Greenhouse Gas Accounting Systems in Wholesale Regional Electricity Markets:

Considerations for the Western Interconnection

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I. Introduction

As Western states and electric utilities contemplate the development of a regional wholesale electricity market, the issue of how to achieve consistent tracking of greenhouse gas emissions associated with electricity transacted in various wholesale electricity markets involves many questions. Without a regional accounting system, states cannot consistently track utility compliance with greenhouse gas emission and renewable energy obligations. Inadequate tracking in electricity markets can also result in unfair price advantages for certain types of generation resources, poor planning of optimal siting of renewable resources, and resource dispatch that does not reflect state clean energy policy goals or mandates, all of which can lead to higher costs to deliver clean energy. Yet, regional markets have huge potential to create renewable energy cost savings and efficiencies while decarbonizing electricity. Thus, a regional greenhouse gas accounting system is crucial for realizing the benefits of a regional wholesale electricity market. Our aim here is to offer best practices and recommendations for a future greenhouse gas accounting system for a regional wholesale electricity market in the West.

Wholesale regional electricity markets match generation resources to satisfy demand reliably and cost-effectively by dispatching least-cost resources first. This dispatch sequence continues from a lowest-to-highest marginal cost. A multi-state centralized electricity market offers significant benefits in terms of economies of size and scale, as compared to a smaller single state or utility balancing area footprint. Some of the key benefits include lower costs as a result of shared reserves, access to larger quantity and diversity of clean energy resources over a large geographical footprint, reduced risks of curtailments due to automated and centralized dispatch of energy, and a low- to zero-cost access to clean energy resources.

Currently, the Western Interconnection, the power grid that connects the West, has a mix of bilaterally managed transactions for energy and one independent system operator, the California Independent System Operator (CAISO), that operates a real-time and day-ahead market service for energy for most of the state of California. Outside California, the Western Interconnection includes a patchwork of 37 Balancing Authority Areas (BAAs), with each area balancing its own demand and supply for energy. This fragmentation leads to higher transaction costs in terms of reserves and resource pooling, and creates the need for increased coordination and communication to sustain the reliability of the bulk power system.

> ***Imbalance and Day-Ahead Market Services in the West:*** *Utilities in the West have experienced two prior attempts to develop an organized electricity market for wholesale electricity. While these attempts were unsuccessful, regional coordination for imbalance reserves or other market expansion efforts have shown incremental progress. The absence of a centralized wholesale market for electricity in the West has resulted in the successful operation of a few real-time electricity market services. CAISO operates a real-time intra-hour imbalance market for imbalance reserves: The Western Energy Imbalance Market (Western EIM). Functionally equivalent to the Western EIM is the Southwest Power Pool's (SPP's) Western Energy Imbalance Service (Western EIS). CAISO is also developing the Extended Day Ahead Market (EDAM) for day-ahead unit commitment, as an additional service to improve efficiency beyond the intra-hour services of the Western EIM.*

Harnessing the rich renewable energy resources within the Western United States is key to decarbonization. Forming an organized electricity market in the West would lead to significant economic benefits in accessing such resources. However, there is also a challenge in accounting for greenhouse gas emissions associated with the generation of the electricity that is scheduled and dispatched in a wholesale market. While the Western Interconnection spans 11 states with diverse renewable energy resource potential, it also has a patchwork of utility contractual arrangements for transmission, bilateral trading relationships between utilities within and outside the interconnection, an existing independent system operator, and varying clean energy mandates and goals across the region. Creating a coordinated regional wholesale market for energy would require compatibility with a variety of state-level greenhouse gas reduction policies.

Figure 1: Western States' Renewable Portfolio & Clean Energy/Carbon Reduction Standards and Goals[1]

Western States' Renewable & Clean Energy Standards							
Renewable Portfolio Standard	MT	OR	CO	NM	AZ	NV	CA
Renewable Portfolio Goal	UT						
Clean Energy Standard	NM	WA	CA				
Clean Energy Goal	CO	NV					
No Clean or Renewable Goals or Standards	ID	WY					

Today, there is no multi-state regional greenhouse gas accounting framework in the West. Instead, as Figure 1 depicts, each individual state has its own regulations – or not. Some states have established ambitious greenhouse gas reduction targets that include prescriptive policies for tracking compliance with climate goals, while others have no emission reduction goals or requirements. States also vary in how they regulate greenhouse gas emissions; some measure only those emissions produced in-state, while others also account for emissions associated with imported electricity or other out-of-state emission sources.

There is an urgent need for a greenhouse gas accounting framework that can provide a common architecture while still accommodating the wide-ranging spectrum of Western states' policy objectives. Such a system should be robust enough to satisfy states with emission reduction mandates in place, but should also be structured to allow for participation by states without emission reduction policies. The framework should also manage to provide data that enables relevant entities to demonstrate compliance with applicable emission reduction requirements (or targets). A robust and credible greenhouse gas accounting framework should facilitate the diverse policy aims of different Western states, and allow tracking and verification of greenhouse gas emissions while being flexible to market design changes of the regional market to which it is linked.

Benefits of an Organized Market for Wholesale Electricity

The benefits of regional electricity markets stem from their market footprint, operations, and governance structure. Specifically, this means:

- A larger geographic footprint increases the supply and diversity of available generation resources. For example, while an electricity market operating exclusively in the Pacific Northwest could have an ample supply of hydroelectric power, the addition of Southwestern states with plentiful solar generation would add diversity to both the available resource mix and the set of utilities engaged as buyers and sellers in the market. Such diversity could result in different areas of the West providing clean energy resources to serve load in places where existing supplies are scarce. Leveraging the benefits of diversity is the foundational economic and environmental value of an organized market for wholesale electricity.

- Utilities participating in an independent system operator or regional transmission organization (RTO) benefit from automated procurement and dispatch of energy resources. This automated system involves use of an algorithm to optimize dispatch in the most cost-effective and reliable way across the region (i.e., reflecting security and reliability requirements), decreasing reliance on bilateral transactions of lesser economic efficiency. Under a bilateral system, pre-scheduled commitments for transmission access and transfers result in sunk costs for transmission that could be under-utilized in real time. In an organized market, secure automated dispatch enables real-time adjustments to serve load using the least-cost resources, in order to better match supply and demand. Without a regional market, excess renewable production would have to be curtailed or sold only via a bilateral contract. In contrast, a regional market can seamlessly procure and integrate excess zero-cost and zero-emission energy to serve load across the region. This automatic and cost-efficient dispatch enables greater procurement of renewable resources. Resource diversity also leads to other benefits of regional markets: risk reduction and increased reliability. A larger footprint with greater

[1] Information sourced from https://programs.dsireusa.org/system/program/maps

diversity of resources reduces the risk of local resources being unable to serve load and leverages regional access to energy supplies to serve load reliably. The August 2020 rolling outages in California proved that clean energy resources from across the West could help mitigate the impact of unplanned outages.

- The diversity of resources in a regional market creates economies of size and scale, contributing to increased renewable dispatch. Once in place, a regional market incentivizes low-cost resource dispatch. Because fossil fuel generation is becoming less cost-competitive, a regional market tends to lessen dispatch of fossil fuel resources. This displacement of fossil fuels with clean resources can aid in accelerating emission reductions from the power sector.

- Eastern organized wholesale energy markets already have all-generation tracking systems (demonstrating that greenhouse gas accounting can occur in a regional wholesale market) and do not interfere with least-cost and centralized dispatch of electricity.

II. Clarification of Greenhouse Gas Accounting Terms

The terms ***"production-based"*** and ***"consumption-based"*** accounting, as well as their many synonyms, are used in differing ways across existing literature on greenhouse gas accounting. For purposes of our analysis, we use the term *"production-based"* accounting to refer to a system that is primarily concerned with tracking emissions from point sources where electricity is generated, without attempting to assign the associated emissions to end users.

We use the term *"consumption-based"* accounting to refer to the tracking of emissions to end users by assigning greenhouse gas content to load-serving entities. These emission attributes[2] are not physically delivered on the grid and instead are disaggregated from physical power and tracked separately, allowing for greenhouse gas accounting to occur without tracking exact resources from source to sink. We employ the term *"consumption-based"* accounting expansively, in that it does not necessarily entail tracking physical electricity flows. We also use it to describe methodologies that track contractual electricity flows and assign average or more granular emissions' rates to electricity.

Although *"consumption-based"* accounting is sometimes used to refer to methods that attempt to match real-time data to load served, we do not use the term in this way. Instead, we refer to these types of systems as "*real-time*" accounting.

While other sources of research have examined the issue of tracking renewable energy attributes, we address renewable energy and attributes tracking only insofar as they intersect with greenhouse gas accounting, such as in the situation of unspecified power in market transactions. If a market operator does not provide load-serving entities with information on the sources of energy dispatched, it creates challenges for both greenhouse gas and renewable attribute tracking. The treatment of unspecified power, when done inaccurately, can lead to double counting of attributes, especially when other tracking instruments – like renewable energy certificates or "RECs" – are involved.

III. Overview of Greenhouse Gas Accounting Methodologies

Production-based and consumption-based accounting methods for greenhouse gas emissions differ primarily on their point of regulation. Traditionally, these methods only address direct emissions from thermal generation and do not include secondary impacts, such as avoided emissions from displaced generation sources. Production-based accounting (also referred to as generation-based or source-based accounting) measures emissions at the point of generation.[3] Using measurements taken at the electric generating unit, this approach accounts for greenhouse gas emissions prior to the energy entering electric grids. In contrast to production-based accounting, consumption-based accounting (also referred to as flow-based or load-based accounting) tracks electricity through the grid to its point of consumption and assigns associated greenhouse gas emissions to end users or an area of load. Consumption-based accounting uses a variety of tracking instruments to follow electricity on its journey from generation through the electric grid until its final delivery to a load-serving entity.

[2] Emission attributes are the characteristics of a specific amount of power and its resultant greenhouse gases profile, as denoted by information on a generation certificate. These characteristics include the emission rate, as well as associated information such as fuel type, transmission or deliverability specifics, generator ID, and geographic area.

[3] Full definitions of these terms are available in the Center for Resource Solutions' *Renewable Energy and Greenhouse Gas Accounting Glossary*, https://resource-solutions.org/wp-content/uploads/2021/03/Glossary-of-Terms.pdf.

Production-Based Accounting – Scope, Advantages, and Potential Challenges

Scope

Production-based accounting measures greenhouse gas emissions at the electric generating unit, amalgamating emissions of those units in a given geographic area to determine overall emissions associated with electricity generation. Production-based accounting relies on data reported by electric generating units, such as emissions data sent to the U.S. Environmental Protection Agency as part of its mandatory Greenhouse Gas Reporting Program.[4] The federal program requires electric generating units with a capacity of over 25 megawatts to annually report greenhouse gas emissions. This data can be accessed through the EPA's Air Markets Program Database and is used to calculate greenhouse gas intensity. The information is compiled in eGRID data, an annual EPA database of greenhouse gas intensity sourced from generator reporting.[5]

Advantages

Production-based accounting offers ease of implementation, posing no additional administrative burden to electric generating units. Since the primary sources of information are either all-generation tracking within an independent system operator or eGRID data, additional data collection is minimal for market operators. Independent system operators can also perform their own production-based accounting, by requiring electric generating units in their footprint to report their generation directly to the system operator's database and assigning an emissions rate based on eGRID data or other measures of a unit's emission rates. With this accounting method, tracking of generation to load is unnecessary because emissions are assigned to specific generators, not end users.

Potential Challenges

Production-based accounting methods cover all the greenhouse gas emissions of electricity generation in a certain geographic area. However, these methods do not include emissions associated with electricity that is imported or exported. Production-based accounting only measures greenhouse gas emissions associated with electricity *generation*, not electricity *use*. Therefore, it may not reflect greenhouse gas emissions associated with multi-state transfers of electricity. Furthermore, production-based accounting does not account for transactions of emission attributes. Consequently, an independent system operator can have a fairly accurate picture of the emissions associated with energy produced within its footprint, but not of emissions associated with electricity serving load in its region.

Consumption-Based Accounting – Scope, Advantages, and Potential Challenges

Scope

Tracking electricity is a complicated endeavor; once electricity enters a grid, each individual electron is indistinguishable from other electrons. Electricity itself cannot be clearly and definitively marked as renewable or thermal. Therefore, proxy methods to track emissions are necessary in any consumption-based accounting methodology. In bilateral transactions, resources being bought and sold, as well as dispatched and delivered, are clear-cut and relatively easy to account for in terms of greenhouse gas emission or renewable attributes. Still, bilateral transactions require contractual attribute tracking and informational exchange. Wholesale markets pose a challenge in greenhouse gas accounting, because they do not have these traits that bilateral transactions do.

The West has widely used, established systems for tracking renewable energy, primarily through the use of RECs, which are tracked and certified by the Western Renewable Energy Generation Information System (WREGIS). RECs contain information about the attributes of renewable energy generation, including zero-emission attributes,[6] and will have implications for any comprehensive greenhouse gas accounting in the West.

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[4] "Greenhouse Gas Reporting Program," EPA, https://www.epa.gov/ghgreporting/greenhouse-gas-reporting-program-and-us-inventory-greenhouse-gas-emissions-and-sinks

[5] Emissions & Generation Resource Integrated Database (eGRID)," EPA, 2021, https://www.epa.gov/egrid/egrid-questions-and-answers

[6] Zero-emission attributes are the characteristics of a specific amount of power, the generation of which releases no greenhouse gases, as denoted on a generation certificate. These characteristics may include a REC ID and generation type. Dispatched energy must have an associated generation certificate to validate zero-emission claims.

In contrast, thermal generation emission attributes are not generally tracked. Yet, a consumption-based accounting system will require a similar tracking system for thermal resources, including specifying an emissions rate. The fuel utilized in a particular thermal plant – such as coal or methane gas – will affect the emissions intensity of the generation unit. A variety of tools are available to track electricity sources or their emission attributes. One strategy is the use of e-tags, which track the transmission path energy takes from source to end use, providing an emissions rate associated with the energy in question. Because e-tags represent the purchased physical transmission path that energy must travel, they are an attribute-based tracking strategy. In order to access e-tags, a database must be in place that allows for a query to search for a specific path of e-tags that match with a certain amount of energy. E-tag use therefore requires good data management practices.

For alignment with state emission reduction policies and Renewable Portfolio Standards (RPS), electricity emission attributes would need to accommodate each state's compliance requirements. This would require utilities and corporate renewable energy customers to claim electricity and report its emission attributes for compliance. However, within a security-constrained economic dispatch (SCED) system, such as an independent system operator or an EIM, assigning emissions to load-serving entities becomes complicated as system resources meet system loads, but do not differentiate between load-serving entities. An entity receives energy without knowledge of its source, and the source of the energy dispatched is not tracked. To resolve this problem, market operators could develop detailed emission rates to provide a consistent measure of the greenhouse gas emissions of the energy dispatched from thermal resources. When coupled with REC tracking for renewable attributes, greenhouse gas estimation could be accurate over the long term, allowing for flexibility while still meeting annual climate goals. Using specific emission rates would allow load-serving entities to have the rates serve as an unbiased, consistent estimator of the emissions associated with dispatched electricity, ensuring accurate annual attribution.

Advantages

Bilateral energy transactions can easily include the accompanying renewable or emission attributes. In such transactions, e-tags are not necessary, since the contractual electricity can be prioritized over the physical electricity for compliance purposes and the associated emissions are assigned to the purchasing entity. Furthermore, consumption-based accounting allows for the complex flows of electricity to be represented in greenhouse gas accounting while tracking emissions to load-serving entities, which are often the point of regulation for state policies concerning emissions reductions.

Potential Challenges

Unspecified power, or power from unknown sources, presents a challenge for greenhouse gas accounting. Because market purchases from unknown sources come without specific information about fuel source, they pose a challenge for consumption-based greenhouse gas accounting. Assigning an emission rate to unspecified power is difficult, as it relies on making a best estimate about the power source or assigning an emission rate specifically for unspecified power. That unspecified power can come from multiple sources: out-of-market imports that are not source-specific (whether they be bilateral transactions or one independent system operator purchasing power from another); energy from an independent system operator (generally pools of unspecified power); or null power,[7] which has had its RECs representing the renewable attributes unbundled from the power to be sold separately.[8]

Because consumption-based accounting requires the assignment of power to end users, it requires coordination and sharing of relevant information to ensure no attributes are double counted or left unassigned. Creating and administering a robust tracking framework requires the cooperation of all relevant stakeholders, including market participants and administrators as well as economic and environmental regulators.

[7] Null power means any electricity produced by a renewable energy electric generating facility from which a Western Renewable Energy Generation Information System (WREGIS) certificate has been unbundled and sold separately.

[8] Joe Kaatz and Scott Anders, "The role of unspecified power in developing locally relevant greenhouse gas emission factors in California's electric sector," *The Electricity Journal* 29, Issue 9 (November 2016): 3, https://doi.org/10.1016/j.tej.2016.10.008

Attribute-Based GHG Accounting for Regional Markets

Attribute-based accounting is a type of consumption-based accounting that records generation attributes and assigns them to a specific amount of load through all-generation certificate[9] pairing. An attribute-based accounting methodology is best suited to serve the greenhouse gas accounting needs of the dynamic and complex flows of energy transactions in contemporary wholesale electricity markets. Due to attribute-based accounting's flexibility, which allows assignment of emission rates to electricity based on the best available emissions profile information, this method is more suited for the various transactions that occur in market constructs and can capture the resource profile of unspecified power transactions. An attribute-based approach also offers flexibility for tracking and compliance under varying state policy requirements for reducing and tracking greenhouse gas emissions. We advocate use of attribute-based accounting due to its focus on power transactions without the challenges of tracking physical energy flows.

Relationship between Attribute-Based GHG Accounting and REC Accounting

RECs generally represent the renewable attributes of one megawatt hour (MWh) of electricity generated by a renewable energy resource[10] and are used to demonstrate compliance with state Renewable Portfolio or Clean Energy Standards. RECs may be sold with the associated electricity (bundled) or separately (unbundled). The renewable attributes of that power may be claimed only by the single holder of the REC. In the Western Interconnection, the Western Renewable Energy Generation Information System (WREGIS) "issues and tracks RECs for generation of renewable-source electricity."[11]

Attribute-based GHG accounting tracks and verifies emission attributes with associated energy flows in an existing or future regional market. An attribute-based GHG emissions accounting framework is a complement to, and not a replacement for state (RPS) policies. While treatment of RECs has implications for GHG accounting, **RECs are not interchangeable with GHG accounting.** RECs track and verify MWhs of renewable energy and renewable attributes procured virtually or through a third-party transaction. In order to claim that a particular MWh of electricity generated by a renewable energy resource is zero-emission from a GHG accounting perspective, it must be accompanied by the associated REC. However, RECs alone are insufficient to track the GHG emissions created by other sources of electricity generation.

Conflation of REC tracking and GHG accounting within states can complicate both systems and lead to potential double counting of generated energy attributes. Distinguishing between REC accounting and GHG accounting is essential for consistency and improved accuracy of compliance with greenhouse gas reduction efforts and clean energy goals, respectively.

Value Proposition for an Attribute-Based GHG Accounting Framework

A centralized, attribute-based GHG accounting framework across the West would facilitate electricity decarbonization and support states in meeting their GHG reduction goals. Such a framework should do the following:

- Establish emission (including zero-emission) attribute eligibility criteria, while addressing the challenge posed by states' differing definitions of renewable generation (or lack thereof), in the form of all-generation certificate tracking (that includes RECs related information associated with renewable generation).
- Address emissions leakage that REC tracking within states may not account for, such as the shuffling of emissions to other states from imported and exported power.
- Incorporate best practices to work compatibly with state policies across the West.

[9] A generation certificate is an authentication issued by the market operator for a specific amount of generated power, including that power's emission attributes, which is granted to the load-serving entity or market purchaser. A certificate contains emission attributes, along with any Renewable Energy Credits associated with that power, and may be traded and used to assess resource fuel mix and compliance with any applicable state clean energy policies.

[10] Environmental Protection Agency. *Renewable Energy Certificate Monetization.* https://www.epa.gov/repowertoolbox/renewable-energy-certificate-monetization.

[11] Western Electricity Coordinating Council. *WREGIS Frequently Asked Questions.* https://www.wecc.org/Administrative/WREGIS%20Frequently%20Asked%20Questions.pdf.

In essence, an attribute-based approach offers flexibility for tracking and compliance under varying state policy requirements for reducing and tracking greenhouse gas emission reductions. We advocate for the use of attribute-based accounting due to its focus on power transactions without the complexity of tracking physical power flows.

IV. Best Practices for a Greenhouse Gas Accounting System in the West

We recommend an attribute-based greenhouse gas accounting system because it has the robustness and flexibility required to meet the needs of Western states and align with regional market functionality and potential expansion. Certain best practices are foundational to any greenhouse gas accounting system using attribute-based tracking. We offer these recommendations:

Foundational Best Practice #1: A Single, Centralized Accounting Methodology Across a Regional Wholesale Electric Market

Potential issues to address

How can a greenhouse accounting system avoid double counting of generated energy attributes,[12] indeterminate or conflicting rules on emissions attribution and assignment, and the development of parallel, differing frameworks within the same market?

Relevance

An accounting system must have clear procedures and guidelines to accommodate the variety of dispatch and transactions that occur, encompassing all transactions in a market. Having a single, centralized methodology in place is critical for avoiding double counting and fragmentation within a regional electricity market. If multiple greenhouse accounting systems were in use, significant cross-system friction and integration challenges would arise. The need for constant information sharing and access, coupled with the complexities of multiple greenhouse gas accounting systems, will create risk of zero-emission attributes being double counted or not being assigned to the corresponding transacted energy. The development of multiple accounting systems with different methodologies within the same market footprint could also create perverse incentives to assign greenhouse gas emission attributes to the system with the least strict accounting methodology.

Applicability

This best practice is primarily applicable to the utilities participating in a regional electric market and the market operator. A centralized greenhouse gas accounting system can either be operated by the regional market itself, or contracted to a third party. Operation would require carrying out the procedures for emissions accounting and ensuring a seamless coordination of internal operations to execute low-cost and security-constrained dispatch. Participating utilities would commit to reporting and accessing such a system to account for their transactions and demonstrate compliance with any relevant state policy obligations.

Implementation

Considering the pitfalls of not having uniform greenhouse accounting, we recommend having a single, consistent accounting system that is implemented over an entire market with specified data inputs and outputs. All participating utilities engaged in market transactions for electricity should submit the data inputs and outputs required at each step of the accounting process. The essential inputs from a generator would include date of generation, fuel type, generator name and location, and the associated emissions' rate. These inputs would attach from the point of electricity generation, entry into the grid, and in the market's resource mix. The associated outputs would include these same emission attributes, and generation certificates representing these emission attributes would be transferred

[12] Double counting may occur if the REC associated with generated renewable energy is not linked with that energy's generation attribute certificate. If RECs and zero-emission attributes are disaggregated, separate entities could both use the generation certificate and the added REC information to claim the renewable or zero-emission qualities of that energy, resulting in double counting. To avoid this, renewable attributes – including the zero-emission attributes – from a specific amount of load must only be claimed once. One way to prevent double counting would be to link the REC ID number for the renewable energy directly as an information field on to the generation certificate. If the energy is not paired with the associated REC, then the energy would be assigned null power attributes, including the relevant default emission rate for unspecified energy for GHG accounting purposes.

to the purchasing entity, except in cases of unspecified power purchases. To the extent possible, the data from one transaction type should be similar to the data accompanying a different type of energy sale or purchase transaction.

Using uniform inputs and outputs for different types of generation and market transactions ensures that accounting can occur over a market. This type of standardization enables end users of the data (such as load-serving entities filing state policy compliance documents) to have a consistent amount of information. If information is omitted from an electrical generating unit at the input stage, such as not including a generator's fuel type, it will create challenges for state policy compliance. Especially considering the varying heat rates and, therefore, emission rates, of different generating units, inputting the emission rate is crucial. Inaccurate or missing emission rate input data will distort calculations of the residual system mix over the market. Having clear guidelines in place on expected inputs and outputs in an accounting system allows end users to have an adequate amount of information for policy compliance and ensures market-wide emissions calculations are accurate.

Foundational Best Practice #2: Compatibility with an Array of State Policies

Potential issues to address

The West has a diverse patchwork of different greenhouse gas reduction objectives and policies. Some states may have their own greenhouse gas compliance systems or procedures that differ from those of the relevant regional electricity market. In these circumstances, an appropriate translation or alternative accounting pathway will be needed. Conversion of a state-specific accounting structure to align with attribute-based accounting guidelines may be necessary in order to process and utilize data from a central greenhouse gas accounting system.

Relevance

To the extent possible, greenhouse gas accounting market rules should be consistently implemented by market participants and the market operator. For states with bifurcated market participation, where there are organized markets and existing bilateral transfers of energy, it is more important for each state's respective market participants to be aligned with the accounting system of the market they participate in, rather than being aligned with each other. This market alignment can circumvent issues raised when market participants operate in multiple states with varying guidelines.

Applicability

This best practice is mainly applicable to states with their own greenhouse gas accounting system in place and with utilities that participate in the wholesale regional electric market. States with existing accounting systems can explore potential linkage with a market's accounting system. This best practice also is applicable to market operators, because a consistent greenhouse gas accounting system can assist market operators in dispatching power in a manner that reflects that state-specific policy goals.

Implementation

How states choose to interpret and incorporate data from a regional greenhouse gas accounting system for their policy compliance purposes is within their purview. We recognize that some states have existing emissions accounting policies and guidelines. Utilities in those states may also participate in a regional electric market which requires a different greenhouse gas accounting process. However, from the perspective of overall market and emissions accounting system functionality, it is preferable for states with no current greenhouse gas accounting system to allow participating utilities that serve load in their state to utilize the regional accounting system of whichever electricity market construct the utility participates within. For states with existing accounting systems, we recommend exploring alignment with the accounting system of markets their utilities participate in.

If a state's emissions compliance methodology is fundamentally oriented to discourage a utility in that state from participating in a regional electricity market and is misaligned with a market's greenhouse gas accounting system, this may disincentivize market transactions and even encourage the restriction of energy flows to the state. It should be noted that states with production-based greenhouse gas accounting systems, which require generation facilities in the state to report their emissions, can also benefit from allowing utilities to participate in the consumption-based accounting system administered by a market operator. While the production-based system is important for state policy goals such as limiting air pollution and ensuring air quality around generation sites, the consumption-based

accounting system can provide a holistic representation of emissions associated with electricity delivered to and serving load in the state.

Foundational Best Practice #3: Guidelines for Unspecified Power and Associated Renewable Energy Certificate Attribution

Potential issues to address

Unspecified power presents a challenge due to its lack of emission attributes, the need to assign emission attributes to it, and the variety of methods to do so. Similarly, electricity generated by a renewable resource that has been unbundled from the associated REC or unspecified energy paired with a REC can raise questions about how that energy should be treated from a greenhouse gas accounting perspective.

Relevance

Unspecified power must have emission attributes assigned to it for market dispatch. Additionally, any market participant seeking to add renewable attributes to unspecified power in order to, for example, meet state RPS standards or facilitate a voluntary green energy program, must follow specific market dispatch guidelines. Those guidelines for transacted unspecified power would also assist a market operator with clarity on the treatment of unspecified power and appropriate attribution across participating utilities.

Applicability

We expect unspecified power transactions to continue in the Western Interconnection until a fully centralized wholesale electricity market is operational. This best practice applies to the market operator who sets the greenhouse gas accounting system rules, as well as market participants who buy or sell RECs. However, the relevance of this best practice varies based on the type of market product for wholesale energy. Currently, in a real-time energy imbalance market, all purchases can be unspecified power. That is, participating entities purchase power by quantity to meet their demand, and no information is available on the resource type. The participating entities in an energy imbalance market are balancing authorities, not load-serving entities, since the transactions involve balancing in real time. In a day-ahead market construct, there would be increased day-ahead resource scheduling and commitment, which yields greater predictability and certainty of the emission attributes. Thus, in a day-ahead market construct, the share of unspecified energy is likely to decline significantly. However, this will not displace the continued need for greenhouse gas accounting in a real-time market, and these transactions would still need to be accompanied by tracking of emission attribute transfers.

Implementation

For unspecified power, clear guidelines must be in place to consistently assign emission attributes, including an emission rate, using the best available information. The practice of pairing unbundled RECs with unspecified power may need to be restricted to better align with state policy guidelines. For instance, purchasing a REC that could plausibly be physically delivered to a particular end user might prevent that unbundled REC from qualifying as renewable energy. While a full discussion of the nuances of REC accounting is beyond the scope of this paper, we do strongly recommend that, in order for unspecified power to be treated as renewable or zero-emissions from a GHG accounting perspective, it must be coupled with associated REC retirements.

For example, if a market's system mix is 30% renewable and 70% thermal, then unspecified energy should not be assigned a default 70/30 thermal/renewable mix and should instead be noted as exclusively thermal. Purchasers of unspecified energy must purchase and retire RECs if they are claiming renewable attributes for their unspecified energy, including zero-emission attributes.

This practice prevents potential double counting of renewable and zero-emission attributes and, coupled with existing REC accounting procedures, allows for verification of emission attributes. Furthermore, as the bulk power system transitions to an increasingly decarbonized resource mix, more RECs will become available for pairing with unspecified energy. It is preferable for RECs to stay bundled with generated renewable power to avoid the creation of null power, which must be assigned emission attributes due to the unbundling of its renewable qualities.

Foundational Best Practice #4: Alignment with Federal Environmental Requirements

Potential issues to address

A greenhouse gas accounting system must be aligned with federal requirements on electrical generating unit reporting to the EPA under the Greenhouse Gas Reporting Program, the Clean Air Markets Program, and the Energy Information Administration (which supplies the data the EPA uses for its eGRID database), as well as any other reporting requirements.

Relevance

A greenhouse gas accounting system must not interfere with existing federal reporting requirements and should use data from these federal reporting systems when possible.

Applicability

This best practice applies to electrical generating units that are subject to federal emissions reporting requirements (such as Clean Air Act related – Title V, or other regulations).

Implementation

Since the EPA's greenhouse gas reporting requirements occur at the electrical generating unit level, a greenhouse gas accounting system does not interfere with this data collection. In fact, many Eastern independent system operators rely on eGRID data for assigning emission rates to imports and unspecified power. An emissions accounting system therefore does not need to have specific best practices to comply with federal emissions reporting requirements beyond the current practices at the electrical generating unit level.

Foundational Best Practice #5: Compatibility with State Policies and Goals

Potential issues to address

Western states have a variety of renewable energy and greenhouse gas policies in place, such as emissions reductions goals, Clean Energy and Renewable Portfolio Standards, and other measures that require emission attributes from market transactions to be assigned to each load-serving entity and aggregated at state level. Sometimes, these policies apply exclusively to electricity serving retail load in the state. As such, electricity from a market must be assigned to load-serving entities that then must comply with these state policies. However, this process can be complex to administer jurisdictionally when load-serving entities span multiple states with varying compliance obligations. Furthermore, wholesale electricity market designs rarely align with state borders; this means system power must be allocated to each load-serving entity and then by its emission attributes, as well as aggregated for each state.

Relevance

Load-serving entities are required to comply with various state policies. In order to do so, the greenhouse gas accounting system must supply the needed information for load-serving entities to use in filing for compliance.

Applicability

This best practice is applicable to load-serving entities that participate in markets and must demonstrate compliance with various state policy requirements. It also applies to the market operator/administrator that must ensure the greenhouse gas accounting system relays accurate and adequate information to load-serving entities and regulatory state agencies.

Implementation

To ensure that load-serving entities receive sufficient information on the emission attributes associated with their power, it is crucial that adequate information is both available and accessible. Additionally, load-serving entities with a footprint over multiple states must apportion those emission attributes and the associated energy based on load served in each state. For this purpose, each load-serving entity should have a single account within a greenhouse gas tracking and accounting system. The system operator could assign resources into this account, which would then be automatically divided proportionally into subaccounts for each state where the entity serves load. However, in cases of contractual purchases of energy intended for use in only a single state, the system

operator should document and report the relevant generation certificates into the given state's subaccount. This compartmentalization of load served by state, done automatically, would prevent resource shuffling among multiple states. This same proportional practice, except in cases of contractual delivery of energy or REC purchases, could be utilized for system power in a wholesale market.

For power purchased through an energy imbalance market, integration with an all-generation tracking system would allow for greater specificity in determining the resources dispatched and purchased, information that is necessary to demonstrate compliance with various state policies. Creating an all-generation certificate database specific to an energy imbalance market would achieve greater data accuracy and specificity for the resources entering the energy imbalance market resource pool. Such a database could be administered as a sub-account in an all-generation tracking system or as a separate database.

In a scenario in which no all-generation tracking system was in place, the market administrator could create a database for all market participants, with capabilities to upload generation certificates and to transfer them between accounts. The upload of specific generation certificates (containing REC information in the case of renewable energy resources) would allow for a decoupling of physical power and emission attributes. For instance, if a utility generated an amount of excess wind power that was dispatched by the EIM, the utility would also deposit an equivalent amount of generation certificates and the associated RECs into the EIM database, with verification that the renewable and emission attributes were not being claimed by another entity. The user of the energy would then either purchase the RECs, allow the original utility to retain them, or allow for the purchase of the RECs by another EIM entity. Such an approach would avoid having the market operator attempt to track exact flows of power, while still ensuring that the resources transacted had a probability of delivery, since they were EIM resources. In the alternative, the market operator could directly assign generation certificates to purchasers. This assignment could be done randomly, to avoid resource shuffling, or could be based on bid adder processes like those in California, for states with greenhouse gas pricing measures in place.

Foundational Best Practice #6: Alignment with State-Based Carbon Pricing Requirements

Intended goal

Today, California is the only state in the West with a carbon pricing program. As a result, CAISO's Western EIM has a greenhouse gas "bid adder" for resources. Because renewable resources are unburdened by this additional cost, they are more often the least-cost resource, and since resources with the lowest cost are deemed delivered into CAISO, the operator tends to procure greater levels of renewable resources from the Western EIM. We may see other states in the West develop or adopt carbon pricing programs in the future. Thus, a greenhouse gas accounting system must include and integrate information on provisions for re-ordering dispatch based on carbon pricing. We specifically consider best practices in the case of heterogeneous, state-by-state carbon pricing, as it is unlikely that all states in a Western market would have identical carbon pricing policies. CAISO's bid adder approach is successful largely because most of CAISO's footprint aligns closely with the state of California, and it operates almost exclusively in California. For multi-state balancing authorities utilizing real-time or day-ahead markets, or for load-serving entities within a wholesale market spanning a multi-state footprint such an approach would not be sufficient.

Relevance

This best practice is not currently relevant, but would become relevant if multiple states with differing emissions pricing programs were also part of a market with a multi-state footprint.

Applicability

This best practice is applicable to market operators who must incorporate carbon pricing into their dispatch algorithm. Participating utilities would also need to comply with carbon pricing if it was not accounted for by the market operator in dispatch. Generators would need to input emissions information for resources in order to reflect the appropriate marginal cost of electricity, including the cost of carbon.

Implementation

For some states within an existing wholesale electric market with greenhouse gas pricing structures in place, the protocols of a greenhouse gas accounting system need not be changed. The same best practices still hold with the

addition of a pricing component for greenhouse gases, but the resources dispatched would be affected if emissions costs were internalized. We presuppose that the market design for a regional electricity market would utilize a different dispatch order for participating entities in states with greenhouse pricing as compared to states with no such pricing in place. For this reason, markets would have to institute differing prices for resources based on the intended point of delivery. Market operators also would have to specify carbon content of resources, as opposed to an overall greenhouse gas emission rate.

To accomplish this, a regional market structure would need to incorporate border adjustments for greenhouse gas pricing into the market design. Border price adjustments within markets are difficult to execute, as they reorder which resources are least-cost depending on whether a greenhouse gas price is needed or not. This may require the creation of sub-zones of dispatch within the market, to account for the differing resource costs for entities subject to and not subject to carbon pricing. Another strategy would be to allow entities subject to carbon pricing to make contractual purchases after the fact, to minimize their compliance costs and minimize market disruption. This would avoid creating sub-zones for dispatch or multiple passes of dispatch. If it was more cost-effective for a load-serving entity to purchase contractual electricity (not physical electricity, as the dispatch within the market is not changing) instead of adding a price adjustment for the greenhouse gas content of the energy dispatched to them, it could purchase a corresponding amount of contractual power.

This approach differs from allocating renewable resources disproportionately to entities subject to carbon pricing, avoiding resource shuffling by having emission attributes available for purchase after dispatch. For this to be possible, a robust all-generation tracking system detailing the emission attributes of dispatched power to each load-serving entity must be in place. However, if a state's carbon pricing system required that the electricity must be physically delivered to the state, rendering these types of post hoc purchases insufficient, then sub-markets or a multiple-pass optimization system would likely be necessary to ensure physical electricity delivery.

Foundational Best Practice #7: "One-stop" Greenhouse Gas Verification System Design

Potential issues to address

For data to be used in policy compliance and for accounting purposes, the information must be valid and verifiable. Without validation, data may not be sufficient to demonstrate compliance with applicable state policy, and the metrics reported may not be credible.

Relevance

This practice allows for the greenhouse gas data collected to be verified and ensures that it is as accurate as possible. However, this verification process does not disrupt market transactions and functioning.

Applicability

This best practice applies to market operators/administrators and market participants.

Implementation

Greenhouse gas measurement through an all-generation "common portal" tracking system administered by the market operator can be paired with emissions reported to the EPA or a state environmental agency. These emission rates can serve as the emission rates on generation certificates. The market administrator can also choose to carry out third-party verification for emission rates. This process of pairing previously verified data with generation reported to the market operator for dispatch purposes creates an accurate measure of the greenhouse gas emissions in a system.

Additional best practices apply to consumption-based greenhouse gas accounting systems, which require increased specificity in assigning resources to load. These best practices focus on the *operational* aspects of such a consumption-based system, as well as the treatment of unspecified power:

Attribute-Based Best Practice #1: Information Flow and Real-Time Tracking

Intended goal

The state policy compliance and market functionality requires the collection, processing, and dissemination of immense amounts of data in a consumption-based system. Tools and practices for information flow and real-time tracking can help accomplish this.

Relevance

Information flow and real-time tracking are necessary for the end users of greenhouse gas accounting information, in order to accurately assign resource to load served in a consumption-based accounting system. The types of emission attributes that are necessary will depend on the relevant state policies, and can include proof of delivery of resources serving load in a state.

Applicability

These practices involve the market operator or greenhouse accounting system administrator, and the market participants. Affected entities would include the participating utilities, public interest stakeholders, third-party energy consultants, and financial traders of energy.

Implementation

The best practices presented here are based on tools and approaches that can accomplish information flow and real-time tracking.

- **E-tags:** The use of e-tags can help track contractual delivery of a resource by tracing its physical transmission path from source to end use. While e-tags do not offer an ironclad guarantee of physical delivery of electricity from a specific source, they do trace out a plausible, good-faith presumed path for the power delivery. E-tags are best utilized in resource-specific transactions to confirm contractual resource purchase and are a useful tool for policy compliance in states with more stringent deliverability requirements. For example, if a state requires that electricity used to qualify for its emissions reduction goals or RPS be delivered and used within the state, e-tags could verify this. In certain cases, e-tags are not a viable strategy, and other proxies can be used to assign greenhouse gas emissions to thermal energy. For instance, if an independent system operator owns the transmission infrastructure and therefore no transmission rights need to be purchased, e-tags are not a useful tool.

- **Average emissions intensity:** In an independent system operator with all-generation tracking for its footprint, an average rate of emissions intensity can be established for internal energy. An operator can similarly assign emission rates to imports and could choose to use the average emission rates or an alternate rate. So long as average emissions intensities are tracked and made available, informational exchange could accompany imports. While representing an average, this approach is a simple way to manage imports. Additionally, using average data that is dynamic, pulling from the regular reports of an independent system operator, increases the accuracy of this tracking, as opposed to using more static annual data. An important consideration in determining the appropriate emission rates is whether the emission attributes associated with the electricity have been transferred to the reporting entity. If those emission attributes have been transferred to another entity (such as a specific utility, a city, or a corporation), they should be excluded from the calculation of the average emissions rate, to avoid double counting.

- **Periodic reporting of market performance and emission attributes:** A greenhouse gas accounting system should include a public-facing interface displaying the amount of energy dispatched and the emission attributes, such as emission rates, associated with that energy's fuel mix. This information should be presented as granularly as possible, with distinctions being made based on geographic area, plant type, fuel type, and any other relevant information. This information should be accessible and shared in a transparent manner on a periodic basis.

Attribute-Based Best Practice #2: Emission Rates for Unspecified Power

Potential issues to address

Unspecified power presents a challenge for greenhouse gas accounting, due to uncertainty about the electricity's emission attributes. This creates difficulties in assessing whether a generation facility, a load-serving entity, or state is meeting relevant state policy standards, such as greenhouse gas reduction requirements. It is critical to establish an accurate residual emission rate for unspecified system power.

Relevance

The use of a residual emission rate for unspecified power purchases decreases the possibility of double counting emission attributes and increases the accuracy and specificity of the emission rate assigned to unspecified power. We believe use of a residual thermal rate represents the most realistic assumed residual emission rate for unspecified energy.

Applicability

This practice applies to market operators/administrators insofar as they need to operate a greenhouse gas accounting system. It also is applicable to market participants utilizing unspecified power resources.

Implementation

For unspecified power coming from a specific wholesale market, we advocate for the use of a residual thermal rate to assign an emission rate (and fuel mix) to the power. A residual rate employs the use of a subtractive process to assign emission attributes to power. This means residual rates focus primarily on which emission attributes *cannot* be assigned to the power due to having already been claimed by another party. A residual rate is largely about what the power is not; it takes resources which have been claimed through REC purchases, contractual purchases, or confirmed delivery to one end user, and removes them from the system mix calculation, preventing double counting. To apply a residual rate to unspecified system power, generation certificates should be assigned to the power and deposited in the accounts of purchasers or users of the power. These certificates should reflect the residual rate determined by amalgamating all unclaimed thermal generation certificates. This amalgamation should occur on a regular basis, in tandem with compliance periods for fuel mix disclosure requirements.

For unspecified power purchased from another market, the best available information should be used to assign an emission rate. For imports from a market with a greenhouse gas accounting system or an all-generation tracking system in place, the accounting system administrator should acquire information on the system mix. For unspecified power imports from a source where such information is not available, eGRID data can be utilized based on the Control Area the energy is being purchased from.

V. Recommendations and Conclusion

Overview

In the West, the regional electricity market landscape continues to evolve. Our recommendations are grounded in the current Western electricity markets landscape, as well as in the context of two broadly set regional electricity market constructs. An optimal greenhouse gas accounting system for the region must include: (1) robust data collection and information tracking; (2) accounting procedures for unspecified power; (3) consistent tracking tools; (4) REC policy consistency; and (5) air quality and economic regulator coordination.

Development of a greenhouse gas accounting system could occur under several regional market scenarios:

Regional Market Constructs

- Status Quo
  Greenhouse gas recommendations for the current system in the West take into account the system of 37 BAAs transacting energy bilaterally, as well as CAISO's Western EIM and SPP's Western EIS real-time markets.

- Energy Imbalance and Day-Ahead Market
  Another likely scenario would be a regional electricity market in the West that offers market transfer opportunities for electricity through an intra-hour imbalance market and a day-ahead market service. We believe this Western Interconnection would involve the continued progression of an incremental strategy that includes a fully expanded energy imbalance market in the West and an additional layer for day-ahead market services for energy imbalance market member utilities. Such a framework would involve maximum utilization of existing transmission capability and access for imbalance market and day-ahead economic opportunities.

- Single RTO or Multiple RTOs in West
  This regional electricity market construct involves the creation of a regional transmission organization (RTO) across Western states outside California and would allow for trading of wholesale electricity resources. Possible options for this scenario could be the creation of either several smaller regional RTO markets or a single RTO for the West outside California. In either case, we presume CAISO or any other credible market operator would take on contractual obligations for RTO construction and operational management. Implementing such a vision would create benefits including reducing or eliminating regional transmission pancaking practices, enabling regional diverse resource sharing and coordination.

Recommendations Under Varying Wholesale Electricity Market Constructs

Our recommendations for a regional greenhouse gas accounting system would apply in each possible market scenario:

Recommendation #1: Robust Data Collection and Information Tracking

Establish an all-generation tracking system in the West.
For any market scenario, we recommend the establishment of an all-generation tracking system, with a generation certificate being created for each MWh of generation. While these generation tracking systems rely on data collection done by independent system operators, we believe a generation tracking system need not have an independent system operator as its administrator. For any scenario presented not including an RTO, we recommend all-generation tracking be added to the existing Western Renewable Energy Generation Information System (WREGIS) interface, which currently tracks only renewable energy. We advocate for this integration with the existing WREGIS system in order to prevent possible double counting of emission attributes. Also, adding thermal resource data to WREGIS would allow for increased availability of information and more accurate emission rate assignment for unspecified power purchases. Having such a system in place would allow for generation information to be centrally located and administered, regardless of market organization status.

Status Quo Market Framework: Create an internal tracking system for energy imbalance markets with emission attributes resources dispatched through the EIM.
In the current Western Interconnection, which includes an EIM framework, a greenhouse gas accounting system would largely focus on the transactions in the real-time markets. Bilateral transactions, whether resource-specific or system mix purchases, would all have contractual agreements specifying the amount of power transacted and detailing the specific resources or the systems mix emission rate. With these protocols in place, bilateral transactions would not pose a significant challenge in terms of data collection and information exchange for greenhouse gas accounting. If an all-generation tracking system is created in the West, these bilateral transactions would need to be coupled with the transfer of the generation certificates in question from the seller's account to the purchaser's account for attribute-based tracking. However, power purchased from an energy imbalance market is not resource-specific and requires the assignment of an emission rate. While California has developed a system for resources being deemed delivered into California and assigning emission attributes, this does not reflect the resource dispatch practices of an energy imbalance market. Resources within imbalance markets are dispatched in the most cost-effective manner possible and are not assigned to specific load. Attempting to match resources to load in real time would disrupt the centralized dispatch in these markets, lessening their efficiency. As such, we recommend creating an internal emission attributes accounting system for each energy imbalance market that operates parallel to the actual dispatch of resources, but does not interfere with the dispatch process.

Energy Imbalance and Day-Ahead Market Framework: Create an all-generation certificate tracking system for energy procured through a day-ahead market.
Unlike an EIM, day-ahead markets allow for more specified resources to be transacted with day-ahead predictability.

As such, greenhouse gas accounting would build on the energy imbalance accounting system, allowing participating utilities to transfer generation certificates associated with their energy purchases. Power purchases would include the associated generation certificates of the purchased resources, and these generation certificates would be transferred to the purchasing utility's account. This tracking system would operate parallel to the energy imbalance tracking system but would not be integrated within it. In practice, this would require two databases operated by the market administrator, or each utility would need multiple subaccounts.

Single or Multi-RTO Framework: Perform all-generation certificate tracking and deposit generation certificates into utility subaccounts.
Single or multiple RTOs in the West would give the market operator(s) increased access to generation data. Utilities participating in an RTO would not need to manually upload generation certificates. Instead, an RTO could perform all-generation tracking over its footprint and integrate the generation certificates into an RTO greenhouse gas accounting system, if there was no existing all-West generation tracking database. Participating utilities would have associated accounts within the greenhouse gas accounting database, with a subaccount for generation certificates associated with their generation resources, as well as subaccounts for generation certificates to be deposited according to energy dispatched to the utility.

Recommendation #2: Accounting Procedures for Unspecified Power

Use a residual thermal rate or the best available thermal system mix rate to assign an emission rate to unspecified power.
For transactions of unspecified power, we recommend the use of best available data to assign it a thermal emission rate and the creation or issuance of a generation certificate reflecting those assigned emission attributes. We also recommend instituting practices to disincentivize the transaction of unspecified power and to require utilities to report generation data via an all-generation certificate database. Renewable attributes should not be assigned to unspecified power based on an average system mix, because the renewable attributes are often claimed by specific end users. In short, the renewable attributes have value on the REC market, whereas there is no comparable value to non-renewable attributes. Therefore, it is reasonable to assume unspecified power does not contain any renewable attributes. Assuming unspecified power includes renewable attributes is likely to lead to double counting of those renewable attributes. Under this approach, if a utility or market had an average of 70% thermal generation and 30% renewable, and sold or dispatched an amount of unspecified power, it could not claim that the power was 30% renewable. Instead, it would have to utilize the thermal generation statistics unless the energy was accompanied by the associated RECs.

This average system mix approach disincentivizes utilities from labeling their thermal resources as unspecified power to allow them to have more favorable assumed emission attributes. Especially in a policy landscape with carbon pricing in place adding to the overall price of the resource, such generation labeling would be advantageous to the utility selling the power through the energy imbalance market. As such, we recommend the use of unspecified power generation certificates with a thermal generation mix based on the utility's system mix, to account for the greenhouse gas emissions of unspecified power dispatched.

Status Quo Framework: Create a residual thermal rate to assign to unspecified power based on a utility's thermal generation residual emissions intensity.
The West's current energy imbalance markets, Western EIM and Western EIS, involve transactions of unspecified power. Unspecified power dispatch through an energy imbalance market occurs when a participating utility has excess system power or unspecified resources to sell. If a utility has unspecified energy to dispatch through an energy imbalance market, it should still upload a generation certificate to the energy imbalance market's database with emission attributes based on the best available data.

Single or Multi-RTO Framework: Use a residual thermal rate for unspecified power and use the best available information for assigning emission attributes to imports.
Unspecified power generated within an RTO is likely to be minimal, due to increased access to generation information paired with all-generation tracking. However, if generators within an RTO do have unspecified power, it should be assigned the residual thermal generation rate of power generated in the RTO when issued generation certificates. Additionally, having robust generation tracking guidelines in place should stem the amount of unspecified power requiring the

assignment of emission attributes within the RTO. Unlike in the previous two scenarios, imports and exports of unspecified power would need to be accounted for. For imports of unspecified energy from another RTO (in a multi-RTO scenario), it is possible that the selling RTO would already have system-mix generation certificates to accompany the power. If not, the purchasing RTO could request information on the residual rate of the selling RTO's power. If this information was unavailable or the RTO was purchasing unspecified power from another source, eGRID data based on the power's geographic origin could be utilized instead. In any case, if the imports did not have accompanying generation certificates, the RTO should create such generation certificates for eventual assignment to an end user. For exports of unspecified power from the RTO to another entity, the RTO would export the power with the associated system mix generation certificates.

Recommendation #3: Consistent Tracking Tools: Use all-generation certificate tracking systems for relevant emission attributes.

Status Quo Framework: Create a generation certificate tracking system of the resources dispatched in an EIM.
An all-generation certificate tracking system within an energy imbalance market would allow for disaggregation of emission attributes from physical power flows within a closed system (the energy imbalance market in question). As such, the market operator would not need to conduct real-time "load matching," but the participating utilities could have plausibility of delivery for the resources they were claiming. This middle-way approach balances the needs of states to have utilities only claim energy that could have possibly served load in the respective state with the functioning of centralized dispatch. Such a database would need to have a user interface with accounts allowing for participating utilities to upload information about the generation associated with the resources sold via an energy imbalance market. Furthermore, accounts for participating utilities would need to have the capability for transfer and retirement of these generation certificates. When, for example, a utility purchases energy and that energy is dispatched, the utility's account would need a subaccount for generation certificates associated with that energy. Utilities (or balancing authorities) could upload generation certificates for resources dispatched through the energy imbalance market. This would be coupled with a subaccount to deposit generation certificates in an equivalent amount to the power a utility receives through an energy imbalance market.

Energy Imbalance and Day-Ahead Framework: Create a database for EIM and EDAM all-generation certificate tracking.
A market operator administering both an EIM and a day-ahead market would need a database to provide for greenhouse gas accounting in both markets. Such a database could account for all transactions in both markets with subaccounts for each market type. Alternatively, a market operator could have two databases in place for all-generation certificate tracking for market participants: one for the energy imbalance market and another for the day-ahead market. The day-ahead market's database would be most efficient if it were directly integrated with the day-ahead market's scheduling platform, allowing for transactions being scheduled to automatically initiate a transfer of the corresponding generation certificates from the seller's account to the purchaser's account.

Single or Multi-RTO Framework: Register generation certificates in utility accounts for ISO-generated power and use e-tags or contracts for imported energy.
An RTO's centralized dispatch of resources necessitates the use of proxies for the assignment of generation certificates. An RTO should not attempt to trace physical flows of power with complex real-time matching processes, but instead should allocate generation certificates proportionally. A utility should deposit generation certificates in utility accounts based on the principles outlined in the best practices section, with a focus on plausibility of deliverability and avoiding resource shuffling. This pragmatic approach to greenhouse gas accounting does not seek to track exact physical flows of electricity or allow for all renewable resources to be attributed in a manner that is most advantageous to the market participants with the greatest compliance obligations, and it represents an intermediate approach to greenhouse gas accounting. For imports and exports, the utilization of e-tags could be helpful if ensuring delivery of a particular resource is required. For instance, if an RTO was importing renewable energy, e-tags could confirm this transaction and allow for the RECs associated with the power to be considered bundled,[13] as they accompanied the near real-time delivery of power.

[13] There may be instances when REC sales or contractual transactions for bundled RECs could include RECs delivered immediately and energy delivered later in time.

Recommendation #4: REC Policy Consistency

Require Renewable Energy Certificates to be paired with generation certificates for the claim of associated zero-emission attributes, and exclude unspecified power from being able to claim zero-emission attributes associated with electricity from the generated renewable energy.
Most states have rules or statutes governing the treatment of RECs. A greenhouse gas accounting system should prohibit double counting of renewable attributes by not allowing unspecified power to be paired with any zero-emission attributes absent accompanying RECs.

Single or Multi-RTO Framework: Keep RECs and their associated zero-emission attributes paired whenever possible.
An RTO's all-generation tracking system would need to include REC creation in tandem with zero-emission attributes. These RECs, whenever possible, would need to remain grouped with the corresponding zero-emission attributes. Preventing the disaggregation of the RECs and the zero-emission attributes would protect against double counting of zero-emission attributes and prevent the certificates from losing their renewable attributes and becoming null power that would require the assignment of an assumed emission attribute.

Recommendation #5: Air Quality and Economic Regulatory Coordination

Allow for joint regulation on the requirements for greenhouse gas accounting.
Regardless of market construct, we propose that the regulation for generators in each state should be harmonized across air quality and public utility (economic) regulators. The roles of regulators in each state would not change, short of an RTO market, as energy imbalance and day-ahead markets do not fundamentally alter the electricity market landscape in the way that a regional wholesale market would. However, regulators could establish guidelines (and operating procedures) on information needed to account for the emissions associated with energy purchased through an energy imbalance market. Stakeholder groups associated with any new market formation design efforts should include representatives of both air quality and public utility regulators from impacted states.

Single or Multi-RTO Framework: Ensure state regulators have input on market design by forming a committee with air and utility regulator participation.
In an RTO or multi-RTO scenario, it would be crucial for state regulators to have input on market design and greenhouse gas accounting procedures. As such, we recommend the formation of a single committee with state-level representation from air and utility regulators from each state with participating utilities. Such a committee would provide an opportunity for states to ensure market design can accommodate them relevant to their energy- and emissions-related policy interests.

Conclusion

Regional greenhouse gas accounting can viably be implemented in various existing and future scenarios for regional energy markets. Eastern markets already have all-generation tracking systems, demonstrating that greenhouse gas accounting can occur in a regional wholesale market and need not interfere with least-cost and multi-state centralized dispatch of electricity. Greenhouse gas accounting can also be implemented in less centralized markets such as energy imbalance or day-ahead markets. We recommend an accounting system that allows for granularity and accuracy in tracking greenhouse gases according to load served without instituting disruptive, cumbersome tracking tools or methods that would interfere with market dispatch principles. Given the potential for market expansion in the West and the benefits of regional markets, we present these recommended best practices to ensure greenhouse gas accounting does not hinder the expansion or functioning of regional markets.

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WESTERN RESOURCE ADVOCATES

VI. Appendix: Glossary and Acronyms

The definitions in the below glossary are sourced from CAISO's Business Practice Manual "Definitions and Acronyms" document unless otherwise noted. Definitions sourced from the FERC Market Assessments glossary are denoted with a single asterisk. The below glossary's terms are alphabetized by acronym.

BA – Balancing Authority: The responsible entity that integrates resource plans ahead of time, maintains load-interchange-generation balance within a Balancing Authority Area, and supports Interconnection frequency in real time.

BAA – Balancing Authority Area: The collection of generation, transmission, and load within the metered boundaries of the Balancing Authority. The Balancing Authority maintains load-resource balance within this area.

CAISO – California Independent System Operator: The California Independent System Operator Corporation, a state-chartered, California non-profit public benefit corporation that operates the transmission facilities of all participating transmission owners and dispatches certain generating units and loads.

Day-Ahead Market: Day-ahead markets allow market participants to buy and sell energy through day-ahead unit commitment. These commitments are optimized across all participants to increase savings beyond real-time trading.

EDAM – Extended Day-Ahead Market: CAISO's initiative to improve market efficiency by integrating renewable resources using day-ahead unit commitment and scheduling across a larger area.

eGRID – Emissions and Generation Resource Integrated Database: The Emissions and Generation Resource Integrated Database (eGRID) is a comprehensive source of data from EPA's Clean Air Markets Division on the environmental characteristics of almost all electric power generated in the United States.

EIM – Energy Imbalance Market: Energy imbalance markets allow balancing authorities to voluntarily buy and sell energy in real time, with intra-hour economic dispatch facilitating the balance of supply and demand between balancing authority areas.

Emission Attributes: The greenhouse gas profile of a specific amount of power, as denoted by information on a generation certificate. These characteristics include the emission rate, as well as associated information such as fuel type, transmission or deliverability specifics, generator ID, and geographic area.

Generation Certificate: An authentication issued by the market operator for a specific amount of generated power, including that power's emission attributes, which is granted to the load-serving entity or market purchaser. A certificate contains emission attributes, along with any renewable attributes – such as RECs – associated with that power, and may be traded and used to assess resource fuel mix and compliance with any applicable state clean energy policies.

GHG – Greenhouse Gas: Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and other fluorinated greenhouse gases.

ISO – Independent System Operator: A neutral operator responsible for maintaining instantaneous balance of the grid system. The ISO performs its function by controlling the dispatch of flexible plants to ensure that loads match resources available to the system.

Load-Serving Entity: Any entity, including a load aggregator or power marketer, that serves end-users within a control area and has been granted the authority or has an obligation pursuant to state or local law, regulation, or franchise to sell electric energy to end-users located within the control area.

REC – Renewable Energy Certificate: RECs generally represent the renewable or non-energy attributes of one

megawatt hour (MWh) of electricity generated by a renewable energy resource[14] and are used to demonstrate compliance with state Renewable Portfolio or Clean Energy Standards.

RPS – Renewable Portfolio Standard: Renewable portfolio standards (RPS), also referred to as renewable electricity standards (RES), are policies designed to increase the use of renewable energy sources for electricity generation.[15] These policies require or encourage electricity suppliers to provide their customers with a stated minimum share of electricity from eligible renewable resources.

RTO – Regional Transmission Organization: A voluntary organization of electric transmission owners, transmission users and other entities approved by the Federal Energy Regulatory Commission (FERC) to efficiently coordinate electric transmission planning (and expansion), operation and use on a regional (and interregional) basis. Operation of transmission facilities by the RTO must be performed on a non-discriminatory basis.

SCED – Security-constrained economic dispatch: Security-constrained economic dispatch is an area-wide optimization process designed to meet electricity demand at the lowest cost, given the operational and reliability limitations of the area's generation fleet and transmission system.

SPP – Southwest Power Pool: SPP is a regional transmission organization (RTO)

Western EIM – Western Energy Imbalance Market: CAISO's real-time voluntary energy market which has an advanced market system that automatically finds low-cost energy to serve real-time consumer demand across the west.

Western EIS – Western Energy Imbalance Service: SPP's real-time wholesale electricity market that balances generation and load regionally, delivery cost savings and enhanced reliability to participants.

Zero-Emission Attributes: The characteristics of a specific amount of power which releases no greenhouse gases, as denoted on a generation certificate. If the zero-emission electricity is generated by a renewable resource, it may also be accompanied with a REC. In this situation, retention of the REC is necessary to claim the zero-emission attributes.

[14] Environmental Protection Agency. *Renewable Energy Certificate Monetization.* https://www.epa.gov/repowertoolbox/renewable-energy-certificate-monetization.

[15] https://www.eia.gov/energyexplained/renewable-sources/portfolio-standards.php