This verification guidance supplements the Reserve's Verification Program Manual and describes verification activities specifically related to boiler efficiency projects.

Verification bodies trained to verify boiler efficiency projects must be familiar with the following documents:

- Climate Action Reserve Program Manual
- Climate Action Reserve Verification Program Manual
- Climate Action Reserve Mexico Boiler Efficiency Project Protocol

The Reserve's Program Manual, Verification Program Manual, and project protocols are designed to be compatible with each other and are available on the Reserve's website at http://www.climateactionreserve.org.

Only ISO-accredited verification bodies trained by the Reserve for this project type are eligible to verify boiler efficiency project reports. Verification bodies approved under other project protocol types are not permitted to verify boiler efficiency projects. Information about verification body accreditation and Reserve project verification training can be found on the Reserve website at http://www.climateactionreserve.org/how/verification/.

8.1 Verification of Multiple Projects at a Single Facility *[new section]*

Because the protocol allows for multiple projects at a single project site or facility, project developers have the option to hire a single verification body to verify multiple projects under a joint project verification. This may provide economies of scale for the project verifications and improve the efficiency of the verification process. Joint project verification is only available as an option for a single project developer; joint project verification cannot be applied to multiple projects registered by different project developers at the same facility.

Under joint project verification, each project, as defined by the protocol, must be registered separately in the Reserve system and requires its own verification process and Verification Statement (i.e. each project is assessed by the verification body separately as if it were the only project at the facility). However, all projects may be verified together by a single site visit to the facility. Furthermore, a single Verification Report may be filed with the Reserve that summarizes the findings from multiple project verifications.

Finally, the verification body may submit one Notification of Verification Activities/Conflict of Interest (NOVA/COI) Assessment form that details and applies to all of the projects at a single facility that it intends to verify.

If during joint project verification, the verification activities of one project are delaying the registration of another project, the project developer can choose to forego joint project verification. There are no additional administrative requirements of the project developer or the verification body if a joint project verification is terminated.

8.2 Standard of Verification

The Reserve's standard of verification for boiler efficiency projects is the Mexico Boiler Efficiency Project Protocol (this document), the Reserve Program Manual, and the Verification Program Manual. To verify a boiler efficiency project report, verification bodies apply the guidance in the Verification Program Manual and this section of the protocol to the standards described in Sections 2 through 7 of this protocol. Sections 2 through 7 provide eligibility rules, methods to calculate emission reductions, performance monitoring instructions and requirements, and procedures for reporting project information to the Reserve.

8.3 Monitoring Plan

The Monitoring Plan serves as the basis for verification bodies to confirm that the monitoring and reporting requirements in Section 6 and Section 7 have been met, and that consistent, rigorous monitoring and record keeping is ongoing at the project site. Verification bodies shall confirm that the Monitoring Plan covers all aspects of monitoring and reporting contained in this protocol and specifies how data for all relevant parameters in Table 6.1 are collected and recorded.

8.4 Verifying Project Eligibility

Verification bodies must affirm a boiler efficiency project's eligibility according to the rules described in this protocol. The table below outlines the eligibility criteria for boiler efficiency projects. This table does not present all criteria for determining eligibility comprehensively; verification bodies must also look to Section 3 and the verification items list in Table 8.2.

Table 8.1. Summary of Eligibility Criteria for a Mexico Boiler Efficiency Project

Eligibility Rule	Eligibility Criteria	Frequency of Rule Application
Start Date	For 12 months following the Effective Date of this protocol, a pre-existing project with a start date on or after may be submitted for listing; after this 12 month period, projects must be submitted for listing within 6 months of the project start date	Once during first verification
Location	Mexico	Once during first verification
Performance Standard		Every verification
Legal Requirement Test	Signed Attestation of Voluntary Implementation form and monitoring procedures for ascertaining and demonstrating that the project passes the Legal Requirement Test	Every verification
Regulatory Compliance Test	Signed Attestation of Regulatory Compliance form and disclosure of all non-compliance events to verifier; project must be in material compliance with all applicable laws	Every verification

8.5 Core Verification Activities

The Mexico Boiler Efficiency Project Protocol provides explicit requirements and guidance for quantifying the GHG reductions associated with the boiler efficiency improvements. The Verification Program Manual describes the core verification activities that shall be performed by verification bodies for all project verifications. They are summarized below in the context of a boiler efficiency project, but verification bodies must also follow the general guidance in the Verification Program Manual.

Verification is a risk assessment and data sampling effort designed to ensure that the risk of reporting error is assessed and addressed through appropriate sampling, testing, and review. The three core verification activities are:

1. Identifying emission sources, sinks, and reservoirs (SSRs)
2. Reviewing GHG management systems and estimation methodologies
3. Verifying emission reduction estimates

Identifying emission sources, sinks, and reservoirs
The verification body reviews for completeness the sources, sinks, and reservoirs identified for a project, such as, *inter alia*, fuel combustion, un-combusted fuel from the boiler, increased grid electricity consumption and new sections of natural gas pipeline.

Reviewing GHG management systems and estimation methodologies
The verification body reviews and assesses the appropriateness of the methodologies and management systems that the boiler efficiency project operator uses to gather data and calculate baseline and project emissions.

Verifying emission reduction estimates
The verification body further investigates areas that have the greatest potential for material misstatements and then confirms whether or not material misstatements have occurred. This involves site visits to the project facility (or facilities if the project includes multiple facilities) to ensure the systems on the ground correspond to and are consistent with data provided to the verification body. In addition, the verification body recalculates a representative sample of the performance or emissions data for comparison with data reported by the project developer in order to double-check the calculations of GHG emission reductions.

8.6 Mexico Boiler Efficiency Verification Items

The following tables provide lists of items that a verification body needs to address while verifying a boiler efficiency project. The tables include references to the section in the protocol where requirements are further specified. The table also identifies items for which a verification body is expected to apply professional judgment during the verification process. Verification bodies are expected to use their professional judgment to confirm that protocol requirements have been met in instances where the protocol does not provide (sufficiently) prescriptive guidance. For more information on the Reserve's verification process and professional judgment, please see the Verification Program Manual.

Note: These tables shall not be viewed as a comprehensive list or plan for verification activities, but rather guidance on areas specific to boiler efficiency projects that must be addressed during verification.

8.6.1 Project Eligibility and CRT Issuance

Table 8.2 lists the criteria for reasonable assurance with respect to eligibility and CRT issuance for boiler efficiency projects. These requirements determine if a project is eligible to register with the Reserve and/or have CRTs issued for the reporting period. If any requirement is not met, either the project may be determined ineligible or the GHG reductions from the reporting period (or subset of the reporting period) may be ineligible for issuance of CRTs, as specified in Sections 2, 3, and 6.

Table 8.2. Eligibility Verification Items

Protocol Section	Eligibility Qualification Item	Apply Professional Judgment?
2	Verify that the project meets the definition of a Mexico Boiler Efficiency project	No
2.3	Verify ownership of the reductions by reviewing Attestation of Title	No
3.2	Verify project start date	No
3.2	Verify accuracy of project start date based on operational records	Yes
3.2	Verify that the project has documented and implemented a Monitoring Plan	No
3.3	Verify that project is within its 10 year crediting period	No
3.4.1	Verify that the project meets the Performance Standard Test	No
3.4.2	Confirm execution of the Attestation of Voluntary Implementation form to demonstrate eligibility under the Legal Requirement Test	No
3.4.2	Verify that the project Monitoring Plan contains a mechanism for ascertaining and demonstrating that the project passes the Legal Requirement Test at all times	No
3.5	Verify that the project activities comply with applicable laws by reviewing any instances of non-compliance provided by the project developer and performing a risk-based assessment to confirm the statements made by the project developer in the Attestation of Regulatory Compliance form	Yes
6	Verify that monitoring meets the requirements of the protocol. If it does not, verify that a variance has been approved for monitoring variations	No

8.6.2 Quantification

Table 8.3 lists the items that verification bodies shall include in their risk assessment and recalculation of the project's GHG emission reductions. These quantification items inform any determination as to whether there are material and/or immaterial misstatements in the project's GHG emission reduction calculations. If there are material misstatements, the calculations must be revised before CRTs are issued.

Table 8.3. Quantification Verification Items

Protocol Section	Quantification Item	Apply Professional Judgment?
4	Verify that all SSRs in the GHG Assessment Boundary are accounted for	No
5.1	Verify that the baseline emissions are properly aggregated	No
5.2	Verify that the project emissions were calculated according to the protocol with the appropriate data	No
	Verify that the project developer correctly monitored, quantified, and aggregated electricity use	Yes
	Verify that the project developer correctly monitored, quantified, and aggregated fossil fuel use	Yes
	Verify that the project developer applied the correct emission factors for fossil fuel combustion and grid-delivered electricity	No
	Verify that the project developer correctly applied emission	No

Protocol Section	Quantification Item	Apply Professional Judgment?
	factors	
	If default emission factors are not used, verify that project-specific emission factors are based on official source-tested emissions data or are from an accredited source test service provider	No
	Verify that appropriate system boundaries in line with protocol guidance are chosen for the boiler	Yes

8.6.3 Risk Assessment

Verification bodies will review the following items in Table 8.4 to guide and prioritize their assessment of data used in determining eligibility and quantifying GHG emission reductions.

Table 8.4. Risk Assessment Verification Items

Protocol Section	Item that Informs Risk Assessment	Apply Professional Judgment?
6	Verify that the project Monitoring Plan is sufficiently rigorous to support the requirements of the protocol and proper operation of the project	Yes
6	Verify that appropriate monitoring equipment is in place to meet the requirements of the protocol	No
6	Verify that the individual or team responsible for managing and reporting project activities are qualified to perform this function	Yes
6	Verify that appropriate training was provided to personnel assigned to greenhouse gas reporting duties	Yes
6	Verify that all contractors are qualified for managing and reporting greenhouse gas emissions if relied upon by the project developer. Verify that there is internal oversight to assure the quality of the contractor's work	Yes
7.2	Verify that all required records have been retained by the project developer	No

8.6.4 Completing Verification

The Verification Program Manual provides detailed information and instructions for verification bodies to finalize the verification process. It describes completing a Verification Report, preparing a Verification Statement, submitting the necessary documents to the Reserve, and notifying the Reserve of the project's verified status.

9 Glossary of Terms

Note to Workgroup: Please provide comments letting us know if there are important terms missing from this glossary.

Accredited verifier	A verification firm approved by the Climate Action Reserve to provide verification services for project developers.
Additionality	Project activities that are above and beyond “business as usual” operation, exceed the baseline characterization, and are not mandated by regulation.
Anthropogenic emissions	GHG emissions resultant from human activity that are considered to be an unnatural component of the Carbon Cycle (i.e. fossil fuel destruction, de-forestation, etc.).
Biogenic CO_2 emissions	CO_2 emissions resulting from the destruction and/or aerobic decomposition of organic matter. Biogenic emissions are considered to be a natural part of the Carbon Cycle, as opposed to anthropogenic emissions.
Carbon dioxide (CO_2)	The most common of the six primary greenhouse gases, consisting of a single carbon atom and two oxygen atoms.
CO_2 equivalent (CO_2e)	The quantity of a given GHG multiplied by its total global warming potential. This is the standard unit for comparing the degree of warming which can be caused by different GHGs.
Direct emissions	GHG emissions from sources that are owned or controlled by the reporting entity.
Effective Date	The date of adoption of this protocol by the Reserve board: .
Energy credits	Defined by ASME PTC 4-2013 as the energy entering the steam generator envelope other than the chemical energy in the as-fired fuel. Credits can be negative, such as when the air temperature is below the reference temperature.
Energy losses	Defined by ASME PTC 4-2013 as the energy that exits the steam generator envelope other than the energy in the output stream(s).
Emission factor (EF)	A unique value for determining an amount of a GHG emitted for a given quantity of activity data (e.g. metric tons of carbon dioxide emitted per barrel of fossil fuel burned).
Fossil fuel	A fuel, such as coal, oil, and natural gas, produced by the decomposition of ancient (fossilized) plants and animals.
Greenhouse gas (GHG)	Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), or perfluorocarbons (PFCs).

GHG reservoir	A physical unit or component of the biosphere, geosphere, or hydrosphere with the capability to store or accumulate a GHG that has been removed from the atmosphere by a GHG sink or a GHG captured from a GHG source.
GHG sink	A physical unit or process that removes GHG from the atmosphere.
GHG source	A physical unit or process that releases GHG into the atmosphere.
Global Warming Potential (GWP)	The ratio of radiative forcing (degree of warming to the atmosphere) that would result from the emission of one unit of a given GHG compared to one unit of CO_2.
Higher Heating Value	Defined by ASME PTC 4-2013 the total energy liberated per unit mass of fuel upon complete combustion as determined by appropriate ASTM Standards. The higher heating value includes the latent heat of the water vapor. When the heating value is measured at constant volume, it must be converted to a constant pressure value for use in this Code.
Indirect emissions	Emissions that occur at a location other than where the project is implemented, and/or at sources not owned or controlled by project participants.
MMBtu	One million British thermal units.
Mobile combustion	Emissions from the transportation of employees, materials, products, and waste resulting from the combustion of fuels in company owned or controlled mobile combustion sources (e.g. cars, trucks, tractors, dozers, etc.).
Project baseline	A "business as usual" GHG emission assessment against which GHG emission reductions from a specific GHG reduction activity are measured.
Project developer	An entity that undertakes a GHG project, as identified in Section 2.3 of this protocol.
Steam generator envelope	The steam generator envelope is the physical boiler enclosure.
Tonne (t, metric ton)	A common international measurement for the quantity of GHG emissions, equivalent to about 2204.6 pounds or 1.1 short tons.
Verification	The process used to ensure that a given participant's GHG emissions or emission reductions have met the minimum quality standard and complied with the Reserve's procedures and protocols for calculating and reporting GHG emissions and emission reductions.
Verification body	A Reserve-approved firm that is able to render a verification opinion and provide verification services for operators subject to reporting under this protocol.

10 References

[Still Under Development]

Appendix A Development of the Performance Standard [Under Development]

Appendix B Default Factors

B.1 Default Fuel and Electricity Emission Factors

Table B.1. Emission Factors for Various Fuels

Fuel Type	kg CO2/TJ
Natural gas (Dry gas)	56,100
Petroleum coke	97,500
Residual fuel oil	77,400
Coke of coal	Per Source
Diesel	74,100
Liquefied petroleum gas	63,100

Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy.

Appendix C Summary of Legal Requirements & Regulatory Framework Research [Under Development]

Appendix D Data Substitution [Under Development]

Appendix E Guidance on Application of the CONUEE Tool [Under Development]