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Using Project Accounting to Report the Full Impact of Combined Heat and Power Projects

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Introduction

Combined heat and power (CHP) has long been recognized as the most efficient method of generating power and useful thermal energy (heating and/or cooling). CHP has been deployed effectively for many decades throughout all sectors (industrial, governmental, and commercial) to reduce fuel use and emissions significantly when compared with procuring electricity from the grid and producing thermal energy in an onsite boiler (i.e., separate heat and power).

By employing heat recovery technology to capture a significant portion of the waste heat created as a by-product of fuel-based power generation, CHP systems typically achieve total system efficiency that is 20%–40% higher than that of any grid-based electric generation.[1] Electricity generation from CHP has been displacing less efficient grid-based generation for years, reducing both fuel use and emissions for every unit of electricity generated. Onsite CHP continues to increase resilience and reduce emissions throughout the country. In the US, more than 4,000 CHP installations currently operate across all regions to produce approximately 12% of total electricity while eliminating in excess of 200 million tons of CO_2 annually.[2]

The Greenhouse Gas (GHG) Protocol's Corporate Accounting and Reporting Standard (Corporate Standard), although widely used for corporate greenhouse gas inventories, has limitations when being used to evaluate CHP systems. The standard considers only emissions within corporate boundaries, potentially mischaracterizing CHP systems. In reality, efficient CHP systems reduce overall emissions by displacing less efficient grid-based power generation. However, because these reductions occur outside corporate boundaries, they are not captured by the Corporate Standard. For a comprehensive assessment of CHP benefits, organizations should instead use the GHG Protocol's Project Accounting methodology, which accounts for emissions reductions beyond organizational boundaries.

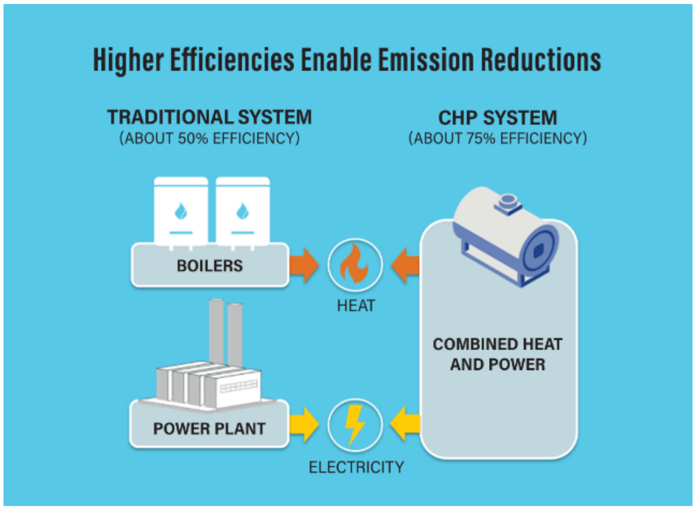

Figure 1. Traditional vs. CHP system.

This document explains how CHP developers and owners can use the GHG Protocol for Project Accounting (Project Protocol) to ensure the true efficiency and global emission impact of a CHP project are accurately reported—both internally for corporate decision-making and externally to stakeholders.

How CHP Helps Decarbonize the Grid

CHP systems reduce GHG emissions by consuming less total fuel to produce the same amount of useful energy as that produced in separate heat and grid-delivered power systems (Figure 1). Calculating the fuel or emissions savings of a CHP system requires accounting for both of its outputs: thermal energy and electricity. As an onsite energy system, CHP's thermal output typically displaces fuel that otherwise would be consumed in an onsite boiler

[1] https://chp.ecatalog.ornl.gov/benefits/today-tomorrow
[2] https://www.ieca-us.com/wp-content/uploads/06.14.23_Industrial-CHP-WHP-and-Decarbonization-MATAP_3.pdf

or direct heating system, and the electric output displaces fuel that would otherwise be consumed at a grid-based power plant. Additionally, grid transmission and distribution (T&D) losses are reduced because the CHP system generates power at the point of consumption, saving additional fuel.[3]

When an onsite CHP system operates, the last (marginal and typically highest emitting) unit dispatched on the grid turns down or off, as does the onsite boiler that supplies thermal energy to the site. Moreover, CHP systems often operate at over 90% annual capacity factor throughout the year, allowing CHP's efficiency to drive emissions savings around the clock. Zero emission solar photovoltaic (PV) generation averages a 25% annual capacity factor, and wind generation averages a 36% annual capacity factor.[4] Although CHP is not zero carbon (unless low-carbon fuels like renewable natural gas and green hydrogen replace natural gas firing), CHP can reduce more GHG emissions than the same capacity of zero emissions projects that operate with lower capacity factors. Figure 2 compares CO_2 reductions of a 15 MW CHP project to the same 15 MW installed capacity of wind or solar PV; the figure also shows the additional emissions savings that can be realized if a low-carbon fuel is available starting in 2035 to replace natural gas. Furthermore, CHP complements renewable resources by unloading congested transmission and distribution grids that subsequently free up additional system capacity for renewables.[5]

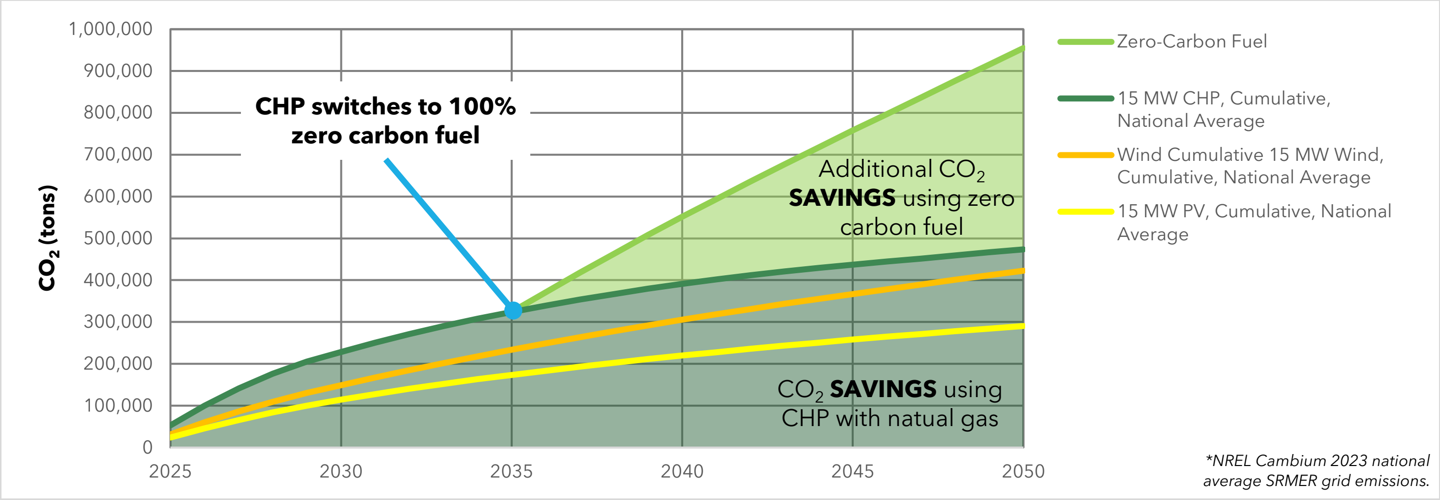

Figure 2. Cumulative emissions reductions compared for 15 MW of CHP, PV, and wind capacity (SRMER = short-run marginal emissions rate).

Energy and emissions savings from CHP play an important role in defining the value proposition of CHP for investors, host organizations, policymakers, project developers, and other industry stakeholders. Therefore, the emissions impact and savings associated with CHP developments versus the impact without the project must be fully and appropriately quantified.

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[3] US EPA, "Fuel and Carbon Dioxide Emissions Savings Calculation Methodology for Combined Heat and Power Systems," February 2015.
[4] US DOE, "Land-Based Wind Market Report: 2023 Edition," available at: http://www.osti.gov/scitech.
[5] https://www.epa.gov/chp/chps-role-decarbonization

CHP's Key Role in Decarbonizing Industry

The US industrial sector is among the most difficult to decarbonize because of the diversity, complexity, and high temperature of energy inputs for many sector processes and operations. In 2021, the industrial sector accounted for 35% of US primary energy use and 33% of energy-related CO_2 emissions.[6,7] Heating is the process responsible for the largest energy demand and GHG emissions in the manufacturing sector. In 2018, process heating accounted for 51% of energy used at industrial sites and 31% of energy- and process-related GHG emissions sector-wide.

Renewable technologies have played a growing role in decarbonizing the industrial sector. However, with over 80% of the industrial sector's thermal requirements for the supply of steam or direct heat between 200°F and 800°F, CHP remains well suited to continue meeting these requirements today while also reducing emissions well into the future throughout most regions.[8] As low-carbon fuels become available, their use in CHP systems will achieve greater emissions reductions than their use in separate heat and power systems because of CHP's higher efficiency. Renewable natural gas and hydrogen fueled CHP systems can ultimately be a long-term path to decarbonizing industrial thermal processes resistant to electrification because of technology or cost barriers, and for critical operations where dispatchable onsite power is needed for resilience and reliability.

The Role of CHP as the Electric Grid Transitions

Over the past decade, the primarily fossil fuel–based electric grid has transitioned rapidly to increased percentages of renewable energy, driving an overall "greening of the grid." This has led to growing uncertainty about how long CHP will continue delivering regional emissions savings throughout the US. This uncertainty is compounded by the dramatic rise in the number of organizations that report their GHG emissions inventories using the GHG Protocol Corporate Accounting and Reporting Standard, which typically increases an organization's Scope 1 inventory emissions when adding a CHP system because of increased fuel use at the site.[9]

CHP projects normally *increase* an organization's Scope 1 emissions from additional fuel used at the site while reducing emissions occurring on the grid by displacing less efficient generation. However, the emission reductions on the grid are not included in the organization's inventory because these reductions are outside the organization's boundaries. Additionally, the Corporate Standard stipulates that organizations must use grid average emissions factors to account for electricity purchased from the grid; using average emissions factors reduces credits realized in Scope 2 emissions compared with using marginal emissions factors.

These methodologies are designed to ensure no "double counting" of physical emissions attributed to organizations inside their boundaries but fail to account fully for the overall emissions reduction realized as a direct result of a CHP project's operations. In fact, the current Corporate Standard specifically states that

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[6] End-use energy consumption includes primary energy consumption by the sector and retail electricity sales to (or purchases by) the sector. Total energy consumption includes primary energy consumption, retail electricity sales/purchases, and electrical system energy losses associated with the retail electricity sales.
[7] DOE Industrial Decarbonization Roadmap | Department of Energy, September 2022.
[8] Renewable Thermal Energy Systems: Systemic Challenges and Transformational Policies (Report 2) NREL, February 2023.
[9] GHG Protocol Blog Post, December 20, 2023, www.ghgprotocol.org.

onsite energy projects such as CHP often provide emissions reductions that are not included in the facility's inventory boundary. The Corporate Standard recommends separately quantifying and reporting those savings in a company's public GHG report under optional information, similar to the current treatment of renewable energy certificates (RECs).[10]

This document is structured as follows. The "GHG Protocol and Emissions Reporting Framework" section provides an overview of GHG Protocol's Corporate Standard covering inventory accounting and contrasts it with the GHG Project Protocol. The "Using Project Protocol" section provides a step-by-step process for using the protocol, provides marginal emission data sources, and explains the marginal forecasting models. The "Quantifying and Reporting GHG Reductions for CHP Based on Project Protocol" section focuses on how to evaluate the effect of CHP emissions using Project Protocol. The final sections, "Applying Inventory and Project-Based Accounting" and "Summary," provide an overview of how the results are reported using Project Protocol.

GHG Protocol and Emissions Reporting Framework

GHG Protocol was established over 20 years ago through a collaboration between the World Resources Institute and the World Business Council for Sustainable Development. It is now recognized as the de facto global standard for voluntary carbon accounting and inventory reporting. The GHG Protocol comprehensive framework of standards is designed to help businesses, governments, and other entities measure, report, and manage both up- and downstream emissions throughout their entire value chains and align with international GHG reporting standards to ensure accuracy, consistency, completeness, and transparency in reporting.[11] Today, the majority of organizations and nations use GHG Protocol standards for voluntary climate disclosure as well as for disclosures required by the European Union's Corporate Sustainability Reporting Directive, the proposed US Securities and Exchange Commission climate disclosure rules, and the State of California SB 253 and SB 262 to take effect in 2026.[12]

In 2023, GHG Protocol began a 2 year overhaul of its corporate standards and guidance suite, with early focus on Scope 2 location and market-based guidance. These updates are intended to ensure GHG Protocol standards and guidance remain effective in providing a rigorous and credible accounting foundation for organizations to measure, plan, and track progress toward science-based and net-zero targets.[13] Proposed modifications to Scope 2 and other guidance are expected to be published for peer review in 2025.

Two Methods for Emissions Reporting—with Different Roles

The GHG Protocol offers two distinct methodologies for emissions reporting: the Corporate Accounting and Reporting Standard (Corporate Standard) and Protocol for Project Accounting (Project Protocol).[14] GHG inventory accounting, as described in the Corporate Standard, focuses on organization-wide emissions

[10] *A Corporate Accounting and Reporting Standard – Revised Edition*, Page 61, https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf.
[11] https://ghgprotocol.org/standards
[12] https://corpgov.law.harvard.edu/2024/02/22/the-california-climate-disclosure-laws-secs-proposed-climate-related-disclosure-rule-and-the-csrd-what-u-s-companies-need-to-do-now-to-comply/
[13] https://ghgprotocol.org/blog/standards-update-process-frequently-asked-questions
[14] https://ghgprotocol.org/project-protocol

accounting, reported as Scope 1 and 2 emissions that occur inside the organization's boundaries (further details provided in the next section).

Project Protocol describes how to evaluate emissions impacts of a GHG intervention (reduction) project, such as CHP or renewable energy development, relative to a counterfactual baseline scenario[15] (what emissions would be without the project). No organizational boundaries are involved with Project Protocol, as illustrated in Figure 3, but assessment boundaries must be defined for a specific project.

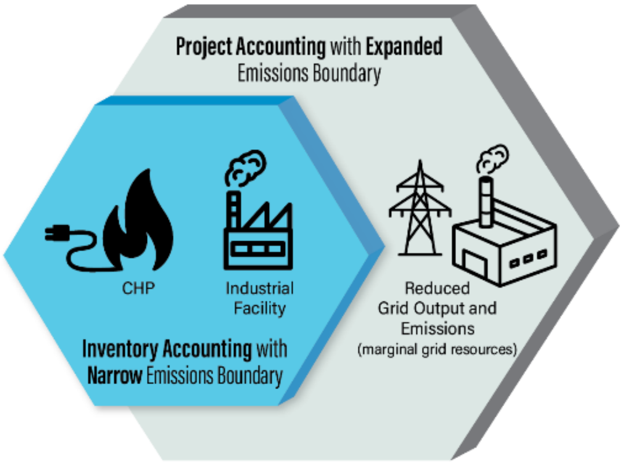

Figure 3. Illustration of inventory and project accounting reporting boundaries.

These two reporting frameworks use different methodologies for organizations to review, evaluate, and understand the impact of their decarbonization strategies and decision-making processes. In its recent review and updating process, GHG Protocol recommended that organizations use both reporting methods to inform their decision-making.[16] Table 1 contrasts the two standards.

Table 1. Comparison of GHG inventory and project accounting.

Characteristics	Corporate-Based Accounting	Project-Based Accounting
Scope	Encompasses entire organization's GHG emissions inventory	Focuses on specific emission reduction activities or initiatives
Timeline	Continuous monitoring across fiscal years	Limited to project duration and specific milestone
Key features	• Organizational boundaries • Scope 1, 2, and 3 emissions • Annual reporting cycles • Corporate-wide targets	• Baseline determination • Additionality assessment • Direct emission reductions • Project-specific boundaries
Purpose	Complete emissions inventory	Specific reduction initiatives

[15] GHG Protocol Blog Post, December 20, 2023, Inventory and Project Accounting: A Comparative Review | GHG Protocol.
[16] https://ghgprotocol.org/blog/inventory-and-project-accounting

Method 1: GHG Protocol Corporate Standard (Attributional) Overview

The Corporate Standard is an attributional framework that guides organizations in assessing and reporting their corporate-level physical emissions inventory.[17] It provides accounting and reporting for seven greenhouse gases covered by the Kyoto Protocol (i.e., CO_2, CH_4, N_2O, CCl_2F_2, CHF_3, SF_6, NF_3).[18] The Corporate Standard is designed to help companies prepare a GHG inventory that represents a true and transparent account of emissions attributed to facilities owned or controlled by the organization, inside their boundaries. This bottom-up approach provides a framework for organizations to develop and maintain an inventory of the physical emissions to be measured against a historic base year set by the organization and depicted in Figure 4a.

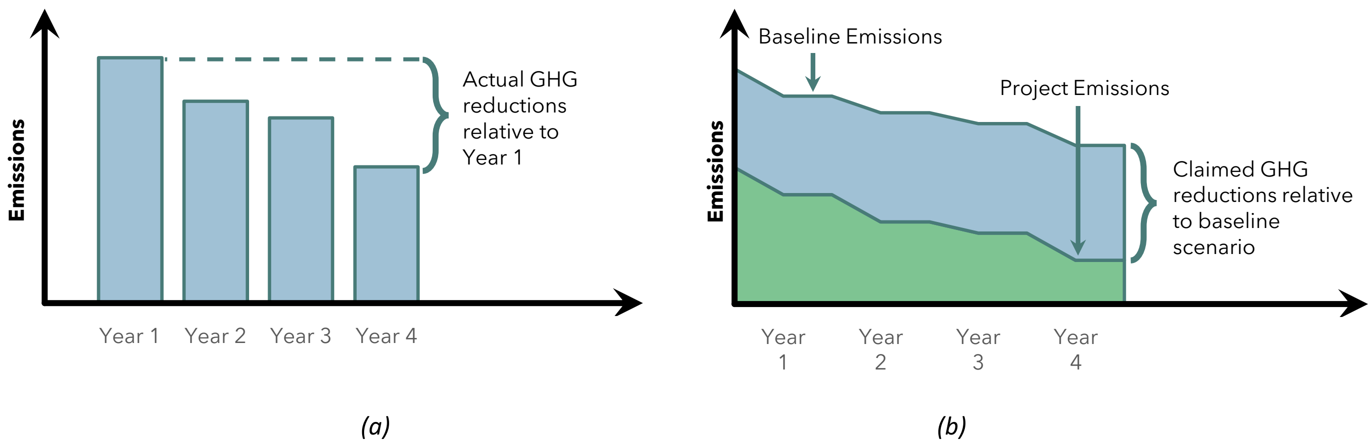

Figure 4. Quantifying emissions reductions relative to a baseline scenario: (a) comparison against a base year for corporate inventory accounting, and (b) comparison against a counterfactual baseline for project accounting.

Method 2: GHG Protocol for Project Accounting (Intervention/Consequential) Overview

Project accounting enables organizations to quantify emissions avoided by implementing specific GHG mitigation projects such as renewable energy, CHP, fuel switching, or efficiency. In some cases, project accounting may be used to facilitate development of offsets or credits for specific projects, as shown in Figure 4b.

To use project accounting, the organization must establish a credible baseline or counterfactual (business-as-usual) case representing emissions levels to measure impacts with and without the project. GHG Protocol has designed procedures for establishing credible baselines using historical data, industry benchmarks, and sophisticated emissions modeling.[19]

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[17] https://ghgprotocol.org/corporate-standard
[18] https://www.c2es.org/content/main-greenhouse-gases/
[19] *GHG Protocol Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects,* World Resources Institute and the World Business Council for Sustainable Development, https://ghgprotocol.org/sites/default/files/2022-12/Guidelines%20for%20Grid-Connected%20Electricity%20Projects.pdf

Project Protocol permits users to account for marginal grid emissions displaced by a CHP project,[20] whereas the Corporate Standard (for inventory accounting) stipulates that organizations must use average grid emission factors to calculate the impact of grid emissions displaced by CHP at the site.

A Review of the Use of Scopes 1, 2, and 3 in Inventory Accounting

GHG Protocol classifies emissions into three scopes for inventory accounting purposes (Figure 5). Organizations must establish plans to address all three scopes to mitigate or eliminate the impact of their carbon footprint effectively and ensure accurate carbon inventories.

The GHG Protocol's Corporate Standard emissions scopes are summarized as follows:

Scope 1: Direct GHG emissions—includes direct emissions from energy sources owned or controlled (operated) by a company generally to produce electricity, steam, and/or heat inside the boundary.[21] These emissions arise from stationary sources (onsite boilers, furnaces, and turbines), chemical and material processing, equipment leaks (i.e., chlorofluorocarbons, methane), and other sources. Scope 1 also includes emissions from mobile sources such as fuel combustion in owned or controlled vehicles (trucks, trains, ships, airplanes, buses, and cars). Fuel for operating a CHP unit is reported in Scope 1 emissions.

Scope 2: Indirect GHG emissions—includes all indirect emissions associated with purchased electricity, heating, cooling, and/or steam generated off-site (outside facility boundary), including those from the local electricity grid. Note that GHG Protocol requires the following two methods for reporting Scope 2 emissions from grid-purchased electricity:

The Scope 2 location-based method considers only the average emissions intensity of the local electric grid, excluding other purchasing arrangements unless a direct connection exists between the generation source and a facility.

The Scope 2 market-based method considers all contractual arrangements a company uses to purchase electricity from specific sources including renewable energy attributes or credits (RECs), power purchase agreements, and associated attributes.

Organizations are required to include both location- and market-based methods in their Scope 2 emissions reporting. The Corporate Standard's location-based reporting using average (not marginal) grid emissions is convenient and consistent but does not accurately reflect what occurs on the grid when load increases or

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[20] Use of marginal emissions factors is an established approach for estimating avoided emissions from the grid:
Tool to Calculate the Emission Factor for an Electricity System, United Nations' Clean Development Mechanism, https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v4.0.pdf.
Appendix I: Methods for Quantifying Energy Efficiency and Renewable Energy Emission Reductions, US EPA, https://www.epa.gov/sites/default/files/2016-05/documents/appendixi_0.pdf.
Quantifying the Emissions and Health Benefits of Energy Efficiency and Renewable Energy, Part Two, Chapter 4, US EPA, https://www.epa.gov/sites/production/files/2018-07/documents/mbg_2-4_emissionshealthbenefits.pdf.
Fuel and Carbon Dioxide Emissions Savings Calculation Methodology for Combined Heat and Power Systems, 2020, US EPA, https://www.epa.gov/sites/default/files/2015-07/documents/fuel_and_carbon_dioxide_emissions_savings_calculation_methodology_for_combined_heat_and_power_systems.pdf.

[21] https://ghgprotocol.org/corporate-standard

decreases. All generating units in a region do not respond and increase or decrease output and emissions as load changes; only the marginal unit does. Thus, using average grid emissions for Scope 2 location-based emissions reporting has led to challenges from stakeholders in the Scope 2 updating process. Use of average grid emissions credits CHP projects for a reduction of grid purchases at the site. However, the credit does not account for the full displaced GHG emissions occurring across the grid because of reduced marginal electricity generation resulting from CHP generation. Updated guidance on this issue is expected from GHG Protocol in 2025.

Scope 3: Other indirect GHG emissions up- and downstream (value chain)—accounts for all other indirect emissions associated with a company's activities across its entire value chain. These emissions span upstream activities (leased assets, transportation, transmission, and distribution losses) and downstream activities (end-of-life treatment of sold products, investments, and use of sold products). Although reporting Scope 3 emissions is currently optional, it will likely become mandatory in the future; thus, many organizations have already begun reporting and working to manage Scope 3 emissions. This document does not address Scope 3 emissions.

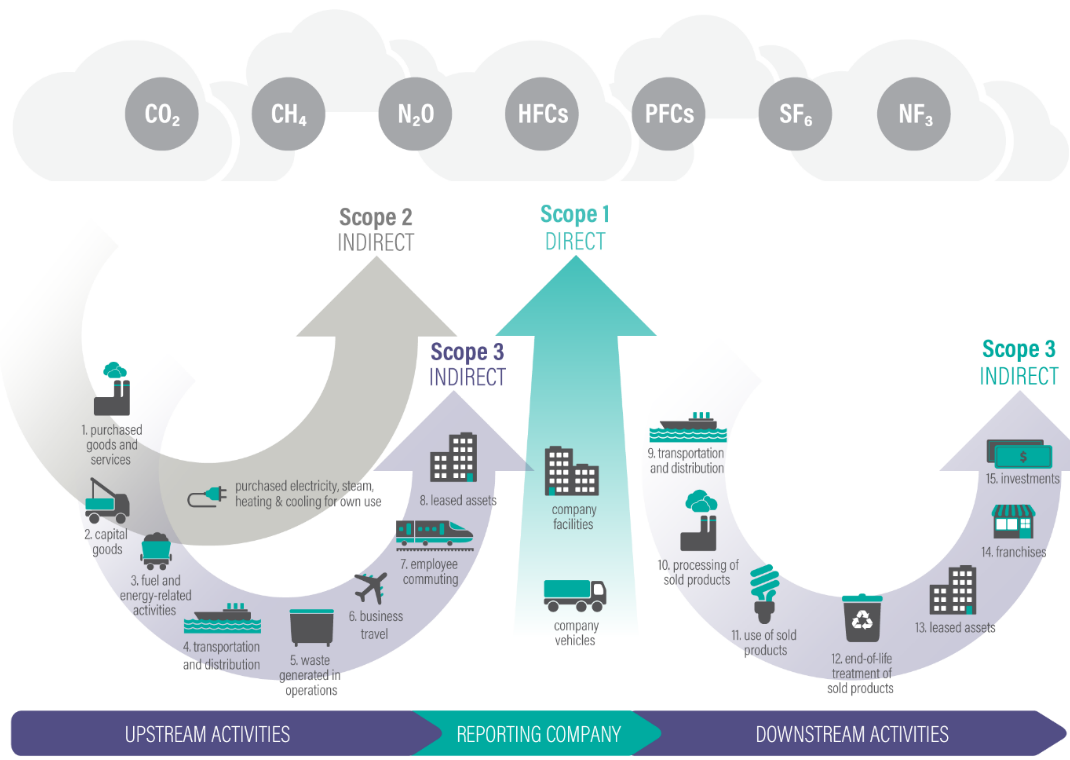

Figure 5. Overview of GHG Protocol scopes and emissions across the value chain.[22]

[22] https://ghgprotocol.org/sites/default/files/2023-03/Scope3_Calculation_Guidance_0%5B1%5D.pdf, page 6

Note that Scopes 1, 2, and 3 emissions are designed to be mutually exclusive for accurate counting. When totaling emissions from each scope, the sum should capture all emissions output of a company's activities without double counting.[23]

Using Project Protocol

Step-by-Step Process for Using Project Protocol

When an organization wants to evaluate the global effect of a GHG mitigation project like CHP, Project Protocol provides step-by-step guidance. The following is a summary of the guidance[24]:

1. Define the GHG assessment boundary to use for the project assessment.
    - Identify the specific site being considered for the project and relevant emissions sources, such as the fuel supply and emissions from the combustion of that fuel. Identifying the relevant grid with which the CHP project would interconnect is important.
    - The GHG assessment boundary should include all primary effects with significant secondary effects (if any) of the GHG emissions reduction project.
    - The primary effect of a CHP project activity (generating onsite electricity and useful thermal energy) is reducing combustion emissions from grid-connected central power plants and alternative thermal energy resources (e.g., onsite boilers).
    - Secondary effects should be considered if relevant, such as up- or downstream emissions (e.g., emissions associated with construction of the project, if material). These may be negligible compared with primary effects.
2. Estimate the baseline emissions.
    - Estimate the GHG emissions that would occur without the CHP project. This should be done using historical data when calculating actual avoided emissions to report, but forecasts can also be developed through a modeling exercise.
    - In general, baseline emissions are estimated by determining the extent to which the project affects the build margin (BM) and operating margin (OM). OM refers to energy displaced from existing plants, whereas generation from new capacity whose construction is avoided owing to the project activity is referred to as BM. As discussed in the next section, the use of sophisticated marginal emissions forecasting models currently available can supersede the need for establishing project-specific BM and OM for project accounting analyses.
    - Grid-connected projects can affect both the immediate operation of the grid and the future build-out of resource capacity on the grid that would be needed without the project.

[23] https://www.carbonchain.com/carbon-accounting/scope-1-2-3-emissions

[24] *GHG Protocol Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects,* World Resources Institute and the World Business Council for Sustainable Development, https://ghgprotocol.org/sites/default/files/2022-12/Guidelines%20for%20Grid-Connected%20Electricity%20Projects.pdf

- Project Protocol guidelines suggest that using a simple average grid emissions rate is not suitable except where necessary data are unavailable to calculate more accurate baseline emissions.

3. Monitor and quantify GHG reductions.
    - Create a monitoring plan for GHG emissions from all GHG sources and sinks related to the primary and any significant secondary impacts that would occur within the assessment boundary because of implementing the project. Monitor data related to assumptions underlying the baseline emissions estimates and update the baseline if required to ensure accuracy.
    - Quantify emissions reductions compared with the baseline to ensure accuracy.
    - Identify the time period, which is dependent on the availability of both CHP operating data and grid marginal emission factors (MEFs) as reported by Emissions & Generation Resource Integrated Database (eGRID), AVoided Emissions and Generation Tool (AVERT), or another credible source.
    - Estimate the GHG emissions that would be avoided or reduced as a result of a CHP project. This involves subtracting monitored CHP emissions from estimated baseline emissions.
    - Verify and report emissions reductions as determined by the organization's sustainability manager.
    - Consult with the organization's sustainability manager to determine the most effective manner to report emissions reductions. If necessary, consult with an independent third party to assess the accuracy of emissions reduction calculations.
    - Include avoided grid emissions reporting under supplemental information on the organization's sustainability report. Note: This is not reported as part of an organization's Scope 1 or Scope 2 inventory.

Marginal Emissions Data Sources

An MEF represents the emissions impact of adding or removing one unit of electricity demand from the grid at a specific time. It measures the emissions from the specific power plant(s) that would increase or decrease their generation in response to this change in demand (known as *marginal units*) rather than the average emissions from all power plants operating on the grid. MEFs can vary significantly by time and location. During periods when coal plants are the marginal units, the MEF would be higher than when natural gas plants are on the margin. Similarly, regions with different generation mixes will have different MEFs. Using MEFs enables a more complete and accurate evaluation of the emission impact of demand-side interventions such as electrification, behind-the-meter generations such as solar PV or CHP, and energy storage projects.

Historically, limited sources of regional power sector marginal emissions data have been available outside of the US Environmental Protection Agency's (EPA's) eGRID and AVERT. EPA's eGRID calculates emissions and emission rates at generation points, with several important limitations. These emission factors do not account for losses within power plants through net generation figures, and they exclude critical factors such as power transactions between regions (including purchases, imports, and exports), T&D losses between generation and consumption points, and real-time variations in emissions between peak and off-peak demand periods. Additionally, eGRID data typically lag by approximately 2 years, meaning they may not reflect current grid conditions or recent changes in generation mix. This time delay and the inability to capture hourly emission variations limit eGRID's utility for precise, real-time emissions analysis.[25]

AVERT is an open-access emissions tool built for the EPA by Synapse to estimate the hourly emissions and generation benefits of energy efficiency and renewable energy policies and programs. It organizes data into 14 regions to recognize differences in electricity generation source by region. AVERT publishes data generally 1 year behind actual data but can also be used as a tool for short-term forecasting (3–5 years forward).[26]

Several private and public sources now compile and publish historic and near real-time avoided emissions data, including Singularity, WattTime, and Electricity Maps.[27] These organizations also provide 24 h, day-ahead marginal emissions forecasts to support their clients' emissions accounting and tracking efforts. Some data companies have developed effective tools using algorithms to calculate hourly marginal emissions for various customer load shapes and energy efficiency measures. However, at this time, only the National Renewable Energy Laboratory (NREL) and REsurety have established sophisticated longer-term (20 year) marginal emissions forecasting models suitable for establishing a CHP project's lifetime counterfactual baseline required for project accounting.[28] Marginal emissions forecasting models have evolved substantially to become important tools for navigating the complexities of the rapidly changing electricity grid. Such models typically predict the amount of GHG emissions emitted to generate or reduce an additional unit of electricity in a specific region or location at a specific time (hour).

In essence, these models provide a time- and location-based emissions intensity rating for a regional power grid, enabling stakeholders to make more data-driven decisions on the future effect of project or policy alternatives on GHG emissions. Today, these models are designed to facilitate decisions on clean energy choices, renewable energy procurement, energy efficiency projects, emissions accounting impacts, and even overall climate policy. Considerable variation in effectiveness, sophistication, and capability exists among marginal emission forecasting models at the current stage of development.[29]

Marginal Emissions Forecasting Models

An industry-wide review of marginal emissions forecasting data sources, models, and methodologies clearly identified two leading models: NREL's Cambium and REsurety's Locational Marginal Emissions (LME) model.[30] These models stand out owing to their depth, sophistication, and capacity to provide robust analyses of time- and location-based power sector hourly emissions output. Both produce credible marginal emissions forecasts over 20 year horizons. These forecasts are invaluable in establishing credible baselines that streamline the application of Project Protocol.

[25] US Environmental Protection Agency, "Frequent Questions about eGRID," https://www.epa.gov/egrid/frequent-questions-about-egrid.
[26] US Environmental Protection Agency, "Avoided Emissions and Generation Tool," www.epa.gov/avert.
[27] www.singularity.energy, www.watttime.org, www.electricitymaps.com
[28] Clean Energy Buyers Institute (CEBI), "Guide to Sourcing Marginal Emissions Factor Data," 2022.
[29] Clean Energy Buyers Institute (CEBI), "Guide to Sourcing Marginal Emissions Factor Data," 2022.
[30] https://www.nrel.gov/analysis/cambium.html, www.resurety.com

Overview of NREL's Cambium and REsurety's LME

Evaluation of these two marginal emissions forecasting models identified their pros and cons. As sophisticated as these models are, they are still forecasts with variations in underlying assumptions and outputs. However, both provide substantial improvements over the manual process of establishing a baseline to quantify projects that avoid or displace power generation on electricity grids, as detailed in the GHG Protocol supplementary publication, *Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects.*[31] The next section describes details of these marginal emissions forecasting models.

Cambium

The Cambium datasets contain modeled hourly emissions, cost, and operational data for a range of possible futures of the contiguous US electricity sector through 2050. Cambium expands on the metrics reported in NREL's Standard Scenarios[32]—an annually released set of projections of how the US electric sector could evolve across a range of potential futures. Cambium's fourth annual edition, 2023, was released late Q1 2024.[33]

Cambium is publicly available and free to use. It models the contiguous US as 140 Balancing Areas that cover both independent system operator (ISO) and non-ISO regions. Data are available for the Balancing Areas plus 18 Generation and Emissions Assessment Regions, individual states, and the US. In its 2023 fourth annual edition, Cambium makes data available only in 5 year increments (e.g., 2025, 2030), requiring the user to fill in gaps between increments. Cambium does not capture the full impact of transmission constraints within each Balancing Area, and recent releases use a 2012 weather model.

Cambium reports both short-run marginal emissions rate (SRMER) and long-run marginal emissions rate (LRMER). SRMER estimates emissions induced or avoided by a change in electricity demand while keeping grid assets (such as generators and transmission) substantially fixed. LRMER considers both operational and structural consequences of changes in electricity demand, thus forecasting how changes in demand might influence the grid's structure (e.g., building or retiring generators and transmission lines) over longer periods. Cambium produces long-range forecasts of generation expansion plans and loads via production costing models to select a region's future mix. This longer-range planning approach makes it difficult to evaluate the accuracy and effectiveness of Cambium's LRMER forecast. According to Gagnon and Cole, "A significant weakness of an LRMER is that its derivation requires projections of how the electric grid will evolve and therefore is only as good as those projections. An LRMER built upon a poorly built model could produce worse estimates than AER [average emission rates] or SRMER metrics derived from empirical methods."[34]

Locational Marginal Emissions Forecast

REsurety is a privately owned firm that developed and offers a marginal emissions forecasting methodology referred to as LME Forecast.[35] LMEs are calculated at each power system node on the grid, thus incorporating the effect of congestion or other localized grid issues. REsurety forecasts also use a regularly updated proprietary long-range weather model.[36] REsurety's LME data are available by subscription. Users

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[31] https://ghgprotocol.org/sites/default/files/2022-12/Guidelines%20for%20Grid-Connected%20Electricity%20Projects.pdf
[32] https://www.nrel.gov/analysis/standard-scenarios.html
[33] https://www.nrel.gov/docs/fy24osti/88507.pdf
[34] Gagnon and Cole, "Planning for the Evolution of the Electric Grid with a Long Range Emissions Model," iScience, March 18, 2022.
[35] www.resurety.com
[36] https://resurety.com/solutions/locational-marginal-emissions/

can access both historic and forecasted LMEs through REsurety's online Renewable Energy Market Analytics Platform (REmap).

REsurety incorporates plant additions and retirements directly from each ISO member forecast, offering transparency in how it arrives at grid forecasts. REsurety's LME is not specified as short- or long-run but can provide insights into long-term trends and potential impacts based on each ISO member's consolidated generation expansion and retirement plan.

REsurety's LME only includes coverage for current organized ISOs (California ISO, Electric Reliability Council of Texas, PJM Interconnection, Midcontinent Independent System Operator, New York ISO, ISO New England, and Southwest Power Pool). LMEs are not currently provided for large regions of the Southeast and West but may be added in the future.

Using a Marginal Emissions Forecasting Model in Project Protocol

The GHG Project Protocol outlines steps to quantify and report GHG reductions from climate change mitigation projects such as CHP. The traditional steps to establish a baseline for a GHG mitigation project that reflects the emissions without the project and to determine operating and build margins, as summarized in the previous sections, are complex and time-consuming as detailed in *Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects*,[37] a Project Protocol supplement explaining the process for quantifying GHG reductions from projects that displace or avoid power generation on grids. However, use of the marginal emissions forecasting models discussed in this document can streamline the project accounting methodology. Marginal emissions forecasting models use the latest and most sophisticated industry data and can be used to establish a credible project baseline derived from project-specific inputs of a CHP or another GHG mitigation project to measure against its baseline.

Quantifying and Reporting GHG Reductions for CHP Based on Project Protocol

The following sections focus on how to evaluate the impact of CHP on GHG emissions using Project Protocol.[38]

Evaluating the Impact of CHP on GHG Emissions

For consistency, an example CHP project is used to illustrate the steps outlined in this section.[39] The example site is an industrial manufacturing facility that operates ~96% of the year, requiring approximately 25,000–35,000 kW of electric power and 100–140 klb/h of steam.[40] The facility, located in the Carolinas region of the southeastern US, has higher electrical demand in the warmer summer months and a relatively consistent process steam load throughout the year as shown in Figure 6. Table 2 summarizes the plant operating profile.

[37] https://ghgprotocol.org/sites/default/files/2022-12/Guidelines%20for%20Grid-Connected%20Electricity%20Projects.pdf
[38] https://ghgprotocol.org/project-protocol
[39] For simplicity, this example focuses only on CO_2 emissions from combustion of fuels. Using the same steps with factors for additional pollutants or CO_2e will result in a somewhat more comprehensive emissions analysis.
[40] For this example, 1 klb = 1,000 lb = 1.005 MMBtu.

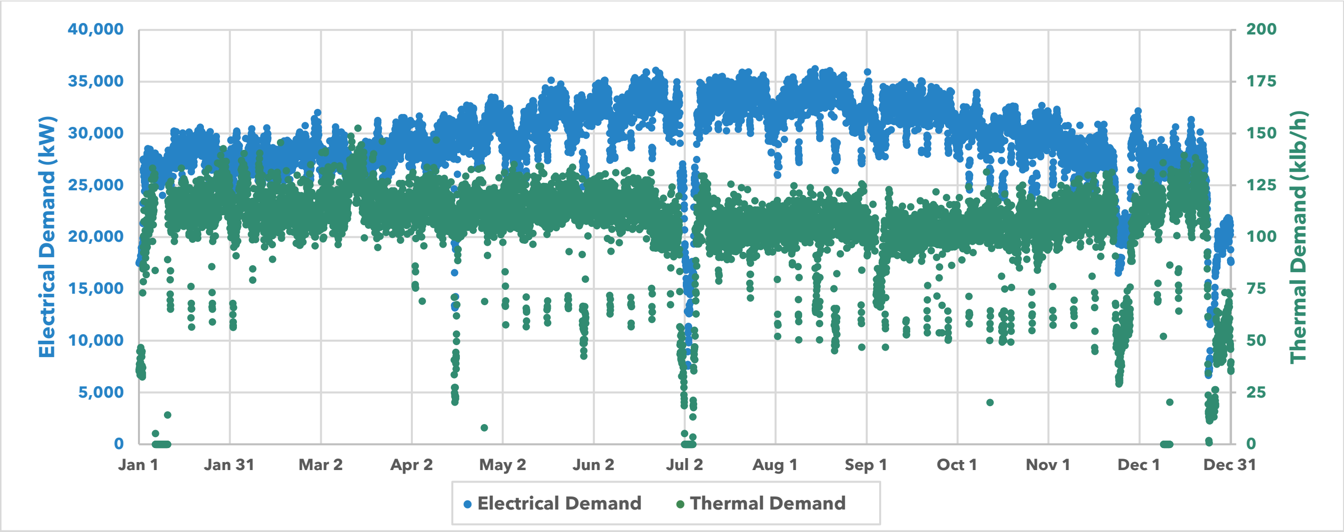

Figure 6. Site baseline electric and thermal demands.

Table 2. Key operating data for example facility.

	Steam Demand (klb/h)	Electrical Demand (kW)
Minimum	47.0	22,132
Average	108.2	30,010
Maximum	152.6	36,244

The CHP plant is designed as a primary energy source for the facility and is sized to operate base loaded, with the electrical grid providing supplemental electricity and the facility's preexisting boilers providing the balance of the steam demand. The prime mover for the CHP plant is a 21,000 kW rated combustion turbine (CT), with balance-of-plant equipment including a fuel gas compressor and inlet cooling provided by an electric chiller. Table 3 summarizes key parameters of the facility and the CHP plant.

Table 3. Metrics for example CHP plant.

	Value	Unit
Gross Power	21,019	kW
Net Power	20,510	kW
Fuel Consumption	208.9	MMBtu/h (HHV)
Steam Flow	90.0	klb/h
Electrical Efficiency	33.5%	–
Thermal Efficiency	43.3%	–
Power-to-Heat Ratio	0.774	–
Average CT Load	99.5%	–
Thermal Utilization	96.3%	–
Boiler Efficiency	82%	–

HHV = higher heating value

Figure 7 and Figure 8 show the site power and thermal demands in relation to the dispatched electrical output of the turbine and the thermal energy generated by the CHP plant, respectively. The electrical output of the CHP plant (Figure 7) is the net electrical output after deducting auxiliary loads, including the gas compressor and inlet cooling, from the gross output of the generator. The CT is paired with an unfired heat recovery steam generator, which generates baseload steam for the plant.

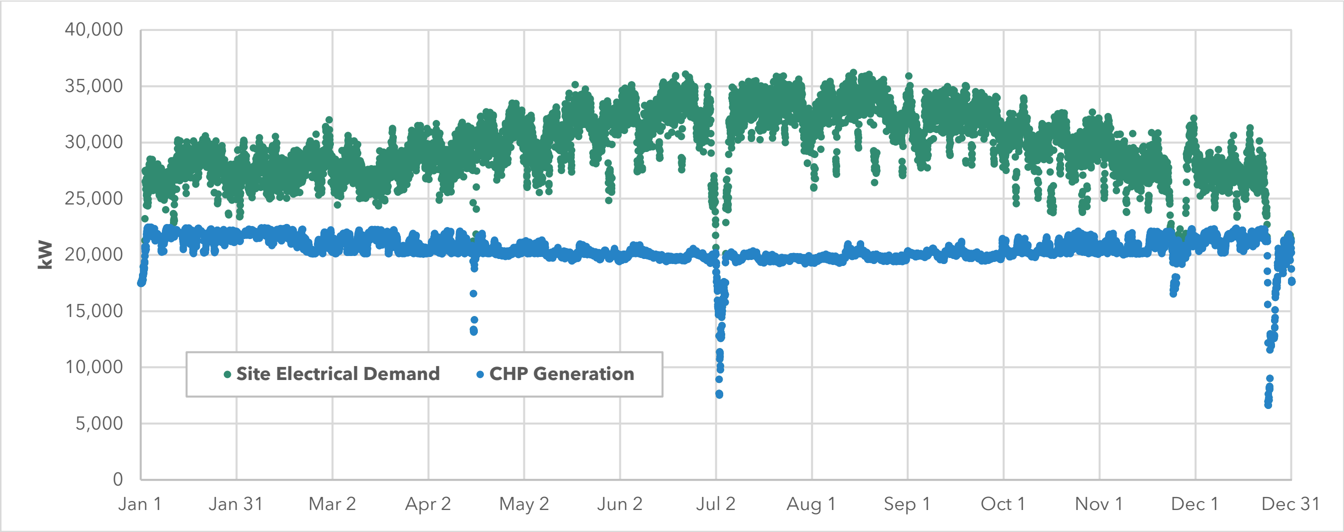

Figure 7. Site electric power demand and CHP generation.

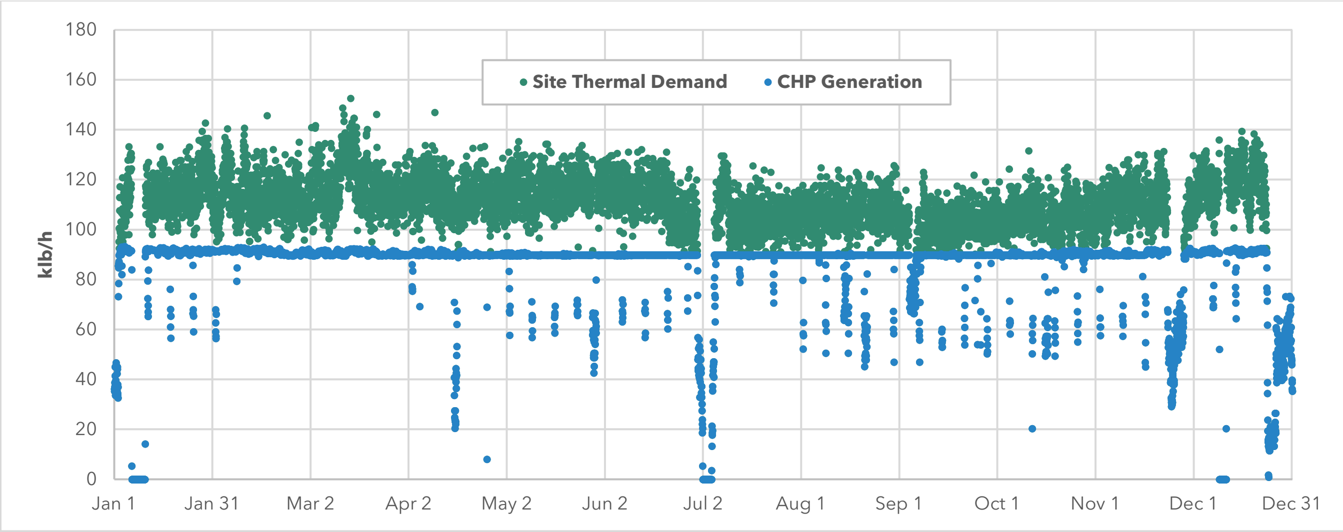

Figure 8. Site thermal demand and total thermal energy generated by the CHP plant.

The previous charts and the following calculation process are based on hourly data (8,760 points per year). Each project should use the most detailed data that are available, accurate, and practical to secure. Key steps include the following:

Step 1. Define the GHG Assessment Boundary for the Project

For grid-connected CHP plants, the relevant boundaries—which are not defined by physical proximity to the project but instead are defined by the project's primary and secondary effects—are typically resources that would serve the facility's electric and thermal loads under a separate heat and power scenario (i.e., the regional electric grid and alternative thermal energy resource [e.g., boiler, district heating system]). For this example, the assessment boundary is the regional electrical grid serving the Carolinas and the facility's preexisting natural gas–fired boilers.

Step 2. Estimate the Baseline and Project Emissions

Baseline emissions—those that would occur without the CHP project—typically are based on historical fuel and electricity consumption, including anticipated changes to the facility operating profile (production levels/hours) and equipment (e.g., a new boiler is required if the CHP project is not executed). The prospective CHP plant should be modeled to meet the same thermal and electric loads used for the baseline energy consumption. Table 4 shows the baseline and CHP case annual energy consumption. Once these operating data are compiled, the associated emissions can be calculated using fuel and electrical grid emissions factors. Emissions projections should be established for the project timeline, typically 15–25 years for a CHP project.

Table 4. Baseline and CHP case electricity and fuel consumption.

	Baseline Energy		CHP Energy	
	Electric (MWh)	Fuel (MMBtu)	Electric (MWh)	Fuel (MMBtu)
Boilers	–	1,101,033	–	198,429
Grid	257,508	–	77,992	–
CHP Plant	–	–	179,516	1,846,396
Total	**257,508**	**1,101,033**	**257,508**	**2,044,825**

Calculating the Baseline and Project Thermal Emissions

Emissions factors for fuel consumption can be either combustion-only-based factors or factors that include precombustion (i.e., "upstream" emissions), provided the electric grid factors use the same assumptions. For this example, the electric grid factors are combustion-only values; therefore, the thermal emissions[41] calculations use those same assumptions.

To calculate thermal emissions for both the baseline and CHP fuel consumptions using fuel-specific emissions rates (e.g., 116.9 lb CO_2/MMBtu for natural gas[42]),

$$Thermal\ Emissions = \frac{F \cdot ER_F}{2{,}000},$$

where

F	=	annual fuel use, MMBtu/year
ER_F	=	fuel-specific emissions rate, lb/MMBtu
2,000	=	conversion from lb to ton

Table 5 shows thermal emissions associated with fuel consumption, which was shown in Table 4.

Table 5. Baseline and CHP case thermal emissions per year.

	Baseline Emissions (ton/year)	CHP Emissions (ton/year)
Boilers	64,355	11,598
CHP Plant	–	107,922
Total	**64,355**	**119,520**

[41] Thermal emissions are from the use of fuel for heating and cooling. In the baseline case, that would be the boiler fuel; for the CHP case, that would be the total fuel use of the CHP system.
[42]https://www.epa.gov/sites/default/files/2015-07/documents/fuel_and_carbon_dioxide_emissions_savings_calculation_methodology_for_combined_heat_and_power_systems.pdf

Table 5 shows an increase of 55,165 ton/year in thermal emissions resulting from CHP project operation. For this example, the CHP project was expected to start operations in mid-2022, meaning the project was expected to operate only during the second half of 2022. Therefore, emissions calculations for that year are based on only those months of operation (Figure 9).

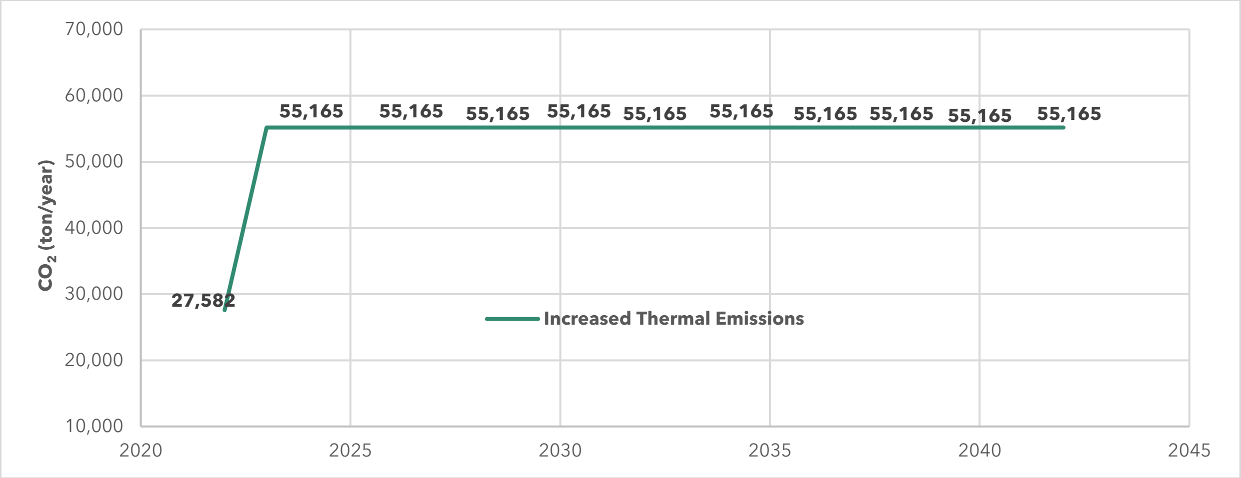

Figure 9. Increased thermal emissions due to the CHP plant by year.

Calculating the Baseline and Project Electrical Emissions

Calculating the baseline emissions rate

The traditional steps to establish a baseline for the project that accurately reflects the emissions without the project are complex and time-consuming. These steps are provided in *Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects*,[43] a supplement to the Project Protocol explaining the process for quantifying GHG reductions from projects that displace or avoid power generation on grids.

Steps for establishing the baseline were first written 20 years ago when the evolution of the grid was easier to forecast and, more importantly, before the comprehensive marginal emissions models discussed in the previous section were available. The comprehensive marginal emissions models now available provide the most reliable forecast for comparing a potential CHP project with its counterfactual baseline.

This example uses a publicly available forecast from Cambium. REsurety and other private resources under development are also capable of providing credible information on marginal emissions. However, Cambium offers both SRMER and LRMER. The SRMER is the actual marginal emissions rate for a specific hour within a modeled year and is akin to the rates calculated by EPA's AVERT. The LRMER is an estimate of the marginal emissions rate that would be either induced or avoided by a change in electric demand, considering how the change could influence both the operation and structure of the grid (i.e., the building and retiring of capital assets such as generators and transmission lines).[44] Cambium calculates the LRMER by determining how the capacity expansion and production cost model outputs change after application of a scalar increase in end-

[43] https://ghgprotocol.org/sites/default/files/2022-12/Guidelines%20for%20Grid-Connected%20Electricity%20Projects.pdf
[44] https://data.nrel.gov/submissions/230

use load. This tends to result in greater deployment of wind and PV, leading LRMERs to be generally lower than SRMERs.

However, as noted in a paper by NREL,[45] "a LRMER does not necessarily include structural change—if a change in load would not induce structural changes in the grid, then a properly calculated LRMER would likewise not include structural change, and the SRMER and LRMER would be equivalent."

Does behind-the-meter CHP induce structural changes to the grid? The concept of the LRMER is conceptually similar[46] to the combination of OM and BM introduced in the guidelines for grid-connected projects[47] from GHG Protocol, with the build margin representing the structural change of the grid reflected in LRMER. Those same guidelines offer the following information on whether a project will affect BM:

- "Many individual end-user project activities are small in scale and are often implemented for reasons wholly unrelated to grid capacity requirements. These types of project activities will have little or no effect on the BM."
- "If a project activity has no capacity value, then all of its output will affect the OM. Capacity value is largely determined by the extent to which the project activity provides firm power, but also by the timing of its generation."

Given that virtually all CHP plants operate at the discretion of the facilities they serve, not the utility or grid operators, and will continue to be backed up by the grid, how they could have a meaningful impact on utilities' capacity planning is unclear. Because behind-the-meter CHP impacts the grid essentially as a reduction in load (or, more accurately, a reduction in load growth), a short-run marginal emissions rate is an appropriate metric for calculating emissions impacts for Project Protocol.[48] The project developer or owner should independently review the use of SRMER vs. LRMER forecasting methodologies to determine which provides the most transparent and suitable method for their specific project accounting analysis. This may change periodically as new marginal emissions forecasts are released and reviewed for relevance to the specific project accounting analysis being performed.

Calculating the marginal emissions rate

Cambium makes hourly data files available for download by region and year. Using these files enables calculation of the weighted averages for the short-run marginal emissions rate for each year available.[49]

$$ER_W = \frac{\sum_{i=1}^{8760} P_i \cdot ER_i}{\sum_{i=1}^{8760} P_i},$$

where

ER_W = weighted emissions rate

[45] Present, Gagnon, Wilson, Merket, White, and Horowitz. 2024. "Choosing the Best Carbon Factor for the Job: Exploring Available Carbon Emissions Factors and the Impact of Factor Selection." Preprint. Golden, CO: National Renewable Energy Laboratory. NREL/CP-5500-86682. https://www.nrel.gov/docs/fy24osti/86682.pdf.
[46] Gagnon & Cole, iScience 25, 103915. 2022. https://doi.org/10.1016/j.isci.2022.103915.
[47] https://ghgprotocol.org/sites/default/files/2022-12/Guidelines%20for%20Grid-Connected%20Electricity%20Projects.pdf
[48] Consensus among professionals in interviews.
[49] Cambium does not publish hourly data for every year, so unavailable years will need to be interpolated.

P_i = hourly CHP electrical output
ER_i = hourly emissions rate

Because the CHP plant was expected to begin operations in mid-2022, these project accounting forecasts would have taken place in 2021. Therefore, data from Cambium 2021—the latest data available—are used for this example. Cambium 2021's Mid-Case, the baseline case in the US Department of Energy's annual Standard Scenarios,[50] reflects a potential future based on the prevailing policies and trends at the time of the modeling exercise. Other scenarios may better align with a specific organization's outlook, so reporting organizations must determine what data sources and scenario(s) to include in the project accounting forecast. Figure 10 shows the calculated weighted average of the short-run marginal emissions rate.

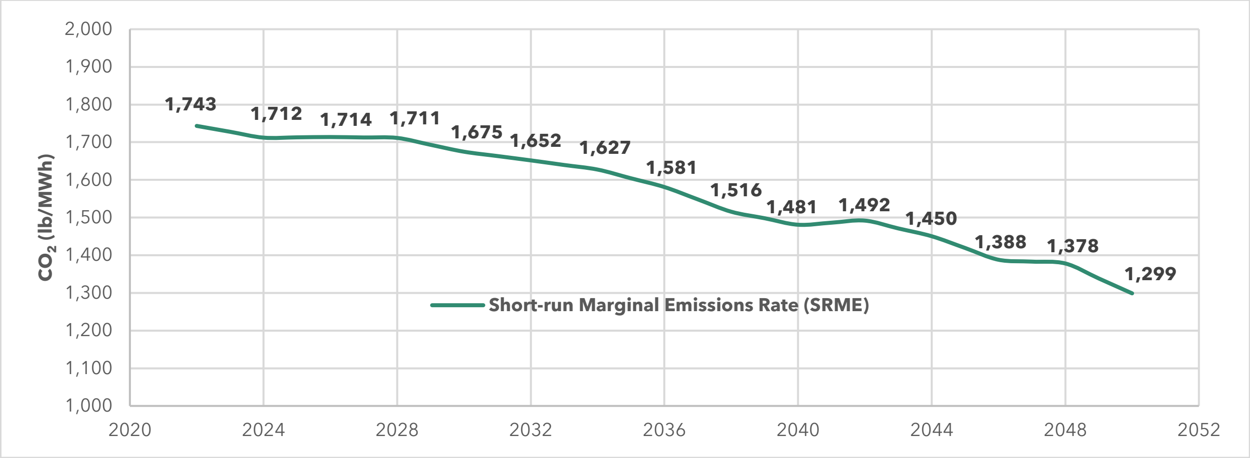

Figure 10. Weighted average emissions rates.

To calculate avoided grid emissions associated with the project using the annual CHP electrical generation and weighted average emissions rates,

$$Marginal\ Grid\ Emissions\ Savings = \frac{(P_{BL} - P_{CHP}) \cdot SRMER_W}{2{,}000},$$

where

P_{BL} = baseline purchased power, MWh/year
P_{CHP} = CHP purchased power, MWh/year
$SRMER_W$ = weighted average short-run marginal emissions rate, lb/MMBtu
2,000 = conversion from lb to ton

Because the project is expected to operate during only half of 2022, the emissions reductions for that year are based on only those months of operation (Figure 11).

[50] https://www.nrel.gov/analysis/standard-scenarios.html

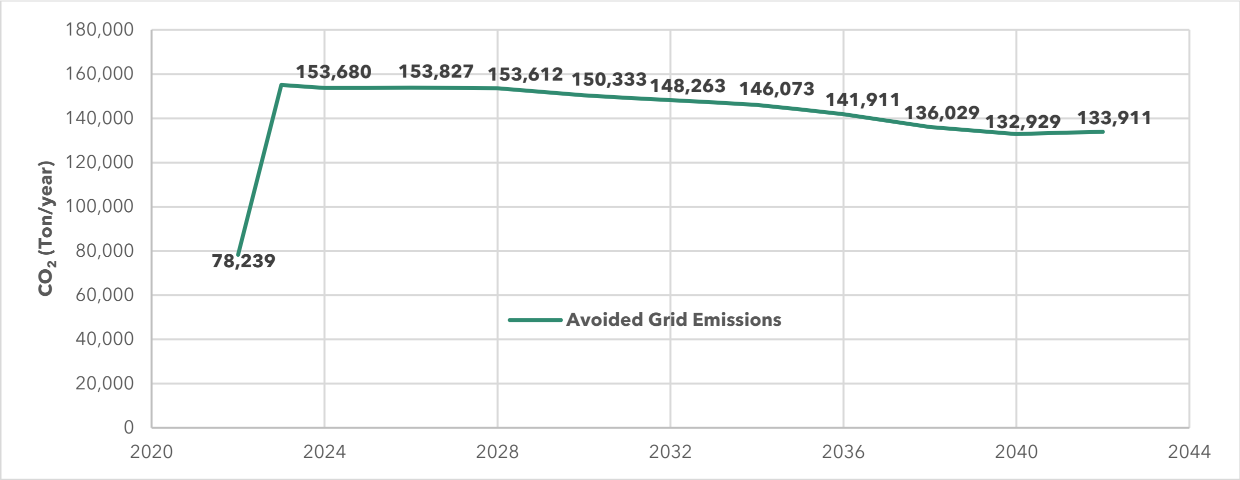

Figure 11. Annual grid emissions reductions with mid-2022 start-up.

Reporting Project Accounting Results

Having determined the emissions impacts from both the thermal and electrical impacts of the project, the *combined impact* of the project can be calculated by deducting the marginal grid emissions savings from the increased thermal emissions (e.g., *annual CHP emissions impacts = increased thermal emissions – marginal grid emissions savings*). Figure 12 shows this graphically.

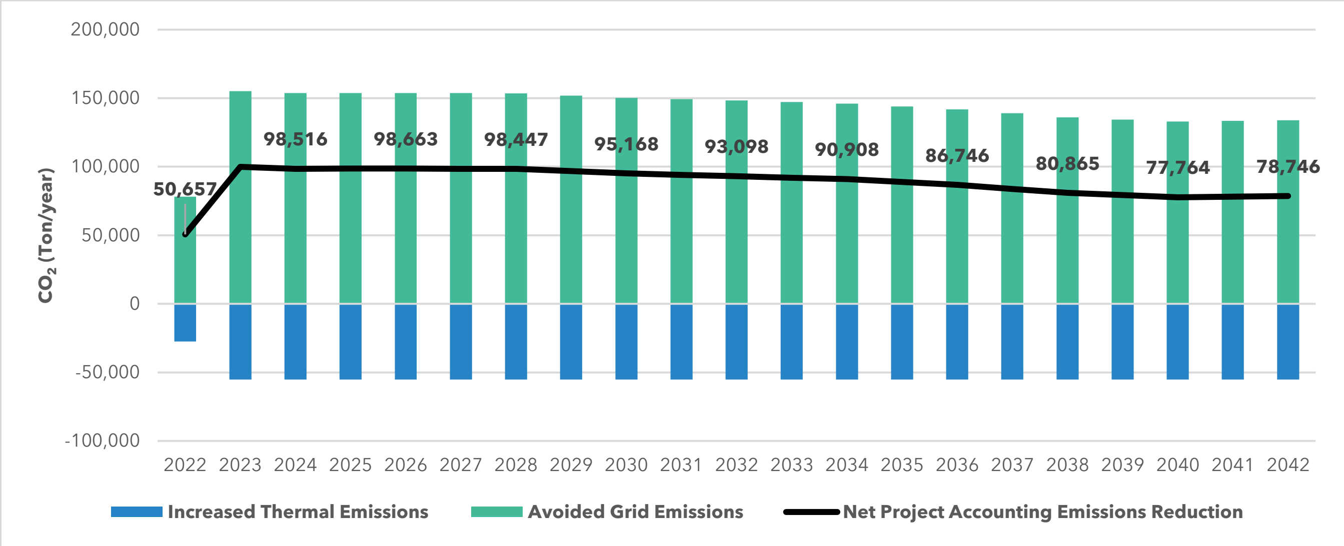

Figure 12. Combined impact of thermal and electrical emissions impacts from the CHP project.

Monitoring, Quantifying, and Reporting GHG Reductions

A periodic monitoring plan should be established to evaluate and determine the validity of forecasts. Alternately, the forecast can be periodically updated. Once the project is operating, CHP project operations should be monitored and recorded, replacing previously established baseline and emissions forecasts with actual project operation data.

As previous calculations are updated with actual plant operation data (including measured electrical and thermal generation and fuel consumption), the forecasted grid marginal emissions rates should be replaced with the best available historical grid emission rates, such as those published annually by eGRID and AVERT, to reflect actual grid operation.

For this example, the forecasted SRMERs calculated from the Cambium 2021 dataset were 1,743 lb CO_2/MWh for 2022 and 1,728 lb CO_2/MWh for 2023. (This was interpolated from 2022 and 2024, the years for which data were available.) However, actual marginal emissions rates for 2022 and 2023, as calculated by AVERT, were 1,434 and 1,511 lb CO_2/MWh,[51] respectively, for the Carolinas region applicable to this example. Thus, the actual savings were less than those projected, as shown in Table 6.

Table 6. Updated emissions savings[52] based on actual marginal emissions rates from AVERT.

	Projected Emissions Savings (Ton/yr)			Actual Emissions Savings (Ton/yr)		
Year	Thermal	Electric	Total	Thermal	Electric	Total
2022	−27,582	78,239	**50,657**	−27,582	64,351	**36,768**
2023	−55,165	155,079	**99,915**	−55,165	135,662	**80,498**

This type of monitoring (including updating assumptions if necessary) is a key element of Project Protocol, ensuring transparency of the project accounting analysis, which is a primary objective of the standard. Monitoring and reporting also generate data for third-party review, should the organization desire an external review of the forecast and results.

Applying Inventory and Project-Based Accounting

Early in its ongoing multiyear updating process that began in 2023, GHG Protocol noted the importance of using both accounting methods, stating,

> *"Throughout both the GHG Protocol Corporate Standard and Project Protocol, there is a clear recognition of the value these two fundamental accounting methods provide to organizations in evaluating their decarbonization strategies. Companies should generate and use both types of information to inform decision-making."*[53]

Although virtually all organizations are familiar with inventory accounting procedures, many remain unfamiliar with Project Protocol and how it differs from the Corporate Standard. Inventory and project accounting are distinct in two ways: (1) the assessment boundary and (2) the reliance on historic (observed) data vs. counterfactual scenarios with Project Protocol. The Corporate Standard approach uses boundaries defined by emissions sources owned or controlled by the reporting organization and in the company's value chain. Conversely, Project Protocol accounting identifies potential primary and (possible) secondary impacts

[51] These are uniform EE values from AVERT, however it is suggested that the AVERT statistical model be used with the hourly CHP operating profile to determine project specific avoided emissions rates.
[52] In reality, this would also be based on actual operating data for the facility rather than the forecasted operation; however, there are no operating data for this facility because the CHP plant was never built, largely because of concerns about its environmental impact.
[53] GHG Protocol Blog Post, December 20, 2023, Inventory and Project Accounting: A Comparative Review | GHG Protocol.

of the project in question and assesses the system-wide (global) GHG emissions increases or reductions from the baseline relative to the project activity.

Inventory accounting as described in the Corporate Standard quantifies and reports direct emissions that have been attributed to a specific site or organization. Theoretically, all direct (Scope 1) emissions values could be summed within a defined geographical or political region to equal total emissions of that region (if there were complete reporting). Inventory accounting, however, does not quantify impacts of an organization's individual project-based actions or impacts that occur outside their boundaries.

By contrast, project accounting provides a holistic view of the impacts from a specific project (intervention) relative to what would have otherwise occurred (business-as-usual case), including the global impacts beyond the GHG inventory boundary. Therefore, applying Project Protocol enables management to consider system-wide impacts of projects and whether to pursue those that go beyond reducing only their own GHG emissions inventories to reducing emissions anywhere across the globe.

Reporting Results Using Project Protocol: It Is Not Scopes 1 and 2 Reporting[54]

At the start of its update process, GHG Protocol acknowledged that methods for disclosure and reporting of Project Protocol results had not been clearly established in the past and are not well aligned with inventory accounting reporting as covered in the Corporate Standard. GHG Protocol's updated guidance is expected to better facilitate reporting using both inventory accounting and project accounting.

Each GHG Protocol standard addresses the important distinction between inventory and project accounting concepts. This includes requirements that reporting of avoided emissions estimated with project-based accounting methods[55] be disclosed separately from Scope 1 and Scope 2 inventory accounting totals. In other words, Scopes 1 and 2 refer only to inventory accounting of physical emissions inside the organizational boundary, not to system-wide emissions calculated for project accounting assessments.

Therefore, project-based accounting results are never reported within an organization's required inventory emissions report for the inventory results or goals of Scopes 1 and 2 (as well as Scope 3). Project-based accounting reports are not mandatory. Therefore, the organization's sustainability officer can determine if and where to report project-based accounting results.

Project Protocol reports can communicate sustainability messaging and impacts to shareholders, boards, employees, customers, and other institutions and provide details of the global impacts of GHG mitigation investments the organization either has made or is considering. The reporting can be higher or lower profile depending on the messaging the organization chooses; however, as noted previously, Project Protocol results must always be reported separately from Scopes 1 and 2 emissions reporting. The Corporate Standard recommends reporting Project Protocol results in a similar way as RECs are reported in the organization's overall GHG reporting.

[54] GHG Protocol Blog Post, December 20, 2023, Inventory and Project Accounting: A Comparative Review | GHG Protocol.
[55] As an example, emissions avoided across the electric grid resulting from displacing purchased electricity through efficiency or clean onsite generation projects.

Numerous organizations surveyed for the GHG Protocol standards update indicated that project-based accounting has not traditionally played a meaningful role in organizational goal setting or disclosures, which are driven by corporate physical emissions inventory reporting. However, recent GHG Protocol stakeholder feedback confirms increasing support to account for projects that are expected to have an overall benefit on the climate and to include these actions in corporate-level GHG reporting[56]. GHG Protocol will provide detailed guidance on this issue with submittal of their proposed stakeholder revisions to standards planned for publication for peer review in 2025.

Illustrating Both Inventory and Project Accounting Impacts for a CHP Project

Figure 13 continues the previous example, showing inventory accounting emissions of separate heat and power (business-as-usual case) compared with the inventory accounting emissions of the CHP project implemented in 2022. The CHP project's inventory accounting results report higher combined Scope 1 and 2 emissions over time than those of the business-as-usual case. When communicating a potential project's benefits for internal approval, showing only the impact on the inventory results for the site can be misleading.

Although, as noted previously, project accounting and inventory accounting are always reported separately in an organization's overall GHG reporting, in some cases it can be helpful to show a specific project's impacts based on both inventory and project accounting. Displaying them together not only shows the scale of the project accounting results in relation to the inventory accounting but also highlights that some projects can have substantial benefits that are not reflected in inventory accounting.

Figure 13 illustrates one way to show both inventory and project accounting impacts of a CHP plant. When presenting project emissions savings along with inventory savings, to avoid double counting, calculate the emissions reductions from the CHP plant that go beyond what has already been captured in Scope 2:

$$Additional\ Grid\ Emissions\ Savings\ = E_M - (S2_{BL} - S2_{CHP}),$$

where

E_M	=	marginal grid emissions savings, ton/year
$S2_{BL}$	=	baseline Scope 2 emissions, ton/year
$S2_{CHP}$	=	CHP case Scope 2 emissions, ton/year

These additional savings can be added to the total Scope 1 and 2 reductions to show the overall impact of the CHP plant compared to the inventory accounting results. In this example, incorporating project accounting shows the significant impact of capturing marginal emissions avoided on the grid when the more efficient CHP generation supplies power to the site, avoiding 80,000–90,000 tons of CO_2 per year instead of increasing emissions as shown in the CHP project's inventory accounting.

[56] GHG Protocol Blog Post, December 20, 2023, Inventory and Project Accounting: A Comparative Review | GHG Protocol

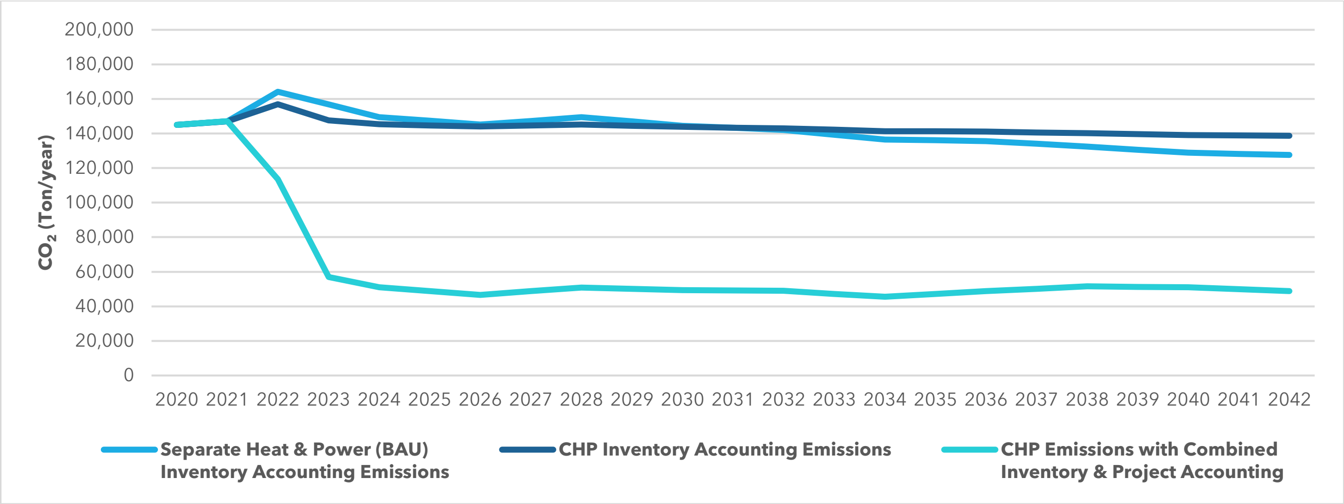

Figure 13. Example comparing both inventory and project accounting impacts of a CHP plant for purposes other than organizational GHG reporting.

Additionality: What Is It and Why Is It Important?

Additionality is an essential idea when measuring the GHG reductions of a specific project or program. It means that the reductions claimed by a project should add to reductions that would have naturally occurred without that specific project. When considering a GHG mitigation project, additionality can be used as a standard that says GHG reductions should be recognized only for project activities that would not have otherwise occurred. Although additionality is a key consideration and GHG Protocol provides a framework for evaluating whether a project meets an additionality criterion, Project Protocol does not require an additionality test as a mandatory element of performing a project accounting assessment.[57]

Generally, an additionality assessment is required when seeking to qualify and formally certify a project for carbon offset or REC credits. Some corporations require additionality assessments on GHG mitigation projects under consideration to ensure the real impact of each project is clearly understood. Even when not required, assessing additionality compared with the established project baseline can enhance the overall credibility and impact of a GHG mitigation project and may be instrumental in gaining approval.

As an example of additionality, one could ask: Would an organization replace its aging boiler because it is at the end of its useful life, regardless of the emissions savings gained from replacing it with a more efficient boiler? In this example, a "yes" answer clearly means the project does not meet the additionality criteria because the owner would replace the boiler regardless of the emissions benefits. If the organization would not replace the boiler for reasons other than the emissions savings, this case more likely meets additionality criteria. Simply put, are the emissions reductions a key element of approving the boiler replacement (or any other GHG mitigation project) investment?

Many online resources are available to assist an organization in assessing additionality for a project.[58]

[57] https://ghgprotocol.org/sites/default/files/standards/ghg_project_accounting.pdf
[58] https://ghgprotocol.org/sites/default/files/standards/ghg_project_accounting.pdf

Summary

For many decades, CHP projects have played an essential role in supplying efficient heat and power onsite, boosting resilience, and helping decarbonize the grid by reducing emissions of less efficient grid-based power sources. However, as the grid becomes greener, CHP's role is changing. Organizations should monitor and report the global impact of their CHP projects instead of focusing solely on the physical inventory of emissions inside organizational boundaries in order to properly assess the emissions impacts of CHP systems.

Project Protocol has a well-established methodology enabling an organization to capture and report a GHG mitigation project's global impact on marginal GHG emissions without regard to physical boundaries. As the nation's power system grows increasingly complex with integration of renewables, battery energy storage, demand response, and conventional natural gas capacity, the use of sophisticated marginal emissions forecasting models that are available from sources discussed in this document are increasingly important for forecasting a project's lifetime emission impact.

Because Project Protocol results are not part of an organization's Scope 1 and 2 inventory reporting, GHG Protocol has established a separate, voluntary framework for quantifying and reporting results. An organization's management or sustainability director is responsible for determining if and how project accounting results will be used and reported. In some cases, an organization may prefer to use project accounting results only internally to communicate a project's impact when screening potential climate change mitigation projects for possible investment, whereas at other times, results of a climate change mitigation project assessment may be reported publicly to investors and shareholders in the organization's overall climate plan as an indication of the organization's commitment to decarbonization. The reporting framework specified by Project Protocol provides guidance with a degree of flexibility as to the depth of quantification and reporting based upon how it will be used. An outline for a project accounting assessment and additional step-by-step guidance on monitoring and reporting principles can be found in Chapter 11 of the GHG Protocol for Project Accounting (Project Protocol).[59]

GHG Protocol recently acknowledged, as confirmed by direct stakeholder feedback, that project-based accounting has not played a meaningful role in organization-level target- and goal-setting programs or disclosures, which have historically relied primarily on inventory accounting and reporting. GHG Protocol updates of key standards in 2025 are expected to place more emphasis on using Project Protocol in organizational goal setting and viewing project-specific lifetime effects on GHG.[60]

The GHG Protocol core principles of relevance, completeness, consistency, transparency, and accuracy are key elements that must be applied across the application of both the Corporate Standard and Project Protocol to ensure the credible accounting of both corporate GHG emissions and project-based GHG reductions.[61]

[59] The Greenhouse Gas Protocol for Project Accounting, https://ghgprotocol.org/project-protocol.
[60] GHG Protocol Blog Post, December 20, 2023, Inventory and Project Accounting: A Comparative Review | GHG Protocol
[61] The Greenhouse Gas Protocol for Project Accounting, https://ghgprotocol.org/project-protocol, pages 23-24.

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Abbreviations

AVERT	AVoided Emissions and Generation Tool
BM	build margin
CHP	combined heat and power
CT	combustion turbine
eGRID	Emissions & Generation Resource Integrated Database
EPA	US Environmental Protection Agency
GHG	greenhouse gas
IEDO	Industrial Efficiency and Decarbonization Office
ISO	independent system operator
LME	locational marginal emissions
LRMER	long-run marginal emissions rate
MEF	marginal emission factor
NREL	National Renewable Energy Laboratory
OM	operating margin
PV	photovoltaic
REC	renewable energy certificate
REmap	Renewable Energy Market Analytics Platform
SRMER	short-run marginal emissions rate