

Guide to Electricity Sector Greenhouse Gas Emissions Totals

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There are many ways to account for the greenhouse gas (GHG) emissions associated with electricity production and consumption. Different metrics are used for different purposes. This document defines several different GHG emissions totals for electricity generation that can be used by electricity suppliers and consumers to set goals, measure progress, and make claims, and by policymakers and regulators to design reporting and/ or compliance programs. Using the right accounting approach for a particular objective will enable accurate accounting, better decision making, and incremental or complementary programs. Using the wrong approach will result in confusion, and potentially false claims, double counting, and ineffective program design.

Types of GHG Accounting for Electricity

In general, there are two important distinctions in accounting for the GHG emissions associated with electricity. The first is between "attributional" and "consequential" accounting—or between accounting for direct and avoided emissions. Attributional¹ accounting measures the direct emissions at the point of electricity generation (e.g. zero for wind, solar, and hydropower generation). Consequential² accounting, on the other hand, measures the emissions effect or the change in emissions (e.g. emissions created or avoided) at other sources on the grid resulting from electricity production or consumption, or measured relative to a reference case or baseline scenario.

The second important distinction is between "source-based" and "load-based" accounting—or between accounting for production and consumption. Source-based (also called production-based or generation-based) accounting measures the (direct or avoided) emissions associated with electricity generated in a place. Whereas load-based (also called consumption-based) accounting measures the (direct or avoided) emissions associated with electricity consumed, sold or purchased in a place. Load-based accounting requires the use of a tracking instrument or method to allocate generation and emissions to load, and both source emissions data and "market data" about transactions of generation and generation attributes.

These two distinctions result in the four general types of accounting shown in Table 1.

Table 1. Four General Types of GHG Accounting for Electricity

	Source-based	Load-based
Attributional	<i>Source-based Attributional:</i> Direct emissions from generators or a subset of generators in a place	Load-based Attributional: Direct emissions from purchased/sold generation in a place, sold by an LSE, or purchased by a consumer
Consequential	Source-based Consequential: Avoided emissions from generation in a place	Load-based Consequential: Avoided emissions from purchased/sold generation

¹ Attributional accounting is referred to as an "emissions rate approach" in the 2015 GHG Protocol *Scope 2 Guidance* (see Pg. 27-8; https://ghgprotocol.org/sites/default/files/standards/Scope%202%20Guidance_Final_Sept26.pdf).

² Referred to as an "avoided emissions approach" in the 2015 GHG Protocol Scope 2 Guidance (see Pg. 27-8).



Accounting Definitions*

Attributional emissions accounting: accounting for/regulating direct emissions from electricity generation.

Consequential emissions accounting: accounting for/regulating avoided grid emissions, or the effect of electricity generation on sectoral/grid emissions.

Source-based (generation-based) accounting: accounting for/regulating what is generated in a place (geographic area, e.g. a state) or by a subset of generators (e.g. those owned/controlled by a supplier, those physically supplying electricity in a geographic area); generation where it occurs; does not account for use/delivery of the generation.

Load-based (consumption-based) accounting: accounting for/regulating what is consumed/purchased, delivered, or sold to retail customers/load in a place; generation allocated to load; accounts for contractual/market transactions of generation and attributes; requires use of a contractual tracking method/instrument outside the grid; may not be limited to what is generated local to or physically supporting load.

* For a full glossary, see our Renewable Energy and Greenhouse Gas Accounting Glossary at https://resource-solutions. org/document/031921/.

There are many reasons for choosing one accounting type over the other, for example, based on who is regulated or reporting—e.g. generators, load-serving entities (LSEs)³, or consumers—and who is regulating or requiring reporting for what purpose—e.g. an air regulator, an energy/utilities regulator, or a corporate GHG reporting standard. While each type is potentially valuable, it is optimal to decide on a single type to be used across jurisdictions, if not a single comprehensive policy. Ensuring that everyone is measuring the same thing in the same way will help policies to have incremental impact.

³ See CRS's (July 2021) *Measuring What an LSE Manages Under a Federal Clean Energy Standard* for related discussion of different ways to measure (and design programs for) LSE electricity and associated emissions. It is available at: https://resource-solutions.org/wp-content/uploads/2021/07/Measuring-What-an-LSE-Manages-Under-a-Federal-CES.pdf.



Accounting for Renewable Energy and GHG Emissions Is the Same

Emissions are determined by fuel type. These two attributes of electricity generation cannot be separated in terms of where they occur or where they are delivered. So, there is no real distinction between accounting for GHG emissions and fuel type (e.g. renewable energy) within either source-based accounting or load-based accounting. The same accounting instrument/method (e.g. renewable energy certificates, or RECs) should be used for load-based accounting of either fuel type or emissions, or both.

While RECs are commonly considered a renewable energy tracking instrument, they represent all environmental attributes. Appropriately, they convey both the renewable energy fuel type and the emissions associated with the generation to the buyer for load-based accounting. RECs are required to account for the GHG emissions associated with renewable energy in load-based accounting programs, as shown below.

RECs are not required.	RECs are required for renewable energy.
• Source-based renewable energy (RE): RE generation (or percent of total generation) in a place	 Load-based RE: RE generation purchased/sold (or percent of total retail sales) in a place, sold by a provider, or purchased by a consumer
• Source-based attributional emissions: direct emissions from generators or a subset of generators in a place	 Load-based attributional emissions: direct emissions from purchased/sold generation in a place, sold by an LSE, or purchased by a consumer
Source-based consequential emissions: avoided emissions from generation in a place	 Load-based consequential emissions: avoided emissions from purchased/sold generation

Emissions Totals

Accounting at different levels (e.g. state, LSE, and individual consumer) and for subsets of generation, emissions, and avoided emissions results in many different generation and emissions totals. Each total includes different sources and provides a different picture of generation and emissions. In this paper, we have identified 11 examples of different totals and identified how each is associated with different accounting and reporting frameworks, consumer claims, and data sets.⁴

⁴ Any of the following emissions totals can also be expressed as rates or emissions factors, e.g. metric tons carbon dioxide-equivalent per megawatt-hour (CO2e/MWh).



Table 2.	Electric	Sector	GHG	Emissions	Totals
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No.	Туре	Level	Emissions Total
1	Source-based Attributional	State	State (or other boundary) emissions from electricity generation
2	Source-based Attributional	LSE	An LSE's emissions from owned generation, the set of generators serving/ supporting its load, the generators on its system or available to it, or another subset of generators
3	Source-based Attributional	Generator	An electricity generator's (owner's) or subset of generators' direct (Scope 1) emissions
4	Source-based Attributional	Consumer	A customer's (grid average) location-based Scope 2 emissions
5	Source-based Attributional	Consumer	A customer's grid modeling location-based emissions
6	Load-based Attributional	State	State (or other jurisdiction) emissions associated with retail sales/ consumption (the sum of all LSE retail sales emissions and any other retail sales/purchases for non-LSE retail load in the state/region)
7	Load-based Attributional	LSE	An LSE's emissions from owned and procured generation mix used for retail product sales
8	Load-based Attributional	Consumer	A customer's market-based Scope 2 emissions
9	Load-based Consequential	Consumer	A customer's load-based consequential emissions
10	Source-based Consequential	Generator	An electricity generator's source-based consequential emissions
11	Source-based Consequential	Generator/	Global/sectoral emissions reductions



Table 3. Electric Sector GHO	C Emissions Totals for	[•] Different Users o	of this Guide
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User of this Guide	Relevant Emissions Totals (from Table 2), Uses and Options
	Total 1: regulate generators
Policymakers,	Total 2: regulate LSEs for generation
Regulatory Program	Total 6: consumption-based target for the state
Design	Total 7: regulate LSEs for retail sales, disclosure of emissions to customers, LSE-specific emissions for electric vehicle (EV) charging for clean transportation programs
	Totals 4 and 8: carbon footprint (Scope 2) for green power purchasing
Companies, Clean	Total 5: for operations siting and energy management decisions
Customers	Total 9: impact of green power purchased
	Total 11: atmospheric impact of green power purchasing
Generators	Total 3: reporting direct emissions Total 10: reporting avoided grid emissions, emissions effect of generation Total 11: reporting changes to global emissions beyond a baseline
	Total 2: carbon footprint (Scope 1) for owned/operated generation, emissions from sources of owned or purchased electricity, LSE system emissions target setting
LSEs	Total 3: for reporting direct emissions
	Total 7: emissions delivered to customers, emissions factors for customers to use for their Scope 2 reporting, disclosure of emissions to customers (utility-specific emissions factors)
NGOs/Government Data,	Totals 3, 4, and 8: measuring carbon footprints (Scopes 1 and 2)
	Total 7: database of LSE-specific emissions factors for customers
Recognition	Total 9: evaluating the impact of generation voluntarily procured by corporate consumers.
	Total 11: carbon offset programs, atmospheric impact of green power purchasing

Each total in Table 2 is described in detail in the tables further below.

The same generation may appear in different GHG emissions totals due to the difference between sourcebased and load-based reporting, or reporting at different levels. For example, a generator may report its emissions in its Scope I footprint (Total 3) or for statewide reporting of emissions (Total 1), while the same emissions may be reported by customers in the grid region in their location-based Scope 2 emissions (Total 4), by the purchaser of the generation (and REC owner) from that generator in their market-based Scope 2 emissions (Total 8), and potentially in the future by the recipient of the power from that generator (Total 5). The same is true for avoided emissions—a generation owner may estimate its avoided emissions (Total 10), while the purchaser of that generation (and REC owner) claims those avoided emissions as a benefit of its purchased generation (Total 9).



But increases or decreases to one total do not necessarily mean there will be changes (or commensurate changes) to other or all totals, due to different generation, methodologies, and requirements for each. For example, changes to load-based attributional emissions (demand for emissions) may not result in changes to source-based attributional emissions in the same area or global emissions on a one-to-one basis due to other transactions and imports and exports of power, other factors affecting generation and dispatch in a specific area, and the relationship between supply and demand. Only for source-based Totals 1, 4, 5, 10, and 11 in Table 2 does a change to the total necessarily represent a change to source emissions. The other emissions totals may increase or decrease without representing a change at the source, as sources change ownership and are used by different LSEs and consumers. This is the case when emissions are reported at a company level, rather than at a plant/generator or geographic area level. See the box on "Corporate GHG Emissions Inventory or 'Footprint' Totals" for more information.

There should be no double counting, however, of generation or emissions within each total or within a reporting program intended for a single purpose. Using different totals or methodologies for a particular reporting program or purpose may produce double counting. For example, mixing source-based and load-based totals (e.g. Totals 4 and 8 in Table 2) in an emissions inventory can produce double counting—the same generation and associated emissions being claimed delivered to more than one customer.

There are also circumstances where different totals may be the same amount, despite differences in methodology. In these cases, the associated claim may still be different. For example, consequential emissions Totals 9 and 11 in Table 2 may be the same where the same data and (short- vs. long-term) calculation method is used. Total 9 may be reported by a customer with the purchase of a REC, or that REC may be retired to substantiate the creation of a carbon offset (where permitted under carbon offset programs and protocols⁵), in which case the carbon offset purchaser can report the amount as Total 11. Though the totals are the same, the consumer claim, tracking requirements, and project qualifications are intentionally different for each.

⁵ Large-scale renewable electricity generation projects outside of least developed countries and small island states are no longer widely eligible in major voluntary carbon offset verification programs.



Corporate GHG Emissions Inventory or "Footprint" Totals

Emissions totals reported as corporate inventories or footprints represent a special category of attributional emissions. They are reported at the corporate level—the emissions associated with a company's operations. They are categorized into three "Scopes," defined by The Greenhouse Gas Protocol.

- **Scope I:** Emissions from operations that are owned or controlled by the reporting company.
- **Scope 2:** Indirect emissions from the generation of purchased or acquired electricity, steam, heat or cooling consumed by the reporting company.
- **Scope 3:** All indirect emissions (not included in Scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.

All Scopes are defined by at least three general characteristics. First, they are attributional accounts of emissions. They are emissions produced by the company's operations, equipment, and buildings (Scope 1) and from the production of the products and services it uses (Scopes 2 and 3). They are not the emissions effect or the change in emissions in a sector resulting from the company's operations or the products it uses.

Second, they require data in addition to source emissions data to determine who is responsible for emissions. Determining the produced GHG emissions that are attributable to different companies requires both source emissions data and other data—about ownership, control, and purchasing of emitting assets, activities, and products and services with associated emissions. Emissions in corporate footprints are not necessarily the emissions occurring at the company's location. Likewise, the emissions occurring at a particular location are not necessarily the emissions for which companies at that location are responsible.

Third, emissions in all Scopes can increase or decrease without reflecting changes at the source or to actual emissions to the atmosphere. This is because, first, ownership of emissions overlaps between entities. Indirect emissions are "shared" as both the direct (Scope 1) emissions of the owner/operator of the source and the indirect (Scope 2 or 3) emissions of the user of products and services created using that source. Second, corporate emissions, both direct and indirect, can shift or move between companies. Companies can sell assets rather than shut them down to reduce their Scope 1 emissions, in which case the asset may continue to operate and overall emissions do not change (the GHG Protocol addresses this by requiring base year recalculation and disclosure). Companies can choose cleaner products or even stop buying altogether to reduce Scope 2 and 3 emissions without that affecting overall global production and emissions.

But measuring footprints serves an important purpose—it allows companies to understand and reduce their responsibility and demand for emissions (e.g. use cleaner electricity) to drive sustainable change and decarbonization. It also allows others to hold those companies accountable.

Both Total 2, if it represents an LSE's emissions from owned or operated generation, and Total 3, a generation owner's corporate emissions, (in Table 2) can be Scope 1 emissions. Scope 1 emissions require both ownership (or operational control) and source data. Total 8 is market-based Scope 2 emissions, and it requires both market (transaction) and source data.



Emissions Total Details

Total 1. Source-based Attributional: State Emissions from Electricity Generation

Emissions from all (eligible) electric generating units located in a state



Description	The emissions from electricity generators occurring within state borders.
Consumer Claim	Emissions from power generation located in the consumer's state.
What it is not	 The emissions associated with generation contractually consumed by or delivered to customers in the state. The emissions attributed to state load or for which consumers in the state are responsible based on their purchases or use (Total 6), which accounts for market transactions and attribute ownership by or on behalf of state customers. The emissions associated with the generation of electricity that physically reaches consumers in the state, which accounts for imported/exported power and grid constraints (Total 5).
How it is calculated	The sum of emissions from all eligible generators in the state over a given timeframe.
Generation Data	Plant-specific emissions data
Market Data required?	No
RECs required?	No
How it is reported/ regulated	 Emitting entities report direct emissions to states. Regulated at the state level in states with emissions "caps" or other GHG regulation for emitting sources.
Reporting entity	Generator
Reporting timeframe	Typically, annual reporting for either annual or multi-year compliance.
Uses/Importance	 Facilitating supply-side actions to reduce emissions. Understanding where the emissions and any local impacts are taking place. Holding states and emitters accountable for local impacts. In combination with load-based attributional accounting, revealing and addressing the extent to which generation and associated emissions in the state are supporting other states. As one indicator of load-based policy and program effectiveness in changing in-state generation.
Limitations	Ignores the effect of demand on supply, since these emissions do not reflect market data or the emissions that consumers in the state are physically or contractually responsible for and cannot be attributed to state load or purchasing behavior.
How to manage it	These emissions are controlled by generation owners and grid operators. They are out of the direct control of the customer, except to the extent that it may move to a different state, and of the LSE, except to the extent that it owns in-state generators. Customers and LSEs can indirectly affect the operation of in-state generators through markets (with procurement, contacting with clean in-state facilities) as well as with their physical in-state load. State policymakers and regulators can regulate in-state generators to directly affect these emissions, or LSEs or others to indirectly affect them.



Total 2. Source-based Attributional: LSE Emissions from Electricity Generation

Emissions from the sources of an LSE's owned or purchased electricity



Description	 Emissions from the sources an LSE owns and/or purchases from (or plans to use) to meet load in its service territory. LSE Scope 1 emissions (for owned generation only).
Consumer Claim	Emissions from power generation used (or planned for use) by the consumer's LSE to meet load in its service territory.
What it is not	 The emissions associated with purchased electricity that can be legally claimed by customers (Total 8). The emissions associated with electricity that is sold or contractually delivered/attributed to customers/utility load (Total 7). The emissions associated with the generation of electricity that physically reaches LSE customer buildings (Total 5).
How it is calculated	The sum of emissions from generation at an LSE's owned facilities, or that sum minus emissions from any wholesale electricity sales and plus emissions from the sources of electricity that an LSE procures to meet load. Could be modeled (projected, forward- looking) if used for planning purposes.
Generation Data	Plant-specific emissions data, wholesale electricity sales data, bilaterally contracted electricity data, wholesale market purchase and residual mix emissions factors
Market Data required?	Yes, energy transaction data
RECs required?	No
How it is reported/ regulated	 LSEs report GHG emissions to states or voluntary reporting inventories. May be regulated at the state level in states with GHG targets for integrated resource planning (IRP), historical verification against these targets, LSE emissions disclosure requirements (certain versions of power source disclosure), and/or certain other GHG regulation for LSEs.
Reporting entity	LSE
Reporting timeframe	Hourly, annual, or multi-year.
Uses/Importance	 LSE system emissions target setting, planning, and reductions. Understanding what LSEs own and are contracting for to meet load. Facilitating supply-side actions to reduce emissions. Comparison with statewide emissions (Total 1) and LSE delivered emissions (Total 7), to reveal extent of emissions imports and exports.



	These emissions may only reflect transactions of energy and have no bearing on the distribution of attributes or the retail use and delivery of clean/dirty generation. Reporting or regulating these emissions would not integrate with or build on the progress of existing load-based programs.
Limitations	Cannot be used for retail claims. These emissions may be misunderstood to represent the emissions associated with generation delivered to customers (Total 7) when they do not. LSEs and customers using this measurement to make retail claims may double count progress toward commitments.
	Because attribute ownership is not reflected, reporting and verifying these emissions would not make use of RECs. It would require invention of a different verification method— to assign generation to LSEs—including a way to report transactions of energy from known sources.
How to manage it	These emissions are controlled by LSEs. Customers may switch providers, if permitted, or move to a different LSE territory. Switching portfolio or product options will not affect these emissions (it would affect Total 7).
	State policymakers and regulators can regulate these emissions.



Total 3. Source-based Attributional: Generation-owner Direct Emissions

Emissions from owned or operated electricity generation units



Description	The emissions from owned or operated electricity generators.An electricity generator's (owner's) direct Scope 1 emissions.
Consumer Claim	Emissions from certain power generation occurring someplace relative to the consumer, and which may or may not be sold to the consumer or physically serving the consumer's load.
What it is not	 The emissions associated with generation physically or contractually consumed by or delivered to local customers or customers in the state (Totals 5 or 8). The grid emissions effect, change in emissions, or avoided emissions associated with generation (Total 10). Change to global emissions beyond a baseline or business-as-usual scenario (Total 11).
How it is calculated	Emissions measured at the source over a given timeframe.
Generation Data	Plant-specific emissions data
Market Data required?	No
RECs required?	No
How it is reported/ regulated	 Generation owner reports direct emissions to states or voluntary reporting programs. Regulated at the state level in states with emissions "caps" or other GHG regulation for emitting sources.
Reporting entity	Generator
Reporting timeframe	Typically, annual reporting.
Uses/Importance	 Facilitating supply-side actions to reduce emissions. Understanding where the emissions and any local impacts are taking place. Holding emitters accountable for local impacts. In combination with load-based attributional accounting, revealing and addressing the extent to which generation and associated emissions in the state are supporting other states.
Limitations	These source emissions do not reflect the sources of demand and other factors that may be driving them, including power and attribute purchases, state and regional policies, and other market, institutional, and physical factors affecting where, when, and why certain generation and emissions occur. Reporting and regulating these emissions would not necessarily address these drivers.
	These emissions are controlled by generation owners and grid operators, driven by market activity and the physical needs of the electricity system. They are out of the direct control of grid customers, and of the LSE, except to the extent that it owns specific generators. Customers and LSEs can indirectly affect the operation of specific generators through
How to manage it	markets (by purchasing from or contracting with them or not) as well as with their physical proximal load.
	State policymakers and regulators can regulate certain generators within their jurisdiction to directly affect these emissions, or LSEs or others to indirectly affect them.



Total 4. Source-based Attributional: Grid Average Location-based Scope 2 Emissions

Average emissions from electricity generation in a grid region



Description	 Average emissions from electricity generation per unit of output (MWh) in a grid region A customer's share of the regional emissions total based on its load.
Consumer Claim	 Average emissions from electricity generation in the consumer's grid region. Carbon footprint: location-based Scope 2 emissions—emissions associated with purchased electricity.⁶
What it is not	 The emissions that are "physically" delivered to customers, or a "physical emissions footprint" for electricity. The emissions associated with generation that has been sold or contractually allocated/ delivered to specific customers/load (Total 8) in the region or out of region. A "residual mix" emissions factor, representing publicly shared or standard delivery generation, that removes generation that has been sold to specific/voluntary customers. Utility- or supplier-specific emissions or rate.
How it is calculated	 The sum of emissions from generators located in a region (e.g. eGRID subregion) divided total MWh output (grid average emissions rate). A customer's location-based Scope 2 emissions is calculated using regional generation mix/grid average emissions rate and the customer's load.
Generation Data	Regional grid average emissions factors, or regional electricity generation output and emissions data
Market Data required?	No
RECs required?	No
How it is reported/ regulated	 Reported as a customer's location-based Scope 2 emissions footprint. Common methodology is the location-based method in the 2015 GHG Protocol's <i>Scope 2 Guidance</i>. In the U.S., grid average output emissions factors are reported at the subregional level through the U.S. EPA's eGRID database.
Reporting entity	Generator or customer (for its share)
Reporting timeframe	Typically, annual. Hourly reporting emerging.

⁶ This assumes that source-based equals load-based emissions. This is acceptable both as an approximation of load-based emissions in markets where electricity generation is not differentiated or transacted on a resource-specific basis (e.g. outside of the U.S.), and in the context of "dual reporting" as the location-based Scope 2 figure per the GHG Protocol's 2015 *Scope 2 Guidance*.



Uses/Importance	 In the context of "dual reporting" of Scope 2 emissions in the U.S., the location-based Scope 2 figure can be helpful extra information for customers, allowing them to see the average of what is produced in the region in which they consume. This is good for transparency and energy management decisions. As a rate/intensity, it shows changes to the grid mix that may not be reflected in total/ absolute emissions alone (Total 1) (e.g. more emissions but fewer on average). Measuring grid average emissions on an hourly basis can facilitate load management decisions to create grid and emissions benefits, such as load-switching from times with a high average emissions rate to time with a low average emissions rate, or EV charging at times with a low grid average.
Limitations	These emissions do not reflect transactions of specified power and generation attributes by either utilities or customers in the U.S. They are therefore limited as an estimation of the emissions associated with either the generation physically supporting load or the generation contractually delivered to load. Depending on the geographic and temporal granularity, these emissions may serve more as context for decision-making by generators, consumers, or states, or be used for comparison.
How to manage it	These emissions are controlled by generation owners and grid operators. They are out of the direct control of the customer, except to the extent that it may move to a different region or build new (e.g. onsite) clean generation to incrementally affect the average. They are out of the control of the LSE, except to the extent that it owns in-region generators. Customers and LSEs can indirectly affect the operation of in-region generators through markets (with procurement, contacting with clean in-state facilities) as well as with their physical in-region load, including through activities like hourly load management or load-shifting. State policymakers and regulators can regulate in-state generators to directly but perhaps
	incrementally affect the regional average emissions (depending on the state's share of the region), or LSEs or others to indirectly affect them.



Total 5. Source-based Attributional: Grid Modeling Location-based Emissions

Emissions associated with the generation of the power that electrifies (or is physically consumed at) a customer's location



Description	Emissions associated with the likely origins of the physical electricity a given location, based on the geographic proximity of generation to that location and paths of least resistance for electricity on the grid.
Consumer Claim	Emissions most likely associated with the generation of the power that electrifies a consumer's location.
What it is not	 The emissions associated with generation that has been sold or contractually allocated/ delivered to customers (Total 8). These emissions may be contractually allocated/ delivered to/purchased by a different LSE/customer. Regional grid average emissions (Total 4).
How it is calculated	Requires tracing electrons back to their source on the grid, or a grid modelling approach to measure the group of resources that meet electrical load at an individual node—an assessment at the individual node level of the emissions associated with what's operating.
Generation Data	Proprietary grid modelling and real-time nodal grid data
Market Data required?	No
RECs required?	No
RECs required? How it is reported/ regulated	 No Not currently reported. Data not widely available, except through advanced grid studies and some new proprietary tools. Updated corporate accounting guidance could allow these emissions to be reported as location-based Scope 2 emissions.⁷
RECs required? How it is reported/ regulated Reporting entity	No • Not currently reported. Data not widely available, except through advanced grid studies and some new proprietary tools. • Updated corporate accounting guidance could allow these emissions to be reported as location-based Scope 2 emissions. ⁷ Grid operator, customer, or third-party data provider
RECs required? How it is reported/ regulated Reporting entity Reporting timeframe	No • Not currently reported. Data not widely available, except through advanced grid studies and some new proprietary tools. • Updated corporate accounting guidance could allow these emissions to be reported as location-based Scope 2 emissions. ⁷ Crid operator, customer, or third-party data provider Real-time applications available.
RECs required? How it is reported/ regulated Reporting entity Reporting timeframe Uses/Importance	No • Not currently reported. Data not widely available, except through advanced grid studies and some new proprietary tools. • Updated corporate accounting guidance could allow these emissions to be reported as location-based Scope 2 emissions. ⁷ Grid operator, customer, or third-party data provider Real-time applications available. • Measuring these emissions can facilitate beneficial siting and load management (energy efficiency, conservation, and load-shifting) decisions, and generation siting decisions. • These emissions may also be used as one indicator of policy and market effectiveness in changing the grid.

⁷ The 2015 GHG Protocol *Scope 2 Guidance* addresses "advanced grid studies" in the context of location-based accounting, (pg. 29-30, 53, and 61-2).



	These emissions are directly controlled by grid operators. They are out of the direct control of the customer and LSE, except to the extent that they decide where to physically site generation relative to load (or vice versa), and to the extent that customers may move and manage their load/use differently (energy efficiency, conservation, load-shifting).
How to manage it	Customers and LSEs can indirectly affect dispatch and the operation of specific generators through markets (with procurement, contacting with clean local facilities) as well as with their physical load.
	State policymakers and regulators can work together to create policy to resolve grid constraints, improve transmission and distribution, or support the expansion of regional wholesale markets that may affect these emissions.



Total 6. Load-based Attributional: State Emissions from Electricity Purchased by Retail Consumers

Emissions associated with the generation of the power that is sold to serve retail customers in a state



Description	 Emissions associated with retail electricity sales to retail customers in a state, reflecting all market transactions, procurement, and purchasing decisions by suppliers and customers in the state. The generation attributes that are delivered to and consumed by customers in a state.
Consumer Claim	Emissions from electricity sold to retail customers in the consumer's state.
What it is not	 Emissions from power generation located in the state (Total 1). Emissions from the generation physically meeting load located in the state, or emissions from the sources that LSEs in the state own and/or purchase (or plan to use) to meet physical load in their service territories (sum of Total 2s for LSEs in the state). Emissions from power generation located in the state (Total 1) adjusted for imported and exported power. Emissions directly caused by customers in the state.
How it is calculated	The sum of emissions associated with generation sold to or contractually used by customers in the state based on state LSE retail sales and non-LSE direct customer procurement data—owned and procured generation and attributes for retail product sales and other retail claims.
Generation Data	Utility/LSE product-specific retail emissions factors, voluntary contract/product emissions factors, generation attribute tracking system data
Market Data required?	Yes
RECs required?	Yes
How it is reported/ regulated	Regulated at the state level in states with load-based clean energy standards.
Reporting entity	LSE and/or large customers/purchasers
Reporting timeframe	Typically, annual reporting for either annual or multi-year compliance.
Uses/Importance	 This emissions calculation would align with the amount of renewable energy generation sold/delivered to retail customers in the state through existing state RPS and voluntary renewable energy programs. These emissions reflect the state's demand (power and attribute purchases) that may be driving source emissions inside and outside the state. Reporting and regulating these emissions may address this driver. Measuring these emissions can facilitate choice (at the wholesale and retail level) and leverage regulatory and voluntary demand as a driver of change. These emissions (and associated retail resource mix and/or renewable energy percentage) are the basis upon which LSEs' procurement/sales can be regulated.



Limitations	These emissions are disconnected from source emissions. Changes to these emissions may precede and not reflect changes to supply, source emissions, or global/sectoral emissions, due to other transactions and imports and exports of power, other factors affecting generation and dispatch in a specific area, and the relationship between supply and demand. These emissions do not reflect the grid impact or emissions effect of retail sales in the state (sum of state customers' Total 9s).
How to manage it	These emissions are controlled by customers and LSEs in the state, though there may be institutional, market, political, and other barriers to procurement. Customers and LSEs may contractually switch to lower-emitting sources using a variety of contracting options, each of which may have different transaction costs and market, grid, and emissions impacts. Grid operators do not directly affect these emissions, if calculated on an annual basis. Grid operators can support the development of regional residual mix data to support more accurate accounting.
	State policymakers and regulators can regulate the emissions associated with retail portfolios/sales. Policymakers and regulators can also expand purchasing options and choice for customers, and address barriers to LSE procurement of clean power.



Total 7. Load-based Attributional: LSE Emissions from Electricity Sold to Retail Customers

Emissions associated with the generation of the power that is sold and contractually delivered to an LSE's retail customers



Description	 Emissions associated with retail electricity sales to customers, reflecting all market transactions, procurement, and purchasing decisions by the LSE (may be differentiated by retail product). The generation attributes that are delivered to an LSEs customers. Emissions that LSEs are responsible for delivering to retail customers.
Consumer Claim	 Emissions from power generation sold by the consumer's LSE. If product-specific, then a portion of market-based scope 2 emissions (Total 8) based on the product's proportion of the consumer's total electricity purchases.
What it is not	 Emissions from the generation physically meeting an LSE's electrical load (Total 5). Emissions from the sources that an LSE owns and/or purchases (or plans to use) to meet physical load in its service territories, which do not reflect all transactions of power and attributes (Total 2). Emissions directly caused by an LSE or LSE's customers.
How it is calculated	An LSE's retail sales/product emissions factor or emissions is calculated using its owned and procured generation and attribute mix for its retail product sales and the LSE's retail product sales.
Generation Data	LSE retail product-specific resource mixes and emissions factors, regional residual mix emissions factors, and wholesale market residual mix emissions factors; generation attribute tracking system data
Market Data required?	Yes
Market Data required? RECs required?	Yes Yes
Market Data required? RECs required? How it is reported/ regulated	Yes Yes • Regulated at the state level in states with clean energy standards for LSEs. • Reported by certain LSEs through voluntary databases. Methodologies vary. • Reported by certain LSEs as a part of state power source disclosure regulations. Methodologies vary.
Market Data required? RECs required? How it is reported/ regulated Reporting entity	Yes Yes • Regulated at the state level in states with clean energy standards for LSEs. • Reported by certain LSEs through voluntary databases. Methodologies vary. • Reported by certain LSEs as a part of state power source disclosure regulations. Methodologies vary. LSE
Market Data required? RECs required? How it is reported/ regulated Reporting entity Reporting timeframe	Yes Yes • Regulated at the state level in states with clean energy standards for LSEs. • Reported by certain LSEs through voluntary databases. Methodologies vary. • Reported by certain LSEs as a part of state power source disclosure regulations. Methodologies vary. LSE Typically, annual. Hourly reporting emerging.



Limitations	These emissions are disconnected from source emissions. Changes to these emissions may precede and not reflect changes to supply, source emissions, or global/sectoral emissions, due to other transactions and imports and exports of power, other factors affecting generation and dispatch in a specific area, and the relationship between supply and demand. These emissions do not reflect the grid impact or emissions effect of an LSE's sales (sum of LSE customers' Total 9).
	These emissions are controlled by the customer and LSE, though there may be institutional, market, political, and other barriers to procurement. Customers and LSEs may contractually switch to lower-emitting sources using a variety of contracting options, each of which may have different transaction costs and market, grid, and emissions impacts.
How to manage it	Grid operators do not directly affect these emissions, if calculated on an annual basis. Grid operators can support the development of regional residual mix data to support more accurate accounting.
	State policymakers and regulators can regulate the emissions associated with retail portfolios/sales (e.g. RPS or clean energy standard). Policymakers and regulators can also address barriers to LSE procurement of clean power, and facilitate voluntary sales and use of clean power.



Total 8. Load-based Attributional: Market-based Scope 2 Emissions

Emissions associated with the generation of the power that is purchased and contractually used by retail customers



Description	 Emissions associated with purchased electricity. The generation attributes that are consumed by retail customers. The legally enforceable allocation of attributes/emissions to retail customers. Emissions that retail customers are responsible for buying/using.
Consumer Claim	Carbon footprint: market-based Scope 2 emissions—emissions associated with purchased electricity.
What it is not	 Emissions from the generation physically meeting a customer's electrical load (Total 5). Grid average emissions adjusted for imported and exported power. Emissions directly caused by customers.
How it is calculated	A customer's market-based Scope 2 emissions are calculated using its purchases of generation and attributes, its LSE's retail product mixes (generation and attributes for retail sales), and/or residual mixes (public/unsold generation and attributes), and the customer's load.
Generation Data	Residual mix emissions factors, Utility/LSE product-specific retail emissions factors, voluntary contract/product emissions factors, emissions factors associated with self-generation; generation attribute tracking system data
Market Data required?	Yes
RECs required?	Yes
How it is reported/ regulated	Reported as a customer's market-based Scope 2 emissions footprint. Common methodology is the market-based method in the 2015 GHG Protocol's <i>Scope 2 Guidance</i> .
Reporting entity	Customer/purchaser
Reporting timeframe	Typically, annual. Hourly reporting emerging.
Uses/Importance	 Measuring these emissions allows consumers to understand and change their demand. It facilitates consumer choice and leverages voluntary demand as a driver of change. Programs aimed at reducing these emissions have led to market expansion, increased trading, and new purchasing options that have increased access to and grown overall demand for clean and renewable energy.
Limitations	These emissions are disconnected from source emissions. Changes to these emissions may precede and not reflect changes to supply, source emissions, or global/sectoral emissions, due to other transactions and imports and exports of power, other factors affecting generation and dispatch in a specific area, and the relationship between supply and demand. The sum of reported market-based Scope 2 footprints is not necessarily equivalent to arministic area the electricity and the incomplete supply and the relationship between the electricity and the relationshi
	These emissions do not reflect the grid impact or emissions effect of a consumer's purchase (Total 9).



How to manage it	These emissions are controlled by the customer and LSE, though there may be institutional, market, political, and other barriers to procurement. Customers and LSEs may contractually switch to lower-emitting sources using a variety of contracting options, each of which may have different transaction costs and market, grid, and emissions impacts, which are not measured in a footprint. Customers may also physically move to a different utility territory or market environment, install and contractually use onsite renewable energy generation, and reduce energy consumption to affect these emissions.
	Grid operators do not directly affect these emissions, if calculated on an annual basis. Grid operators can support the development of regional residual mix data to support more accurate market-based Scope 2 accounting.
	State policymakers and regulators can regulate the emissions associated with retail portfolios/sales to address the market-based Scope 2 emissions of individual consumers. Policymakers and regulators can also expand purchasing options and choice for customers.



Total 9. Load-based Consequential Emissions





Description	 The grid emissions effect of purchased generation, based on short-term displaced production and/or longer-term changes to construction/operation of emitting generation. Can be absolute or net, where net subtracts the direct emissions of the purchased/sold generation. Where the effect or change in grid emissions is a reduction, generally referred to as "avoided grid emissions."
Consumer Claim	Avoided grid emissions associated with purchased generation.
What it is not	 The direct emissions associated with generation. Avoided emissions or emissions reductions associated with the purchase or sale, or caused by the purchaser or seller. Not necessarily the effect of the purchase on the grid, rather the effect of the generation. The change/difference in a customer's Scope 2 (load-based attributional) emissions before and after purchasing nonemitting generation. Global emissions reductions (Total 11)
How it is calculated	 Short-term annual avoided grid emissions can be calculated using an annual regional marginal emissions rate/factor for the location of the generator and the amount of purchased generation. Hourly and more geographically precise marginal emissions data can be used where available to calculate more temporally and geographically precise totals. Net avoided emissions associated with generation located in (i.e. displacing generation) a region where the emissions from the electricity sector are "capped" by law are equal to zero because others will emit more.
Generation Data	 Short-term: regional marginal (non-baseload output, operating margin) emissions rates. Longer-term: "build" margin estimations rates or a combined rate.
Market Data required?	Yes
RECs required?	Yes
How it is reported/ regulated	Reported outside of the (Scopes) inventory/footprint as avoided emissions associated with purchased generation. Cannot be reported as a net adjustment to Scope 2 emissions or overall footprint. Not typically reported in a regulatory context.
Reporting entity	LSE or customer/purchaser
Reporting timeframe	Typically, annual. Hourly reporting emerging.
Uses/Importance	As one indicator/metric for grid "impact," measuring these emissions can facilitate procurement of generation that can create the most emissions benefit on the grid.



Limitations	 These avoided emissions occur at resources other than what is being purchased by customers and what is physically used to serve customer load. Purchasing to maximize avoided grid emissions may disincentivize local procurement and associated benefits as well as procurement from regions/states with a "cap" on emissions from the electricity sector. They cannot be used by consumers to understand and reduce their responsibility and demand for emissions on the grid. Does not ensure that MWh purchased match load. For example, these avoided emissions may be associated with an amount of purchased generation (MWh) that is less than the amount of electricity used by the customer, leading to less purchasing/demand for clean energy than would be the case using a different accounting framework. These avoided emissions are estimated, and may be inappropriately presented as the measured impact of consumer activities. There is currently no data standard for avoided grid emissions. These avoided emissions are easily confused with Total 11, creating risk of overstated offset-type claims and inappropriate net adjustments to footprints.
How to manage it	These avoided emissions are controlled by the customer and LSE, though there may be institutional, market, political, and other barriers to procurement. Customers and LSEs may contractually switch to sources that net avoid emissions on the grid using a variety of contracting options, each of which may have different transaction costs. While customers and LSEs may change procurement to change avoided emissions associated with purchased electricity, hourly avoided emissions associated with generation may depend on grid operation and generator location.



Total 10. Source-based Consequential Emissions

Change in (or avoided) grid emissions resulting from power generation or load management activities



Description	 The grid emissions effect of generation or changes to load in a defined area, based on short-term displaced/avoided production and/or longer-term changes to construction/ operation of emitting generation. Where the effect or change in grid emissions is a reduction, generally referred to as "avoided grid emissions." For power generation, can be absolute or net, where net subtracts the direct emissions of the generation.
Consumer Claim	Grid emissions avoided by power generation that is either owned or operated by the consumer or located in a defined area relative to the consumer (e.g. on the consumer's rooftop or in the consumer's state), and grid emissions avoided by changes to consumer's load.
What it is not	 The direct emissions associated with generation. Global emissions reductions or reductions beyond a baseline or business-as-usual scenario (Total 11) The emissions effect of (or avoided emissions from) purchased generation (Total 9).
How it is calculated	 Short-term annual avoided grid emissions calculated using an annual regional marginal emissions rate/factor for the location of the generator or load and the amount of generation or load change. Hourly and more geographically precise marginal emissions data can be used where available to calculate more temporally and geographically precise totals. Net avoided emissions associated with generation located in (i.e. displacing generation) a region where the emissions from the electricity sector are "capped" by law are equal to zero because others will emit more.
Generation Data	 Short-term: regional marginal (non-baseload output, operating margin) emissions rates. Longer-term: "build" margin estimations rates or a combined rate.
Market Data required?	No
RECs required?	No
How it is reported/ regulated	 Reported outside of the (Scopes) inventory/footprint as avoided emissions from electricity generation or load management. Cannot be reported as a net adjustment to footprint. Certain programs exist to allow reporting of avoided emissions from onsite generation, energy efficiency, and load-shifting activities as "mitigation" for other activities that create emissions, without registration as offset projects.
Reporting entity	Generator or load manager (e.g. customer)
Reporting timeframe	Typically, annual. Hourly reporting emerging.



Uses/Importance	A measure of the grid impact of changes to supply and/or demand that can facilitate siting and load management decisions to create emissions benefits. Measuring these emissions on an hourly basis may facilitate hourly energy management decisions, like conservation or load-shifting, to create emissions benefits on the grid, e.g. load-shifting from times with a high marginal emissions rate to times with a low marginal emissions rate resulting in a reduction in marginal emissions.
Limitations	 These avoided emissions do not capture the emissions that actually occur, the generation that customers receive, or the generation that LSEs deliver. These avoided emissions are estimated, and may be inappropriately presented as the measured impact of consumer activities. There is currently no data standard for avoided grid emissions. These avoided emissions are easily confused with Total 11, creating risk of overstated offset-type claims and inappropriate net adjustments.
How to manage it	These avoided emissions are controlled by generation owners and load managers. Hourly avoided emissions associated with generation may depend on grid operation and generator location. Customers (and others) may install onsite (or offsite) clean generation equipment to displace emitting generation (and reduce the need for new emitting generation in the future) and reduce or shift electricity consumption to help reduce counterfactual production from local marginal generating units.



Total 11. Global/Sectoral Emissions Reductions

Change in grid emissions from additional power generation or load management projects beyond a business-as-usual baseline



Description	 Emissions reductions beyond a business-as-usual baseline, representing global reductions, from generation projects that have passed "additionality" tests. A purchaser's emissions reductions, where the project participates in a carbon market and project-level additionality testing establishes a causal relationship between the purchase and the generation.
Consumer Claim	Emissions reduced by the customer.
What it is not	The direct emissions associated with generation.
How it is calculated	 Short-term annual avoided grid emissions calculated using an annual regional marginal emissions rate/factor for the location of the generator and the amount of purchased generation. Hourly and more geographically precise marginal emissions data can be used where available to calculate more temporally and geographically precise totals. Net avoided emissions associated with generation located in (i.e. displacing generation) a region where the emissions from the electricity sector are "capped" by law are equal to zero. Use of emissions reductions from projects located within a capped sector for net adjustments to inventories or compliance obligations would result in double counting and is generally prohibited.
Generation Data	 Short-term: regional marginal (non-baseload output, operating margin) emissions rates. Longer-term: "build" margin estimations rates or a combined rate.
Market Data required?	Yes, if emissions reductions are allocated to load/customers using carbon credits ("offsets").
RECs required?	If emissions reductions are transferred via a credit to a purchaser, RECs are retired to substantiate creation of the carbon credit (offset).
How it is reported/ regulated	Could be used for a net adjustment to a purchaser's/customer's inventory footprint, where the project participates in a carbon market and carbon credits (offsets) have been issued and retired by or on behalf of the purchaser. Otherwise reported outside of the (Scopes) inventory/footprint.
Reporting entity	Generator or customer/purchaser
Reporting timeframe	Typically, annual. Hourly reporting emerging.
Uses/Importance	 This is the strongest emissions claim for a project/producer of emissions—global reductions beyond a baseline. Where the project participates in a carbon market, the market/demand can create more reductions and lower the cost of mitigation. The claim can be credibly transferred to buyers using carbon credits (offsets), which can be used for net adjustments to footprints.



Limitations	 Does not include the avoided emissions or reflect the market impact of non-additional clean energy and beneficial load management activities that nevertheless indirectly and in aggregate force change on the grid and make emissions reductions cheaper and more likely. The project evaluation, validation, and verification process is costly and lengthy. There is limited supply of projects that have completed the process and met all criteria, particularly for renewable energy projects in developed countries. Additionality is not a precise determination. Where offsets are used, they are a single-attribute instrument for a specific carbon claim. Offsets often face criticism for providing flexibility that allows companies to defer reducing their direct and gross emissions.
How to manage it	These avoided emissions are controlled by generation owners. Global and beyond-baseline reductions may depend not only on project additionality, but also on activity within and outside of the sector, which may be outside of the generator's control. Offsets may be procured by customers or compliance entities where permitted. Supply of offsets from electricity generation projects may be limited, particularly in developed countries and/or where electricity sector emissions are "capped."



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