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Achieving Western States Greenhouse Gas (GHG) Reduction Objectives:

Least-Cost Compliance in a Constantly Evolving Policy Environment

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Acknowledgments

This report has been prepared at the request of the Public Generating Pool (PGP) and PacifiCorp to evaluate and analyze the accounting necessary to monitor compliance with environmental regulations that focus on reducing atmospheric emissions of carbon dioxide.

This is an independent report by Joseph Cavicchi and Todd Schatzki of Analysis Group, Inc. (AG). They wish to express their appreciation for the assistance of colleagues at Analysis Group: Luke Daniels and Hannah Krovetz. Also, our work has benefited from input and comment from PGP and PacifiCorp. However, the analysis and conclusions herein reflect the independent judgment of the authors alone.

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About Analysis Group

Analysis Group is one of the largest international economic consulting firms, with more than 1,000 professionals across 14 offices in North America, Europe, and Asia. Since 1981, Analysis Group has provided expertise in economics, finance, health care analytics, and strategy to top law firms, Fortune Global 500 companies, government agencies, and other clients worldwide.

Analysis Group's energy and environment practice area is distinguished by expertise in economics, finance, market modeling and analysis, regulatory issues, and public policy, as well as deep experience in environmental economics and energy infrastructure development. We have worked for a wide variety of clients, including (among others) energy producers, suppliers and consumers, utilities, regulatory commissions and other federal and state agencies, tribal governments, power-system operators, foundations, financial institutions, and start-up companies.

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I. Executive Summary

This paper focuses on details of designing effective and least-cost compliance mechanisms within the electricity sector, and identifying the complications and trade-offs that can emerge in designing these mechanisms given the physical nature of electricity as an energy source and the structure of interstate electricity markets.

Many states are embarking on aggressive state policies aimed at reducing GHG emissions. Policies aimed at reducing GHG emissions from the electricity sector have been particularly aggressive, with many states implementing measures aimed at largely or fully reducing GHG emissions from the sector over medium-term horizons (e.g., by 2040). While many different policy approaches can be used to achieve deep decarbonization, at present most states are pursuing reductions through renewable portfolio standards (RPS), clean energy standards (CES), or some variant thereof.

This paper also looks at key aspects of Washington's Clean Energy Transformation Act (CETA), how it interacts with wholesale electricity trading in the West, and how it is likely to interact with other Western states' policies to promote growth in the reliance on non-emitting resources.

The complications that can emerge in designing regulatory compliance are illustrated by considering Washington State's efforts to decarbonize within the broader structure of a complex Western electricity market. A close examination of the recently passed CETA identifies challenges in implementing regulations to achieve the legislation's targets and developing a framework for demonstrating compliance. The interaction of Western states' non-emitting resource policies with wholesale electricity trading is complex, given the rich set of existing bilateral arrangements, the patchwork of independent balancing authority areas, California's cap-and-trade program, the expansion of the Western Energy Imbalance Market (EIM), and the potential implementation of a Western Extended Day-Ahead Market (EDAM), all of which significantly impact resource dispatch and energy transactions.

A key consideration for compliance strategies is the relationship to centralized markets. The rapid expansion of the Western EIM has demonstrated how centralized markets offer the opportunity to lower the cost of integrating renewable resources by centralizing the least-cost resource dispatch and automating market clearing price reporting to more efficiently utilize available resources and transmission, thereby increasing the use of supply from zero-cost resources and reducing curtailment.

Greater penetration of renewable resources leads to the displacement of supply from fossil fuel resources and lower electricity sector GHG emissions, thus achieving clean energy policy goals. An EDAM has the potential to further improve the market's ability to efficiently schedule resources and integrate both existing resources (including a large network of hydroelectric facilities) and new renewable resources. Ensuring that state policies and regulations are harmonized with the short-term hour-to-hour centralized energy markets and the longer-term bilateral electricity markets that underpin resource planning over a large portion of the West is important to cost-effectively achieving clean energy policy goals for consumers.

As states increase reliance on non-emitting resources, and adopt new and evolving policy approaches that may vary significantly, frameworks for measuring compliance have important consequences for environmental and economic outcomes. States have alternatives in developing these frameworks that address the complexity of electricity systems and markets in different ways. The framework chosen by the state will impact the effectiveness of the policies (see **Table ES 1**).

Some compliance proposals recommend methods seeking to match the "flow" of electricity generated with consumer consumption at very granular time intervals; this paper explores several limitations to that approach:

1. **Market efficiency relies on "system" transactions.** As many common types of electricity transactions involve electricity supplies from a "system" rather than a specific source, requirements that all electricity used flow from particular sources would impair market functioning, reduce operational efficiency, and limit the market's ability to efficiently integrate non-emitting resources;

2. **Electricity flows are not tracked from resource to load.** In the normal course of business, electricity system operators do not "track" electricity flows from specific sources – within or outside the operator's balancing area – to specific utilities and their consumers; and

3. **After-the-fact estimates of flows are impractical.** Ex post efforts to assign individual resource flows to retail loads would be impractical due to computational complexity, and inconsistent with flows defined by contractual relationships.

Thus, while it may seem straightforward in some respects to align generation resource production with actual consumer consumption, electricity flow tracking is impractical, likely to be very costly, and unnecessary to ensure climate policy objectives are achieved.

By comparison, a resource-based compliance proposal avoids these problems and can achieve policy environmental objectives, support well-functioning electricity markets and the integration of non-emitting resources, facilitate cost-effective achievement of climate policy objectives, and provide an administratively efficient and effective system for achieving compliance.

Rather than tracking all individual electricity flows, this approach first accounts for electricity at the generation resource and then load-serving entities comply by assigning these resources to their compliance obligations subject to administrative rules. The design of these rules can reflect policymakers' environmental and economic goals. The Western states should consider working toward establishing a framework that allows for consistent accounting across the region, similar to compliance frameworks in the mid-Atlantic and Northeastern regions of the US.

Determining the framework for compliance is but one of the many important decisions that need to be made to develop an effective compliance system. Many important decisions will remain, including: determining the criteria for resource types eligible to comply with non-emitting resource requirements, including geographic criteria reflective of resource deliverability; determining how compliance requirements will account for the timing of when the electricity is generated; developing regulatory accounting systems for both resources producing electricity and load-serving entities' (LSEs') compliance with requirements; rules related to accounting for production outside the state's jurisdiction (e.g., double-counting, leakage); the relationship between compliance requirements and integrated resources plans; and unique issues raised by multistate utilities and balancing authorities. These details will have important consequences for both the environmental benefits created by new climate policies, as well as their economic consequences.

Table ES 1: Options for Compliance with State Decarbonization Policies

Category	Resource-Based	Flow-Based
Accurate Measurement	Actual production Deliverability based on predetermined locations (approximation) Timing granularity flexible	Actual and scheduled production Deliverability determined for each flow (contract paths, approximate and actual) Timing constrained (e.g., within the hour)
Administrative Feasibility	Low/moderate complexity, high transparency – standardized systems of WECC-wide accounts would improve reliability	High complexity, low transparency
Cost-Effectiveness	Supports any type of out-of-state resources Temporal flexibility can lower costs Supports market structures with ability to integrate renewables	May limit supply from certain out-of-state resources Lack of temporal flexibility may raise costs May constrain market ability to integrate renewables
Transactions and Administrative Costs	Low/moderate – standardized systems of WECC-wide accounts may lower costs, after initial development	High – flow-based accounting (e.g., resource hourly scheduling and E-Tag tracking) more complex; currently no system capturing all flows; developing proxies for system flows would be time-consuming and subject to error
Support Well-Functioning Markets	Yes. Accommodates all transactions and market structures.	No. May not accommodate system supply and centralized markets.
Out-of-State Activities	Can accommodate provisions aimed at accounting for out-of-state activities	Can accommodate provisions aimed at accounting for out-of-state activities

State clean energy compliance methods that align with and support the broad use of electricity markets will be critical to provide utilities and policymakers confidence that electric sector decarbonization policies are being implemented at least cost to consumers.

The Western states cooperatively developed an extensive electric transmission network that reduced consumer costs and allowed sharing of resources over hundreds and thousands of miles. As studies have shown, fully utilizing the potential for the region’s grid to balance variable renewable supplies will be important to help meet Western states’ climate policy objectives. It is critical to ensure that the pathway to zero emissions from the electricity sector preserves and reinforces the benefits available from this expansive and unique electricity network. Highly efficient wholesale electricity markets are a key component for ensuring that this network is fully utilized, thus reducing consumer costs while achieving environmental objectives.

II. Introduction and Background

Many states have developed or are developing state-level climate policies that vary from state to state in terms of both the stringency of the targets being pursued and the mix of policies being deployed to achieve the targets. The design of decarbonization regulations for the electricity sector must consider the unique features of the electricity markets. These features include the physical properties of the electricity system and the market structures through which electricity is procured on behalf of customers. In this paper, we consider the implications of the particular features of Western electricity markets for the design and implementation of state-level climate policies in Western states.

In this section, we provide an overview of climate policies and electricity markets in the Western states and identify key criteria for policy design. In Section III, we discuss the implications of the unique physical properties of electricity systems and the particular structure of Western electricity markets for the design of climate policy. We also discuss how certain types of market structures can help achieve climate policy objectives through the improved integration of renewable resources. Finally, in Section IV, we compare alternative approaches to designing climate policy compliance frameworks in light of the particular features of the electricity sector.

A. Overview of Climate Policies Impacting the Electricity Sector in the West

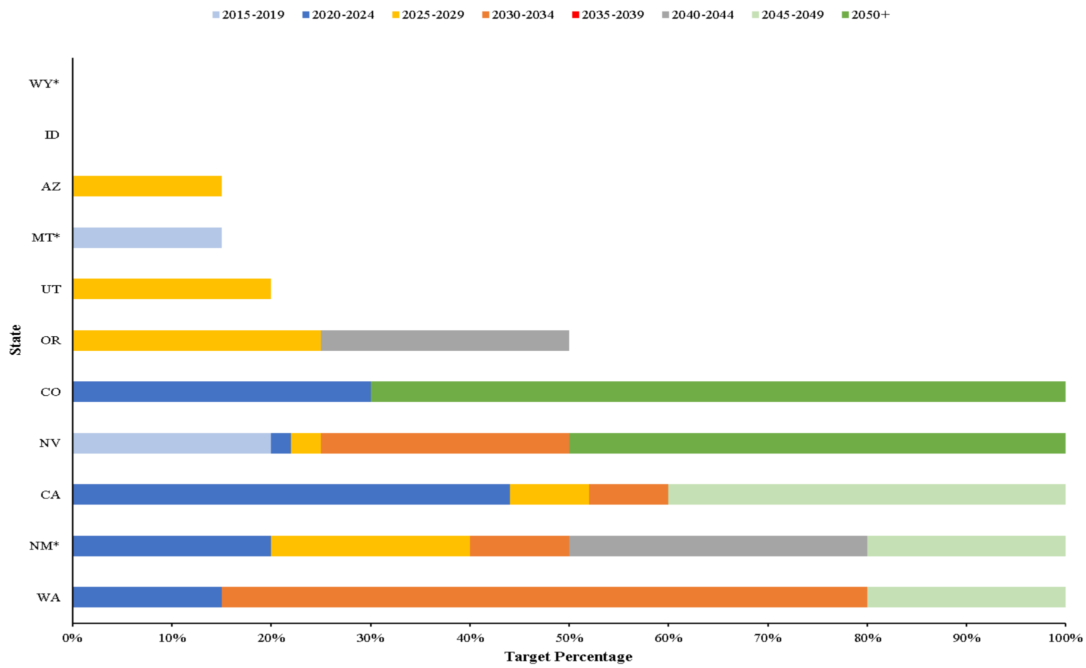
Within the electricity sector, the policies having the most significant and direct effect are technology-based policies dictating that a percentage of customer load be met through electricity meeting certain technological requirements.[1] These technology-based policies include RPS policies and, more recently, non-emitting electric generation sourcing requirements such as Clean Energy Standards (CES). Initially, these policies were developed to achieve a combination of policy objectives but are increasingly being expanded to achieve climate policy objectives.

RPS and similar policies have been widely deployed in 29 of the 50 states (and the District of Columbia). **Figure 1** summarizes renewable targets for the electricity sector undertaken by Western states. Multiple states have set targets to decarbonize the electricity sector by at least 2050, including California, Colorado, Nevada, New Mexico, and Washington, with aggressive interim targets. However, some other states have modest or no targets, in some cases opting not to pursue climate policy objectives.

In aggregate, these state-level renewable and clean energy targets are expected to drive a significant expansion of renewable resources in the West.

[1] While relying heavily on these technology-based policies, Western states have undertaken many other policies that are facilitating the transition to a lower-carbon electricity sector. These policies include subsidies for renewable technologies (e.g., solar), storage and energy efficiency, customer rate structures that support renewable adoption (e.g., net metering), and policies that place a price on carbon emissions. These policies interact to varying degrees with wholesale electricity markets.

Figure 1: Renewable Portfolio Standards and Clean Energy Goals for States in the WECC Region



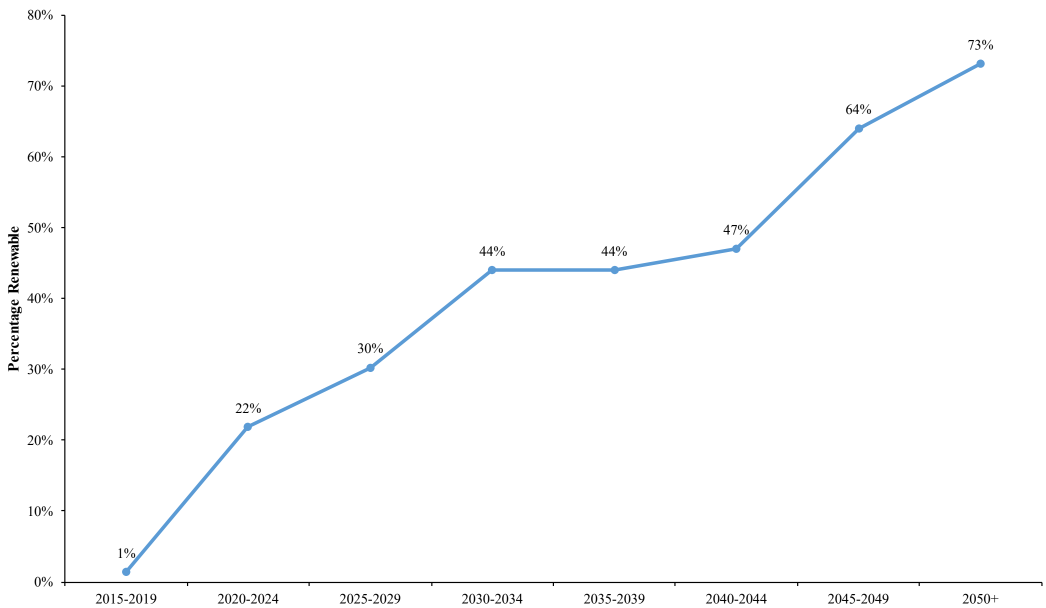
Note: States denoted with an asterisk (*) are only partially in the WECC region.
Sources: Barbose, G., "U.S. Renewables Portfolio Standards 2019 Annual Status Update," US Department of Energy, July 2019, accessed at: https://eta-publications.lbl.gov/sites/default/files/rps_annual_status_update-2019_edition.pdf. State Renewable Portfolio Standards and Goals, NCSL, accessed at: https://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx

Figure 2 shows the estimated growth of WECC state renewable and non-emitting energy supply objectives as a percentage of total WECC load. Over the next 10 years (to 2030), the amount of WECC load associated with non-emitting energy resources will grow by 100%, reaching about 45%. Over the following 10 years (to 2040), the growth rate slows and then accelerates again during the 2040–2050 time period, reaching almost 75% by 2050.

The details of the RPS and CES policies vary from state to state and in many cases are still under development. Typically, the LSE must demonstrate it procured renewable and non-emitting generation resource technologies' output in an amount equal to a percentage of retail sales or load based on particular specifications that vary by state. The CES policies often build on existing RPS frameworks, expanding compliance to non-emitting resources such as nuclear and hydropower that may previously not have been covered by a state's RPS.[2]

[2] At present, all Western US states with RPS and CES policies, except Arizona, allow for renewable energy credits (REC) tracking to be facilitated through a common accounting system, referred to as the Western Renewable Energy Generation Information System (WREGIS). WREGIS is an independent, web-based tracking system for RECs that encompasses the Western US interconnected electric grid (https://www.wecc.org/WREGIS/Pages/Default.aspx).

Figure 2: Western States' RPS/Clean Energy Requirements as a Percentage of Consumer Load



Sources: EIA 2018 Utility Bundled Retail Sales – Total (data from forms EIA-861, schedules 4A & 4D), accessed at https://www.eia.gov/electricity/data.php. Barbose, G., "U.S. Renewables Portfolio Standards 2019 Annual Status Update," US Department of Energy, July 2019, accessed at: https://eta-publications.lbl.gov/sites/default/files/rps_annual_status_update-2019_edition.pdf. State Renewable Portfolio Standards and Goals, NCSL, accessed at: https://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx

Carbon pricing policies have also been under discussion in the Western states for many years, but at present only California has adopted legislation imposing a price on carbon.[3] Under California's cap-and-trade policies, fossil-fuel-fired electric generation resources must obtain CO_2 emission allowances to cover their actual emissions. The policy covers electric energy generated within California, requiring that in-state generation sources obtain allowances to cover their actual emissions. The policy also covers electricity imported into California. In this case, the importing entity must obtain allowances to cover the carbon content of the imported electricity. Challenges with "tracking" electricity flows make accurately quantifying emissions associated with electricity imports complex for the program's administrator, the California Air Resources Board (CARB) and have implications for centralized markets operated by the California Independent System Operator (CAISO).

B. Overview of Western US Electricity Markets – Moving Toward Greater Integration

The Western US electricity markets are characterized by a complex mix of bilateral contractual arrangements and organized markets. Moreover, this structure continues to evolve, notably with the introduction of the EIM, a multistate organized market that currently covers real-time transactions and may expand to cover day-ahead.

[3] Both Oregon and Washington have considered ballot and legislative proposals for cap-and-trade systems, but none of these proposals have been approved by voters or legislators.

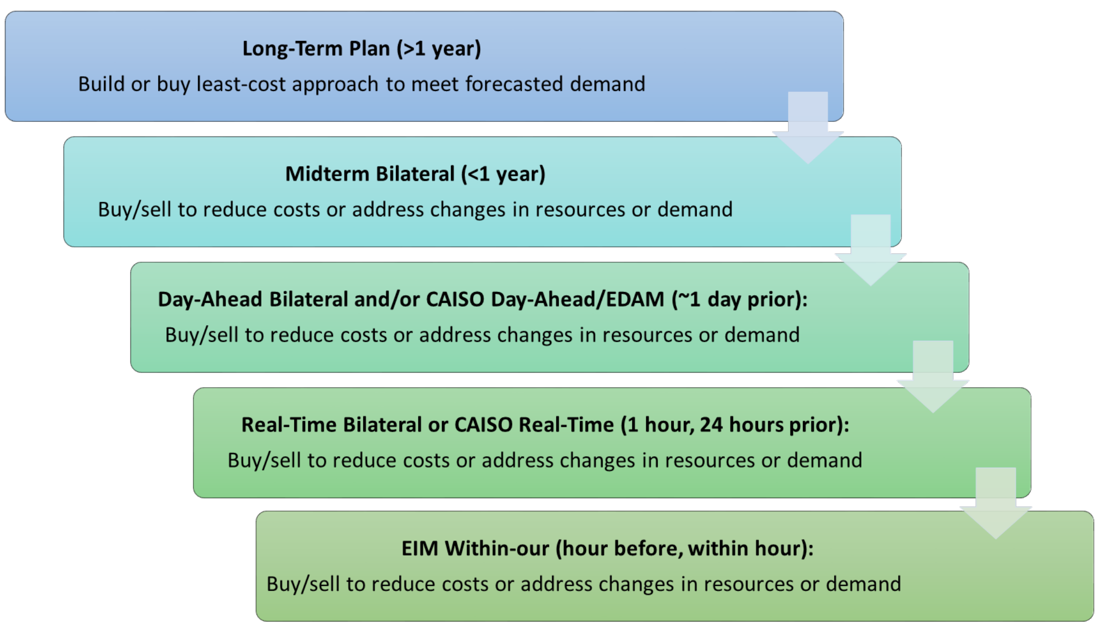
1. *Benefits of Electricity Markets to LSEs*

Electricity markets, including bilateral and centralized markets, are critical for LSEs to minimize resource acquisition costs and ensure least-cost operations day-to-day. Electricity markets allow LSEs to:

1. **Cost-effectively acquire sufficient supply** from resources across a wide geographic footprint to meet forecasted demand,
2. **Manage (hedge) the costs** associated with known and uncertain risks, and
3. **Achieve least-cost dispatch** to meet variation in actual demand (from forecasted demand) and minimize renewable energy curtailment.

LSEs use markets to buy and sell supplies based on long-term forecasts of resource needs and continue to refine their resource mix through shorter-term transactions as they get closer to the delivery hour to reflect changes in forecasted load and resources. The markets support the efficient use of resources, utilizing the lowest-cost resources to meet the demand in the region. **Figure 3** shows the sequential steps toward energy delivery, with the many Western markets providing multiple opportunities to compare planned generation costs with market prices. This sequential process helps to ensure the lowest-cost resources in the market are running and thus reduce customer costs.

Figure 3: Sequential Process for Procuring Electricity to Meet Customer Loads



2. *Bilateral Markets and Balancing Authority Areas*

Market efficiency requires well-functioning markets. Forward contracts are essential to mitigating the financial risks of highly volatile electricity spot markets and can both produce consumer savings and reduce the financial risks of undertaking resource investments. A key element to a well-functioning market is liquidity, which measures the sufficiency of buying and selling by market participants so as to facilitate efficient price formation.

Electricity market liquidity is generally improved by a large number of buyers and sellers and improved by more broadly defined products, such as unspecified energy or system sales.

For more than three decades, the Western bilateral markets have facilitated short-term and long-term electricity trading throughout the Western Electric Coordinating Council (WECC) interconnection, which covers 14 Western states, two Canadian provinces, and parts of Northern Mexico. A region-wide organization, WSPP, has facilitated the development of these bilateral markets by establishing a standardized contract structure for bilateral transactions that covers many products, including unspecified or system sales, unit-contingent and firm energy, RECs, and ancillary services transactions.[4]

While contracting arrangements can be made among a number of different types of energy suppliers, individual resources and loads are included in balancing authority areas (BAAs). Each BAA operator is responsible for balancing the loads and resources within its BAA and for monitoring imports and exports at their electrical boundaries with other directly connected BAAs.[5]

These BAAs represent a wide array of legal entities, including private and public utilities, municipalities, and federal agencies, such as the Bonneville Power Administration (BPA) and the Western Area Power Administration (WAPA). As of January 2017, there were 38 BAAs in WECC, and eight operating in Washington State alone.[6] A consequence of the complex overlay of BAAs in the Western states is that scheduling any electricity transactions across the region can be quite complex, as electricity may “flow” through multiple BAAs to reach its final destination.

While BAAs operate and maintain the reliability of the bulk power system, individual LSEs provide local retail electricity service to industrial, commercial, and residential customers. LSE geographic service territories differ from the BAA footprints, with the potentially complex overlaps between the two.

3. Centralized Markets

Centralized markets rely on a single entity (referred to as an independent system operator, or ISO) to manage electricity supply and demand. Among the Western BAAs, the CAISO is the only BAA that operates a centralized market. CAISO’s energy market uses a bid-based, least-cost resource commitment, dispatch, and market-clearing process to supply bulk power throughout most of California.[7] Market participants submit offers to sell and bids to buy energy, and the market model solves for the optimal dispatch of resources for a given time horizon. In all of its market processes, the CAISO seeks to minimize the bid-based costs incurred to meet

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[4] The WSPP began in early 1987 and was formally approved to facilitate electricity sales in the region by the Federal Energy Regulatory Commission in 1991. Under the auspices of the WSPP, market participants in the region can complete electricity sales and REC transactions using a standardized contractual arrangement that simplifies transactions and reduces regulatory requirements (see https://www.wspp.org/pages/History.aspx, accessed May 5, 2020).

[5] The actual mathematical mechanism for maintaining balance is complex and uses area control error (ACE) to guide resource dispatch adjustments. However, the ability to rely on ACE measurements to maintain system stability simplifies system operational requirements, as the transmission system ratings are already captured in the scheduled imports and exports.

[6] Western Interconnection Balancing Authorities, January 5, 2017, https://www.wecc.org/Administrative/Balancing_Authorities_JAN17.pdf.

[7] The term “market-clearing” refers to the process by which market supply and demand bids for a good are evaluated and the market-clearing quantity and price for that good are established.

forecasted and actual consumer energy demand by committing the lowest-cost resources.[8] By applying least-cost dispatch principles over a large number of supply resources and consumer demand, the CAISO can reliably and efficiently meet the needs of California consumers. The CAISO's centralized market design not only manages the real-time reliability for the BAA but also provides an automated method of day-ahead and real-time trading to provide the least-cost approach to serve consumers.

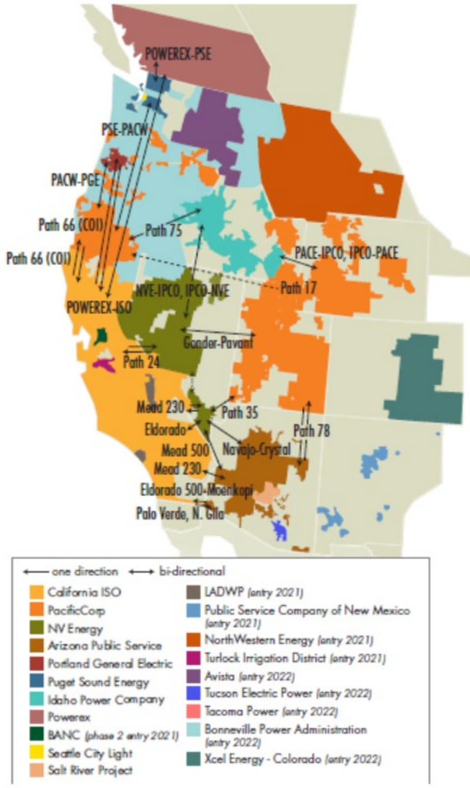
To complement bilateral trade in electricity markets, the CAISO, along with operators in other BAAs, have developed the EIM to provide an automated approach for real-time bid-based energy trading to support the balancing of electricity loads across Western BAAs. The EIM expands the CAISO Real-Time (RT) market least-cost dispatch principles across multiple additional Western BAAs (See **Figure 4**) allowing for improved productive efficiency of electricity system generation resources. The EIM allows for the integration of a large number of additional generating resources and consumer demand into the CAISO's RT dispatch. As a result of this increased integration, a much larger geographic region is available to balance intermittent resource production variability and reduce instances where renewable resource production is curtailed. Specifically, the EIM provides access to a broader market to sell variable energy generation. Moreover, the extended geographic reach reduces RT dispatch costs for EIM participants by drawing on a much larger generation resource fleet to balance RT supply and demand fluctuations. **The existing bilateral markets achieve many market efficiencies but do not offer the efficiency, scope, and timing of centralized markets.**

More efficient use of generation and transmission assets through centralized markets supports the achievement of zero-carbon policy objectives. As solar, wind, and other non-emitting generation expands in the Western markets, the EIM's ability to expand the geographic reach of the real-time market and efficiently utilize available transmission infrastructure can lower the cost and expand the use of renewable resources. In the absence of more-efficient markets, renewable resource supply can be curtailed. Reduction in curtailments ensures that renewables are able to displace fossil generation, resulting in lower GHG emissions, reduces the likelihood of negative energy prices, and provides investors in renewable resources with greater revenue certainty to support investments. The EIM has reduced renewable curtailment by more than 1.25 million MWh since its inception.[9] However, **Figure 5** illustrates the continued growth in renewable curtailments in the Western markets and shows increasing curtailments under current market structures, which underscores the importance of an expanding centralized market to attempt to reduce renewable curtailment.

[8] The details of these processes are complex and vary between the day ahead and RT markets. However, the overall objective is to minimize the costs of meeting demand.

[9] California ISO, Western EIM Benefits Report Second Quarter 2020, July 29, 2020, www.westernEIM.com

Figure 4: Western EIM Balancing Authority Areas and Transmission Paths



Path	Estimated Max Capacity (MW)
Path 24 *(west to east)*	100
Path 24 *(east to west)*	35-90
Eldorado	797
Path 35 *(west to east)*	580
Path 35 *(east to west)*	538
Gonder-Pavant	130
PACW to PGE	320
Path 66 *(ISO to PGE)*	627
Path 66 *(PGE to ISO)*	296
Path 66 *(ISO to PACW)*	331
Path 66 *(PACW to ISO)*	432
Path 17	0-400[1] [2]
PSE to PACW	300
Eldorado 500-Moenkopi	732
Palo Verde, N. Gila	3,151
Path 78 *(PACE to APS)*	625
Path 78 *(APS to PACE)*	660
Navajo-Crystal	522
Mead 500	349
Mead 230 *(APS <-> ISO)*	236
Mead 230 *(ISO to NVE)*	3,443
Mead 230 *(NVE to ISO)*	3,476
IPCO to PACW (Path 75)	1,500
PACW to IPCO (Path 75)	400-510
PACE to IPCO	2,557
IPCO to PACE	1,550
NVE to IPCO	262
IPCO to NVE	390-478
Powerex <-> PSE	150
Powerex <-> ISO	150

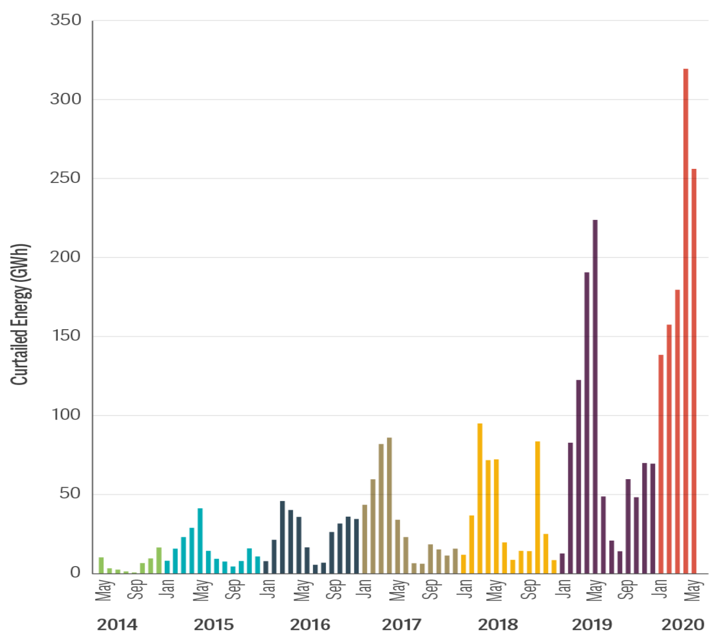
[1] Is an optional path available for PACE-PACW EIM transfers and the capacity is a subset of PACE-IPCO/IPCO-PACE and Path 75 capacity.

[2] When in use, the available capacity on PACE-IPCO/IPCO-PACE and Path 75 will be subsequently reduced by the used amount on Path 17, and not double counted.

Current as of July 2020

Source:
California ISO, Western EIM Benefits Report First Quarter 2020, April 30, 2020, www.westernEIM.com.

Figure 5: Renewable Energy Curtailments in Western Markets by Year (GWh)



Source:
"Wind and Solar Curtailment by Month," CAISO, accessed at:
http://www.caiso.com/informed/Pages/ManagingOversupply.aspx

In addition, the operational benefits and cost savings available from the greater integration of Western electricity markets are substantial. For example, the benefits associated with participation in the EIM are over $1 billion since its inception.[10] These benefits arise as the EIM provides a platform for its participants to share in system cost reductions that are achieved by a regional real-time dispatch.

In addition, there is an effort underway to expand the EIM to incorporate a day-ahead market (referred to as EDAM).[11] Under the EIM, participating BAAs coordinate and schedule resources to meet projected hourly and within-hour demand. With an expansion to the day-ahead time frame, BAAs would coordinate and schedule resources on a day-ahead basis taking into account forecasted demand and available generation resources located in all BAAs. Thus, as opposed to capturing only the cost savings achievable by jointly dispatching resources in the real-time balancing markets, the EDAM minimizes the costs of commitment and dispatch in the day-ahead time frame as well.

The EDAM may offer even greater opportunities for reducing Western US consumer electricity costs. Recent Western US electric system simulations show that regionally coordinated electric system operations (e.g., those envisioned with the EDAM and experienced with the EIM) alongside transmission upgrades to facilitate intermittent resource delivery to loads, growth in storage resources, resource diversity, and smart charging can substantially reduce system operational costs.[12] Not only do costs decline due to reduced curtailment, increased system flexibility, and low transmission congestion (relative to a baseline), the region readily achieves non-emitting resource production objectives.

State compliance policies that avoid interfering with the operations of centralized markets can improve environmental outcomes.

The importance of market structures to ensure the greater use of non-emitting resources was highlighted in a recent study that found CO_2 emissions in the Western Interconnection will increase by 43 million metric tons relative to a scenario where greater system integration is assumed.[13] This same study also finds that clean-energy resource penetration reaches only 49% by 2035 when the system relies solely on bilateral markets. Thus, state compliance policies that avoid interfering with the operations of centralized markets can improve environmental outcomes.

In the absence of enhanced regional coordination, integration, and related system investment, the ability to meet state targets may be challenging.

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[10] Id.

[11] See CAISO, Initiative: Extended Day-Ahead Market, http://www.caiso.com/StakeholderProcesses/Extended-day-ahead-market

[12] Energy Strategies, Western Flexibility Assessment, Investigating the West's Changing Resource Mix and Implications for System Flexibility, Webinar Summary of Final Report, December 11, 2019, at 43–49. Note these simulations include an assumed carbon emissions cost adder for California, Oregon, and Washington. However, the key drivers of resource additions are the states' zero-carbon policies.

[13] Energy Strategies, Western Flexibility Assessment, Investigating the West's Changing Resource Mix and Implications for System Flexibility, Webinar Summary of Final Report, December 11, 2019, at 43–49.

C. Important Criteria for Successful Policy Design and Implementation – Environmental and Economic Criteria

The development of sensible environmental policy needs to consider both the improvements to the environment achieved and the costs of achieving those improvements. As this paper focuses on the regulations used to achieve legislatively adopted targets, we do not focus on questions related to the efficacy of these particular targets. We evaluate these regulations along both environmental and economic criteria that we describe below. However, it is important to recognize that the development of the compliance framework can impact a climate policy's stringency, making the costs compared with the benefits of incremental emission reductions an important consideration.[14] Thus, decisions regarding compliance framework design can involve trade-offs between environmental benefits and economic costs.

1. Environmental Criteria

Climate policies achieve environmental benefits through incremental reductions in GHG emissions compared with the status quo. Climate policies and the regulatory mechanisms used to achieve compliance can vary in many ways that affect the environmental gains achieved.

As GHG emissions are global pollutants, the location and timing of incremental emission reductions and the means by which reductions occur do not affect the environmental benefit created. This provides substantial flexibility regarding when and where reductions occur, which can lower costs of achieving policy goals. However, while GHG emissions are a global pollutant, climate policies can also achieve reductions in non-GHG emissions that have local health and environmental consequences, particularly nitrous oxides (NO_X), sulfur dioxide (SO_2), and other criteria air pollutants. This may be a factor leading lawmakers to introduce locational considerations when developing climate policies.

The compliance framework aims to support achievement of the statutory objectives and targets. Additional criteria to be considered in developing climate policy regulations from an environmental standpoint include:

- ***Accurate measurement of environmental benefit.*** Compliance should reflect accurate measure of regulated activity. In particular, measurement should reflect actual production activity or emissions, rather than approximations, to the extent feasible.

- ***Administrative feasibility.*** The framework should provide a transparent and auditable framework for regulators to monitor and verify compliance, and enforce noncompliance.

- ***Activities outside state boundaries.*** The framework may attempt to control for actions that occur outside state boundaries, including compliance activities, such as compliance with RPS and cap-and-

[14] Efficient climate policy considers both the benefits and costs of alternative policies and adopts those policies that maximize the net benefit, reflecting the total benefits less the total costs.

trade requirements in other states that could lead to double-counting, and shifts in economic activity due to the cost associated with in-state compliance requirements (i.e., leakage).[15]

2. Economic Criteria

When evaluating state climate policies, a number of different economic consequences should be considered.

- ***Cost-effectiveness of achieving regulatory targets***. For example, in the context of zero-carbon technology policies, regulations should aim to meet targets for non-emitting resources at the lowest cost. Moreover, as noted above, the compliance framework can impact economic benefit through balancing the costs compared with the benefits of incremental emission reductions.

- ***Transaction or administrative costs***. Regulatory compliance imposes transaction and administrative costs on both governments and business. Given the complexity of electricity markets, these costs are potentially non-trivial. Differences in these costs between alternative compliance mechanisms could unnecessarily increase costs for consumers.

- ***Support well-functioning energy markets***. Within the electric sector, market efficiency is facilitated through the operation of liquid and non-discriminatory markets with wide geographic scope to allow demand to be met through the least-cost resources. The economic gains and benefits to consumers of efficient and well-functioning markets are well established, and the particular benefits associated with the EIM were outlined earlier in this paper.

III. Challenges to the Design of State Climate Policies Created by Electricity Market Physical Realities and Market Structures

The physical and market realities in the electricity sector create unique considerations for the design of state-level climate policies. These issues will become more challenging as states increasingly pursue more aggressive targets and increasingly rely on technology-based policies directly targeting the electricity sector.[16]

A. Challenges Created by State-Level Climate Policies

With state-level regulation, each state sets regulatory requirements that must be independently monitored and enforced. These state-level regulations have introduced new complications compared with historical environmental regulation of the electricity sector. Under prior regulations, compliance only required that state regulators regulate in-state sources, generally through emission limits and requirements, monitored at the stack. However, state-level policies motivated by climate change have introduced new compliance challenges.

[15] Double-counting of compliance instruments occurs when activity used to demonstrate compliance in one jurisdiction is also used to meet compliance in a different jurisdiction. For example, if renewable generation is used by two different LSEs in two different states to satisfy RPS requirements, the renewable generation would be double-counted.

[16] California’s cap-and-trade system is economy-wide and, thus, in some sense, is less stringent than the 100% zero-carbon electricity generation targets being pursued in many states.

- RPS/CES Policies: With an RPS/CES, the utility must demonstrate it procured renewable and non-emitting generation resource technologies' output in an amount equal to a percentage of retail sales or load. This electricity can typically be generated at different sources both within and outside of the state.
- Cap-and-Trade Program: While a cap-and-trade system regulates in-state generators at the source (requiring that they surrender allowances to cover all "actual" emissions), regulation of electricity imports requires measuring the "actual" emissions of imported electricity produced in many different locations.

The RPS/CES policies and cap-and-trade regulatory approaches necessitate accounting systems to track and verify compliance with regulatory standards. The need to account for interstate electricity trade under both technology-based (RPS/CES) and emission-based policies greatly complicates the design of approaches for regulatory compliance. For these programs, state regulators need to consider the "content" of imported electricity, although the original source of the electricity is outside the state's jurisdiction. State regulators may also want to consider exported electricity to avoid, for example, double-counting of "clean" energy attributes toward compliance in two states. Thus, each state must develop procedures for determining the "attributes" of electricity that can be used for compliance in each state. However, as we describe below, the nature of electricity systems and the structure of electricity markets create challenges for assigning such "content" on a physical basis.

The need to account for interstate electricity trade under both technology-based and emission-based policies greatly complicates the design of approaches for regulatory compliance.

B. Consequences of the Physical Realities of the Power System for Climate Policy Regulatory Compliance

With many goods, accounting for the source of production and the content of imports and exports is, in principle, relatively straightforward. Organic food, for example, can be certified at the source, shipped, and labeled as "organic" on the store shelves. However, electricity is not delivered in individual trucks or ships. Instead, electricity flows as electrons in a system in which individual electrons cannot be readily certified and tracked. This creates complications for the "tracking" of imports and exports of electricity that have important implications for the design of climate policies for the electric sector.

As described above, the Western electricity markets rely on both bilateral transactions and centralized spot markets. Electricity market transactional complexity reflects the varied ways that utilities meet customer loads and the steps taken to schedule and balance supply and demand (load). **Table 1** first illustrates different approaches that LSEs use to meet customers' loads, including self-supply through company-owned generating assets, and procurement of supply from within and outside the LSE's service territory. Utilities use a wide diversity of approaches to meet loads because it allows them to lower costs by accessing their own and others' electricity sources within and outside their geographic footprint, take advantage of economies of scale (e.g., when sharing in the development of large facilities), diversify production cost risks, and hedge volumetric uncertainty in customer loads. This diversity of approaches to meeting customer loads, supported by the wide diversity of contract structures and market arrangements within Western markets, has been and will continue to be essential to reliably and cost-effectively meet customers' electricity needs.

Table 1 also illustrates how the energy production of various utility supplies is measured and tracked. As **Table 1** shows, BAA scheduling and balancing processes generally do not track flows from particular resources to particular loads. Instead BAA operators need to know where energy is scheduled to be injected and withdrawn at the interchange points between the BAAs in order to manage system reliability. During actual day-to-day operations electricity then flows across a complex network of transmission and distribution equipment that is carefully specified and designed to maintain system reliability over a wide range of operating conditions. Actual electricity flows from individual resources to individual loads are not relevant for system operators. Instead, the network is operated by monitoring the various transmission interfaces and paths that are defined by the transmission and distribution system topology.

Table 1: Illustrative LSE Electricity Supply Portfolios and Resource Production Tracking

Supply Source	Procurement Time Horizon	Resource Production Tracking[1]
Owned Generation Capacity	Long-Term	Production measured at resource generator and energy delivered into BAA without specifically tracking disposition.
Bilaterally Contracted Generation Capacity	Medium-/Long-Term	Same as above.
Bilaterally Contracted Specified Energy	Short-/Medium-/Long-Term	Production can be system or resource-specific energy supply delivered within or to a BAA.
Bilaterally Contracted Unspecified Energy	Short-/Medium-/Long-Term	Production is system energy supply delivered within or to a BAA.
Bilateral Spot Market Energy	Hourly, On- and Off-Peak	Production can be system or resource-specific energy supply delivered within or to a BAA.
Centralized Spot Market Energy	Hourly & Intra-Hourly	Production measured at generator and energy delivered into BAA without specifically tracking disposition.

Note:
[1] Delivered energy may be sourced on an electronic tag (E-Tag) for scheduling purposes and to facilitate reliable BAA system operations when associated with inter-BAA transfers. However, the vast majority of delivered energy is simply injected into the BAA where the generator is physically located and its flow is not tracked.

Figure 6 provides an illustration of a single, large BAA with its system of loads and resources that are typical for a geographic region such as the Pacific Northwest.[17] The figure illustrates the complexity of transactions

[17] The example in Figure 6 is meant to cover a broad geographic region similar to the Bonneville Power Administration. However, a BAA covering a much smaller geographic region can have a similar system of resources and transactions.

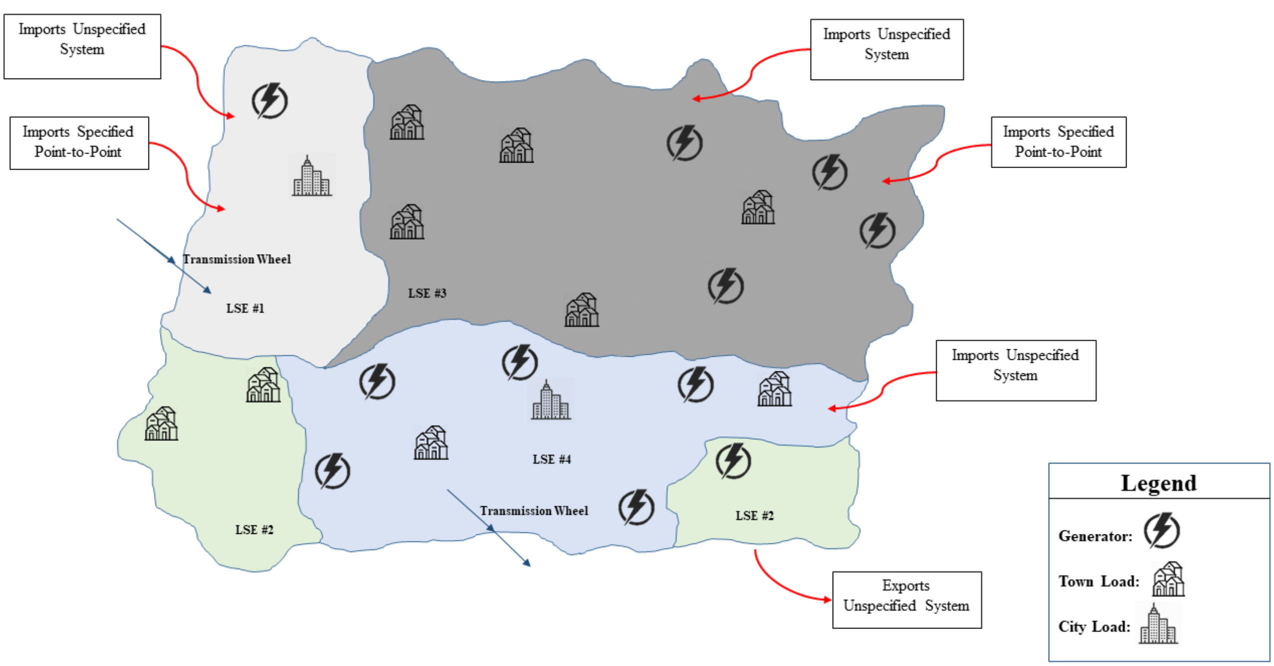
that make it challenging to define the specific electricity source used to serve LSE load, and the following examples describe some of these complexities.

- **Unspecified Energy**: Some electricity flows from outside the BAA geographic region arise from neighboring BAAs ("systems"), rather than individual sources ("points"). Thus, these transactions inherently have no specific source, and are often referred to as "unspecified" energy.

- **Balancing Transactions:** Within the BAA, the BAA operator schedules and dispatches BAA generators to maintain reliability on a moment-to-moment basis ("balancing"). Such scheduling and balancing decisions are undertaken to minimize costs and maintain reliability for the entire system, not for any particular load, and can rely on a number of different generation resources.

- **Overlapping Geographic Regions**: A single BAA can contain multiple LSEs. Thus, electricity supply – whether through imports or for balancing – may not flow to any individual LSE, although that LSE may have separate regulatory compliance obligations under a zero-carbon policy. Moreover, BAAs can span multiple states, further complicating compliance requirements.

Figure 6: Illustrative Example of the Role of BAA Electric System Operation in LSE Day-to-Day Electricity Supply Scheduling and Balancing[18]



[18] The depictions of imports and exports in this figure are illustrative and should not be interpreted as indicating that the energy is delivered or sourced exclusively within the specific LSE territory. As explained herein, energy flows are not tracked and will follow multiple paths within the transmission and distribution system serving any number of LSEs and their customers.

Below, we discuss the implications of the physical realities of the electricity system for accounting for the attributes – technology-type or emission – of electricity flows for the purposes of climate policy compliance. Underlying the desire to measure the flow of electricity from one source to load is the notion of the "deliverability" of electricity, and the desire to meet decarbonization targets through sources of electricity that can, in some sense, be "delivered" to load. As we discuss below, the physical and market realities of electric system operations make capturing the actual "delivery" of electricity based on moment-to-moment, point-to-point flows impractical. These realities affect not only centralized markets, such as the EIM, but also bilateral markets prevalent in the West. Thus, for compliance purposes, a less strict "deliverability" requirement may be more practical given the realities of the electricity system, while still meeting regulatory goals that non-emitting supplies be derived from resources that can plausibly be delivered to loads.[19]

1. Limitations to Accounting with Bilateral Transactions

As described in Section II.B, Western electricity markets rely heavily on bilateral market transactions, which can vary widely in structure and complexity. One important dimension of each transaction is the source of electricity.

a. System Sales

While some transactions involve the supply of electricity from an individual resource, many transactions involve the supply of electricity from a "system" (e.g., a BAA), without identifying a particular source. System transactions are a necessary element to the effectiveness and liquidity of electricity markets, as they provide a means for suppliers to specify transactions independent of the operations of particular resources, which can vary over time due to many practicalities of the electricity system, including plant and transmission outages, transmission congestion, and balancing activities by the BAA operator. For reasons explained in section c. below, all centralized market transactions are system transactions.

System transactions are a necessary element to facilitate effective and liquid electricity markets

With transactions involving system supplies, there is no unique point-to-point matching of resource source to sink (destination). Thus, determining the "content" of imported electricity from a system supply for compliance with a technology- or emission-based policy will require that a proxy for the technology or emission content be determined.

In this situation, existing regulations, such as California's cap-and-trade program, have developed uniform ("unspecified") emission factors as a proxy for imported electricity emissions.[20] California's GHG accounting

[19] In certain cases, for energy delivered over a radial line, the source of energy consumed at another location can be identified. However, this does not necessarily allow for precise identification of the actual recipient of the energy.

[20] One challenge with system electricity is determining its environmental content, whether GHG emissions or no-carbon content. Given that system energy reflects many sources of generation, a proxy needs to be developed to capture these emissions. There are many questions that arise in developing these proxies. First, proxies can reflect average emissions across all resources or emissions from marginal resources. Second, proxies can attempt to capture market circumstances when electricity is traded, such as the source of the electricity (e.g., system or

requires that an estimate of resource production be specifically identified and associated with energy imports into a region with GHG emissions limitations. However, because the day-to-day physical operation of the electric system does not require or call for trying to associate imports and exports between regions with specific generation resources, ex-post efforts to assign this production cannot accurately match individual resources with transmission interface flows. As a result, emission factors that represent estimates of marginal or average system emission rates are used that should not be expected to align with actual energy imports' GHG content.

b. Scheduled vs. Actual Flow for Specified Sales

While some transactions are from system resources, other bilateral transactions are from specific generation resources. In this case, it may be reasonable to assume the flow of environmental attributes from source to sink between BAAs follows the corresponding "contract path" for the flow of electricity. However, even in this case, there are important caveats to take into account.

Flows for point-to-point transactions are "scheduled" to ensure that the parties have sufficient transmission rights to deliver the electricity and to ensure that the transmission system is not overloaded (given interactions between many different flows on the system). However, actual flows can differ from these "scheduled" flows in many different ways.[21] Thus, the "contract path" describing the contractual arrangements may differ from the actual flows of electricity. This discrepancy between contract schedules and actual physical transmission system flows is commonly referred to as "contract path fiction."[22] The contract path fiction arises because electricity does not actually follow the path described by the contract path, but instead the flow path follows the path of least resistance across all possible parallel electrical paths between the two points. As a result, actual flows are a complex function of the operating generation resources and the electrical characteristics of the transmission system.

Contract paths are captured by the E-Tags used to schedule some flows within a BAA as well as to schedule exports and imports between BAAs. E-Tags are used to estimate available marketable transmission capacity and provide BAAs with a tool for congestion management. E-Tags contain the information needed to assess cumulative flows over a contracted transmission path and ensure the net flows at the interties between the BAA and neighboring systems can be supported by the BAA's transmission system without creating reliability risks.[23] Thus, while E-Tags can provide a contract path, or an indication of actual flows between a source and a sink, they do not measure the actual system flows associated with the transaction.

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intertie), the time of day, or the system mix. Third, the frequency of updating proxy values needs to be determined given ongoing changes to resources in the systems and patterns of trade.

[21] See Appendix, examples of contract-path fiction.

[22] See, for example, Harvey, Scott M., Hogan, William W., and Pope, Susan L., Transmission Capacity Reservations and Transmission Congestion Contracts, June 6, 1996 (Revised March 8, 1997) at 8–9.

[23] A description of E-Tags and how they are used can be found in California ISO, Operating Procedure 2510, Version No. 9, December 9, 2019, available at: http://www.caiso.com/Documents/2510.pdf

c. Feasibility of Relying Solely on Specified Sales

The viability of relying on a transaction's contract path to "track" its environmental attributes diminishes as the fraction of electricity the regulator desires to track increases. At present, bilateral transactions from designated generation sources – rather than system sources – are only a fraction of all the electricity resources operated to meet system loads. However, compliance with a 100% non-emitting electricity requirement under a flow-based system would effectively require that all electricity flows be tracked from source to specific loads (e.g., LSEs). Not only would such a requirement limit the scope of market transactions that could be used to meet customer energy needs, but the measurement of these flows would become increasingly inaccurate, since the scheduled point-to-point transaction flow paths would not readily match the actual flows of electricity from generators to loads.[24] Thus, significant reliance on compliance accounting based on resource/load schedules would never match actual system operations and precludes an effective flow-based assignment of resources to loads.

At present, bilateral transactions from designated generation sources – rather than system sources – are only a fraction of all the electricity resources operated to meet system loads.

2. Limitations to Accounting with Centralized (EIM) Transactions

The operation of a centralized market, including both CAISO and the EIM, is fundamentally different than a bilateral market. A centralized market clears the supply and demand across a wide geographic footprint as a system, not through matching of individual bilateral trades. A centralized market clears a single commodity, electricity,[25] and the laws of physics prevent differentiation of the commodity (energy) into different qualities or types (e.g., renewable/non-emitting and non-renewable). Thus, electricity traded within a centralized market reflects a "system" transaction with the environmental attributes reflecting the mix of resources in the system, not particular resources in the system.

These physical realities impose certain restrictions on the systems used to determine compliance with state-level climate policies. Organized markets encompass many of the states with more aggressive climate policies, including state-level RPS and CO_2 cap-and-trade, notably the Regional Greenhouse Gas Initiative (RGGI). Thus, there is much experience with the development of criteria for compliance within these state-level requirements in the context of multistate organized markets, including ISO-NE, PJM, and MISO.

In the context of RPS policies, regulators have dealt with these "deliverability" issues by allowing RECs to be separated from the energy produced by renewable or zero-emitting generation resources and then imposing certain eligibility requirements on RECs that can be used for state-level compliance, including limits on the geography where the REC was generated.[26] These eligibility requirements serve to incorporate a

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[24] This occurs for several reasons: 1) BAA generation resource scheduling will continue to dominate resource commitment decisions and these resources' output is not routinely tracked to specific LSE loads; 2) growth in point-to-point transaction schedules will produce cumulative inconsistencies with actual flows; and 3) a requirement that system energy sales be more frequently matched with specific resource production and LSE loads will further exacerbate inaccuracies as assumptions will be necessary to define these linkages.

[25] Many centralized markets clear supply for multiple products through co-optimization of market-clearing. In particular, markets-clearing for energy and operating reserves is common in many ISO/RTO markets.

[26] See the Appendix for an overview of experience with REC markets in the Northeastern US.

"deliverability" component of compliance with a given standard, recognizing a precise matching of RPS resources to LSE customers is unnecessary and impractical.

IV. Options for State Compliance Frameworks

Regulators in the Western states are beginning the process of determining the compliance requirements for state-level climate policies intended to achieve decarbonization in the electric sector. As these regulations are developed, it is important to account for the unique features of the electric sector, including the physical realities of electricity flows through the grid and the region's market structures. As described above, Western state electricity markets are characterized by a high level of complexity, with many individual BAAs spread across many states, a multitude of varied bilateral arrangements between entities within these BAAs, and the overlay of a growing multistate, centralized market that can help cost-effectively achieve decarbonization objectives with more efficient renewable integration. When designing compliance requirements, this complexity and the system's physical realities create trade-offs for the feasibility, environmental effectiveness, and economic cost of alternative compliance approaches that should be considered.

A. Comparison of Alternative Approaches to Compliance with Zero-Carbon Requirements

To evaluate compliance options, this paper considers the trade-offs between two compliance approaches. One approach, which we refer to as resource-based accounting, has been used for compliance in many states. A second approach, which we refer to as flow-based accounting, is being contemplated in some Western states but has not been used previously.

- **Flow-based compliance**: requires a demonstration that all electricity used to serve customers meets specified criteria.[27] At the extreme, this demonstration accounts for each "flow" of electricity from a specified source that meets the regulatory criteria to customers.

- **Resource-based accounting**: compliance also requires a demonstration that allows all electricity used to serve customers meet specified criteria, but the accounting does not attempt to match each electricity flow from supply to load. Instead, a system of accounts at the supplier level captures the "stock" of electricity generated within the Western markets and its attributes, and another system of accounts at the customer level reflects the electricity used by customers. When determining compliance, electricity is transferred from suppliers to customers through rules that are determined by state regulators to account for factors such as resource type, deliverability, and time period. But there is no effort to match these transfers to actual flows on the electricity system.

Table 2 summarizes our assessment of these two approaches along the environmental and economic dimensions identified in **Section II.C**.

[27] Our assumed flow-based framework focuses on inter-BAA electricity flows. An additional layer of complexity arises when seeking to align within BAA generation resource production with LSE consumption, as intra-BAA flows are tracked to ensure reliable system operations and not to assign generation resource production to consumer loads.

Table 2: Options for Compliance with State Decarbonization Policies

Category	Resource-Based	Flow-Based
Accurate Measurement	Actual production Deliverability based on predetermined locations (approximation) Timing granularity flexible	Actual and scheduled production Deliverability determined for each flow (contract paths, approximate and actual) Timing constrained (e.g., within the hour)
Administrative Feasibility	Low/moderate complexity, high transparency – standardized systems of WECC-wide accounts would improve reliability	High complexity, low transparency
Cost-Effectiveness	Supports any type of out-of-state resources Temporal flexibility can lower costs Supports market structures with ability to integrate renewables	May limit supply from certain out-of-state resources Lack of temporal flexibility may raise costs May constrain market ability to integrate renewables
Transactions and Administrative Costs	Low/moderate – standardized systems of WECC-wide accounts may lower costs, after initial development	High – flow-based accounting (e.g., resource hourly scheduling and E-Tag tracking) more complex; currently no system capturing all flows; developing proxies for system flows would be time-consuming and subject to error
Support Well-Functioning Markets	Yes. Accommodates all transactions and market structures.	No. May not accommodate system supply and centralized markets.
Out-of-State Activities	Can accommodate provisions aimed at accounting for out-of-state activities	Can accommodate provisions aimed at accounting for out-of-state activities

The two approaches, flow-based and resource-based, differ in:

The accounting measurements for compliance. A flow-based system requires the measurement of the quantity of energy delivered to particular LSEs and their retail consumers for each small, discrete time period (e.g., an hour). From the standpoint of deliverability and the compliance time period, in theory, a flow-based system may be perceived to allow for all energy delivered to customers at all moments in time to be tracked to confirm it meets the desired environmental attributes. Thus, a flow-based system might appear to offer certain benefits from an environmental standpoint. However, a resource-based system can also measure the quantity of electricity delivered, although capturing actual generation would be straightforward, as the supply would be measured at the source with no need to track exactly where the energy is consumed. Deliverability would be determined by matching supplies to corresponding customer loads based on resource ownership and control and other market transactions (bilateral and centralized). In this case, compliance under a resource-based system would not require exactly matching all electricity flows between supply and customers. Through appropriately designed rules for matching supplies to customer loads, regulators can achieve various environmental objectives, including: ensuring that non-emitting resources meet technological criteria; ensuring that electricity is "deliverable" based on usual, feasible patterns of electricity flows with Western markets; and requiring that supplies for environmental compliance are consistent with supplies assumed in the utilities' cost of service.

The consequences for the functioning and efficiency of electricity markets. A resource-based system supports well-functioning markets, as it is compatible with all types of electricity market transactions because it separates the attribute accounting from the physical delivery of electricity. By contrast, a flow-based system is incompatible with certain types of transactions, including bilateral transactions involving system sources or loads, and transactions in centralized markets. In these cases, the physical realities and market structures of the electricity system provide no means to connect flows to particular sources and loads.[28] In many cases, system electricity is relied upon to meet schedules and is simply unavoidable.[29] In other cases, regulators might attempt to limit the scope of these types of transactions to encourage flow-based transactions that would identify specific resources. However, these efforts would be very costly and even counterproductive from an environmental standpoint by limiting the market's ability to take full advantage of the transmission system and the balancing resources available to integrate variable renewables throughout the Western states. Alternatively, a flow-based system can accommodate system transactions through proxy values for non-emitting attributes that flow with system electricity. But such proxies introduce their own problems and may become infeasible for states pursuing 100% non-emitting targets (i.e., in this case, system transactions would need to be 100% non-emitting).

As Table 2 shows, a resource-based system is a cost-effective approach for achieving climate policy objectives for the following reasons:

- **Supports well-functioning electricity markets**: a resource-based system can more efficiently use generation and transmission resources throughout the Western footprint to achieve zero-carbon policy targets more cost-effectively. The resource-based approach also increases the system's ability to integrate non-emitting resources, thus increasing environmental benefits by reducing curtailments and expanding non-emitting resource supplies.

- **Accommodates a wide range of market transactions:** a resource-based system may better allow many out-of-state non-emitting resources to help meet a state's zero-carbon policy objectives. By contrast, adopting a more complex flow-based system may deter some out-of-state resources from pursuing arrangements with LSEs seeking to comply with a zero-carbon policy.

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[28] It is widely acknowledged that linking specific electric generation resources' production to retail consumer consumption is at best an imprecise estimate such that energy production and emissions can only be determined contractually due to the nature of the shared power network. See, for example, Jones, T., Bucon, N. "Corporate and Voluntary Renewable Energy in State Greenhouse Gas Policy," CRS, October 17, 2017, at 9, https://resource-solutions.org/wp-content/uploads/2017/10/Corporate-and-Voluntary-RE-in-State-GHG-Policy.pdf

[29] For example, when balancing a BAA system with multiple LSEs, the operator treats the system as a whole and does not distinguish between the operations of resources in the system for the purposes of assigning electricity to each LSE.

- **Offers greater temporal flexibility**, which can lower costs by avoiding costly efforts to meet customer loads in all hours given daily and seasonal variability in non-emitting resources, including hydropower, solar, and wind.

- **Offers less monitoring and enforcement complexity**, **and lower transactions and administrative costs:** resource-based systems are comparatively straightforward to develop and maintain, and there is much experience with systems developed in other regions.

- **Offers greater flexibility in the timing of compliance with non-emitting requirements:** non-emitting supply from one point in time can be used to meet customer loads in another point in time. Because the benefits of GHG emission reductions are largely independent of when those emission reductions occur, these shifts in timing have little impact on economic or environmental outcomes. Moreover, such flexibility in timing can avoid extremely high costs to meet a zero-carbon climate objective in all hours under all conditions.

Flow-based accounting would be costly and challenging to develop. Present electric system and market operations do not disaggregate commitment and dispatch of individual resources against specific loads. Thus, developing such a system could be particularly costly as there is no existing system to rely on and the complexity of aligning resource commitment and dispatch with consumer loads would likely make this infeasible. System operators do not track the actual flows of energy from individual generation resources to an LSE's consumers, and instead rely on generation resource and interchange schedules flows to coordinate system operations.[30] To our knowledge, no entity has developed a flow-based system that captures all flows from specific resource to specific load, rather than a subset of flows monitored to maintain reliability. In addition, developing methods to deal with system transactions would be time-consuming and rely on estimates that we have already seen create conflicts, and we already observe other regions not adopting such systems.

Most US states rely on resource-based compliance frameworks for technology-based low-/zero-carbon policies.

The challenges associated with tracking generation attributes are well understood and have guided the compliance frameworks used by US states with RPS and CES. Most US states rely on resource-based compliance frameworks for technology-based low-/non-emitting resource policies (which to date are mostly RPS policies). These approaches include the Generation Attribute Tracking System deployed by the New England Power Pool in ISO New England and PJM Environmental Information Services in PJM.[31] The compliance frameworks used by these policies set the quantity of non-emitting resources required for compliance based on retail consumer energy consumption, while still relying on verified production data from the source of the non-emitting energy.[32] However, while it is straightforward to associate a retail supplier's access to specific resources by ownership, contract, or, in some

[30] We recognize that actual resource production and certain transmission line and interface flows are monitored and measured, but not for the purposes of tracking the delivery of generation to loads.

[31] The features of these GATS are described in greater detail in the Appendix.

[32] Additional issues that are important to address when designing a compliance framework for zero-carbon policies are noted in the Appendix. These issues include resource eligibility, deliverability, timing, regulatory accounting systems, out-of-region resource considerations, and multistate utilities and BAAs.

cases via energy purchase transactions, the same cannot be said for tracking resource energy flows to loads as we noted earlier in this paper. Thus, while there are several ways to associate actual resource production with retail consumer consumption, there is little experience with systems that attempt to exactly "match" actual resource production with consumer consumption.

B. Compliance Approaches for Emission-Based Policies

The analysis in the prior section focused on zero-carbon policies, similar to an RPS. However, the design of emission-based policies poses a somewhat different problem from technology-based policies. In particular, while zero-carbon policies impose regulatory requirements on load-serving entities, emission-based policies impose requirements on emission sources. As a result, sensible compliance requirements for an emission-based policy impose requirements on the emission source, not the entity procuring electricity for its customers. Thus, all cap-and-trade systems to date, including those regulating sulfur dioxides, nitrogen oxides, and carbon, require that emission sources surrender allowances to cover their actual emissions, rather than requiring the purchasers of that electricity to get involved in program compliance.

However, with a state-level emission program, the state regulator cannot impose a regulatory requirement on emission sources outside the state's legal jurisdiction. Thus, any electricity imported into the state would not face any emission requirements without additional regulations. The absence of requirements on out-of-state electricity has both environmental and economic consequences. A lack of requirements on out-of-state power would allow in-state load to be met through out-of-state power exempt from requirements, thus reducing the policy's environmental impact. In addition, offers for electricity supply from out-of-state sources would not reflect the cost of carbon, thus providing these resources with a competitive advantage, reducing the carbon price signal to consumers, and dampening demand for GHG allowances (thus reducing their price).

To address these issues, importers of electricity can be required to surrender allowances reflecting the carbon content of the imported power. Many of the issues faced in developing a compliance framework for renewable and non-emitting resource policies are relevant for an emission-based policy. In principle, either a resource-based or flow-based system could be used to impose compliance requirements on imported electricity; however, many of the same complexities and trade-offs evaluated above for technology-based policies would be relevant for emission-based policies.[33]

For its GHG cap-and-trade system, California has sought to adopt a flow-based accounting approach for compliance of imported electricity into the CAISO system. All electricity that is scheduled to flow into the CAISO system is assigned either a specified emission rate, if contractually identified as produced by a particular resource, or an unspecified rate, if no contractual identification has been made or it is produced within a particular system.

In the context of the EIM, California has developed a complex "deeming" process that attempts to identify the electricity importer supplying electricity to California. This process, however, has been complicated and controversial, and has not completely resolved the issue. It is also unclear as to whether this "deeming"

[33] For the technology-based policies, the "attribute" is a dichotomous ("yes/no") variable indicating if the electricity was generated by a resource that meets the "non-emitting" standard. By contrast, for emission-based policies, the "attribute" is the emissions associated with the electricity.

approach is scalable to an eventual EDAM, or whether states other than California will adopt GHG pricing policies.

As the Western states evaluate the compliance approaches that best meet their policy goals and provide for integration and harmony with the other states and Western markets, interactions between RPS/CES policies and emissions-based policies should be considered to ensure effective environmental compliance and avoid unintended consequences for efficiency and function of electricity markets.

V. Conclusion

The comparison of the flow-based and resource-based approaches in the context of the physical and market realities of the Western electricity systems suggest several conclusions regarding compliance systems for state-level decarbonization policies:

1. Physical realities of the electricity system make flow-based, source-to-load tracking of attributes or emissions infeasible, impractical, or inefficacious.

2. Resource-based accounting is compatible with market-based transactions, thus supporting the evolving market structures that will be important for the feasibility and cost-effectiveness of decarbonization policies.

3. Resource-based accounting offers more compliance flexibility, particularly with regard to the electricity delivery timing.

4. Resource-based systems are less administratively burdensome and can draw on experience from approaches used for compliance by states with RPS policies in the Northeastern and mid-Atlantic US.

5. Flow-based systems are not currently used anywhere in the US. Variants of a resource-based system are used in other jurisdictions in the US.

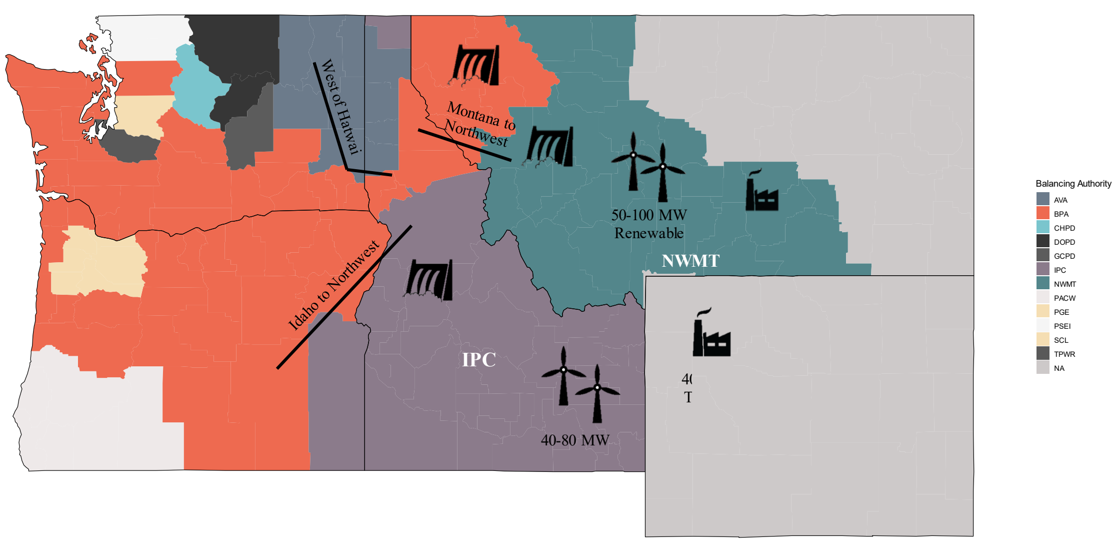
6. Consideration will need to be given to how to integrate compliance with RPS/CES policies and emissions-based policies.

VI. Appendix

Examples of Contract-Path Fictions:

Contract-path fiction refers to the fact that electric system operator BAA import/export schedules do not generally represent actual flows on transmission lines. The following examples illustrate why resource production scheduled on specific paths or over specific transmission interfaces will not align with actual transmission system line/interface flows. First, consider a simple example based on the transmission system configuration in the Northwestern US (See Figure A-1). In this example there are resources depicted as "thermal" and "renewable" shown in geographic regions consistent with actual resource locations. In addition, within these regions there is an assumed amount of native or local load that needs to be served by the thermal and renewable resources. These regions are interconnected by transmission systems where energy is transmitted with no regard for state borders and whose flow limits are a function of multiple transmission lines forming interfaces across which total flows are limited.[34]

Figure A-1: Scheduled versus Actual Generation Resource Transmission System Flows



NWMT Scheduled vs. Actual

	Generation for Exports (MWh)		Generation for Load (MWh)	
Energy	**Scheduled**	**Actual**	**Scheduled**	**Actual**
Thermal	150	200	100	50
Renewable	50	0	0	50

IPC Scheduled vs. Actual

	Generation for Exports (MWh)		Generation for Load (MWh)	
Energy	**Scheduled**	**Actual**	**Scheduled**	**Actual**
Thermal	200	170	200	200
Renewable	50	80	0	50

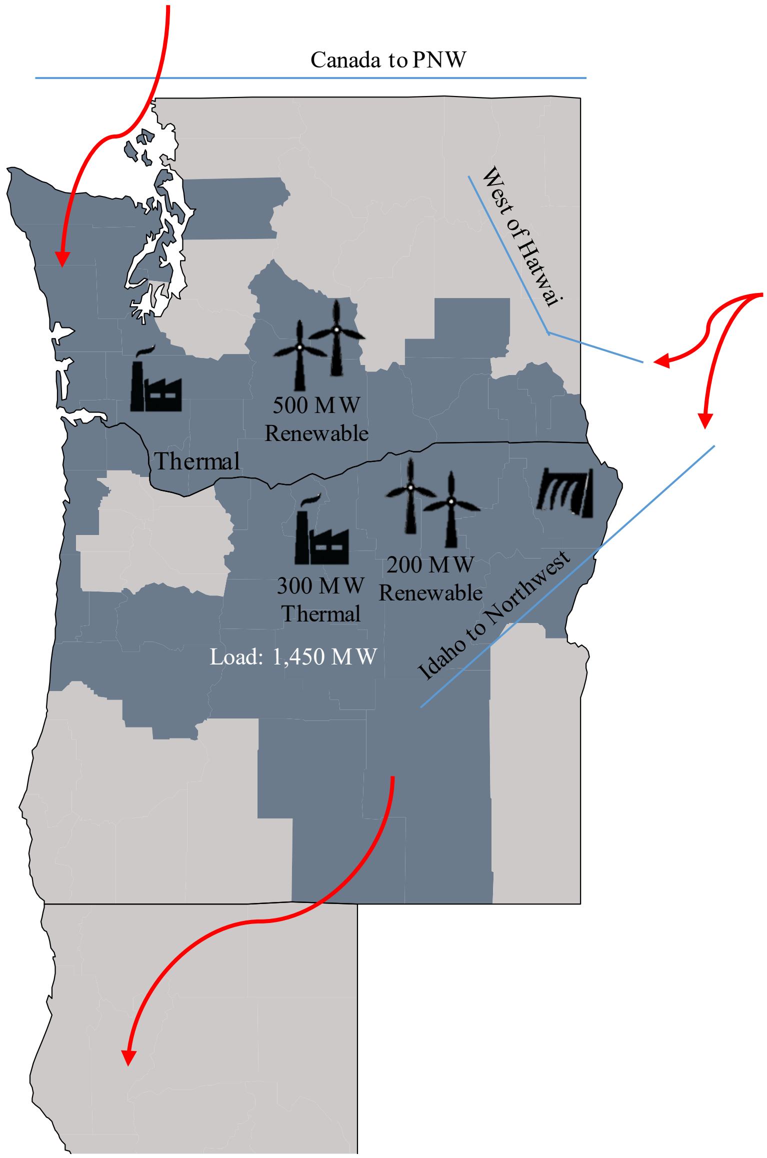
[34] See Appendix Figure A-3 for a schematic of the transmission lines and resources located in the geographic region at the location of the electrical interfaces depicted in this example.

Figure A-1 also includes examples of energy delivery schedules established based on market participants' interaction the day before the actual system operations (i.e., day-ahead schedules planned with a BAA operator for a representative hour). First consider the schedules shown on the lower left of Figure A-1. The schedules show Thermal and Renewable are scheduled to produce 250 MW and 50 MW, respectively. Of these quantities, 150 MW of Thermal and 50 MW of Renewable are scheduled for export (and are "E-Tagged" for BAA operators to know planned interchange) and 100 MW of Thermal is scheduled to serve load. Assuming the 200 MW of energy scheduled for export is maintained on the day of delivery (i.e. actually flows in real-time), the example shows that while Thermal was scheduled to export 150 MW, its actual export quantity was 200 MW and Renewable's planned export of 50 MW was actually consumed in the region to serve load.[35] The lower right side of Figure A-1 provides a similar example of differences between the source of scheduled and actual generation resources that were exported in real-time. However, in this example Thermal exports less and Renewable exports more. The key point of both of these examples is that the exact generation output that is scheduled (i.e., tagged) to be delivered over the transmission system to another geographic region is not necessarily what actually flows. Tags are simply used so that the system operator (BAA) can coordinate net imports/exports "interchange" with adjacent BAAs to ensure reliable system operations.

A more complicated example of the interaction of day-ahead and actual hourly interchange schedules is shown in Figure A-2. Figure A-2 depicts an illustration of how the BPA system generates, imports, and exports energy simultaneously while serving load and maintaining reliability. This example builds upon the example above where a total of 450 MW is being imported from the east and includes an additional import of 250 MW from the north and a 500 MW export to the south to the CAISO BAA. In this example the import from the north is scheduled "through" the BPA BAA and is intended to be exported to the CAISO. Other generation-load schedules are balanced to recognize the additional 250 MW that is scheduled to flow south and to serve the forecasted load. The actual generation shows that thermal declined and renewable increased, and that renewable actually contributed to the export that was originally scheduled from a thermal resource. A portion of the imported energy (50 MW) actually went to serve load and was made up for by energy from a renewable resource. Although this example is simplified, it is a realistic representation of what actually happens in an electricity system hour-by-hour.

[35] In this example it is assumed that those actual generation resources whose output was exported could be identified using detailed system operational data that is not relied upon for day-to-day operations.

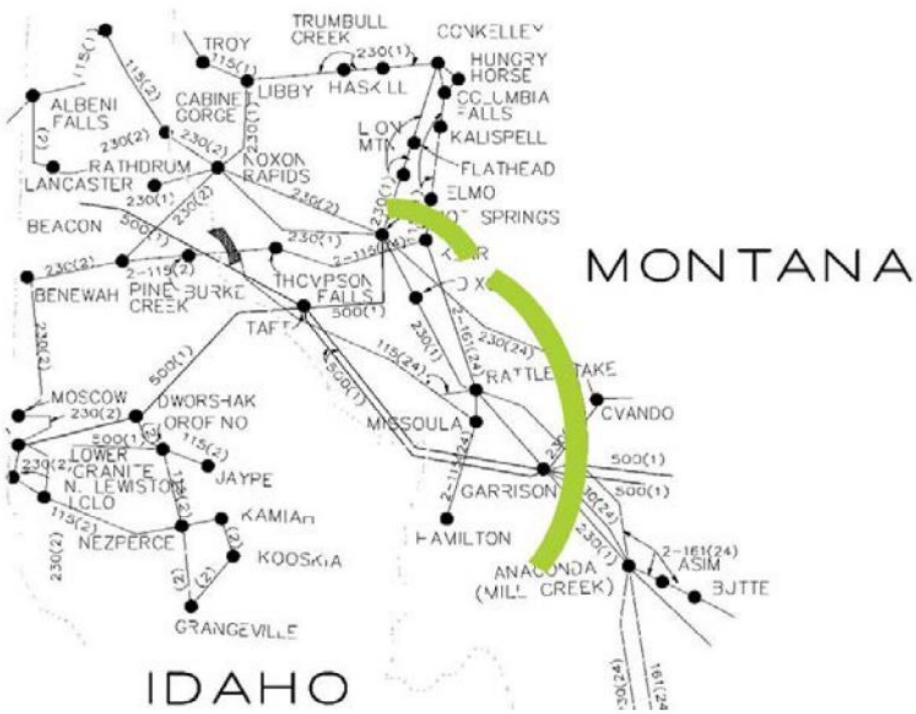
Figure A-2: Scheduled versus Actual Generation Resource Transmission System Flows: BPA



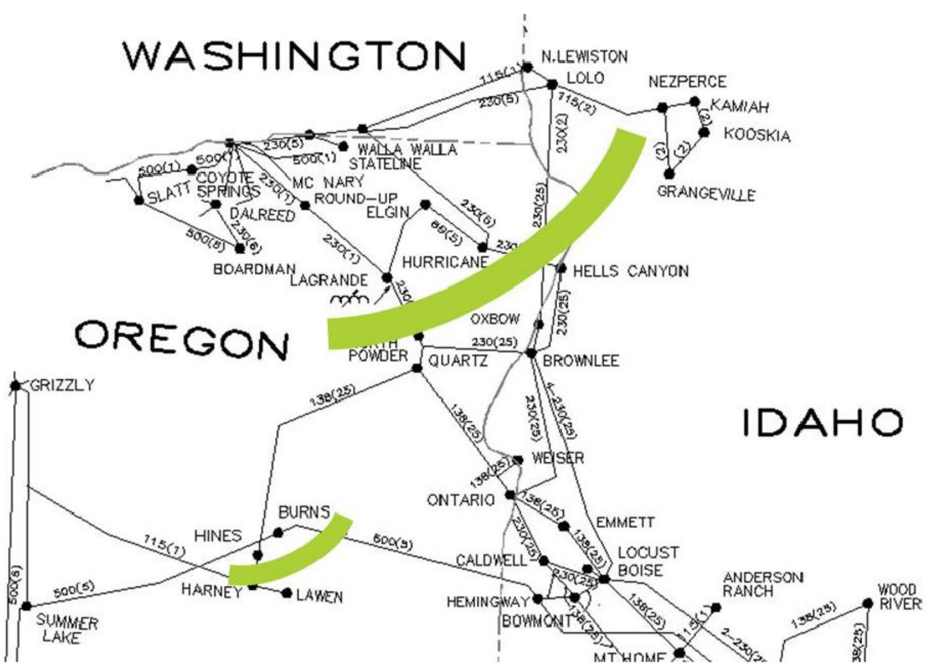
BPA Generator Load/Balance (MW)						
	Generation		Load		Export	
Energy	Schedule	Actual	Schedule	Actual	Schedule	Actual
Thermal	550	500	300	300	250	200
Renewable	700	750	700	650	0	100
Imports from the North	250	250	0	50	250	200
Imports from the East	450	450	450	450	0	0
Total	**1,950**	**1,950**	**1,450**	**1,450**	**500**	**500**

Figure A-3: Transmission Interface Schematics

Montana to Idaho Interface



Idaho to PNW Interface



Source: 2013 WECC Path Reports, WECC Staff, Western Electricity Coordinating Council, September 4, 2013

Examples of Northeastern US REC Markets: New England

REC markets emerge as RPS requirements became large enough to signal a potential constraint in REC supply. Expected supply constraints typically arise when it is straightforward to project that insufficient REC qualified resources will be available to meet RPS or there is evidence that alternative compliance payments have occurred (usually reported in state required accounting reports).[36] This tends to occur most often when RPS obligations cannot be met without the development of new resources.

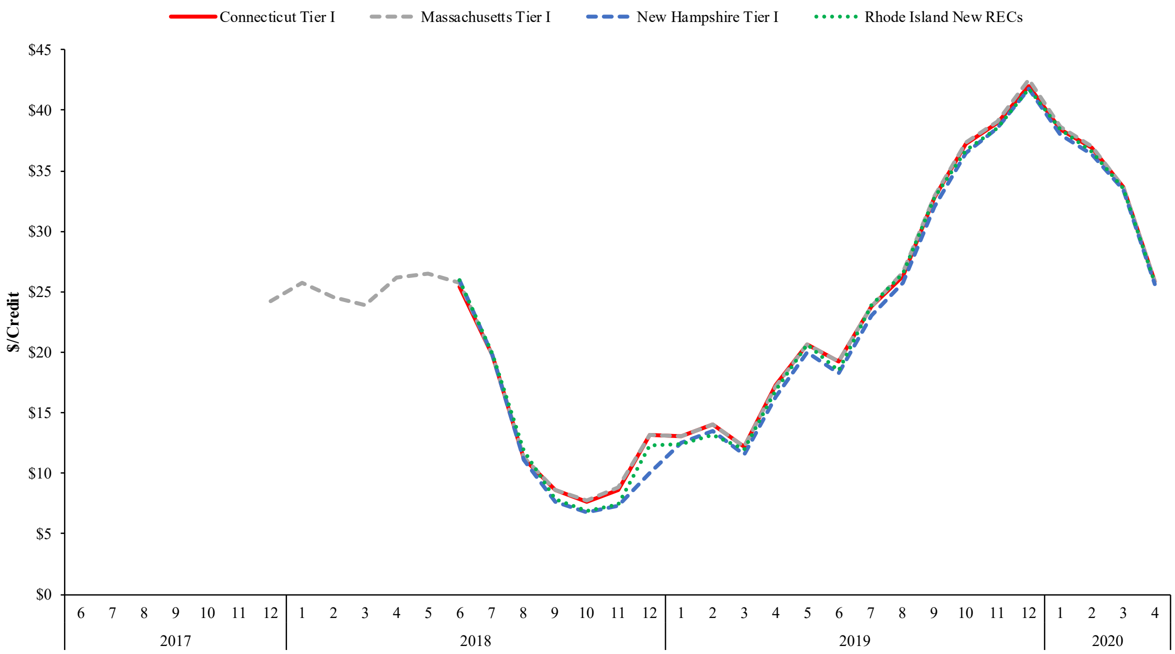
There are both short-term (spot) and long-term REC markets. Long-term REC markets form around both public and private resource procurement processes where contract terms ranging from 10 to 20 years are common. Public processes arise around state-initiated requests for proposals (RFPs) where bilateral contracts are executed between the buyers (often utilities or state agencies) and sellers (renewable energy resource developers). The products solicited under these RFPs vary, but they include the purchase of RECs from qualified resources (or alternatively rights to environmental attributes) and may also include the purchase of other energy and capacity products. Public RFPs typically result in a highly transparent process with the accepted offers' procurement price(s) presented in some form at the time the results of the solicitation are announced. Moreover, as time passes there are often legislative requirements that result in the reporting of additional REC pricing information (albeit many months and sometimes years after the solicitations are completed). Private RFPs largely will include similar considerations except that it is unlikely that any pricing information would be released publicly.

In contrast, short-term markets are transparent and REC pricing is regularly compiled and reported by market brokers and other price reporting services.[37] The trading in these markets is also carried-out via bilateral contracting, but the contract terms are often for no more than a couple years and typically mirror the time horizon over which actual REC transaction prices are being reported. In particular, the short-term markets trade RECs that can be used for compliance currently or in the not too distant future so as to comply with REC vintage requirements. As expected, the prices for RECs rise and fall dependent upon the demand for RECs that entities acquire to meet compliance obligations (See Figure A-4).

[36] Alterative compliance payments are derived from REC price caps which provide a circuit breaker in the event that REC supply is short. States also often include an evaluation of the costs to consumers under RPS programs to guard against undue financial burdens being borne by consumers.

[37] For example, Evolution Markets is a well-known market broker and S&P Global's McGraw Hill regularly reports REC prices obtained by surveying market participants.

Figure A-4: New England States' Tier I Average Monthly REC Prices (2017-2020)



Note:
[1] Rhode Island compares RI New RECS with other New England Tier I RECs. See Source [B].

Sources:
[A] S&P Global Market Intelligence.
[B] "Annual RES Compliance Report for Compliance Year 2016," Rhode Island Public Utilities Commissions, April 2018, accessed at: http://www.ripuc.ri.gov/utilityinfo/2016%20RES%20Annual%20Compliance%20Report%20-%20final.pdf.

Figure A-4 also shows how states can benefit when RECs are defined so that qualified resources can provide RECs that will meet multiple states' obligations. Tier I (new renewable resources) RECs in the states of Massachusetts, Connecticut, Rhode Island and New Hampshire trade at prices that are not materially different over long periods of time. Thus, even though these states' RECs have specific classifications, the definitions allow for the same resources to be qualified across multiple states, increasing the liquidity of the REC markets and allowing states to limit constraints on the qualification of supply (limitations which can result in increased compliance costs).

Generation Attribute Tracking Systems (GATS)

Throughout a large portion of the US, GATS are used to capture information on electric generation resource production attributes.[38] GATS emerged both to provide a platform for compliance with RPSs and to facilitate fuel mixture tracking. To date 29 states have adopted RPS legislation and compliance under these programs is achieved with the support of GATS and their administrators. In addition, fuel mix disclosures (where applicable) and air pollution emission tracking can also be supported using data compiled in some GATS.

The formation of centralized wholesale electricity markets provides a convenient platform to track generation resource production and GATS now cover a large portion of the US. The US currently has four major regional GATS that cover multiple states, and Table A-1 provides information on each of these systems.[39] The oldest of these systems – New England's and PJM's – allow for the tracking of individual generation resource technology, fuel, production and pollutant emissions. The functionality of these systems is greatly enhanced by the availability of market settlement data from ISO-NE and PJM. The market settlement data allow for verified actual real-time generation resource output to be used when certifying that production is from renewable or non-emitting resources and is easily used along with publicly available data to estimate resource pollutant emissions.[40] The Western US and Mid-Western GATS track renewable energy production, relying on various data sources to obtain resource production including production certified by BAA operators and reported through other protocols.[41]

[38] The term "generation information system" is used to describe New England's GATS.

[39] The U.S. also has additional REC tracking systems that are typically associated with single states.

[40] New England Power Pool Generation Information System Operating Rules, NEPOOL, January 1, 2020, accessed at: http://www.nepoolgis.com/wp-content/uploads/sites/3/2017/09/GIS-Operating-Rules-Effective-10-1-17.pdf?x41232.; "Generation Attribute Tracking System (GATS) Operating Rules," PJM EIS, April 2018, https://www.pjm-eis.com/-/media/pjm-eis/documents/gats-operating-rules.ashx?la=en.

[41] "WREGIS Operating Rules," WECC, May 1, 2018, accessed at: https://www.wecc.org/Corporate/WREGIS%20Operating%20Rules.pdf; "Midwest Renewable Energy Tracking System Operating Procedures," M-RETS, March 12, 2012, accessed at: https://www.mrets.org/wp-content/uploads/2014/03/M-RETS-Operating-Procedures_032012.pdf.

Table A-1: Characteristics of Multi-State Generation Attribute Tracking Systems in U.S.[42]

Attribute	NEPOOL Generation Information System (GIS)	PJM Generation Attribute Tracking System (GATS)	Western Renewable Energy Generation Information System (WREGIS)	Midwest Renewable Energy Tracking System (M-RETS)
Start Year	2001	2005	2007	2008
Region	New England (ISO-NE)	Mid-Atlantic (PJM)	Western Interconnection (WECC)	Mid-West
Type of Generation Tracked	All	All	Only Renewables	Only Renewables
Affiliated with ISO/Balancing Authority?	Yes	Yes	No	No
Emissions Tracked	CO_2, NOx, CO, PM, VOCs, SO_2, and Hg	CO_2, NOx, SO_2[1]	N/A	N/A
Participation	Every generator in ISO NE is automatically included. External generators must register	All Units that are pre-certified for state programs	Generators are not automatically included, must register	Generators are not automatically included, must register
Data Source	ISO New England, Account Holder Self-Filing, EPA, Environmental Regulatory Agency	PJM Market Settlement System, Account Holder Self-Filing, Generation Reporting System, EPA.	Account Holder Self-Filing, Balancing Authority Operator, Qualified Reporting Entities	Account Holder Self-Filing, Control Area Settlement Data, Qualified Reporting Entity
States where RPS Compliance Allows for the Use of Tracking System RECs[3]	CT, MA, ME, NH, RI, VT, NY	**PJM-GATS:** DE, IL, IN, PA, KY, MD, MI, NJ, VA, WV, MI **NC-RETS** (North Carolina Renewable Energy Tracking System): NC[2] **NYGATS** (New York Generation Attribute System): NY	**WREGIS:** AZ, CA, CO, MT, NM, NV, OR, WA **NAR** (North American Renewables Registry): IL, MN, MO, WI **NC-RETS** (North Carolina Renewable Energy Tracking System): NC[1]	**M-RETS:** MN, WI **NAR** (North American Renewables Registry): MO **NC-RETS** (North Carolina Renewable Energy Tracking System): NC[1]

Notes:
[1] Carbon monoxide, VOCs, mercury, and PM may be considered for incorporation into GATS in the future.
[2] North Carolina utilities may use unbundled RECs from out-of-state renewable energy facilities to meet up to 25% of the portfolio standard.
[3] The extent to which RECs may be counted in the various listed states is based on the specific state RPS. For example, some states, like Arizona, have specific solar generation carve outs and offer extra credit for in-state generation.
[4] The North American Renewables Registry (NAR) is excluded because the majority of its member states lack Renewable Portfolio Standards. Similar to M-RETs, NAR tracks only renewable generation.

New England's and PJM's GATS also track imports and exports to and from the geographic regions covered by ISO-NE and PJM, including both tagged and dynamically scheduled supplies.[43] This provides a basis for

[42] New England Power Pool Generation Information System Operating Rules, NEPOOL, January 1, 2020, accessed at: http://www.nepoolgis.com/wp-content/uploads/sites/3/2017/09/GIS-Operating-Rules-Effective-10-1-17.pdf?x41232.; "Generation Attribute Tracking System (GATS) Operating Rules," PJM EIS, April 2018, https://www.pjm-eis.com/-/media/pjm-eis/documents/gats-operating-rules.ashx?la=en.; "Program Information," PJM EIS, accessed at: https://www.pjm-eis.com/program-information.; North Carolina Renewable Energy and Energy Efficiency Portfolio Standard, DSIRE, July 9, 2018, accessed at: https://programs.dsireusa.org/system/program/detail/2660.; REC Imports & Exports, APX, accessed at: https://apx.com/apx-services/rec-imports-and-exports/.; New York Generation Tracking System (NYGATS) Operating Rules, May 18, 2018.; "WREGIS Operating Rules," WECC, May 1, 2018, accessed at: https://www.wecc.org/Corporate/WREGIS%20Operating%20Rules.pdf.; "Midwest Renewable Energy Tracking System Operating Procedures," M-RETS, March 12, 2012, accessed at: https://www.mrets.org/wp-content/uploads/2014/03/M-RETS-Operating-Procedures_032012.pdf.

[43] New England Power Pool Generation Information System Operating Rules, NEPOOL, January 1, 2020, accessed at: http://www.nepoolgis.com/wp-content/uploads/sites/3/2017/09/GIS-Operating-Rules-Effective-10-1-17.pdf?x41232.; "Generation Attribute

tracking production and emissions for certain imported and exported resource supply. In addition, these systems also track unspecified energy and have protocols where an average emission rate for the region where the energy is received can be attributed to the energy. At the same time, if these regions are exporting, they can associate an average emission rate with exported energy. However, these emission rates are averages and do not necessarily track the emissions associated with the energy that was actually generated to support the import or exports.

Each GATS also provides a platform that allows energy producers to verify and certify a number of attributes associated with a generation resource's production. Table A-2 provides a comparison of the various attributes that are tracked under the major multi-state GATS in the US. As noted earlier, one key difference between existing GATS in the Western/Mid-Western US and Mid-Atlantic/Northeastern US is the tracking of pollutant emissions. NEPOOL and PJM both track multiple emissions, including sulfur dioxide, nitrogen oxide and carbon dioxide emissions. The NEPOOL GATS administrator uses resource-specific emission factors to calculate generation resource emissions and provide the information necessary for fuel mix disclosures and emission reports.[44] PJM's GATS administrator uses publicly available generation data and emission data to calculate emission factors for each generator in the PJM region.[45] The compilation and maintenance of these detailed emission rates data provide states with information that can be used to estimate emissions attributable to the resource mixture associated with state LSEs.

Tracking System (GATS) Operating Rules," PJM EIS, April 2018, https://www.pjm-eis.com/-/media/pjm-eis/documents/gats-operating-rules.ashx?la=en.

[44] Appendix 1.1, Functional Requirements, at 5, New England Power Pool Generation Information System Operating Rules, NEPOOL, January 1, 2020, accessed at: http://www.nepoolgis.com/wp-content/uploads/sites/3/2017/09/GIS-Operating-Rules-Effective-10-1-17.pdf?x41232.

[45] PJM's GATS administrator is PJM Environmental Information Services, Inc. and it develops the average emissions rates for electric generators in the PJM region (See https://www.pjm.com/-/media/library/reports-notices/special-reports/2019/2019-emissions-report.ashx?la=en accessed May 4, 2020 at 1).

Table A-2: Attributes Tracked by Select United States GATS[46]

	WREGIS	NEPOOL Generation Information System	Attribute Tracking System (GATS)	Energy Tracking System (M-RETS)
Asset Identification				
Asset Identification/Generator ID	✓	✓	✓	✓
Control Area (Utility Name or ISO Name)	✓	✓	✓	✓
Asset Information				
Primary Unit Name	✓	N/A	✓	✓
Primary Facility Name	✓	N/A	✓	✓
Facility Location	✓	N/A	✓	✓
Multi-Fuel Generator Indicator	✓	✓	✓	✓
Generation Technology/Prime Mover	✓	N/A	N/A	✓
Fuel Type	✓	✓	✓	✓
Nameplate Capacity	✓	✓	✓	✓
Generation Period Start/End Date	✓	✓	✓	✓
Total Generation/Customer-Sited Generation	✓	✓	✓	✓
Ownership				
Company/Organization	✓	✓	N/A	✓
Facility Ownership Type	✓	N/A	N/A	N/A
Reporting Entity	✓	N/A	N/A	✓
Vintage				
Vintage	✓	✓	✓	✓
Repowered Indicator	✓	✓	✓	✓
Capacity Addition	X	✓	✓	✓
Repower Date	✓	✓	✓	✓
FERC Hydro License Date	✓	✓	✓	X
FERC Hydro License Status	✓	✓	✓	X
Emissions				
Emissions by Pollutant	X	✓	✓	X
RPS Characteristics				
RPS Selections (State)/Eligibility[3]	✓	✓	✓	✓
Certificate Identification				
Low Impact Hydro/Green E-Eligibility	✓	✓	✓	✓
SMUD Eligible; Certification Number	✓	X	X	X
Certificate Serial Number	✓	✓	✓	✓
Certificate Creation Date	✓	✓	✓	✓
Other				
California Supplemental Payment Received	✓	X	X	X
Receives States Public Benefit Fund Support Indicator	✓	X	X	X
Federal Tax Credits Received Indicator	✓	X	X	X
Labor Characteristics	X	✓	X	X
Status Under RGGI	X	✓	X	X
Meet the WI PSC Definition for "excludable hydro"?	X	X	X	✓
Qualify as a Community-Based Energy Project?	X	X	X	✓
Imports				
Imported?	X	N/A	✓	✓
NERC Tag	X	✓	✓	X
Date Imported	X	N/A	✓	X
Compatible Tracking System Name	X	N/A	✓	X

Notes:
[1] ✓ indicates that the attribute appears on each certificate.
[2] **X** indicates that the attribute does not appear on each certificate and is not tracked by the system.
[3] In WREGIS, generators must take steps independent of WREGIS to make sure their generation qualifies for state RPS. With exception to carve outs, ISO New England generated RECs are able to be used across the region.

46 New England Power Pool Generation Information System Operating Rules, NEPOOL, January 1, 2020, accessed at: http://www.nepoolgis.com/wp-content/uploads/sites/3/2017/09/GIS-Operating-Rules-Effective-10-1-17.pdf?x41232.; "Generation Attribute Tracking System (GATS) Operating Rules," PJM EIS, April 2018, https://www.pjm-eis.com/-/media/pjm-eis/documents/gats-operating-rules.ashx?la=en.; "WREGIS Operating Rules," WECC, May 1, 2018, accessed at: https://www.wecc.org/Corporate/WREGIS%20Operating%20Rules.pdf.; "Midwest Renewable Energy Tracking System Operating Procedures," M-RETS, March 12, 2012, accessed at: https://www.mrets.org/wp-content/uploads/2014/03/M-RETS-Operating-Procedures_032012.pdf.; Allen, P., Lacourciere, P., "United States: A Renewable Generation Owner's Guide to Getting Renewable Energy Certificates from WREGIS," October

GATS in the eastern, Mid-Atlantic and the western US are structured to recognize that those states located within the geographic region are expected to rely on the GATS to demonstrate compliance with RPS programs. The GATS consistently call for the submission of detailed information on the generation resource technology, energy/fuel source and geographic location. In addition, the PJM and NEPOOL GATS permit registrants to specify states' RPS programs and identify the exact class of REC that the resource is qualified to produce (with state RPS program administrator or regulatory authority oversight).[47] Thus, for PJM and NEPOOL, the appropriate renewable resource class and tier designations, or resource eligibility for "carve-outs" for specific types of technologies (e.g., solar RECs), is tracked within the GATS facilitating REC use for compliance.[48]

In contrast, WREGIS and M-RETS do not associate production with state RPS programs using the same level of detail. State RPS program administrators and regulators can indicate if a resource is eligible in a specific state through the provision of a certification number validating eligibility.[49] Under WREGIS the verification of a particular generation resource's eligibility to meet specific state program requirements cannot be directly confirmed without obtaining additional information from state program administrators. In the absence of a specific designation as associated with a state program the attributes associated with a REC must be tracked and confirmed separately.[50]

Because RECS are traded in bilateral markets through a variety of different procurement approaches, access to publicly available, detailed information on renewable and non-emitting generation resources provides market participants helpful information to assess market conditions and make more informed REC procurement decisions. GATS with greater specificity for the applicable programs where generation resource RECs are qualified provide a transparent data source where market participants can easily access relevant data and verify the resource that is being used to support the delivery of a particular REC product.

11, 2007, accessed at: https://www.mondaq.com/unitedstates/Energy-and-Natural-Resources/53104/A-Renewable-Generation-Owners-Guide-To-Getting-Renewable-Energy-Certificates-From-WREGIS.; "Renewable Energy Credits - Washington State Department of Commerce," Washington State Department of Commerce, accessed at: https://www.commerce.wa.gov/growing-the-economy/energy/energy-independence-act/wregis/.

[47] For example, see Appendix 2.4 in New England Power Pool Generation Information System Operating Rules, NEPOOL, January 1, 2020, accessed at: http://www.nepoolgis.com/wp-content/uploads/sites/3/2017/09/GIS-Operating-Rules-Effective-10-1-17.pdf?x41232.

[48] There can be a considerable amount of specific information associated with the types of resources that qualify under individual state's programs that is included in the PJM and NEPOOL GATS.

[49] "WREGIS Operating Rules," WECC, Appendix B-1, May 1, 2018, accessed at: https://www.wecc.org/Corporate/WREGIS%20Operating%20Rules.pdf.

[50] See, for example, the Western Systems Power Pool Agreement at Service Schedule R Annex 2 where this consideration is noted when indicating the environmental attributes associated with a REC.

Other Issues to be Addressed When Designing a Resource-Based Compliance Framework for Zero-carbon Policies

1. ***Eligible resource types.*** A zero-carbon or non-emitting resource policy must decide what types of resource are considered to be "non-emitting". While this designation is non-controversial for many technologies (e.g., photovoltaic solar panels, wind turbines, hydroelectric power), it may be more controversial for others (e.g., biomass generation).

2. ***Deliverability*****.** A resource-based system accounts for the deliverability of a non-emitting resource by limiting eligibility to specified regions. The criteria to determine eligible regions can reflect many factors, including the existence of interconnections or general availability of transmission between the source and load.

3. ***Timing.*** A resource-based system creates a "time stamp" for electricity generated at the source, and use this information when determining eligibility. The time stamp establishes a vintage (e.g., typically a compliance period) that can be used to limit eligibility for electricity used to meet a renewable and/or non-emitting for load (or a fraction of load) to certain temporal periods, such as the year in which the energy is produced and the retail sales are recorded. This allows for annual and multi-year vintages to be used for compliance (i.e., allowing for averaging over annual and multi-year periods) which can reduce costs for consumers. The resource-based system provides far greater flexibility to tailor such compliance requirements to the realities of uncertain weather and market conditions that affect the ability of many zero-carbon resources to produce energy. Such flexibility appears to be embodied in many decarbonization policies, such as CETA, which allows compliance over a multi-year period during 2030-2044, suggesting some intertemporal compliance flexibility.

4. ***Regulatory Accounting Systems.*** Compliance with a technology-based policy, such an RPS or CES policy, requires development of regulatory accounting systems through which regulated entities can demonstrate compliance. Decisions about regulatory accounting are complex, reflecting a number of different factors, including: pre-existing accounting systems that can be used with or without modifications, thus lowering program administrative costs; jurisdictional issues, as state regulators may be able to place requirements on in-state entities but not out-of-state entities; and information needed to reliably determine compliance, including resource characteristics, and the quantity and timing of generation and emissions.

   Because many states are pursuing policies with similar objectives, but with state-specific compliance requirements, a uniform system of accounts for electricity attributes may provide broad benefits. A resource-based tracking system provides a means for each state to determine compliance, while also allowing state-level differences in the eligibility or applicability of different attributes for compliance purposes. In the absence of an appropriate regional framework that allows for consistent accounting, it is difficult, and likely impossible, to ensure that double counting does not occur and that the resources used for compliance reflect consistent criteria.[51]

5. ***Accounting for Changes in Production Outside the State.*** The development of a new regulation can cause a shift in economic activity given the cost of the regulation on in-state production or changes in contractual relations as in-state entities take steps to comply with the new regulation (i.e., leakage). Given these adjustments, there are often discussions regarding whether implementing regulations should account for these shifts and, if so, what regulations might effectively address any undesirable impact of these adjustments. States have reached different resolutions regarding these issues. For example, these factors are not accounted for in the RPS programs in California and the Eastern states, and the RGGI GHG cap-and-trade program. However, California's GHG cap-and-trade program has implemented regulations aimed at addressing these shifts in production and contracting.

6. ***Relationship to Integrated Resource Plans (IRP).*** On its face, compliance with a zero-carbon policy need not have a direct relationship to a utility's IRP. However, to the extent that there are concerns that utilities within a state pursuing decarbonization will not undertake investments in new non-emitting resources, such decisions can be monitored through the IRP process and action taken, if a utility's actions appear inconsistent with the intent of decarbonization legislation.

7. ***Accounting for Multi-state Utilities.*** Across the Western states, there are several utilities with assets, operations, and load-serving obligations in multiple states. Accounting for the compliance obligations of these utilities introduces unique complications, complications that are not dissimilar to these faced by state utility commissions when establishing regulated rates for the utility's customers.

   Multi-state utilities often integrate operations and planning across their service territory, irrespective of state boundaries. This approach to planning and operations can benefit customers by taking advantage of greater economies of scale and diversification. But, regulation of these entities must account for many factors when determining compliance with state-level regulations, including the allocation of resources to customers in different states (with potentially different environmental compliance requirements), relationship between rate-setting and environmental compliance, and the utility's compliance decisions if it were not operating as a multi-state utility.

8. ***Multi-state BAAs***. Within multi-state BAAs, supply and demand are balanced to maintain reliability at least-cost incorporating both bilaterally scheduled generation resources and BAA to BAA net-interchange. Many utilities operate BAAs whose geographic reach aligns with their service territories, whereas some balancing authorities are operated by entities independent of the local utilities. BAA operations are performed without regard to LSE boundaries and require rules to allocate generation to customers in different states, potentially subject to different environmental requirements. Further, criteria to determine which resources to operate are complicated if environmental requirements differ across the footprint.

[51] These complexities arise in other regions of the U.S. and GATS are relied upon to provide a platform that avoids or minimizes compliance accounting problems.