# Common Decarbonization Methodology

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## Section 1: Overview

### 1.1. Introduction.

1.1.1. This document describes the methods used by WattCarbon for estimating hourly carbon emissions from electricity consumption or production, where a power grid connects multiple end users and where production resources are shared amongst all interconnected Assets. These methods yield hourly Asset-level emissions outputs. The primary use case is decarbonization accounting, sometimes referred to as consequential emissions accounting. As such, key considerations are replicability and availability of data. The methods described in this document require only commonly-available Asset-level consumption and grid-level production data.

This methodological specification is intended to provide transparency and auditability. There are a significant number of choices that are made when calculating emissions, the results of which can significantly change the results. By illuminating these choices, this document provides an opportunity to create standards for certain choices, and to allow flexibility for others, so long as each choice is documented.

1.1.2. These methods will be familiar to carbon accounting practitioners. They are similar in many ways to the World Resources Institute's GHG Protocol Scope 2 guidance, but are also informed by Energy Tag and the 24/7 Carbon Free Energy Compact. In addition to a long history of use in carbon accounting, these approaches draw on a methodological foundation developed in energy savings practices and are commonly used for forecasting, measurement and verification, and evaluation of energy programs.

1.1.3. As a rule, these methods are written for a technical audience of practitioners, however, where useful, a pragmatic effort is made to provide interpretation and context for use cases.

1.1.4. This is a "living" document, in the sense that we continue to work to change or update existing guidance as additional evidence arises supporting new approaches or challenging current approaches. These methods are version controlled to allow users to pin their programs, policies, or analysis to a particular instantiation of the methods. The latest version will always reflect what we believe to be the most complete and well-tested approach.

1.1.5. To further assist with referenceability and versioning, this document provides a numbering scheme to facilitate referencing the methods. As the numbering scheme may change as the methods are tested and refined, it should be used in combination with a document version to prevent ambiguity.

1.1.6. These methods are designed to be general enough to implement using any general-purpose programming language and are not required to be deployed with any particular software implementation.

## 1.2. Participation in methods development.

1.2.1. WattCarbon has organized the OpenEAC Alliance to encourage industry participation in the development of decarbonization accounting methodologies. Learn more at www.openeac.org.

## 1.3. Scope.

1.3.1. Some items have been considered to be generally in-scope for improvements to these methods.

1.3.1.1. Technical clarifications or improvements to existing methods.

1.3.1.2. Methods for calculating uncertainty or establishing criteria for use cases.

1.3.1.3. Empirical tests to evaluate methodological choices and assumptions.

1.3.2. Some items have, to date, been considered out-of-scope:

1.3.2.1. Analysis or evidence based in datasets which cannot be otherwise replicated

1.3.2.2. Non-energy emissions accounting

1.3.2.3. Programming language or implementation-specific constraints.

1.3.2.4. Proprietary, closed-source, or restrictively-licensed algorithms, procedures, or content.

## 1.4. Definitions.

1.4.1. Asset. An Asset is the term describing the energy intervention that results in EACs, such as a solar panel system, battery, demand response event, or building that underwent an energy efficiency upgrade. An Asset exists at a point of metered interconnection between a production or consumption Asset and a network of other Assets that share a common and bounded electricity grid where all imports or exports of electricity to this grid are metered.

1.4.2. EAC. An EAC is an Energy Attribute Certificate, which represents a unique claim to the environmental benefits of a decarbonization project. EACs are granular certificates assigned to a watt-hour of energy or a gram of CO2e that specify all attributes of the underlying energy resource, including Asset type, production time, precise location, local grid carbon emissions intensity, resource operation start date, and reporting requirements.

1.4.3. Grid. A market-defined geographical area in which a balancing authority manages aggregate supply and demand as well as imports and exports.

1.4.4. Generation Mix. The aggregation of all production that enters into a grid that is accounted for by a grid operator.

1.4.5. Energy Consumption. A value derived from a physical meter based on the amount of electricity delivered over particular intervals of time at a particular Asset.

1.4.6. Distributed generation. Electricity that is produced at an Asset including what is consumed by the Asset. This electricity is not considered part of the generation mix and is not accounted for by the grid operator other than as lower aggregate demand.

1.4.7. Carbon Intensity. Measured as a CO2e weight per unit of electricity produced (e.g., lbs/mwh or grams/kwh). Calculated by multiplying the Emissions Factor for each fuel type in the Generation Mix by the total amount of each fuel in the Generation Mix and weighting the average by the percentage of each fuel type in the overall mix.

1.4.8. Emissions Factor. The Carbon Dioxide Equivalent (or CO2e) produced as a result of the combustion of a particular fuel source per unit of energy produced.

1.4.9. Renewable Energy Credit (REC). The environmental attributes represented by a unit of generation that is delivered to the Generation Mix.

1.4.10. Import/Export Mix. The amount of electricity that enters or leaves a Balancing Authority within a specific time period.

## 1.5. What is an EAC?

1.5.1. An EAC captures the externality value of energy or carbon savings. When a project or Asset is deployed and results in energy or carbon savings, the benefit is shared collectively. The EAC is a way to assign responsibility for the collective good to an individual party.

1.5.2. Wh-Electricity EAC. A Watt-hour of electricity **at a given hour** consumed or released (generated or discharged) by an Asset with an associated amount of generated and avoided carbon emissions comparing the generation and consumption of that electricity to if that Asset was not deployed

1.5.3. g-CO2e EAC. A gram of CO2e **of a given hour** that was emitted or avoided by an Asset based on the net of the emitted and avoided emissions of that Asset compared to if that Asset was not deployed.

1.5.4. Consequential Carbon Accounting. Project level carbon savings (including leakage from generated emissions)

1.5.4.1. Consequential Carbon Accounting may include estimates of causal impact on short-run or long-run grid operations or assume no distinct measurable impact (assume that the dispatched fuel mix will be determined by other factors).

# Section 2: Data Management

## 2.1. Data Inputs.

The data requirements to apply these methods to a single Asset are listed in this section. These represent the “ideal”. Additional constraints and sufficiency requirements follow in section (2.2) and considerations for handling missing or incomplete data follow.

2.1.1. Asset Owner Information.

2.1.1.1. Asset Owner Full Legal Name. Legal name of the individual or entity that owns the Asset

2.1.1.2. Asset Owner E-mail Address. Primary contact email for the Asset owner

2.1.1.3. Asset Owner Phone Number. Primary contact phone number for the Asset owner

2.1.1.4. Asset Owner Mailing Address. Primary mailing address for the Asset owner

2.1.1.5. Asset Owner Mailing Address 2. Secondary address line for the Asset owner

2.1.1.6. Asset Owner City. City of the Asset owner’s mailing address

2.1.1.7. Asset Owner State. State of the Asset owner’s mailing address

2.1.1.8. Asset Owner Zip Code. ZIP code of the Asset owner’s mailing address

2.1.1.9. Custom ID. A unique identifier to ensure that this Asset is not registered more than once.

2.1.2. Asset Location Information.

2.1.2.1. Asset Address. Primary street address where the Asset is located

2.1.2.2. Asset Address 2. Secondary address line for the Asset location

2.1.2.3. Asset City. City where the Asset is located

2.1.2.4. Asset State. State where the Asset is located

2.1.2.5. Asset Zip Code. ZIP code where the Asset is located

2.1.2.6. Latitude. Geographic latitude coordinate of the Asset location

2.1.2.7 Longitude. Geographic longitude coordinate of the Asset location

2.1.3. Balancing Authority Data.

2.1.3.1. Date(s).

2.1.3.1.2. Time intervals should be no greater than hourly. Sub-hourly time intervals may be averaged to create an hourly time-series.

2.1.3.2. Fuel Mix.

2.1.3.3. Dispatched power should be reported in terms of fuel type and aggregated by fuel type such that the total dispatched power for each time interval is accounted for across all fuel types (even if a particular fuel type is not dispatched in a particular time period).

2.1.3.3. Imports from multiple neighboring balancing authorities should be accounted for separately so that the fuel mix from each balancing authority can be considered separately.

2.1.3.4. Fuel types should be sufficiently differentiated that appropriate emissions equivalencies can be established (e.g., coal and natural gas should be reported separately so that the higher GHG emissions from coal can be distinguished from the lower GHG emissions of natural gas).

2.1.4. Time zone. All data should be reported in UTC time.

## 2.2. Data constraints.

2.2.1. Missing values and data sufficiency for measurement period.

2.2.1.1. Data is considered missing if it is clearly marked by the data provider as NULL, NaN, or similar.

2.2.1.2. Values of 0 are not considered missing.

## 2.3. Guidelines for handling data quality issues.

In many cases, data quality issues can be resolved by going back to the source to resolve issues in export or transfer. This guidance is a second line of defense for handling or correcting for common data issues, and is provided in the hope of mitigating the myriad issues and discrepancies which arise using different methods for data cleaning.

2.3.1. Extreme values: Usage values that are more than three interquartile ranges larger than the median usage should be flagged as outliers and manually reviewed.

2.3.2. Generally recommend an audit for dataset completeness using expected counts of Assets, meters, and carbon emissions totals.

2.3.3. Roll up data if not given with expected frequency.

### 2.4. Matching an Asset to a balancing authority.

2.4.1. Balancing authority to be used is grid operator that manages distribution within the geographical area of the Asset location

2.4.1.1. If there are more than one grid operators that match a location, a manual review should be conducted to determine the correct balancing authority for the Asset.

## Section 3(a): Calculating Hourly Emissions - When Hourly Consumption is Available

### 3.1. Overview of emissions methodology.

3.1.1. Model intuition.

3.1.1.1. An Asset receives electricity from the grid to which it is interconnected. The source of this electricity comes from a variety of power plants that are dispatched according to contracts and bidding mechanisms established by the balancing authority. The Asset operator can choose to consume or not consume electricity during a particular period of time, but does not have control over the source of electricity provided by the grid operator.

3.1.2. Foundations in literature. Modeling does not strictly adhere to these methods, but draws from them for inspiration.

3.1.2.1. World Resources Institute GHG Emissions Scope 2 Emissions Protocol.

3.1.2.2. Energy Tag.

3.1.2.3. 24/7 Carbon Free Energy Compact.

3.1.3. Follow the process outlined below and detailed in subsequent sections:

3.1.3.1. Use hourly emissions factors from matched balancing authority.

3.1.3.2. Align timestamps of Asset-level energy consumption to equivalent timestamps of power systems data.

3.1.3.3. Compute all hourly emissions values by multiplying hourly consumption by the associated grid emissions value.

## 3.2. Use Hourly Emissions factors from matching balancing authority.

3.2.1. Basic structure applies to analysis using both actual and modeled energy consumption.

3.2.1.1. Carbon emissions: weighted average of operational emissions from each fuel dispatched during a particular time period on a grid.

3.2.1.2. Produced electricity mix: The aggregate amount of electricity dispatched onto a grid from power plants within a particular balancing authority. This number does not include imports or exports to/from neighboring balancing authorities.

3.2.1.3. Consumed electricity mix: The aggregate amount of electricity consumed within a grid including power dispatched from power plants within the grid and any imported power from neighboring grids and excluding any power exported to neighboring grids.

3.2.2. When calculating emissions for an Asset, the emissions factor of the Consumed electricity mix should be used.

3.2.2.1. If calculating negative emissions from distributed generation, the Consumed electricity mix should be used.

3.2.3. Equation: Annual emissions = sum of hourly energy use multiplied by emissions factor.

## 3.3. Align timestamps.

3.3.1. All time series data should be consistently formatted such that a time stamp indicates the beginning of a known length of time (e.g., 7:00 AM indicates the period between 7:00 and 8:00 AM).

3.3.2. Time series data should be upsampled to create a consistent hourly time-series for both consumption and power systems data.

3.3.3. If any data is in local time, it should be converted to UTC prior to computing hourly emissions.

## 3.4. Compute all Hourly Emissions.

3.4.1. For each hour, multiply the Asset consumption value by the appropriate emissions factor.

3.4.1.1. If an hour is missing a grid emissions factor, the corresponding consumption value for that hour should be filled in with average of non-missing values for the preceding and subsequent intervals with a limit of +/- 3hours, and if still null, with the preceding or subsequent day.

3.4.1.2. If hourly grid emissions factors are calculated by averaging higher frequency data, no more than 50% of high-frequency values should be missing.

3.4.1.3. Missing consumption values should be filled in with average of non-missing values for the preceding and subsequent interval.

3.4.1.4. Data is considered missing if it is clearly marked by the data provider as NULL, NaN, or similar.

# Section 4: Information content of the digital certificate

## 4.1 The following conventions shall apply to the information provided:

4.1.1. Timestamps are given in UTC timezone

4.1.2. Dates are given in the local timezone where the Asset is located

4.1.3. "Period" refers to the specific time range with explicit start (inclusive) and end (exclusive) where the corresponding amount of energy load was avoided

4.1.4. Energy amounts are expressed in Wh

## 4.2 The digital certificates resulting from a verification methodology shall contain the following information:

4.2.1. Asset information:

4.2.1.1. Name of the production Asset

4.2.1.2. A unique identifier for the certificate

4.2.1.3. Commenced operation date when the Asset began making an impact

4.2.2. Location information for the Asset:

4.2.2.1. Longitude

4.2.2.2. Latitude

4.2.2.3. Address

4.2.3. Time information about the period:

4.2.3.1. Start timestamp

4.2.3.2. End timestamp

4.2.4. Energy content:

4.2.4.1. Load reduction for the time period

4.2.5. Emissions:

4.2.5.1. Average emission intensity of the grid over the period as described in Emissions Calculation

4.2.5.2. Source of the average emission intensity data

4.2.5.3. Identifier of the grid region corresponding to the emission intensity data

4.2.5.4 If emitted or avoided emissions are based on the carbon intensity of a fixed fuel source, the intensity as well as related provenance must be included

4.2.6. Details about certificate issuance:

4.2.6.1. Timestamp when the certificate was generated

4.2.6.2. Country for which the certificate is issued

4.2.6.3. A link to the verification methodology (where the URL points to the specific version used to generate the
certificate)

4.2.7. Legal information:

4.2.7.1. Name of certificate owner

4.2.7.2. Name of the Asset owner

## 4.3. M&V Plan

4.3.1. The M&V Plan shall be a document that outlines the agreement between the registry and supplier of the project that states how methodologies were implemented and outlines the role and responsibility of each party. Key considerations shall be outlined in the M&V Plan. They should at minimum include:

4.3.1.1. The breadth of projects that the M&V Plan will cover

4.3.1.2. Selection of the source for carbon intensity data

4.3.1.3. The time period a project will be available to certify EACs

4.3.1.4. How the data will be exchanged between the supplier and registry and the agreement for the timeliness of this exchange

4.3.1.5. Who is responsible for the Measurement & Verification

4.3.1.6. Who is responsible for the reproduction of data, savings results, and methodological adherence to this method

4.3.1.7. Definition of Ownership for the claims to the credit

4.3.1.8. Monitoring of Trigger Events / non-routine adjustments: Examples include significant operational changes or new regulatory requirements that may require an adjustment to the analysis.