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Evidence Submission 1



Status and Trends in the U.S. Voluntary Green Power Market (2021 Data)

Jenny Sumner,¹ Eric O'Shaughnessy,² Sushmita Jena,¹
and Jesse Carey¹

1 National Renewable Energy Laboratory

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List of Abbreviations and Acronyms

CCA	community choice aggregation
LMI	low- and moderate-income
PPA	power purchase agreement
RECs	renewable energy certificates
RPS	renewable portfolio standard

Executive Summary

Voluntary green power, for the purposes of this report, refers to renewable energy procurement above state renewable energy mandates by retail electricity customers. In this report, which the National Renewable Energy Laboratory publishes annually, we present data and key trends for voluntary green power market, except for a small portion of voluntary purchasing where no data are available.

In 2021, about 8 million retail electricity customers procured about 244 million megawatt-hours (MWh) of voluntary green power (Figure ES-1), which represents about 27% of all U.S. renewable energy sales, about 39% of non-hydropower renewable energy sales, and about 6% of all U.S. retail electricity sales. Most of the remainder of U.S. renewable energy sales reflects renewable energy procured by load-serving entities to comply with state renewable energy mandates, also known as compliance-based procurement.

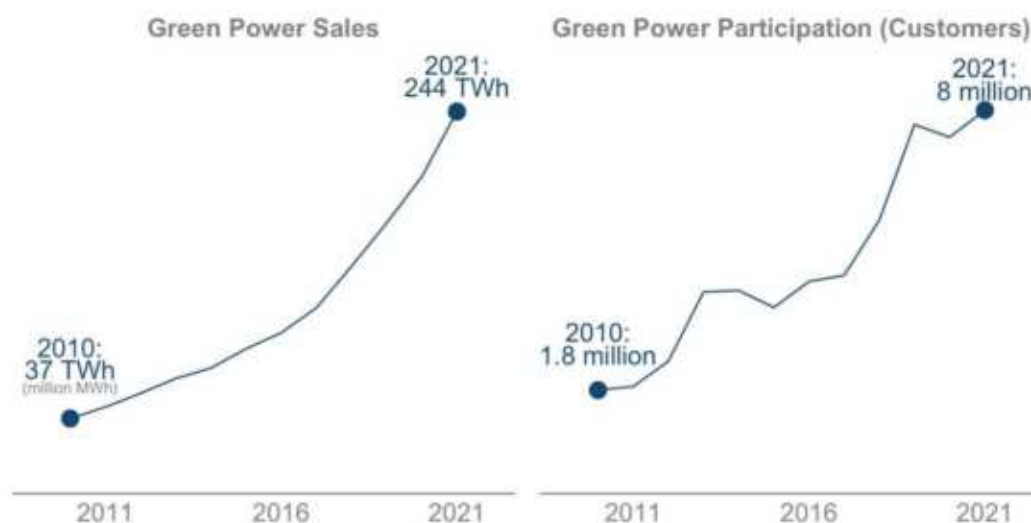


Figure ES-1. Voluntary green power sales (left) and participation (right), 2010–2021

In this year's report, we explore two emerging issues in the U.S. voluntary green power market. First, we explore emerging issues that could constrain the expansion of voluntary green power products. We explore how the increasing complexity of the voluntary green power market could help buyers implement green power procurement more impactfully but also pose some unique challenges for certain buyers, especially smaller buyers. Our second exploration focuses on the evolving role of voluntary green power market as grids decarbonize. We discuss how the voluntary green power market has already begun to evolve to changing grid realities by developing new products intended to maximize impacts.

Here are the key takeaways, from this year's report:

- *Green power demand continues to grow across all products.* Growth is particularly strong for the products that offer direct procurement from specific projects: utility contracts and PPAs.
- *Expanding green power access to smaller buyers is a soluble challenge.* Leading utilities and other green power suppliers have already developed innovative new products that expand green power market access, including LMI customers.
- *The green power market has adapted to the evolving needs of customers and grids.* There has been a marked shift toward products that directly connect buyers with power and RECs from specific projects through PPAs and utility renewable contracts, including 24/7, real-time products that ensure green power is delivered to grids when renewable energy is scarcer.
- *The green power market can play a role in deep decarbonization.* Buyers and sellers may develop new products catered to the specific needs of grids with higher levels of baseload renewable energy, such as products that support firm clean energy and battery storage.

In the future, green power buyers and sellers will likely continue to adapt to the changing needs of a decarbonizing U.S. grid.

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1 Introduction

Many states require retail electricity suppliers to buy specified amounts of renewable energy through mandates typically known as renewable portfolio standards (RPS). Retail electricity suppliers comply with RPS by buying and “retiring” renewable energy certificates (RECs), accounting mechanisms that represent the clean energy attributes of renewable energy generation.¹ Retail electricity customers can increase the renewable energy content of their electricity consumption by buying and retiring additional RECs. Voluntary green power, for the purposes of this report, refers to renewable energy procurement (i.e., RECs) above RPS mandates by retail electricity customers.

In this report, we summarize data on the various products through which retail electricity customers—including residential, commercial, and industrial, and institutional (e.g., government) customers—purchase voluntary green power. The report focuses on voluntary green power sales and participation in calendar year 2021.² Note that, though the green power products vary substantially, all green power products ultimately serve as a conduit through which RECs are bought and retired on behalf of customers. Including RECs in all green power products ensures the associated renewable energy use cannot be double-counted and claimed by a retail electricity supplier for RPS compliance.

For the purposes of this report, the term green power refers exclusively to renewable energy procurement above RPS obligations. In some cases, retail electricity suppliers sell voluntary green power in a single product with standard electricity. In these cases, we factor out the portion of renewable electricity supply that was required to meet RPS obligations.

This report does not include green power use where no explicit REC transaction occurs and therefore no usage data are available. This lack of data/absence of REC transaction occurs when customers own on-site systems and “retain” the RECs, so that RECs are never formally retired. Data from the U.S. Environmental Protection Agency’s Green Power Partnership suggest on-site green power consumption by nonresidential customers may amount to about 2% of the green power market summarized in the report (EPA 2023), or about 5 million megawatt-hours (MWh) annually. Additional on-site green power, not accounted for in this report, occurs through residential installations and organizations that are not part of the Green Power Partnership.

We present voluntary green power market data and trends in Section 2. In Section 3, we discuss two emerging issues that, if addressed, could expand access to the voluntary green power market. In Section 4, we discuss the future of the voluntary green power market as grids approach higher levels of renewable energy penetration.

¹ For more information on RECs, see EPA (2018).

² For reports on previous years, see “Voluntary Green Power Procurement,” NREL > <https://www.nrel.gov/analysis/green-power.html>.

2 Voluntary Green Power Market Sales and Participation

In this section, we summarize trends in the voluntary green power market through various visualizations. Numeric values for all figures in this section are available in a workbook format.³

The U.S. voluntary green power market has grown consistently and substantially over the past decade. We estimate that about 8 million customers procured about 244 million MWh of voluntary green power in 2021, up from 1.8 million customers and 37 million MWh in 2010 (Figure 1).

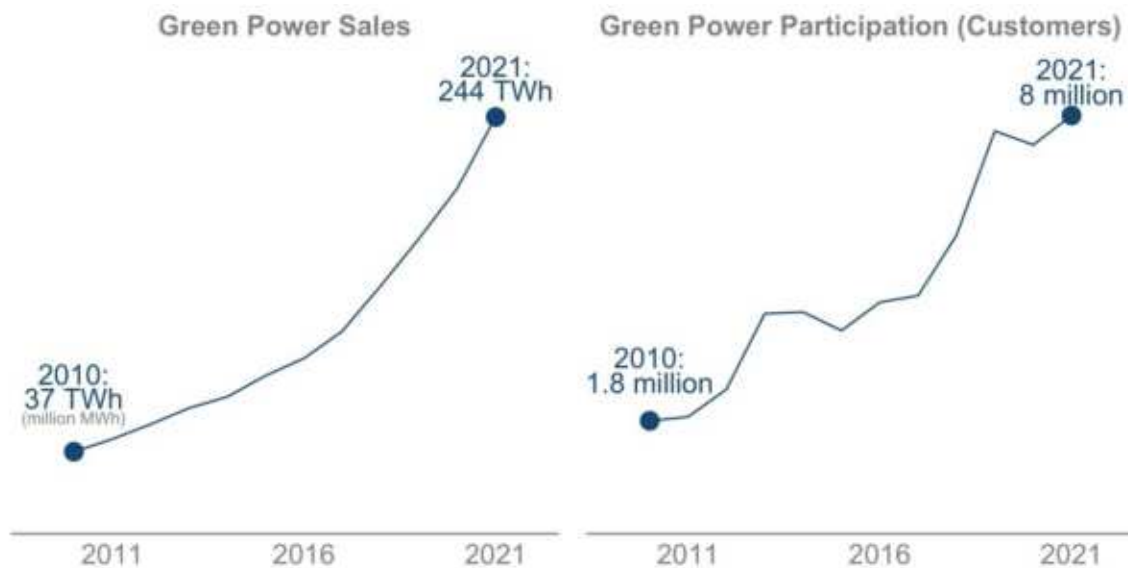


Figure 1. Voluntary green power sales (left) and participation (right), 2010–2021

By 2021, voluntary green power sales accounted for about 27% of all renewable energy sales in the United States and about 39% of renewable energy sales excluding large hydropower, based on data from EIA (n.d.). Further, voluntary sales accounted for about 38% of the total green power market (i.e., all REC-based procurement including voluntary and RPS-based or “compliance” procurement) (Figure 2).

³ “Status and Trends in the U.S. Voluntary Green Power Market (2021 Data),” NREL, <https://data.nrel.gov/submissions/196>.



Figure 2. Renewable energy sales in voluntary and compliance markets, 2011–2021

Compliance estimates are based on data from Barbose (2019); 2021 compliance estimate is based on projected value.

The voluntary green power market comprises six products through which retail electricity customers can buy renewable energy above RPS requirements. Table 1 defines each of these products and summarizes our primary data sources for estimating sales for each product.

Table 1. Voluntary Green Power Product Definitions

Product	Description	Data Sources
Utility green pricing	A program wherein utilities retire RECs on behalf of residential and small commercial customers (includes community solar)	Survey, EIA (2022)
Utility renewable contracts	A program wherein utilities procure power and retire RECs from specific renewable energy projects on behalf of customers who participate on a contractual basis	BNEF (2022)
Competitive suppliers	Non-utility retail electricity suppliers in restructured electricity markets that retire RECs on behalf of their customers	EIA (2022)
Unbundled RECs	Sales of RECs separated or “unbundled” from the underlying power	CRS (2022)
Community choice aggregation (CCA)	A CCA is a legal entity formed to procure power on behalf of a defined geographic area. Some CCAs procure green power on behalf of their customers.	Survey, CalCCA (n.d.), EIA (2022), GECA (2022), ICC (n.d.), MA DPU (n.d.), NY DPS (2022)
Power purchase agreements (PPA)	Sales through direct contracts between renewable energy projects and buyers which include both power and RECs	BNEF (2022)

Figure 3 illustrates how the composition of the voluntary green power market varies in terms of sales and participation (MWh). Sales are driven by products marketed toward large, nonresidential customers, particularly unbundled RECs and increasingly power purchase agreements (PPAs). In contrast, participation is driven by products marketed toward residential and small commercial customers, especially community choice aggregations (CCAs), competitive suppliers, and utility green pricing programs.

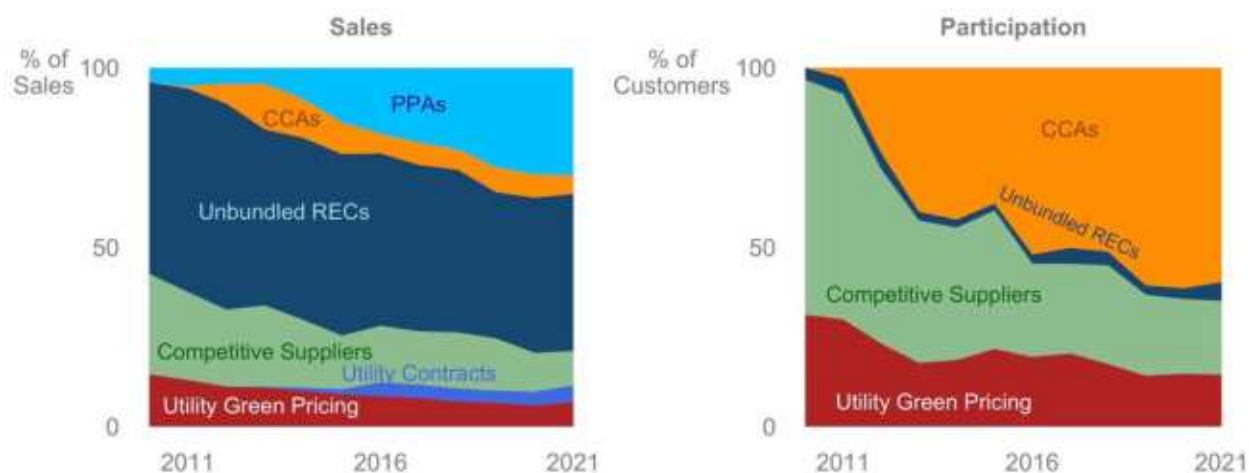


Figure 3. Shares of green power sales (left) and customers (right) over time by product

PPAs and utility contracts collectively account for less than 1% of customers.

Figure 4 illustrates green power sales by product from 2011 to 2021, and Figure 5 illustrates green power participation by product from 2011 to 2021. Key factors driving these trends are discussed below the figures.



Figure 4. Green power sales by product, 2011–2021

Plots are on different scales.



Figure 5. Green power participation by product, 2011-2021

Plots are on different scales.

2.1 Utility Green Pricing

Utility green pricing participation and sales continued to rise steadily in most programs. The relatively sharp increase in utility green pricing sales in 2021 is mostly attributable to significant year-over-year growth in California's community solar program, the largest community solar program in the country that retires RECs on behalf of subscribers. Overall, about 1.1 million customers procured about 16.5 million MWh of voluntary green power through utility green pricing programs in 2021.

Oregon, Washington, Colorado, Minnesota, and Michigan were the top five states with the highest number of customers; Michigan, Washington, Texas, California, and Minnesota were the top five states with highest generation (MWh). The top five states by number of customers were 70% of the total number of customers procuring renewable energy through utility green pricing, and top five states by sales (MWh) form 61% of the total generation (MWh) procured through utility green pricing.

The market recovered after a relatively flat year in 2020, increasing sales by 42% (2020–2021) compared to only 5% (2019–2020). Though sales increased 42% (2020–2021), customers only increased by 6%, indicating larger per-customer volumes are driving sales growth. Admittedly, the utilities were facing uncertainties in the wake of the pandemic in 2020. Utilities that responded to our recent survey reported slight reductions in sales and participation from expected levels, typically around a 5% decrease.

As per the survey participants, the reduction in sales could be due to the reduced ability of utilities to actively market their programs, particularly through in-person marketing (e.g., door-to-door or via in-person events). Some utilities noted that other extreme events such as wildfires have caused similar disruptions to program marketing in recent years. At the same time, some utilities reported increased interest from proactive customers, perhaps because more time at home led to more interest in residential green power.

2.2 Utility Renewable Contracts

Utility renewable contracts continue to expand from a smaller base. Though utility renewable contract sales remained a small portion of the 2021 green power market, contracts in the pipeline suggest strong growth in utility renewable contracts for the foreseeable future (Figure 7). In 2021, utility contracts served 11.4 million MWh, which is nearly the size of the utility green pricing market. Sales increased 46% from 2020 and a substantial share of projects were in the pipeline. Utility contracts are usually used by large commercial buyers, and this number of customers increased by 71% over 2020 to a total of 84 customers. There is about twice as much capacity in the utility contract pipeline as there is current operational capacity. Utility renewable contracts are poised for significant growth, especially in Arizona, Michigan, Virginia, Tennessee, and Utah.

The Clean Energy Buyers Association's Deal Tracker,⁴ which collects publicly announced contracted capacity of corporate deals shows utility-scale solar projects represented 76% of new contracted capacity in 2021. Information technology companies, especially companies with large data centers, represent the most procured clean energy by volume.

There is also interest from customers to use battery storage, partly due to corporate interest in the 24/7 procurement, an approach where buyers match renewable energy procurement to demand on an hourly basis (we discuss 24/7 procurement in depth in Section 4). Keeping in line with interest from potential buyers, it is possible that utilities will integrate battery storage into their green power products.

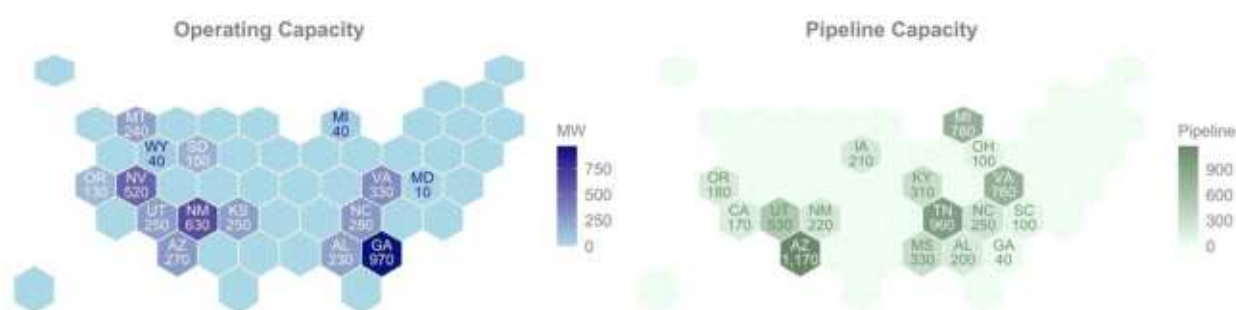


Figure 6. Utility renewable contract operating capacity (left) and pipeline capacity (right) by state.

2.3 Competitive Suppliers

We estimate green power sales from competitive suppliers grew slightly in 2021, mostly due to increased sales from a few suppliers with default 100% green power products. For example, CleanChoice Energy only offers 100% green power products. The sales (MWh) increased by 8 % and the total customers increased by 7 %. About 1.6 million customers procured about 23.4 million MWh of voluntary green power through competitive suppliers in 2021.

Some suppliers have begun to offer long-term green power contracts like utility green tariffs. With this [product], the supplier procures green power from a specific resource (e.g., through a PPA) on behalf of their customers, minimizing expenses and time the customers would need to

⁴ "CEBA Deal Tracker," Clean Energy Buyers Association, <https://ceb buyers.org/deal-tracker/>.

spend to make their own power purchases. For instance, NRG created the Renewable Select plan, a retail contract that make it easier for business customers to obtain off-site green power from specific resources. Currently, the program includes 36 large commercial and industrial customers and provides renewable electricity to more than 345 offices, financial centers, and ATMs in Texas. The program has an output of 3 terawatts (TWh) annually and a collective 600-MW peak load. NRG plans to expand the program to also include smaller customers.

Competitive suppliers have also begun to offer community solar with RECs retired on behalf of subscribers. For instance, MP2 Energy has a community solar program partnership with Local Sun, a 1.5-MW solar project, which will power 300 homes and eliminate the need for long-term contracts. If customers will need more power than can be supplied by the array, MP2 will buy 100% renewable energy from other Texas sustainability projects.

2.4 Unbundled RECs

Unbundled RECs remain the most common source of green power supply (MWh), accounting for about 44% of green power sales in 2021. From December 2020 to August 2021, REC prices (nationally sourced, Green-e Eligible) increased from \$1.50/MWh to \$6.60/MWh. In response to increasing REC prices, some organizations are turning to direct procurement (e.g., PPAs), on-site renewables, and carbon offsets. Nonetheless, the market grew 23% from 2020 to 2021, which is comparable to growth trends in previous years. Unbundled REC customers increased sharply in 2021, to more than 400,000.

2.5 Community Choice Aggregation

Community choice aggregation (CCA) remains a growing way for communities to take charge of their energy choices. About *4.8 million customers* procured about *12.7 million MWh* of voluntary green power through CCAs in 2021. CCA participation and sales growth has plateaued in recent years, and the plateau reflects several trends in the five states where CCAs offer green power.

California has grown to dominate CCA green power sales and participation; it accounted for about 70% of all CCA green power customers in 2021 (Figure 6). Due to its large size, trends in California now dictate broader trends in CCA green power sales and participation. Although CCAs have continued to expand in California, participation and sales have leveled off since around 2019. CCA green participation grew by more than 50% from 2016 to 2021 in Massachusetts, New York, and Ohio, though the smaller absolute sizes of these markets mean this growth has a muted impact on CCA trends overall.

Table 2. Green Power Sales via CCA

State	Green Power Sales (MWh)	Green Power Customers
California	9,050,000	3,798,000
Illinois	178,000	32,000
Massachusetts	1,599,000	449,000
New York	910,000	184,000
Ohio	974,000	301,000
Total	12,711,000	4,764,000

In 2014, Westchester County formed New York’s first CCA. Since then, three other aggregators have emerged to form CCAs in the state. Many New York communities have chosen to provide 100% renewable energy by default (i.e., opt out), and all aggregators offer opt-in green power products. New York CCAs are also innovating. Several CCAs offer their own community solar programs, and one aggregator (Joule Assets) offers a unique opt-out community solar product to eligible CCA customers. Finally, Illinois CCA green power demand has declined substantially from its peak in the mid-2010s, partly offsetting the CCA growth in the other states.

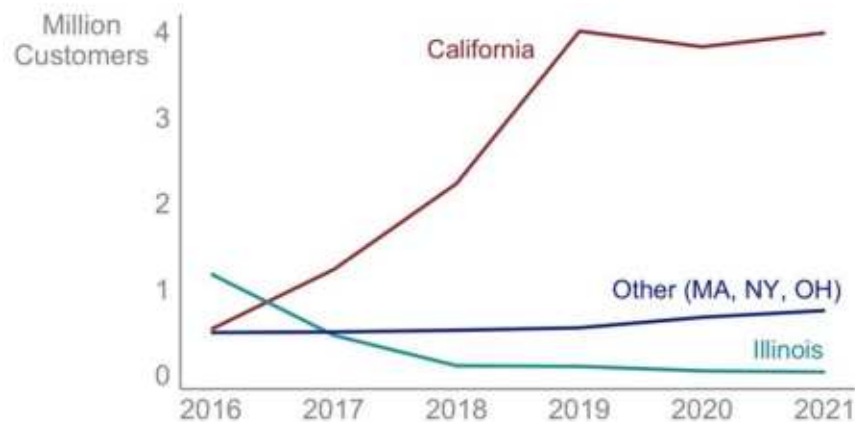


Figure 7. CCA green power participation by state, 2016–2021

2.6 Power Purchase Agreements

Power purchase agreement (PPA) green power sales grew by around 23% from 2020 to 2021. PPA green power sales continue to be concentrated in wind-heavy states with weak or no RPS. In 2021, around 62% of PPA sales came from Texas, Oklahoma, Ohio, and Kansas. The green power PPA market continues to be driven largely by corporate buyers (CEBA 2022). About 613 offtakers procured about 73 million MWh of voluntary green power through PPAs in 2021. These figures include only PPA sales where we estimate that the purchaser has retained the RECs.

3 Emerging Issues in the Voluntary Green Power Market

The future of voluntary green power markets depends on the ongoing expansion and adoption of green power products. In this section, we explore two emerging challenges that could constrain the increased adoption of green power: unequal market access (Section 3.1) and increasing green power product and claim complexity (Section 3.2).

3.1 Challenges to Market Access

In 2021, about 8 million retail electricity customers bought voluntary green power. These customers represent a wide variety of individuals, institutions, and companies with different capabilities, budgets, interests, and goals. The voluntary green power market has frequently adapted to this heterogeneity by developing and offering a diversity of products. Still, not all customers have equal access to green power. Unequal green power access is partly due to differences in the availability of green power products in different regions. Unequal green power access also reflects differences in the procurement ability of customers. For instance, low- and moderate-income (LMI) residential customers may face budgetary constraints that restrict their ability to procure premium products such as utility green pricing. Unequal access could pose challenges to the ongoing expansion of the green power market.

To unpack this challenge, it is helpful to organize green power customers into three classes. The hierarchy below is not a market standard; we developed the hierarchy solely for the purposes of this discussion:

- **Small-Scale Buyers:** residential customers and small businesses.
- **Mid-tier Buyers:** commercial, institutional (e.g., cities, governments), and corporate buyers who have limited staff and resources available to plan and implement green power procurement.
- **Top-Tier Buyers:** large, mostly corporate buyers who dedicate staff and resources toward green power procurement.

Note that we define the customer classes according to two dimensions of scale and capabilities. Mid- and top-tier buyers are primarily distinguished by the resources dedicated to green power procurement, not necessarily customer size. Broadly speaking, small-scale buyers account for most green power customers and top-tier buyers account for most sales (i.e., MWh). As we shall discuss, mid-tier buyers are likely underrepresented in the green power market in both categories.

In the remainder of this section, we explore market access issues in each customer class. We discuss historical and current market activity and specific challenges to maintaining and expanding participation in each class. Then, in Section 3.1.4, we explore challenges across the three customer classes.

3.1.1 Small-Scale Buyers

Small-scale buyers primarily buy green power through utility green pricing, competitive suppliers, and CCAs (where available). In recent years, the small-scale segment has been defined by two different trends illustrated in Figure 9. From 2016 to 2021, small-scale customer

participation in utility green pricing programs and CCAs grew substantially, but most of that growth was confined to a few states. Rising participation in states such as California (3.4 million new customers), Massachusetts (140,000 new customers), and New York (50,000 new customers) is primarily attributable to the expansion of CCAs, and growth in states such as Oregon (190,000 new customers), Washington (80,000 new customers), and Michigan (60,000 new customers) is attributable to innovations in utility green pricing programs. At the same time, small-scale customer participation has been stagnant or declining in most other states.

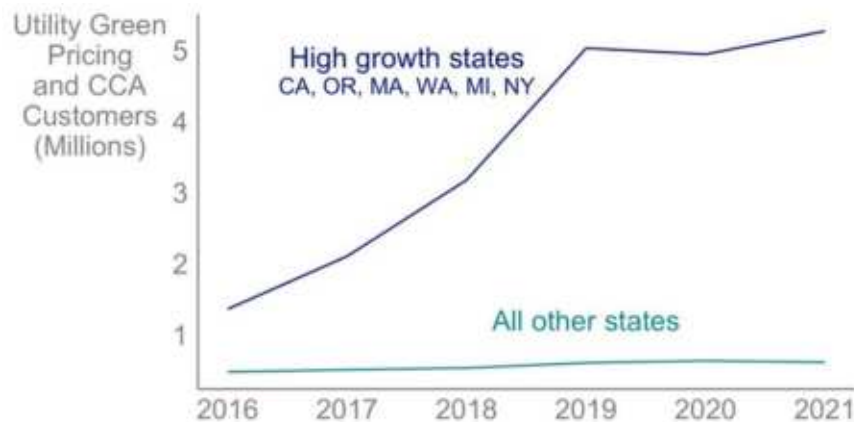


Figure 8. Small-scale green power participation across states

The figure excludes Illinois, an extreme outlier in terms of declining participation due to a contraction of CCAs.

The green power options of most small-scale customers have not substantially evolved in the past decade. Most utility green pricing programs continue to offer the same products and—despite rapidly falling renewable energy prices—at roughly the same cost premiums. Further, while we have limited insights into competitive supplier market activity, there is no evidence that competitive supplier green power products have evolved in the past decade. There are numerous exceptions to this stagnation in small-scale product offerings, but most innovation has concentrated in the few states depicted in Figure 8.

Though further research is required to identify specific challenges for small-scale customer green power products, available evidence from rooftop solar research suggests customer acquisition costs could be a key barrier to market expansion. Customer acquisition refers to costs for finding and recruiting new customers (e.g., advertising and door-to-door marketing). For rooftop solar, customer acquisition is the only installation cost that has generally increased rather than declined over time. Acquisition costs have increased as relatively easy-to-recruit early adopters already have solar and marketers exert more effort to convince more-skeptical, later adopters. A similar dynamic likely exists for small-scale green power programs. Many or most of the easy-to-recruit customers likely already procure green power, meaning program managers must exert more effort per customer to recruit new customers.

Another challenge to broadening small-scale green power participation is the availability of competing products. Small-scale buyer electricity use is often small enough to be fully met through an on-site solar system. One challenge with on-site solar as a substitute for green power is that many on-site solar buyers do not own the RECs generated by their systems. Similarly, many small-scale customers choose to buy community solar. Again, a challenge is that many

community solar products do not retire RECs on behalf of subscribers. In both cases, the risk is that on-site or community solar products displace green power demand without adding the same quantity of REC demand, thus reducing overall demand for renewable energy.

A final challenge is finding ways to make small-scale buyer access more equitable. Although green power equity has not been directly studied, to our knowledge, the cost premiums associated with small-scale products (e.g., utility green pricing and opt-up CCA products) likely pose barriers to participation for LMI households. Developing LMI green power programs may be challenging because program providers must find ways to recoup REC costs without significantly increasing LMI customer electricity costs. Pacific Gas & Electric in California, for instance, uses state funds to subsidize LMI customer enrollment in the utility's Green Saver program.

3.1.2 Mid-Tier Buyers

Few green power products cater specifically to the needs of mid-tier buyers (Brasington 2020). Utility green pricing and competitive supplier products typically entail price premiums that are manageable for smaller customers with less demand but can be cost-prohibitive for mid-tier buyers with larger demand. Mid-tier buyers, who typically do not have as many dedicated procurement staff and resources as top-tier buyers, may struggle to navigate more-complex products such as utility renewable contracts and PPAs. Like the broader renewables market (Tian et al. 2016), mid-tier buyers are thus caught in a gap between products largely catered to small-scale and top-tier buyers.

Though we do not track specific data on mid-tier participation and sales, available evidence suggests mid-tier participation is growing slower than top-tier participation. For instance, direct procurement by local governments has lagged direct procurement by top-tier buyers. In 2021, local governments signed 119 off-site renewable energy deals, up from 52 in 2015 (Gonçalves et al. 2022). The growing number of deals reflects a clear market expansion: three of every four local government deals in 2021 were signed by first-time buyers (Gonçalves et al. 2022).⁵ However, deals by top-tier buyers grew more substantially over the same period. Local government deals grew by about a factor of 2 from 2015 to 2021, and corporate deals increased by about a factor of 5 from 2016 to 2021 (CEBA 2022) (Figure 10).

⁵ The number of local government on-site deals have grown more substantially, from 40 in 2015 to 171 in 2021. Consistent with the rest of this report, we exclude on-site procurement from this discussion.

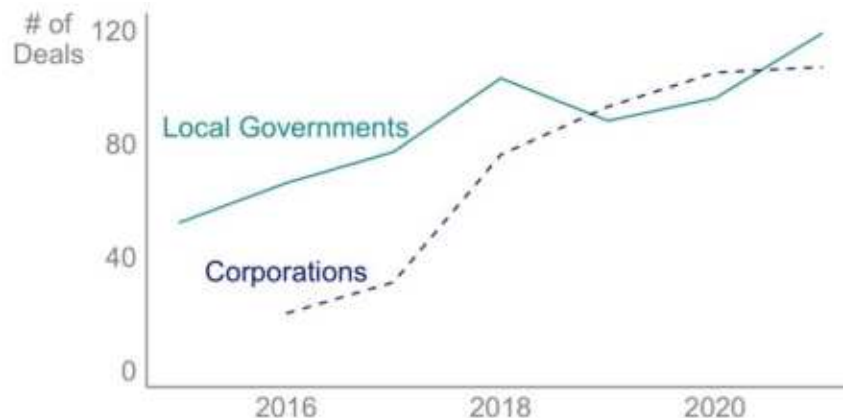


Figure 9. Number of off-site local government and corporate renewable energy deals, 2015–2021

Local government deals are based on off-site deal data from Gonçalves et al. (2022). Corporate deals are based on CEBA (2022). The comparison is provided for illustrative purposes; some of the difference may be attributable to methodological differences across the two sources. A 2015 estimate for corporate deals is unavailable.

Recent years have seen the development of some market innovations that could more effectively address the needs of mid-tier buyers. One emerging model is buyer aggregation, wherein multiple mid-tier buyers work together to buy green power under a single aggregated contract (Brasington 2020; Liu and Reback 2021). Through aggregation, mid-tier buyers can pool staff, resources, and expertise in ways that replicate the more substantial procurement resources of large-tier buyers (Liu and Reback 2021). Further, aggregation allows mid-tier buyers to access the lower costs associated with larger projects (Liu and Reback 2021). Another potential model is for mid-tier buyers to collaborate with top-tier buyers. For instance, in 2021, 14 cities in Georgia partnered with Walmart to sign a renewable energy customer agreement sharing the output of 80 MW of solar capacity (Gonçalves et al. 2022). The deal allowed the cities to leverage Walmart’s green power procurement expertise while also accessing lower costs through economies of scale.

3.1.3 Top-Tier Buyers

The top-tier customer class has exhibited the most substantial green power market growth in recent years. Using data and methods from O’Shaughnessy et al. (2021), Figure 11 depicts how much of the recent growth in the U.S. voluntary green power market has accrued to corporate buyers, the primary group of top-tier buyers under our definition. In 2021, corporations alone signed about 11,000 MW in renewable energy contracts (CEBA 2022)—though not necessarily all of these corporation are “top-tier” buyers as we have defined the term.

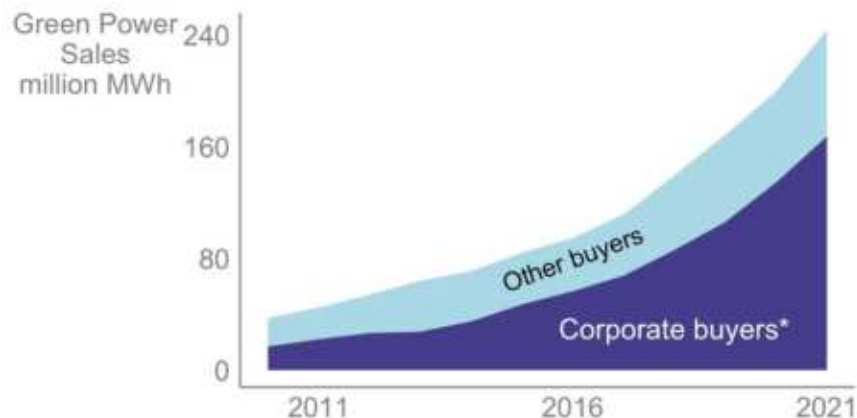


Figure 10. Green power sales among corporate and other buyers, 2010–2021

* Corporate buyer data are based on data and methods described by O’Shaughnessy et al. (2021). The corporate share provides a rough estimate of corporate demand based on available procurement data.

Top-tier buyers can use their size and procurement expertise to shape the green power market to suit their needs (O’Shaughnessy et al. 2021). As a result, the green power market has evolved to meet growing demand from top-tier buyers. This evolution includes the development of new products (e.g., financial PPAs), working with new partners (e.g., utility renewable contracts), and exploring entirely new ways of procuring green power. Arguably the most salient example of the third category is 24/7 procurement. We discuss 24/7 and related topics in Section 4 (page 18).

The top-tier customer class is arguably the healthiest segment of the green power market. Top-tier customer demand is projected to continue to grow at current levels for the foreseeable future (Shreve 2019; O’Shaughnessy et al. 2021). The challenges facing this customer class largely represent the broader challenges of the green power market as grids decarbonize, a topic we explore in Section 4.

3.1.4 Market Access Challenges Across Customer Classes

In the preceding three sections, we discuss how market growth in the small-scale and mid-tier customer classes is stagnant compared to growth among top-tier customers. This difference in market growth is partly attributable to factors within each customer class. For instance, products catered to small-scale customers have evolved little over the past 10 years (with notable exceptions for some utility programs) and the top-tier segment has seen a burst of market innovation that has yielded new products. In this section, we explore two potential challenges *across* the customer classes that could further stymie growth in small-scale and mid-tier market segments.

3.1.4.1 Market Crowding

One potential challenge is that top-tier customer demand could crowd out opportunities for green power participation by small-scale and mid-tier buyers. To unpack this challenge, it is important to recognize that green power supply is fundamentally constrained in the near term. As grids decarbonize, most deployed renewable energy output is procured in the compliance market, leaving a residual of output for voluntary buyers. Top-tier buyers can directly influence the size of that residual market, such as by contracting for new projects through PPAs. However, due to the broad challenges of siting and developing new renewable energy projects, top-tier buyers

have limited influence over the near-term size of the residual renewable energy supply. As a result, all buyers compete to buy green power from the same limited pool of residual renewable energy supply. Some evidence of this market crowding is evident in the increasing market share of corporate buyers depicted in Figure 10.

Top-tier buyers could use their size and procurement expertise to effectively outcompete small-scale and mid-tier buyers. Top-tier buyers can typically procure green power at lower cost and can directly influence suppliers. A tangible example of this phenomenon is utility renewable contracts. Utility renewable contracts are effectively a response to top-tier buyer demands for improved access to renewable energy in states without retail electricity competition (O'Shaughnessy et al. 2021). Utility renewable contracts could divert utility resources from programs to deploy renewables on behalf of small-scale and mid-tier buyers toward programs to deploy renewables on behalf of specific top-tier buyers. The net result could be accelerated renewable energy deployment but with fewer opportunities for small-scale and mid-tier buyer participation.

3.1.4.2 Claims Competition

A second challenge is that friendly competition among green power buyers could undermine the green power claims of small-scale and mid-tier buyers. As discussed in Section 3.2, top-tier buyers are pursuing increasingly complex claims about their renewable energy procurement. These claims are often motivated by friendly competition; top-tier green power buyers aim to differentiate their own procurement practices from those of their peers. In top-tier buyer efforts to distinguish their own procurement, top-tier buyer claims may imply small-scale and mid-tier procurement is less impactful. The risk is certain claims made by top-tier buyers could undermine confidence in the green power products relied on by small-scale and mid-tier buyers.

3.2 Managing Increasing Product and Claim Complexity

Voluntary green power products effectively exist to validate *claims* that electricity customers make about renewable energy usage. Over time, both green power products and claims have become increasingly complex. Increasing product and claim complexity poses challenges to the implicit and explicit frameworks that underpin the voluntary green power market. Importantly, increasing claim complexity creates challenges for the market and legal frameworks that validate renewable energy use claims.

3.2.1 Voluntary Green Power Market Claims Frameworks

The voluntary green power market is largely self-regulated and supported by a legal basis governing green power products and claims. Market conventions dictate that all renewable energy use claims must be substantiated by RECs, and the details of those claims must be consistent with the specific characteristics of RECs used to support those claims. RECs are formally recognized as a valid basis for making renewable energy use claims by the Federal Trade Commission, the U.S. Environmental Protection Agency, the U.S. Federal Energy Regulatory Commission, the U.S. Federal Energy Management Program, the American Bar Association, and at least 35 U.S. states and territories (Jones, Quarrier, and Kelty 2015). RECs are used as accounting mechanisms to comply with power disclosure requirements (Braslawsky, Jones, and Sotos 2016). RECs are also recognized for Scope 2 emissions reduction claims for greenhouse gas accounting purposes (Sotos 2015; CDP 2016; 3Degrees 2018). Third-party

certification and verification services such as Green-e provide further validation for renewable energy use claims. Language from a Federal Trade Commission act (15 USC §45) establishes the fundamental and necessary role of RECs in substantiating renewable energy use claims:

The [REC] represents a property right in the technological and environmental attributes of renewable energy... Generally, one REC represents the right to describe one megawatt [sic] of electricity as “renewable,”⁶ (16 CFR 260 Vol. 72 No. 227)

RECs convey all the clean energy attributes of renewable electricity, including the location and types of generation (e.g., solar and wind). Market best practices dictate that claims should include language about *what* the buyer did (e.g., how many MWh were purchased) and *how* the buyer procured renewables (e.g., the buyer’s financial role in the renewable energy project) (Tawney, Sotos, and Holt 2018).

3.2.2 Increasing Complexity in Claims

Green power products and claims have become increasingly complex as the voluntary green power market has evolved. These two trends are related: increasingly complex products help buyers make increasingly complex claims. For instance, buyers who contractually commit to buying RECs from projects that have yet to be built can make more-complex claims about their roles in project development. The trend toward increasing claim complexity is also driven by a desire for differentiation, especially among corporate buyers. As more corporations made renewable energy use claims, leading buyers began to make efforts to distinguish the impacts of their own procurement practices (Tawney, Sotos, and Holt 2018). The push for differentiation was accelerated by reports such as *Clicking Clean: Who is Winning the Race to Build a Greener Internet?* (Cook et al. 2017) in which the authors analyzed and compared the renewable energy procurement efforts of corporate buyers.

To illustrate this trend toward more-complex claims, we compare public statements about renewable energy use made in corporate social responsibility statements. Note that all the examples we report represent small quotes of text from larger statements on renewable energy use. Our selection of these examples is meant to be illustrative rather than critical.

An example of a basic claim is the following from Starbucks:

Starbucks has invested in renewable energy and achieved a milestone last year by purchasing the equivalent of 100 percent of global company-operated stores’ electricity consumption.—Starbucks

The Starbucks claim simply states that the company has purchased enough RECs to match global company-operated stores’ electricity use. We can contrast this basic claim with two more precise claims:

We have purchased renewable electricity primarily... by buying RECs and entering into green power contracts with various electricity suppliers.—Cisco

⁶ The actual Federal Register language refers to one megawatt, while a REC is a unit of electricity representing one megawatt-hour.

Today we take great pride in becoming the first Fortune 500 company and first bank to sign a long-term agreement to buy as much solar power as we use in a year.—Fifth Third

Like the Starbucks in its claim, Cisco states the company has bought renewable energy without specifying location or technology, but it adds details about precisely how they bought renewables (e.g., RECs and green power contracts). Fifth Third further clarifies that they have bought solar power, specifically. The extended Fifth Third claim includes details about the specific solar project.

These three examples are firmly within market and legal frameworks for renewable energy use claims. However, increasing product complexity has yielded claims that begin to push the boundaries of existing frameworks. Specifically, buyers increasingly try to differentiate their procurement by making claims about procurement *impact*. Consider the following example from Microsoft:

At Microsoft, we have a policy of additionality. We will only purchase a PPA if it adds renewable energy to the grid.—Microsoft

Here, Microsoft—like other buyers—emphasizes the importance of “additionality,” a concept implying a renewable energy purchase results in new capacity that would not otherwise have been installed. While the statement above is not a claim on a specific purchase, implicit in the statement is that all Microsoft PPAs are “additional.”

Consider another statement made by Google related to their procurement goals (emphasis theirs):

We’re carving a path forward to fully decarbonize our electricity supply and operate on carbon-free energy *entirely*. Clean energy every hour, every day, everywhere.—Google

This statement is not a renewable energy use claim, but it could provide a framework for future claims. The line “clean energy every hour, every day, everywhere” refers to the fact that Google plans to implement an emerging type of procurement often known as 24/7: buying green power that geographically and temporally matches the buyer’s load at every hour of the year. There is an implicit claim that 24/7 procurement is more impactful than other procurement approaches. Google states that 24/7 allows buyers to “entirely” decarbonize their supplies, implying that other procurement approaches incompletely decarbonize supplies.

Finally, consider a claim made by Apple:

Over 80 percent of the renewable energy that Apple sources for its facilities are now from Apple-created projects, benefitting communities and other businesses.—Apple

The Apple claim makes a statement on the broader social impact of its green power procurement. Again, the Apple claim goes beyond a simple statement of renewable energy use and offers an analysis of the environmental and social impacts of their procurement.

3.2.3 Challenges

Increasing green power product complexity and claims have enabled buyers to explore new ways to maximize the impact of their procurement. However, increasing claim complexity poses several challenges under existing market and legal frameworks for regulating green power claims. Existing frameworks require quantitative and qualitative claims of renewable energy use to be substantiated by the quantitative and qualitative characteristics of RECs. Increasingly, complex claims push the boundaries of existing frameworks by making qualitative claims beyond those that can be clearly substantiated by RECs.

In the case of impact-based claims such as additionality, it is often unclear how buyers can substantiate specific impacts (Tawney, Sotos, and Holt 2018). For instance, the Microsoft statement asserts that the company will only sign PPAs that “[add] renewable energy to the grid.” However, there is no single accepted methodology for determining when a project is additional. Even in the case of PPAs, an offtaker cannot clearly claim to have added renewable energy to the grid if the project could have sold the power to another offtaker (Sallee 2022). In the absence of a single unifying framework for adjudicating valid claims to additionality, individual buyers may develop their own criteria for additionality claims. Inconsistencies in these criteria could undermine overall confidence in green power claims.

Time-differentiated claims such as 24/7 pose challenges to existing frameworks. There is currently no single definition for 24/7 procurement or set of standards for validating 24/7 claims (LDES Council 2022). RECs could conceivably certify generation on an hourly basis, but there is no existing market or legal basis to validate that a megawatt-hour generated in a specific hour has been matched to a megawatt-hour used by a specific customer in the same hour. The lack of standards could cause market confusion and undermine confidence in 24/7 claims. Though 24/7 claims remain a challenge under existing claims frameworks, it is worth noting that several efforts are underway to develop systems for 24/7 validation. A prominent effort to develop 24/7 standards is the EnergyTag initiative (an independent, non-profit initiative), which aims to verify the purchase of renewable energy at an hourly level. Just as RECs eventually formed a widely accepted basis for green power claims, the widespread adoption of a certification standard such as EnergyTag could eventually lead to a broadly accepted basis for 24/7 claims.

Finally, a third challenge of increasing complexity is claims that go beyond the scope of the REC framework. As recognized by the Federal Trade Commission, RECs convey the “technological and environmental attributes” of renewable electricity. Some buyers use renewable energy procurement to make claims that are not directly related to these technological and environmental attributes, such as Apple’s claim that their procurement benefits communities and other businesses. Though they might be less common today, claims of social benefits may become more common as corporations and other buyers integrate social equity goals into their procurement strategies (Bird, O’Shaughnessy, and Hutchinson 2021). Green power buyers and sellers might need to develop new frameworks and legal bases to validate green power procurement claims that go beyond the technological and environmental attributes of renewable electricity.

4 Voluntary Green Power in a Decarbonizing Grid

The U.S. voluntary green power market emerged in the context of grids with little renewable energy. In 2005, for instance, green power (excluding large hydropower) accounted for just around 2% of U.S. retail electricity sales (EIA n.d.). The voluntary green power market has contributed to the ongoing expansion of renewables, with non-hydropower green power reaching about 23% of U.S. electricity demand in 2021 (EIA n.d.). Under conservative assumptions, DOE (2021) estimates non-hydro renewables will account for around 38% of the grid mix by 2035 and 56% by 2050 (Figure 12). Under scenarios assuming the implementation of ambitious decarbonization policies, DOE (2021) projects non-hydro renewables could account for as much as 75% of the U.S. grid by 2035 and 90% by 2050; actual renewable shares will likely fall somewhere between these two cases.

The progression of renewable energy penetration depicted in Figure 11 reflects an evolving context for the U.S. voluntary green power market. As grids decarbonize, the voluntary green power market might need to adapt to ensure green power products continue to achieve the extent of impacts expected by green power buyers.

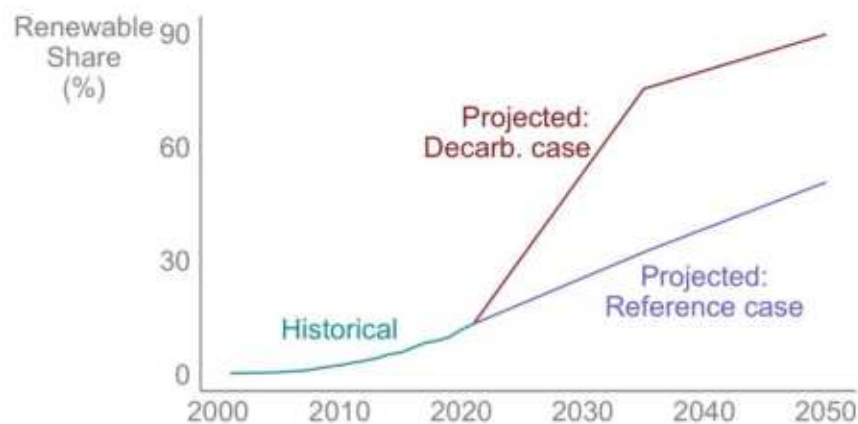


Figure 11. Historical and projected renewable energy shares of the U.S. grid (excluding large hydropower)

Historical estimates are based on EIA (n.d.)/ Projected estimates are based on reference and decarbonization scenarios from DOE (2021).

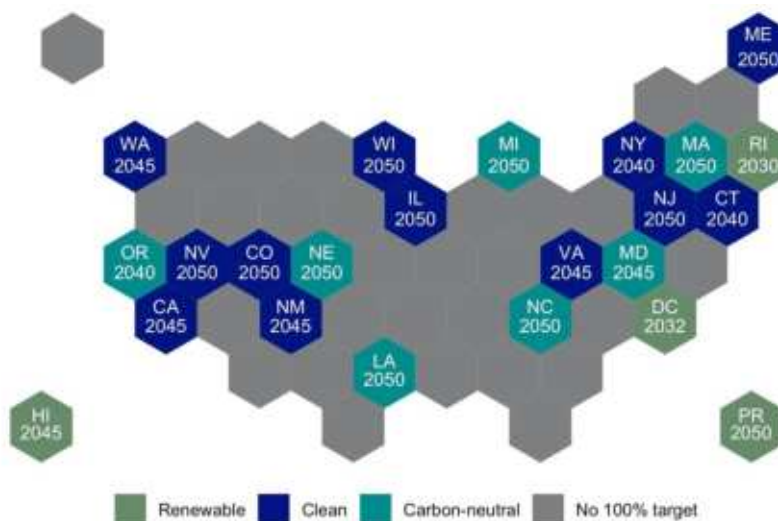
In this section, we explore the implications of ongoing grid decarbonization for the voluntary green power market. And we explore how increasingly renewable grid mixes could change the role of the voluntary green power market and how the market could adapt.

Before proceeding, it is important to establish four considerations for our discussion in this section. First, grid decarbonization is a decades-long process. Even after accounting for increased renewable energy deployment enabled by the Inflation Reduction Act of 2022, the U.S. grid will not likely approach 100% decarbonization even by 2050 (Jenkins et al. 2022). Further, most state-level mandates for 100% renewable or zero-carbon energy do not require 100% decarbonization until 2040 or later (CESA n.d.). Thus, the challenges and trends discussed in this section will play out over decades not years. Second, the following discussion is exclusively prospective and long-term. None of our prospective discussion should be construed as

commentary on historical, current, or near-term aspects of the voluntary green power market. Third, for the sake of simplicity, we use the term “conventional” procurement to refer to broadly accepted prevailing practices for voluntary procurement; however, there is no single definition of conventional procurement. Further, our use of the term “conventional” should not be construed as critical; we simply seek to contrast prevailing practices today with the types of adaptations the market could implement to respond to changing grid needs. Fourth, we restrict our discussion to the potential adaptations and role of the voluntary market on changing grids. Policy and regulatory adaptations will also be required, including policy and regulatory adaptations that could affect the voluntary market (e.g., wholesale electricity market reforms). These policy and regulatory adaptations are outside the scope of our discussion.

4.1 Impacts of Grid Decarbonization on Green Power Market

Grid mixes have become increasingly renewable over time. The renewable share of the national grid mix (including large hydropower) grew from about 14% in 2011 to about 23% in 2021 (EIA n.d.). These shares belie important regional differences. States with strong hydropower resources such as Vermont and Pacific Northwest states already source well over 30% of electricity from renewables (EIA 2020). Further, as of June 2022, 12 states had mandates for 100% clean energy supplies, 2 states, Washington, DC, and Puerto Rico had mandates for 100% renewable energy, and 7 states had carbon neutrality targets (Figure 13) (CESA n.d.). These mandates will most likely be met largely by renewables, primarily solar and wind (DOE 2021), though some mandates allow for nonrenewable, zero-carbon resources such as nuclear.



renewable grid mixes could therefore drive some customers to stay with or return to the grid mix.

- *RPS increases could suppress voluntary demand by increasing voluntary REC prices.* Electricity suppliers and green power buyers compete to buy RECs from a common pool such that increased RPS-driven demand can increase prices in the voluntary green power market and vice versa. Competition between the compliance and voluntary markets has been mild to date because renewable energy supplies have generally kept pace with demand in both markets. However, as grids approach 100% clean energy, RECs may become increasingly scarce. In a future of increasing REC scarcity, voluntary REC prices could correlate more strongly with compliance REC prices, with the most likely outcome being an increase in voluntary REC prices. These higher prices will, all else being equal, suppress green power demand among price-sensitive buyers.

4.2 Evolving Grid Needs

Voluntary green power market have driven grid decarbonization to date by enabling the deployment of renewable energy capacity. As grids decarbonize, the needs of grids evolve in ways that affect the potential role of voluntary markets in future decarbonization. To understand this assertion, it is useful to think of grid decarbonization as an evolving process that can be roughly broken down into three phases:

- **Phase 1: Low (e.g., <50%) Renewable Energy Shares:** The first phase is characterized by grids with relatively low (e.g., <50%) shares of renewable energy. Most grids are currently in this first phase. In this first phase, the decarbonization strategy is relatively straightforward: deploy low-cost renewables—mostly wind and solar—to displace fossil fuel output.
- **Phase 2: Increasing (e.g., 50%–90%) Renewable Energy Shares:** As wind and solar comprise greater shares of the grid, wind and solar supply variability begin to generate more significant issues for grid reliability (Denholm et al. 2021). At higher renewable energy penetration levels (e.g., >50%), grids may need to reinforce certain types of grid infrastructure (e.g., transmission), increase operating reserves to balance fluctuations in variable renewable energy supply, and deploy more energy storage. A few U.S. grids—such as those in California and Hawaii—have begun to make these types of investments in response to increasing renewable energy shares.
- **Phase 3: Deep Decarbonization (>90% Renewable Energy):** The challenges of renewable energy penetration increase manifold as grids approach high renewable energy penetration levels (Figure 14) (DOE 2021), a stage often referred to as “deep decarbonization.” Deep decarbonization will require investments in technologies and infrastructure that were not required during earlier phases of decarbonization, including firm clean energy (e.g., nuclear, biomass, geothermal, and hydrogen), long-term energy storage, and more substantial investments in transmission (Denholm et al. 2021).

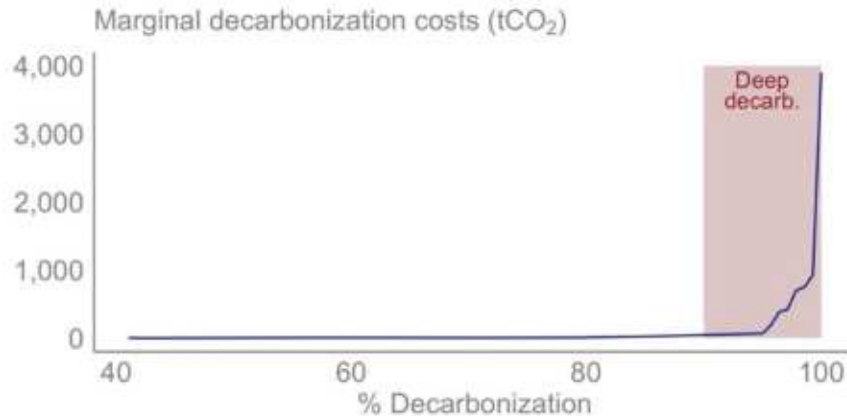


Figure 13. Exponentially increasing decarbonization costs

The figure is based on data from DOE (2021).

Voluntary markets have largely evolved to meet the needs of grids in the first phase, by developing ways to help customers procure enough green power to meet their demand, primarily solar and wind. As grids decarbonize, the potential role and impacts of voluntary procurement in subsequent decarbonization phases changes for several reasons:

- Impact Crowding:** Conventional green power procurement practices tend to favor resources that allow customers to match renewable energy demand at the lowest possible cost, which typically means solar and wind. Over time, demand for low-cost solar and wind causes projects to cluster in areas with strong solar and wind resources. Project clustering causes the marginal impacts of projects to decline as more solar and wind projects come online. For instance, the first wind farm in a region will displace more fossil fuel output than the tenth wind farm in that region, all else being equal. *Conventional procurement practices do not account for these diminishing marginal impacts.*
- Non-Generation Service Requirements:** As renewable energy penetration increases, non-generation services (e.g., reserve capacity, frequency regulation, and voltage control) become increasingly important for balancing variable supply and variable demand (Denholm et al. 2021). Given that non-generation services do not count toward matching customer renewable energy demand, *conventional green power procurement practices provide no incentives for non-generation services.*
- Need for Firm Clean Energy Capacity:** Firm clean energy resources are clean energy generators whose output is available on call to respond to grid needs. Examples of firm clean energy resources include geothermal, low-impact hydropower, concentrating solar power, biofuels, nuclear (under certain definitions), and emerging technologies such as hydrogen combustion turbines. Firm clean energy will become increasingly important for deep decarbonization as these resources can be ramped up or down to balance supply and demand (Denholm et al. 2021; DOE 2021). Firm clean energy resources generally come at a cost premium to variable resources (e.g., solar and wind) in terms of energy costs (\$/MWh). *Conventional procurement practices that prioritize low-cost renewables are unlikely to make a significant contribution to firm clean energy capacity.*
- Need for Energy Storage:** Energy storage will become increasingly vital on decarbonizing grids (Denholm et al. 2021; DOE 2021). Energy storage can store and shift variable

renewable energy, essentially converting variable resources like solar and wind into firm clean energy capacity. *Conventional procurement practices provide no incentives for battery storage*, given that buyers use RECs at the point of generation and glean no additional value from storing and shifting the underlying electricity.

These limitations of conventional green power procurement largely reflect the limited role of retail electricity customers in grid decarbonization. Green power buyers—like all retail electricity customers—are not directly responsible for ensuring their electricity use aligns with grid needs, which are the purview of regulated utilities, system operators, and policymakers. Still, buyers could adapt their procurement practices in ways that meet the evolving needs of utilities and system operators. These potential adaptations are the topic of the next section.

4.3 How the Green Power Market Could Adapt

In this section, we explore how the voluntary market might adapt to the changing needs of decarbonizing grids. Before proceeding, it is worth noting that the discussion in this section is strictly prospective: *it should not be interpreted as analysis of historical or current voluntary green power market practices*. Further, some proposed adaptations conflict with existing voluntary market practices and definitions. The discussion here should be interpreted as a menu of ideas that are not yet broadly accepted by all market stakeholders. Finally, much of the literature discussed in this section focuses on market adaptations for larger buyers and especially large corporate buyers. As we discussed in Section 3.1.1 (page 9) and Section 3.1.2 (page 11), a key challenge for the market will be finding ways to engage smaller and mid-sized buyers as the market adapts.

Voluntary green power buyers and suppliers have frequently adapted to changing market conditions and could similarly adapt to changing grid needs. Adapting to changing grid needs as grids approach 100% clean energy would require a reassessment of the objectives of green power procurement. Under conventional procurement practices, customers generally match RECs to their demand to make claims about their *own* renewable energy use. Bird, O’Shaughnessy, and Hutchinson (2021) argue procurement objectives will need to shift toward actions designed to transform and decarbonize the grid itself. They state that transformative procurement (1) maximizes emissions reductions, (2) accelerates clean energy deployment, (3) enables broader clean energy adoption, (4) supports new technologies and innovations, and (5) enables an equitable and just clean energy transition. Table 3 defines these impacts and describes how transformative procurement practices differ from conventional procurement practices. See Bird, O’Shaughnessy, and Hutchinson (2021) for detailed descriptions and examples of each of these impact categories.

Table 3. Comparison of Conventional and Transformative Procurement Impacts

Impact	Conventional Procurement Practices	Transformative Procurement
Emissions reductions	All procurement can reduce emissions, but conventional products are not designed to maximize emissions reductions.	Transformative procurement includes approaches that are explicitly designed to maximize emissions reductions, such as by prioritizing deployment on carbon-intensive grids or prioritizing technologies that generate more output during carbon-intensive times of the day or year.
Clean energy deployment	Many conventional products support existing projects.	Transformative procurement directly supports the deployment of new clean energy capacity at a faster pace than required by RPS.
Clean energy adoption	Conventional buyers procure green power to maximize the strength of their own claims.	Transformative buyers take actions that enable other customers to buy their own clean energy. For instance, procuring energy storage can make renewable energy projects more flexible, making it easier for other buyers to add more renewable energy onto the grid.
Enabling technologies and innovation	Conventional procurement is mostly based on RECs from solar and wind projects.	Transformative buyers support the broader suite of technologies required for deep decarbonization, including firm renewable energy (e.g., geothermal), energy storage, and grid infrastructure projects.
Enabling and equitable and just clean energy transition	Conventional buyers do not typically consider the broader societal impacts of green power procurement.	Transformative buyers seek opportunities for broader societal benefits, such as supporting minority-owned businesses and engaging with local communities to maximize the local benefits of project development.

Building on the transformative practices identified by Bird, O’Shaughnessy, and Hutchinson (2021), we identify three ways the voluntary green power market could adapt to grid decarbonization (Table 4). We explore each of these potential adaptations in depth in the remainder of this section. We begin our discussion with the adaptation closest to conventional procurement practices (customer-aligned procurement) and then move onto two adaptations entailing more-fundamental shifts from conventional procurement practices.

Table 4. Potential Green Power Procurement Adaptations

Approach	Description	Comparison with Conventional Procurement
Customer-aligned procurement (Section 4.3.1)	Practices that force buyers to procure resources that match the geographic and temporal profiles of customer electricity use	Conventional procurement matches green power supply to demand on a coarser basis, typically through annual matching without specific requirements for resource location.
Grid-aligned procurement (Section 4.3.2)	Procurement practices designed to maximize the impacts of green power on the grid (e.g., MW deployed) or for the environment (e.g., tons of CO ₂ abated)	Conventional procurement does not explicitly aim to maximize impacts on the grid or environment.
Socially motivated procurement (Section 4.3.3)	Procurement designed to achieve specific social benefits	Conventional frameworks do not incentivize socially motivated procurement.

4.3.1 Customer-Aligned Procurement

For the purposes of this report, customer-aligned procurement refers to green power that aligns with the location and timing of the electricity demand of individual customers. Customer-aligned procurement is essentially a sophisticated form of matching that forces buyers to match renewable energy supply to demand geographically and on an hourly or subhourly basis rather than an annual basis. In this regard, customer-aligned procurement is a relatively simple adaptation of conventional procurement.

Customer-aligned procurement can increase green power impacts by forcing buyers to procure more diverse resource portfolios than those driven by conventional procurement (Miller 2020; Xu et al. 2021).⁷ To align procurement and demand profiles, buyers must ensure green power is available even when the sun is not shining or the wind is not blowing. Customer-aligned procurement could therefore drive investments in the types of resources required for deep decarbonization, such as firm clean energy and battery storage (Xu et al. 2021; LDES Council 2022).

Another way to achieve customer-aligned procurement is to reshape customer demand profiles according to solar and wind output (Miller 2020; Bird, O’Shaughnessy, and Hutchinson 2021). Customers can reschedule or shift certain loads to hours when more solar or wind is available, thus better aligning procurement and demand profiles without needing to procure costlier green power resources. There are many ways to reshape demand profiles, ranging from simple and manual—e.g., a household choosing to run a laundry machine during the day—to complex and automated—e.g., data centers shifting computing operations to optimize the use of clean energy at different points on the grid.

⁷ Note that an enhanced impact is not inherent to customer-aligned procurement. For instance, a business that uses most power during the day could theoretically achieve 24/7 matching buying mostly solar power. In such cases, the impacts of 24/7 procurement would not be fundamentally different from the impacts of annual matching. The impacts of customer-aligned procurement should thus be evaluated on whether aligned procurement forces buyers to procure a more diverse portfolio of renewable resources.

Efforts to create a voluntary green power market based on customer-aligned procurement are at an early stage. Only large, sophisticated buyers such as Google, Microsoft, and the U.S. federal government are seriously pursuing customer-aligned procurement practices such as 24/7 procurement (Xu et al. 2021). The primary challenge to scaling customer-aligned procurement is developing a framework through which customers are credited for aligned hourly supply and demand (LDES Council 2022). Initiatives such as EnergyTag have begun to explore potential frameworks. Another key question is whether and how to account for temporal profiles of renewable supply on the grid mix. For instance, should customers somehow be credited for shifting demand to times of day when the grid mix is more renewable, such as midday hours in solar-heavy regions? Such questions will shape the future design of voluntary markets for customer-aligned procurement.

The key distinguishing feature of customer-aligned procurement is that its objectives are defined exclusively by customer needs. Customer-aligned procurement is designed to reduce *individual* emissions and maximize *individual* claims to renewable energy use in ways that benefit the grid. The remaining adaptations shift the focus toward metrics based on the grid or society at large.

4.3.2 Grid-Aligned Procurement

Grid-aligned procurement refers to strategies to achieve specific outcomes on the grid. Grid-aligned procurement actions include strategies that change where, when, and which types of clean energy technologies are deployed.

Buyers can align procurement with grid needs by adjusting *where* green power is procured. A clear example of the role of location in driving procurement impact is spatial differences in grid emissions intensity (tons of CO₂ emitted per MWh of electricity). The emissions intensity of the U.S. grid varies by nearly a factor of seven in the continental United States, from about 0.1 tons of CO₂ (tCO₂)/MWh in upstate New York to about 0.7 tCO₂/MWh in eastern Wisconsin. Buyers can leverage these differences by strategically siting green power on carbon-intensive points on the grid to maximize the impacts of green power procurement.

Buyers can also align procurement with grid needs by adjusting *when* green power is procured. Just as grid emissions vary at different points on the grid, emissions also vary over time. For instance, the emissions intensity of the California grid can vary by roughly a factor of two over the course of a single day due to the daytime availability and nighttime absence of solar power (Figure 15). Green power buyers can maximize the temporal impacts of their procurement by prioritizing technologies that generate during emissions-intensive periods. In some cases, this may mean complementing solar with wind or vice versa. A more effective approach would be to prioritize firm clean energy resources that can generate at any time or to add battery storage to solar or wind projects. Further, buyers can work with project developers to operate projects in ways that maximize the temporal impacts of green power. For instance, in the California example, a buyer could add storage to a solar project and shift some solar output to the late-afternoon peak.

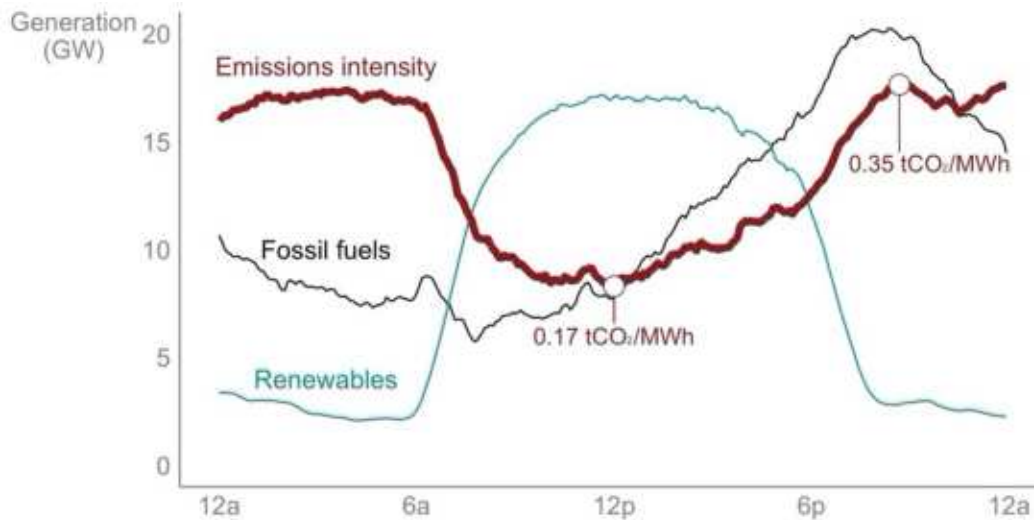


Figure 14. Generation profiles and grid emissions intensity in California on June 21, 2022

The figure is based on data from “Today’s Outlook” from the California ISO.

A final form of grid-aligned procurement is actions to determine *which* types of technologies are deployed. As already noted, decarbonizing grids will require increasing resource diversity. One way buyers can support resource diversity is by enabling emerging clean energy technologies (Bird, O’Shaughnessy, and Hutchinson 2021). Green power buyers can enable new technologies in several ways:

- *Be early adopters of new technologies.* Most emerging technologies rely on early adopters who take risks on uncertain and unproven new products. Early adoption drives technological diffusion when costs are high, allowing industries to find ways to reduce costs through scale and innovation. Buyers can be early adopters of risky new technologies, some of which will scale and drive decarbonization.
- *Demonstrate new technologies.* Buyers could work directly with researchers or suppliers to demonstrate new and emerging technologies at small scales. For instance, some buyers are exploring small-scale demonstrations of carbon capture technologies (Bird, O’Shaughnessy, and Hutchinson 2021). Demonstrations may have negligible impacts on buyer emissions profiles but help emerging technologies to scale and make meaningful contributions to grid decarbonization.
- *Develop products that enable new technologies.* Buyers and suppliers can develop new products that enable emerging technologies. For instance, as already noted, conventional products provide no incentives for battery storage. Buyers and suppliers could develop products that credit buyers for the extra value generated from battery storage used in ways to benefit the grid or reduce emissions.

Grid-aligned procurement requires market products, practices, and protocols that incentivize buyers to take actions that meet grid needs. One example is the Greenhouse Gas Protocol, which allows buyers to use green power to reduce their emissions (for reporting purposes) based on grid emissions intensity at the point of green power generation (Sotos 2020). The Greenhouse Gas Protocol thus provides incentives for these buyers to procure green power that maximizes emissions. Some green power buyers are also exploring how to align procurement plans with grid needs by collaborating with utilities in long-term grid planning (Bonugli et al. 2021). Direct

procurement products, such as PPAs, are inherently sensitive to grid needs given that products that better serve the grid can obtain higher market prices. Utilities and competitive suppliers could potentially explore ways to better align small buyer products (e.g., utility green pricing) with grid needs.

4.3.3 Socially Motivated Procurement

Grid decarbonization will yield enormous benefits as well as costs (DOE 2021). The benefits and costs of grid decarbonization will not necessarily be distributed equitably with respect to factors such as income and race (Carley and Konisky 2020). Governments are increasingly exploring and implementing measures to drive more equitable distributions of clean energy benefits and costs. Voluntary green power buyers could similarly factor social equity and justice into their procurement actions. Examples of socially motivated procurement include:

- **Equitable Siting:** Buyers can prioritize project sites that maximize equity benefits. In some cases, this means supporting projects deployed in disadvantaged communities that generate local benefits for those communities. For instance, solar projects in disadvantaged communities can provide additional tax revenues, lease revenues, and temporary local jobs. In other cases, this means avoiding procurement from projects associated with procedural injustices. For instance, buyers could avoid enabling projects that were opposed by Indigenous communities.
- **Equitable Project Development:** Buyers can maximize the equity benefits of project development. For example, beginning with their supply chain, buyers can prioritize product developers that source parts from manufacturers with sustainability statements or from minority-owned businesses. During development, green power buyers can promote local hiring, workforce diversity, and educational opportunities (Bird, O'Shaughnessy, and Hutchinson 2021).

Of the three adaptations discussed in this section, socially motivated procurement represents the most fundamental shift from conventional procurement practices. Socially motivated procurement would require new market and legal frameworks to validate social claims (see also Section 3.2, page 14). Some early efforts provide testing grounds for potential solutions. For instance, multiple organizations now offer RECs coupled with social attributes, such as social RECs for projects developed in disadvantaged communities and so-called peace RECs for projects in areas recovering from war. These or similar frameworks could be scaled to provide buyers a way to drive a more equitable clean energy transition through socially motivated procurement.

5 Conclusions and Observations

The U.S. voluntary green power market continues to grow. We estimate that in 2021 about 8 million customers procured around 244 million MWh of green power, a 22% increase from 2020. The market owes its continued growth partly to the ongoing adaptations of green power products to evolving customer and grid needs. We conclude with four observations from our report:

- *Green power demand continues to grow across all products.* Growth is particularly strong for the products that offer direct procurement from specific projects: utility contracts and PPAs. Utility contracts and PPAs both have substantial pipelines that ensure continued growth into the foreseeable future.
- *Expanding green power access to smaller buyers is a soluble challenge.* In Section 3 (page 9), we identified some emerging challenges to improving existing products and expanding green power market access, particularly to smaller buyers. These challenges are soluble. Some utilities and other green power suppliers have already developed innovative new products that expand green power market access. Innovative new green power products, where successful, could provide a template for other suppliers to implement. Expanded product access could provide a way to engage a more diverse customer base, including LMI customers.
- *The green power market has adapted to the evolving needs of customers and grids.* The U.S. voluntary green power market has consistently demonstrated an ability to adapt. In the past decade, buyers and sellers have worked together to spawn a variety of new products that meet unique buyer needs and, in some cases, might ensure more substantial grid and environmental impacts. There has been a marked shift toward products that directly connect buyers with power and RECs from specific projects through PPAs and utility renewable contracts. More recently, buyers and sellers have begun working together to develop products that meet the evolving needs of grids, such as designing 24/7 products that ensure green power is delivered to grids when renewable energy is scarcer.
- *The green power market can play a role in deep decarbonization.* In Section 4 (page 18), we discussed how deep grid decarbonization will pose new and unique challenges to the voluntary green power market. The ongoing ability of the green power market to adapt suggests the market will adapt to evolving grid needs and play a role in deep decarbonization. Buyers and sellers could develop new products catered to the specific needs of grids with higher levels of baseload renewable energy, such as products that support firm clean energy and battery storage. By continuing to adapt to the needs of an evolving grid, the voluntary green power market could continue to play a long-term role in grid decarbonization.

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Evidence Submission 2



The Legal Basis for Renewable Energy Certificates

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Introduction

This report summarizes the legal basis for renewable energy certificates (RECs)¹ and the extent to which RECs have been integrated into and upheld by the U.S. legal system. A REC is a tradeable certificate representing the holder's legally recognized property right in the environmental attributes associated with the generation of one-megawatt hour of electricity by a renewable resource.² Each REC is a unique certificate that may be traded independently from the underlying electricity, and each REC can be retired by or on behalf of its owner in order to claim usage of the renewable generation represented by the REC. RECs are not controlled by any one organization or group of organizations, and neither are they instruments of recognition or donation. Rather, RECs are a necessary part of the machinery of U.S. electricity markets, used to demonstrate renewable electricity purchasing, delivery, and use.³

RECs are used in two types of markets in the U.S. "Voluntary" markets primarily serve the demand of corporate, institutional, and individual purchasers who wish to purchase renewable energy to meet a variety of environmental and economic goals. "Compliance" or "mandatory" markets are created by law, most often by a state renewable portfolio standard (RPS), that typically require that a certain percentage of electricity sold to consumers is supplied with renewable resources.

State Law

State law underpins the legal basis of RECs transacted in both markets. While RECs throughout the U.S. represent the environmental attributes of renewable electricity generation, state laws vary with respect to the precise definition of RECs. State statutes and regulations differ with respect to defining the environmental attributes that are represented by a REC. The "environmental attributes" recognized by a particular state may include any combination of the following: the renewable energy source, the geographic location of the facility, the avoidance of emissions and/or local pollution associated with the generation of renewable power, the facility's contributions to workforce development, as well as many other environmental, economic, and social benefits.⁴ State laws and regulations also vary with respect to regulatory compliance eligibility. Many states only recognize RECs generated within the state or its regional tracking system for the purposes of RPS compliance,⁵ while some impose little to no geographic restrictions. Others will recognize out-of-state RECs but provide incentives or multipliers on the value of the REC to encourage in-state renewable energy generation.⁶ States may also establish multiple categories of RECs, some of which provide additional incentives for the procurement of RECs from particularly desirable renewable sources.⁷

While these variations exist, the core mechanics of how RECs function are remarkably consistent. As shown in this report, the significant majority of states, multiple governmental entities at different levels, regional transmission electricity authorities, non-governmental organizations (NGOs), trade associations, and market participants⁸ have recognized that RECs represent the renewable, environmental and/or social

attributes of renewable electricity generation to the owner, along with the legal right to claim usage of that renewable electricity. These entities recognize further that without RECs such a claim could not otherwise be substantiated⁹ by utilities and electric service providers meeting compliance market requirements or by other entities and individuals meeting voluntary emissions targets.

- Thirty-eight (38) U.S. states and territories recognize or have recognized that RECs can be used to track and transact the environmental attributes of renewable electricity injected on the grid and that RECs can be used to demonstrate compliance of regulated entities with RPS or similar laws requiring provision of renewable electricity to grid customers, or participation in voluntary state programs for provision of renewable electricity to grid customers.¹⁰
- Twenty-four (24) U.S. states and territories explicitly recognize RECs as representing “attributes” of generation (or similar);¹¹ twenty-two (22) recognize them as mechanisms for “tracking” or “trading” (or equivalent) electricity or attributes;¹² eighteen (18) describe them as representing electricity or energy “generation” (or equivalent);¹³ four (4) recognize them as “proof of generation,” or equivalent;¹⁴ and five (5) explicitly identify RECs as “property.”¹⁵

In a transactional context, RECs can be sold either separately from the electricity they are associated with (often referred to as “unbundled” RECs) or with the electricity they are associated with (often referred to as “bundled” renewable energy). To effectuate this transactional structure, RECs are inventions of state RPS and property laws whereby the renewable energy generation attributes are always distinct or “unbundled” from the electricity itself and can be transacted together with electricity from the same source, transacted with electricity from a different source, or sold separately and paired to electricity procured through a separate transaction, at the wholesale or retail level and by electricity providers or customers. As such, states set eligibility requirements to focus on various attributes which they deem to be especially relevant.¹⁶ For example, according to the State of Iowa:

Because of the laws of physics that govern operation of the electric transmission system, it is impossible to ensure that electricity produced by a particular renewable source is specifically and exclusively directed, in a physical sense, to the purchasing entity. An accounting system that verifies compliance must therefore rely on an agreed-upon abstract medium of exchange similar to the way the financial markets rely on money to represent value. In the renewable energy area, Tradable Renewable Certificates (TRCs) have been developed as a medium of exchange representing the renewable attributes of renewable energy. TRCs can be used to show compliance with energy-based RPS mandates.¹⁷

According to the State of New York, which began developing its certificate-based tracking system—NYGATS—in 2012:

Unbundling [energy from its environmental attributes] allows NYSERDA, as the RPS Program's central procurement administrator, to acquire environmental attributes from generators instead of the rights that prevent generators from selling or transferring their environmental attributes to others. Increased control of the attributes can provide more assurance that double counting of attributes is avoided. If a certificate-based tracking system is developed, then the title to the environmental attributes could be in the form of renewable energy certificates (RECs), which would be easily transferred to NYSERDA as proof of its acquisition of renewable attributes. Thus, unbundling of attributes has the potential of strengthening significantly the market for renewable energy and opportunities for achieving the objectives of the RPS Program.¹⁸

Tracking Systems

Renewable energy tracking and certificate-issuing entities cover the whole of the lower 48 states and multiple provinces in Canada. These tracking systems include the Electric Reliability Council of Texas (ERCOT), Michigan Renewable Energy Certification System (MIRECS), Midwest Renewable Energy Tracking System (M-RETS), North American Renewables Registry (NAR), North Carolina Renewable Energy Tracking System (NC-RETS), New England Power Pool Generation Information System (NEPOOL-GIS), Nevada Tracks Renewable Energy Credits (NVTREC), New York Generation Attribute Tracking System (NYGATS), PJM EIS's Generation Attribute Tracking System (PJM-GATS), and the Western Renewable Energy Generation Information System (WREGIS). With the exception of the North American Renewables Registry (NAR), all of the tracking system entities were established with the support of U.S. states, which have designated specific tracking systems to be used for issuing and tracking certificates and verifying compliance with state policies or programs.

- Seven (7) of these regional tracking systems define their certificates explicitly as “attributes” of renewable generation.¹⁹ ERCOT requires that RECs must be associated with physically metered renewable energy and verified within the State of Texas. PJM-GATS and the NYGATS tracking systems have “generation attribute” as a part of the name of the entity—Generation Attribute Tracking System.
- All define their instruments as the mechanisms for “tracking” or “trading” (or equivalent) attributes or proof of generation for the purposes of compliance with state programs and/or voluntary programs.²⁰

Federal Law

While there is no single federal REC definition, several federal regulatory agencies have defined, characterized, and recognized RECs. According to the U.S. Federal Trade Commission (FTC), a REC “represents a property right in the technological and environmental attributes of renewable energy.”²¹ The

U.S. Environmental Protection Agency (EPA) has defined a REC as “a tradeable, market-based instrument that represents the legal property rights to the ‘renewable-ness’—or non-power (i.e., environmental) attributes—of renewable electricity generation.”²² The U.S. Commodity Futures Trading Commission (CFTC) has clarified that RECs are a “nonfinancial commodity,”²³ meaning one that “can be physically delivered.”²⁴ As such, it is an “exempt commodity.”²⁵ According to the CFTC:

The CFTC understands that market participants often engage in environmental commodity transactions in order to transfer ownership of the environmental commodity (and not solely price risk), so that the buyer can consume the commodity in order to comply with the terms of mandatory or voluntary environmental programs. Those two features—ownership transfer and consumption—distinguish such environmental commodity transactions from other types of intangible commodity transactions that cannot be delivered, such as temperatures and interest rates. The ownership transfer and consumption features render such environmental commodity transactions similar to tangible commodity transactions that clearly can be delivered, such as wheat and gold. [...] For the foregoing reasons, environmental commodities can be nonfinancial commodities that can be delivered through electronic settlement or contractual attestation. Therefore, an agreement, contract or transaction in an environmental commodity may qualify for the forward exclusion from the swap definition if the transaction is intended to be physically settled.²⁶

The U.S. Federal Energy Regulatory Commission (FERC) has also recognized that RECs can be “unbundled” and traded separately from the energy and capacity associated with the generation.²⁷ In a later hearing, FERC concluded that unbundled REC transactions fall outside of FERC’s jurisdictional authority and instead are under the exclusive jurisdiction of the states, holding that RECs are “state-created and state-issued instruments certifying that electric energy was generated pursuant to certain [state] requirements and standards.”²⁸

On Oct 1, 2003, FERC issued an order declaring that avoided cost contracts entered into pursuant to PURPA, absent express provisions to the contrary, do not inherently convey to the purchasing utility any RECs.²⁹ Rather, the power purchase price that the utility pays under such a contract compensates a generation facility only for the energy and capacity produced by that facility and not for any environmental attributes associated with the facility. FERC later reaffirmed this order by denying a request for rehearing in 2004:

[Those seeking a rehearing] oppose having this Commission rule that contracts for the sale of QF [Qualifying Facility] capacity and energy entered into pursuant to PURPA convey only the capacity and energy, and do not convey RECs, to the purchasing utility (absent express provision in the contracts to the contrary). We disagree.³⁰

If avoided cost rates are not intended to compensate a QF for more than capacity and energy, it follows that other attributes associated with the facilities are separate from, and may be sold separately from, the capacity and energy. Indeed, states in creating RECs that are unbundled and tradeable have recognized this. The very fact that RECs may be unbundled and may be traded under State law indicates that the environmental attributes do not inherently convey pursuant to an avoided cost contract to the purchasing utility.³¹

[W]e note that cogeneration facilities, to receive QF status, are required to produce both electricity and useful thermal output. [...] The thermal output that is a pre-requisite to a cogeneration facility's achieving QF status is saleable separately from the capacity and energy of the cogeneration facility. [...] If the thermal output of a cogeneration QF is separately saleable, the renewable attributes of a small power production QF are similarly separate.³²

The U.S. EPA recognizes unbundled RECs as well:

Retail renewable energy certificates (RECs) are sold, delivered, or purchased separately from electricity (commonly referred to as "unbundled"). They represent proof of renewable electricity delivered to the grid and represent the environmental effect or energy attributes of that renewable electricity. RECs are a marketable commodity that are in demand with electric utilities and large and small electricity consumers (e.g., residential, commercial, and industrial) [...].³³

Caselaw Addressing RECs

Federal courts, state utility commissions, and state courts have broadly recognized that RECs are part of the compliance regime for state RPS programs. Various challenges have been brought to state RPS programs and similar requirements over the years, frequently citing violations of Commerce Clause violations on the theory that regulated entities, such as utilities, obtain an increasing proportion of their electricity from renewable sources, which can be accomplished through RECs, which have been nearly uniformly dismissed.³⁴

For example, in 2017, the Second Circuit Court of Appeals upheld Connecticut's REC program that gave preference to RECs generated in the control territory of its regional independent system operator, ISO-NE or an adjacent territory over RECs generated elsewhere, stating:

*RECs are inventions of state property law whereby the renewable energy attributes are 'unbundled' from the energy itself and sold separately. As such, different states define RECs differently, focusing on various attributes which they deem to be especially relevant.*³⁵

State courts have recognized the general purpose and intent of RECs. For example, the Superior Court of New Jersey has recognized that "One Renewable Energy Certificate represents the environmental benefits or attributes of one megawatt-hour of generated renewable energy," and RECs are considered "property."³⁶

The Connecticut Supreme Court has recognized that:

*The certificates verify that specified units of electricity have been generated using renewable fuel or have been produced with low emissions and, pursuant to state law, can be purchased to satisfy the state renewable energy requirements. See General Statutes § 16-245a (b). Thus, the certificates effectively "unbundled" the renewable energy attribute of the electric product from the generic energy component for accounting purposes and allowed them to be traded separately.*³⁷

The United States Court of Appeals, Second Circuit has recognized that:

*Generally speaking, RECs are inventions of state property law whereby the renewable energy attributes are "unbundled" from the energy itself and sold separately. The credits can be purchased by companies and individuals to offset use of energy generated from traditional fossil fuel resources or by government agencies to satisfy certain requirements that these agencies purchase a certain percentage of their energy from renewable sources.*³⁸

The Armed Services Board of Contract Appeals (ASBCA), the body that resolves contract disputes between government contractors and the U.S. Military, also agrees that RECs, "are personal property, given their exclusive nature and transferability," and on this basis denied an appeal in August of 2013 to a delivery order that characterized RECs as "energy savings."³⁹ The Board found that RECs are not simply financial incentives offered by New Jersey relating to the generation of renewable energy that constitute energy savings. Rather, "[solar RECs or] SRECs simply reflect the clean, renewable aspect of electricity produced by a solar facility."⁴⁰ It found that although the electricity produced by a solar array reduces the amount of energy the owner must purchase, and though RECs may generate revenue that could be used to pay energy costs, the certificates themselves do not reduce those energy costs.⁴¹ Furthermore, the ASBCA found that even were the definition of energy savings to be expanded to include the sale of excess electricity generated by solar facilities, "SRECs are not electrical energy. They are marketable certificates,

representing the clean, renewable nature of a solar facility's electrical production that has been severed from the electricity for the very purpose of being sold separately.”⁴²

Voluntary Usage of RECs

The ability of RECs to demonstrate the voluntary usage of renewable electricity and the attributes of its production is recognized by the U.S. Department of Defense (DOD), U.S. EPA, the U.S. DOE, the U.S. FTC, The Climate Registry, the CDP (formerly the Carbon Disclosure Project), and Center for Resource Solutions (CRS) among others.

- Under federal law, the U.S. DOD is permitted to purchase RECs to meet its renewable energy procurement goals, and the Secretary of Defense is statutorily required to establish and maintain a “policy to maximize savings” for the purchase of RECs.⁴³
- The U.S. EPA has recognized RECs as “market-based instrument[s] that represent the property rights to the environmental, social, and other non-power attributes of renewable electricity generation”⁴⁴ which “provide an essential accounting and tracking function in renewable energy and green power claims.”⁴⁵ The EPA has identified RECs as the “only mechanism available” to both demonstrate (1) compliance with state RPS, and (2) voluntary renewable energy use that is “incremental” to state RPS requirements.⁴⁶
- The White House Council on Environmental Quality (CEQ) defines a REC as “the technology and environmental (non-energy) attributes that represent proof that 1 [MWh] of electricity was generated from an eligible renewable energy resource” and affirms that a REC “can be sold separately from the underlying generic electricity with which it is associated.”⁴⁷ RECs, as a type of Energy Attribute Certificate (EAC) for renewable resources, are required for all renewable energy purchasing by federal agencies in the 2022 Implementing Instructions for Executive Order 14057.⁴⁸
- The Environmental Markets Association (EMA) recognizes RECs as “the property rights to the environmental benefits from generating electricity from renewable energy sources” that “can be sold and traded and the owner of the REC can legally claim to have purchased renewable energy.”⁴⁹
- The American Bar Association (ABA) has recognized that “parties can create a record of the verification and disposition of the environmental attributes of the REC that can travel with further downstream transactions in the particular REC.”⁵⁰
- According to the U.S. FTC, “If a marketer generates renewable electricity but sells renewable energy certificates for all of that electricity, it would be deceptive for the marketer to represent, directly or by implication that it uses renewable energy.”⁵¹ To date, the FTC has not brought an enforcement action for a claim related to the use of renewable energy⁵², despite petitions for investigation.⁵³
- The U.S. CFTC recognized that “market participants often engage in environmental commodity transactions in order to transfer ownership of the environmental commodity (and not solely price

risk), so that the buyer can consume the commodity in order to comply with the terms of mandatory or voluntary environmental programs.”⁵⁴

- The legitimacy of voluntary renewable energy usage and ownership claims through RECs was recognized by the California Energy Commission in 2010, when they ruled that a claim against RECs by a utility after the RECs had already been claimed by voluntary purchasers is not allowed as it would lead to a double-recovery.⁵⁵

According to the U.S. FTC:

*Once renewable electricity is introduced into the grid, it is physically indistinguishable from electricity generated from conventional sources. Accordingly, consumers cannot determine the source of the electricity flowing into their homes and businesses. However, because electricity transactions can be tracked, entities can "buy" renewable power by purchasing power bundled with RECs. Under the REC system, a renewable electricity generator splits its output into two components: (1) the electricity itself (i.e., "null" electricity); and (2) certificates representing the renewable attributes of that electricity. Generators that produce renewable electricity sell their electricity at market prices for conventionally produced power and then sell the renewable attributes of that electricity through separate certificates. Organizations purchase these RECs to characterize all or a portion of their electricity usage as "renewable" by matching the certificates with the conventionally-produced electricity they normally purchase. By allowing these certificates to be sold separately and not requiring the renewable attribute to remain attached to the generated electricity, the REC approach provides flexibility and efficiency for the renewable electricity market.*⁵⁶

And further:

[T]he operation of the renewable energy market relies heavily on the expectation of all market participants that these certificates have not been counted or claimed twice (i.e., double counted). Such double-counting can occur, for instance, through [...] renewable energy claims made by a company that already sold the RECs for its renewable generation. [...] Such double counting, in turn, not only risks deceiving consumers but also threatens the integrity of the entire REC market. By selling RECs, a company has transferred its right to characterize its electricity as renewable.

[...]

In addressing these issues in the Green Guides, the Commission [...] did warn that power providers that sell null electricity to their customers, but sell RECs based on that electricity to another party, should keep in mind that their customers may mistakenly believe the electricity they purchase is renewable, when legally it is not. Accordingly, it advised such

generators to exercise caution and qualify claims about their generation by disclosing that their electricity is not renewable.⁵⁷

Certification through the Green-e® Energy program along with the same tracking systems that are used for state compliance programs (and/or verification of contracts with the original generator) are used in the U.S. voluntary renewable energy market to provide equivalent assurances related to ownership, full aggregation,⁵⁸ and avoidance of double counting to voluntary buyers. Nine (9) tracking systems in North America have protocols in place to prevent double counting of RECs.⁵⁹

RECs in a Transactional Context

RECs have also been fully integrated into many of the most commonly used transactional frameworks for electricity more generally, as well as for renewable energy and environmental attributes in particular, demonstrating their widespread acceptance in the market, including those transactional frameworks and standards maintained by the Edison Electric Institute (EEI), WSPP Inc., the International Swaps and Derivatives Association (ISDA) and the Solar Energy Industry Association (SEIA), and the product offerings of various brokers.

EEI represents U.S. investor-owned electric companies and has worked to develop Master Power Purchase and Sale Agreements. The EEI Master Agreement is widely used by buyers and sellers trading in repeatable, energy and energy-related commodities. In 2010, EEI promulgated an optional RECs Annex (EEI RECs Annex) developed by a working group of members from the Renewable Energy Resources Committee and the Special Committee on Energy and Environmental Finance of the American Bar Association's Section of Environment, Energy and Resources, the Environmental Markets Association, and the American Council on Renewable Energy.⁶⁰ The EEI RECs Annex amends, supplements and supersedes the EEI Master Agreement with respect to the purchase and sale of RECs (REC Transactions).⁶¹ The EEI RECs Annex amends such provisions as payment and netting to account for REC Transactions, and supplements with new provisions allowing for the delivery, transfer of title, tracking and certification of RECs.⁶² The EEI RECs Annex also supplements the EEI Master Agreement with respect to: further representations, warranties and covenants for REC Transactions; a provision regarding the applicable law for REC Transactions; and additional terms with respect to remedies and the scope of force majeure for REC Transactions.⁶³

WSPP Inc. is an organization of electric wholesale market entities that developed a standardized power sales contract (WSPP Agreement). The current WSPP Agreement includes a Service Schedule R for Renewable Energy Certificate Transactions With and Without Energy,⁶⁴ and is a commonly used standardized power sales contract in the electric industry. As the part of the WSPP Agreement that governs REC transactions, Service Schedule R "states terms and conditions applicable to REC Transactions entered into by Parties under the [WSPP] Agreement," including as relates to: the definitions of different types of REC products, such as Resource Contingent Bundled RECs and Facility As-Run RECs; delivery and

title of the REC products; governing law and change in law; seller representations and warranties; confidentiality and records; and remedies for non-performance, among other relevant topics.⁶⁵

The International Swaps and Derivatives Association (ISDA) has “over 1,000 member institutions from 79 countries,” including “corporations, investment managers, government and supranational entities, insurance companies, energy and commodities firms, international and regional banks, [...] exchanges, intermediaries, clearing houses [...] repositories[, ...] law firms, accounting firms and other service providers” and has developed a standard contract for over-the-counter derivatives transactions (ISDA Master Agreement); the ISDA US REC Annex provides terms for governing REC transactions under the ISDA Master Agreement, including as relates to: obligations and deliveries; remedies for failure to deliver or receive; payment; limitation of liability; taxes; title and risk of loss; and minor modifications to the ISDA Master Agreement, among other relevant topics.⁶⁶

The Solar Energy Industries Association (SEIA) endorsed and modified power purchase agreement (PPA) model contracts, including template PPAs for Residential Customers that include RECs in their terms, including as relates to: the ownership of any RECs attributed to the solar panel system installed in the residential customer’s home under the PPA; an obligation for the residential customer to “reasonably cooperate” to allow the provider of the solar panel system or other party to claim the RECs attributed with the residential customer’s use of the solar panel system; and an obligation for the provider of the solar panel system to confirm the availability of any RECs in the amount used to calculate the residential customer’s monthly payments for the solar panel system.⁶⁷ SEIA’s template PPAs for Commercial & Industrial Customers even has a section on “RECs and Incentives,” which entitles the seller of the electricity under the PPA to benefits and ownership interests in the RECs while obligating the purchaser of the electricity under the PPA to cooperate with the seller in this regard but without requiring them to incur any expenses in connection with such cooperation unless reimbursed by the seller.⁶⁸

Conclusion

Rooted in state law and recognized within legal and energy regulatory regimes of a majority of states and other jurisdictions, RECs are essential to any renewable electricity usage claim in the U.S. Despite differences between states and voluntary programs in terms of eligibility requirements,⁶⁹ RECs are heavily used as the primary means of tracking the environmental attributes of grid-connected renewable electricity generation. The evidence is overwhelming that trading a REC in the U.S., whether bundled or unbundled with underlying electricity, effectively transfers ownership rights over all of the attributes of the associated renewable electricity generation to the REC purchaser. RECs therefore allow trading of differentiated electricity products despite the physical inability to identify the exact generating source supplying electricity to an individual customer or facility. RECs have been incorporated into every major standardized form of energy purchasing contract and are a well-understood, routine feature of each and every power purchase agreement respecting any renewable generation source.

End notes

¹ Renewable energy certificate (REC) in this document is a term used to describe the various REC and equivalent instruments in the U.S., which can have different names as used by various state, regional, and voluntary programs, but with the same basic features as described in this document.

² JAN HAMRIN, CLEAN ENERGY STATES ALLIANCE, REC DEFINITIONS AND TRACKING MECHANISMS USED BY STATE RPS PROGRAMS (June 2014), <https://www.cesa.org/wp-content/uploads/RECs-Attribute-Definitions-Hamrin-June-2014.pdf>.

³ Renewable energy certificate (and equivalent instrument) state definitions and accompanying RPS or similar compliance program:

- AZ: ARIZ. ADMIN. CODE § R14-2-1801(N) (2023).
- AK: ARK. CODE. ANN. § 23-18-603 (2023).
- CA: CAL. PUB. UTIL. CODE § 399.12(H)(1)-(2) (West 2022).
- CO: COLO. CODE REGS. § 723-3-3 (3652)(y) (2023).
- CT: CONN. GEN. STAT. § 16-245A(A-B) (2022) (RECs are not specifically defined in CT law. The above Connecticut General Statute citation mentions RECs and states that the CT RPS uses the operating rules of NEPOOL-GIS, available at, <http://www.nepoolgis.com/documents/>).
- DC: D.C. MUN. REGS. tit. 15, § 2999.1 (2023).
- DE: 26-3000-3008 DEL. ADMIN. CODE § 1.1 (2023).
- IA: IOWA CODE § 476.44A (2023) (Underlying RPS statute now technically lapsed, but Iowa law previously acknowledged the use of RECs).
- ID: IDAHO ADMIN. CODE r. 20.03.15.036 (2021) (No explicit definition exists but references renewable energy credits in the calculation of value of geothermal production).
- IL: 20 ILL. COMP. STAT. 3855 / 1-10 (2022).
- IN: IND. CODE ANN. § 8-1-37-3 (West 2023).
- KS: KAN. ADMIN. REGS. § 82-16-1 (L) (2022) (Please note that Kansas' RPS has lapsed).
- MA: 225 MASS. CODE REGS. 14.02 (2023).
- MD: MD. PUB. UTIL. CODE ANN. § 7-701 (m) (West or LexisNexis 2023).
- ME: ME. REV. STAT. TIT. 35, § 3210 (2) (B-2) (2023); 65-407-311 ME. CODE R. § 2 (J) (LexisNexis 2023).
- MI: MICH. COMP. LAWS § 460.1011 (2023).
- MN: MINN. STAT. § 216B.1691 (4) (2023).
- MO.: MO. ANN. STAT. § 393.1025 (West 2023); Mo. CODE REGS. ANN. tit. 20, § 4240-20.100 (2020).
- MT.: MONT. CODE ANN. § 69-3-2003 (14) (2005) (Underlying RPS statute was formally repealed, but Montana law previously acknowledged the use of RECs).
- N.C.: N.C. GEN. STAT. ANN. § 62-133.8 (a)(6) (West 2008).
- N.D.: N.D. ADMIN. CODE 69-09-08-02 (5) (2023) (Please note underlying RPS statute has lapsed).
- N.H.: N.H. REV. STAT. ANN. § 362-F:2 (2023).
- N.J.: N.J. STAT. ANN. § 48:3-51 (West 2023).
- N.M.: N.M. CODE R. § 17.9.572.7 (LexisNexis 2020); N.M. STAT. ANN. § 62-15-37 (C) (2020).
- NV: NEV. REV. STAT. § 704.7803 (2023); NEV. ADMIN. CODE § 704.8908 (2002).
- NY: N.Y. PUB. AUTH. LAW § 1851 (2020).
- OH: OHIO ADMIN. CODE 4901:1-40-01 (W); (BB) (2023).

OR: OR. ADMIN. R. § 330-160-0015 (17) (2020).

PA: 52 PA. CODE § 75.1 (2021) (note, portions of this regulation were held unconstitutional by *Hommirch v. PA Pub. Util.* 231 A.3d 127 (Pa. May 12, 2020), but the ruling does not apply to RECs)

PR: P.R. LAWS ANN. tit. 13, § 10421 (2010).

RI: 39 R.I. GEN. LAWS § 39-26-2 (14) (2022).

SD: S.D. CODIFIED LAWS § 49-34A-95 (2006).

TX: 16 TEX. ADMIN. CODE § 25.5 (107) (2023).

UT: UTAH CODE ANN. §10-19-102 (10) (LexisNexis or West 2023).

VA: VA. CODE ANN. § 56-585.5 (C) (2023).

VT: VT. STAT. ANN. tit. 30, § 8002 (2020).

WA: WASH. ADMIN. CODE § 480-109-060 (31) (2023) (Utilities using RECs to meet RPS targets can only use WREGIS RECs; utilities may not use unbundled RECs from hydroelectric projects).

WI: WIS. ADMIN. CODE PSC § 118.02 (7R); (10) (2007) (Please note underlying RPS statute has lapsed).

⁴ *Id.*; see, e.g., CPUC D. 08-08-028 for California’s definition of “environmental attributes”, https://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/86954.pdf; WAC 480-109-060, for Washington’s definition of “nonpower attributes”, <https://app.leg.wa.gov/wac/default.aspx?cite=480-109-060>. For more information, see also Lisa Koperski, *Why the Renewable Energy Credit Market Needs Standardization*, 13 Wash. J.L. Tech. & Arts 69 (2017).

⁵ For example, for purposes of Connecticut’s RPS program, all RECs must be “issued and tracked” by its regional tracking system, the New England Power Pool Generation Information System. CONN. GEN. STAT. ANN. § 16-245a (West).

⁶ For example, Arizona provides an “in-state power plant installation extra credit multiplier” of 0.5 to utilities acquiring RECs from solar facilities installed in Arizona, such that each megawatt of power generated by in-state solar facilities is valued at one and half (1.5) RECs. RECs acquired from out-of-state facilities are still valued at one REC per megawatt of power.

⁷ For example, Illinois offers a “zero emission credit” or “ZEC” that represents the environmental attributes of one megawatt hour of energy produced by a nuclear facility. 20 ILL. COMP. STAT. ANN. 3855/1-10 (West 2020). New Jersey issues offshore wind RECs or “ORECs” to offshore wind developers.

⁸ This paper is not intended to be a comprehensive or exhaustive listing of all sources supporting the use of RECs. There may be many other specific laws, regulations, etc. that also support the key findings described.

⁹ While this document primarily describes RECs that are issued by tracking systems, RECs may be created and conveyed in contracts even if a renewable generator is not registered with a tracking system.

¹⁰ State regulations listed in n.3 cross-reference to provisions that RECs are used to track and transact the environmental attributes of renewable electricity on the grid, and include Arizona, Arkansas, California, Colorado, Delaware, Florida, Iowa, Illinois, Kansas, Massachusetts, Maryland, Maine, Minnesota, North Dakota, New Jersey, Ohio, Oregon, Puerto Rico, Texas, Utah, Vermont, and Washington state.

¹¹ State regulations listed in n.3 cross-reference to provisions that RECs represent “attributes” of generation (or similar), and include Arizona, Arkansas, California, Colorado, Delaware, Florida, Iowa, Illinois, Kansas, Massachusetts, Maryland, Maine, Minnesota, North Dakota, New Jersey, New Mexico, New York, Ohio, Oregon, Puerto Rico, Texas, Utah, Vermont, and Washington state.

¹² State regulations listed in n.3 cross-reference to provisions that RECS are mechanisms for “tracking” or “trading” (or equivalent) electricity or attributes, and include Arizona, Arkansas, California, Connecticut, Delaware, Iowa, Illinois, Indiana, Kansas, Maine, Michigan, Minnesota, North Carolina, North Dakota, Pennsylvania, South Dakota, Texas, Vermont, Washington state, Wisconsin, the District of Columbia.

¹³ State regulations listed in n.3 cross-reference to provisions that RECs represent electricity or energy “generation” (or equivalent), and include, California, Connecticut, Delaware, Indiana, Kansas, Maine, Michigan, Minnesota, Missouri, North Carolina, North Dakota, New Hampshire, Nevada, Pennsylvania, Puerto Rico, Texas, Wisconsin, and the District of Columbia.

¹⁴ State regulations listed in n.3 cross-reference to provisions that RECs are “proof of generation” (or equivalent), and include California, Missouri, Virginia, and Washington state.

¹⁵ State regulations listed in n.3 cross-reference to provisions that RECs are “property” and include Arkansas, Florida, Pennsylvania, Puerto Rico, and Vermont.

¹⁶ *Allco Fin. Ltd. v. Klee*, 861 F.3d 82 (2d Cir. 2017). See also Order Modifying Renewable Portfolio Standard Program Eligibility Requirements (authorizing the New York State Energy Research and Development Authority to limit its procurement of RECs for RPS compliance purposes to renewable energy projects interconnected to New York’s power grid), <https://statepowerproject.files.wordpress.com/2014/03/ny-psc-order-05-23-13.pdf>.

¹⁷ IOWA UTIL. BD. AEP-07-1 (2007), https://iub.iowa.gov/files/archive/orders/2007/1121_aep071.pdf; https://iub.iowa.gov/sites/default/files/documents/2021/02/1121_aep071.pdf (Order Approving Facilities and Associated Capacities, Adopting Requirements for M-RETS Participation, and Requiring Report; *In Re: Interstate Power & Light Co. & Midamerican Energy Co.*, AEP-07-1, 2007 [Nov. 21, 2007])

¹⁸ N.Y. PUB. SERV. COMM’N. CASE 03-E-0188 (2006), available at: <http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={99B37D71-602B-47F1-8989-5729836A3809}>

(Order regarding Retail Renewable Portfolio Standard. Recognizing Environmental Attributes and Allowing Participation of Projects with Physical Bilateral Contracts, Issued and Effective June 28, 2006)

¹⁹ Listing of tracking systems that define their instruments as representing “attributes” of generation (or similar), See n.11.

²⁰ List of tracking systems that define their instruments as the mechanisms for “tracking” or “trading” (or equivalent) attributes or proof of generation for the purposes of compliance with state programs and/or voluntary programs:

Electric Reliability Council of Tex. (ERCOT)2005. *Glossary - R*. Electric Reliability Council of Texas, Inc. <http://www.ercot.com/glossary/r> <https://www.ercot.com/glossary#>

ERCOT. 2005. *Renewable Energy Credit*. Electric Reliability Council of Texas, Inc. <http://www.ercot.com/services/programs/rec/>

Midwest Renewable Energy Tracking Sys. (M-RETS). 2021. <https://www.mrets.org/wp-content/uploads/2021/01/M-RETS-Operating-Procedures-9-2021.pdf>.

MIRECS: MIRECS 2018 <https://mirecs.org/wp-content/uploads/sites/4/2018/11/MIRECS-Operating-Procedures-November-2018-.pdf>.

N. Am. Renewables Registry (NAR)(2018) at v, http://www.narecs.com/wp-content/uploads/sites/2/2013/10/NAR-Operating-Procedures_April_2013.pdf <http://apx.com/wp-content/uploads/2018/03/NAR-Operating-Procedures- March-2018.pdf>.

New Eng. Power Pool Generation Info. Sys. (NEPOOL-GIS) (2020). <https://nepoolgis.com/wp-content/uploads/sites/3/2022/07/GIS-Operating-Rules-Effective-7-1-22.doc>.

N.C. Renewable Energy Tracking Sys. (NC-RETS): (2011) at iii, 1, <http://www.ncrets.org/wp-content/uploads/sites/7/2014/03/NC-RETS-Operating-Procedures.docx>.

N.Y. Generation Tracking Sys. (NYGATS): (2020) RFP 3014: New York State Generation Attribute Tracking System (NYGATS). <https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Programs/NYGATS/Operating-Rules.pdf>.

PJM Interconnection Generation Attribute Tracking Sys. (PJM-GATS): (2020) *Generation Attribute Tracking System (GATS) Operating Rules*. <https://www.pjm-eis.com/~media/pjm-eis/documents/gats-operating-rules.ashx>.

Western Renewable Energy Generation Information Sys. (WREGIS) (2022) *WREGIS Operating Rules*. Western Electricity Coordinating Council. <https://www.wecc.org/Administrative/WREGIS%20Operating%20Rules%20October%202022%20Final.pdf>.

²¹ U.S. Federal Trade Commission (FTC) (November 27, 2007). Guides for the Use of Environmental Marketing Claims; Carbon Offsets and Renewable Energy Certificates; Public Workshop. Announcement of public workshop; request for public comment. Federal Register. Vol. 72, No. 227. Pg. 66095. Footnote 9. <https://www.govinfo.gov/content/pkg/FR-2007-11-27/pdf/FR-2007-11-27.pdf>

²² EPA Green Power Partnership, Offsets and RECs: What's the Difference (Feb. 2018), avail. at https://www.epa.gov/sites/production/files/2018-03/documents/gpp_guide_recs_offsets.pdf.

²³ U.S. Commodity Futures Trading Commission (CFTC). (August 13, 2012). Further Definition of "Swap," "Security-Based Swap," and "Security-Based Swap Agreement"; Mixed Swaps; Security-Based Swap Agreement Recordkeeping; Final Rule. Federal Register. Vol. 77, No. 156. pg. 48317. <https://www.govinfo.gov/content/pkg/FR-2012-08-13/pdf/FR-2012-08-13.pdf>

²⁴ *Id.* p. 48,232

²⁵ *Id.* p. 48,232

²⁶ *Id.* p. 48,233-4

²⁷ *Am. Ref-Fuel Co., Covanta Energy Grp., Montenay Power Corp., & Wheelabrator Techs. Inc.*, 105 FERC ¶ 61,004 (2003).

²⁸ *WSPP Inc.*, 139 FERC ¶ 61,061 (2012).

²⁹ *Am. Ref-Fuel Co.*, 105 FERC ¶ 61,004.

³⁰ *Am. Ref-Fuel Co., Covanta Energy Grp., Montenay Power Corp., & Wheelabrator Techs., Inc.*, 107 FERC ¶ 61,016, at P 61,043 (2004).

³¹ *Am. Ref-Fuel Co.*, 107 FERC ¶ 61,016, at PP 61,043-44.

³² *Am. Ref-Fuel Co.*, 107 FERC ¶ 61,016, at P 61,044 n.9 (2004).

³³ See EPA, *Renewable Energy Certificates (RECs)* (Apr. 2023), <https://www.epa.gov/green-power-markets/green-power-pricing#one> (last visited Apr. 17, 2023).

³⁴ See e.g., *Am. Tradition Inst. v. Epel*, Case No. 1:11-cv-00859 (Court and Date Filed); *Energy & Env't Legal Inst. v. Epel*, Civ. A. No. 11-cv-00859-WJM-BNB (Court and Date Filed).

³⁵ *Allco Fin. Ltd. v. Klee*, 861 F.3d 82 (2d Cir. 2017) (citation omitted). See also Order Modifying Renewable Portfolio Standard Program Eligibility Requirements (authorizing the New York State Energy Research and Development Authority to limit its procurement of RECs for RPS compliance purposes to renewable energy projects interconnected to New York's power grid), <https://statepowerproject.files.wordpress.com/2014/03/ny-psc-order-05-23-13.pdf>.

³⁶ *In re Ownership of Renewable Energy Certificates ("RECs")*, 913 A.2d 825 (N.J. 2007).

³⁷ See *Wheelabrator Lisbon, Inc. v. Conn. Dep't of Pub. Util. Control*, No. CV054003405, 2006 WL 894895 (Conn. Super. Ct. Mar. 20, 2006), *aff'd sub nom. Wheelabrator Lisbon, Inc. v. Dep't of Pub. Util. Control*, 931 A.2d 159 (Conn. 2007).

³⁸ See *Wheelabrator Lisbon, Inc. v. Dep't of Pub. Util. Control*, 931 A.2d 159 (Conn. 2007)

³⁹ *Honeywell Int'l Inc. v. ICM Controls Corp.*, No. 11-CV-569 JNE/TNL, 2013 WL 6169671 (D. Minn. Nov. 22, 2013)

⁴⁰ *Id.* 2013 WL 6169671, at *8.

⁴¹ *Id.*

⁴² *Id.*

⁴³ 10 U.S.C. § 2911(g)(3). DOD regularly contracts for the procurement of RECs through the Installation Energy program at the U.S. Defense Logistics Agency, <https://www.dla.mil/Energy/Products/Installation-Energy/>.

⁴⁴ Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units; Final Rule, 80 Fed. Reg. 64662, 64806 (Oct. 23, 2015).

⁴⁵ EPA, Guide to Purchasing Green Power (Sept. 2018), https://www.epa.gov/sites/default/files/2016-01/documents/purchasing_guide_for_web.pdf.

⁴⁶ See Minn. Solar Energy Procurement Workshop, Renewable Energy Certificates 101 (Sept. 18, 2019), <https://www.epa.gov/sites/default/files/2020-06/documents/3.0b-solar-claims-and-renewable-energy-certificates.pdf>.

⁴⁷ The White House Council on Env't Quality, *Implementing Instructions for Exec. Order 14057, Catalyzing Clean Energy Indus. & Jobs through Fed. Sustainability* (Aug. 2022), https://www.sustainability.gov/pdfs/EO_14057_Implementing_Instructions.pdf.

⁴⁸ *Id.* p. 11-13

⁴⁹ Env't Markets Ass'n, *Glossary of Terms: Renewable Energy Credits* (last visited Apr. 17, 2023), <https://www.enviromarkets.org/What-are-Environmental-Markets>.

⁵⁰ Am. Bar Ass'n, *Master Renewable Energy Certificate Purchase and Sale Agreement 1.0* at iv (2007), <https://www.enviromarkets.org/resources/Documents/ABA%20EMA%20ACORE%20Master%20RECs%20Agreement%20v1.0.doc>.

⁵¹ 16 C.F.R. § 260.15 (2023), FTC Guides For the Use of Environmental Marketing Claims.

⁵² FTC, *Cases Tagged with Env't Mktg.* (last visited Apr. 17, 2023), <https://www.ftc.gov/enforcement/cases-proceedings/terms/1408>.

⁵³ The FTC received a petition from the Environmental and Natural Resources Law Clinic at Vermont Law School, on behalf of Vermont citizens, urging an FTC investigation into allegedly deceptive trade practices by Green Mountain Power Company's (GMP). In a letter to GMP, FTC stated "Although no findings have been made that these claims violate the law, we urge GMP in the future to prevent any confusion by clearly communicating the implications of its REC sales for Vermont customers and REC purchasers." *Letter from James A. Kohm, Assoc. Dir., Div. of Enf't, Bureau of Consumer Prot. to R. Jeffrey Behm, Esq., Sheehey, Furlong & Behm, P.C.* (FTC Feb. 5, 2015), https://www.ftc.gov/system/files/documents/public_statements/624571/150205gmpletter.pdf.

⁵⁴ Commodity Futures Trading Comm'n, *Further Definition of "Swap," "Security-Based Swap," and "Security-Based Swap Agreement"; Mixed Swaps; Security-Based Swap Agreement Recordkeeping*, RIN 3038-AD46, 97-98 (Aug. 2012)

⁵⁵ See Barkalow, Gina, Theresa Daniels, Lorraine Gonzalez, *Renewables Portfolio Standard 2006 Procurement Verification Final Staff Report*. Cal. Energy Comm'n. CEC-300-2009-006-CMF (July 2010), <https://web.archive.org/web/2011001012214/http://www.energy.ca.gov/2009publications/CEC-300-2009-006/CEC-300-2009-006-CMF.PDF>.

⁵⁶ *Letter from James A. Kohm, Assoc. Dir., Div. of Enf't, Bureau of Consumer Prot. to R. Jeffrey Behm, Esq., Sheehey, Furlong & Behm, P.C., supra* note 53, at 2-3. The 2015 FTC letter reiterated the position the FTC set forth in its 2010 proposed rule. See FTC, *Fed. Proposed Revisions to the Green Guides*, 16 C.F.R. Part 260, 63,551-607 (Oct. 15, 2010), <http://www.gpo.gov/fdsys/pkg/FR-2010-10-15/html/2010-25000.htm> (last visited April 12, 2023 PM).

⁵⁷ *Letter from James A. Kohm, Assoc. Dir., Div. of Enf't, Bureau of Consumer Prot. to R. Jeffrey Behm, Esq., Sheehey, Furlong & Behm, P.C., supra* note 53, at 3-4.

⁵⁸ "Full aggregation" means that individual attributes contained in the REC have not been sold, counted, or claimed separately and that the REC contains all legally available attributes of renewable electricity.

⁵⁹ Electric Reliability Council of Tex. (ERCOT) Sections 14.10.1 - 14.10.2 include mandatory and voluntary retirement provisions to ensure that RECs being counted for RPS compliance purposes are not also

sold/traded to third parties. ERCOT informs the Public Utilities Comm'n of Tex. (PUCT) when any retail entity fails to meet its mandatory retirement obligations. ERCOT Nodal Protocols § 14: State of Texas Renewable Energy Credit Trading Program (Jan. 2021), <https://www.ercot.com/mktrules/nprotocols/current>.

MIRECS: To ensure that double-counting does not occur, MIRECS requires that all generation projects registered in MIRECS have 100% of their output tracked by MIRECS. Registrants must notify MIRECS if part of the output was at one time registered with another tracking system. MIRECS User Guide § 3.1, <https://mirecs.org/wp-content/uploads/sites/4/2018/01/MIRECS-User-Guide.pdf>.

Midwest Renewable Energy Tracking Sys. (M-RETS). M-RETS enters cooperative agreements with other tracking systems to ensure that exported RECs are not double counted. (Section 4.6.5) M-RETS has additional policies in place to prevent double counting, including: (1) prohibiting registering entities from changing the reason that RECs are retired outside the 24-hour notice period (Section 4.2.7), and (2) requiring that generators participating in M-RETS report 100% of their generation output in M-RETS (Section 4.3). <https://www.mrets.org/wp-content/uploads/2021/01/M-RETS-Operating-Procedures-9-2021.pdf>.

N. Am. Renewables Registry (NAR): To ensure that double counting does not occur, generation projects registered in NAR must have 100% of their output or energy savings, as applicable, tracked by NAR. The NAR administrator should be notified of any prior registration with another tracking system and account holders may be required to provide documentation to prove the asset has been removed from the previous tracking system. §§ 5.1; 5.2. <http://apx.com/wp-content/uploads/2018/11/NAR-Operating-Procedures-November-2018.pdf>.

N.C. Renewable Energy Tracking Sys. (NC-RETS): Like other registries, NC-RETS prevents double counting by requiring that facilities registering with NC-RETS have 100% of their output tracked by NC-RETS (with the exception of imported RECs). The NC-RETS administrator should be notified of prior registration in another tracking system and may require documentation that facilities have been removed from the previous tracking system (Section 4.1). Facilities must provide annual attestations to continue to earn RECs eligible for renewable portfolio standard compliance, including attesting that RECs from the facility are not being remarketed. (page 35) <https://ncrets.org/wp-content/uploads/sites/7/2014/03/NC-RETS-Operating-Procedures.pdf>.

New Eng. Power Pool Generation Info. Sys. (NEPOOL-GIS): NEPOOL-GIS has a number of policies in place to prevent double counting of RECs, including: (1) upon retirement of RECs, GIS administrator will provide a mechanism for generators to inform the GIS administrator of which RECs were retired (Section 7); and (2) account holders that sell RECs to third parties must transfer sold RECs to a specific "Reserved Certificate Account" (Rule 3.5) (Operating Rules - <https://nepoolgis.com/documents/>).

N.Y. Generation Tracking Sys. (NYGATS): NYGATS prevents double counting of imported and exported energy data (Section 8.2.4) and of monthly meter adjustments for past months (Section 8.2.3). Under Section 5.2 of its operating procedures, NYGATS will issue RECs for generators that are not registered with any other certificate tracking system and that are importing energy to the NYGATS control area. <https://www.nyserda.ny.gov/All-Programs/NYGATS/Registration-Documents>.

PJM Interconnection Generation Attribute Tracking Sys. (PJM-GATS): To prevent double counting, generating units participating in PJM-GATS must have 100% of their output tracked in PJM-GATS (Section 6.3.1). Monthly meter adjustments will not be double counted (Section 8.2.3). PJM-GATS prevents double counting of imported and exported RECs through cooperative agreements with the other tracking system involved. (Section 12.5). Generators outside of PJM who create certificates within PJM-GATS must sign an affidavit that its RECs are created only in PJM-GATS. (Section 12.5) <https://www.pjm-eis.com/-/media/pjm-eis/documents/gats-operating-rules.ashx>.

Western Renewable Energy Generation Information Sys. (WREGIS). To prevent double counting, generators must attest that 100% of their generation output will be reported to and tracked by WREGIS. (Section 5.3). To prevent double counting of certificates registered in multiple tracking systems, (1) WREGIS must expressly authorize simultaneous registration and (2) the other tracking system and WREGIS will decide upon a mutually agreeable process to prevent double counting, which will be set forth in writing and will be binding upon the generating entity. (Section 5.3.5) WREGIS has protocols in place to prevent double counting of RECs transferred to WREGIS from another tracking system. (Section 5.3.6). WREGIS also has authority to use "forced retirements to protect against double-counting if

needed.” (Section 5.3.7).

<https://www.wecc.org/Administrative/WREGIS%20Operating%20Rules%20October%202022%20Final.pdf>

⁶⁰ See Edison Electric Institute, *Renewable Energy Certificates Annex to the EEI Master Power Purchase & Sale Agreement Version 1.0*, at cover page & intro. (Nov. 4, 2010), <https://www.eei.org/-/media/Project/EEI/Documents/Resources-and-Media/Master-Contract/EEI-RECs-Annex-v1.pdf?la=en&hash=7D4AA20A22A82D07DA9950D0B5BC1976F8E4CBDB>.

⁶¹ See *id.*

⁶² See *id.* at 7-9.

⁶³ See *id.* at 10-13.

⁶⁴ WSPP Inc., *WSPP Agreement*, Section on Service Schedule R Renewable Energy Certificate Transactions With and Without Energy (Aug. 26, 2022), https://www.wspp.org/pages/documents/08_26_22_current_effective_agreement.pdf.

⁶⁵ See WSPP Inc., *WSPP Agreement*, Section on Service Schedule R Renewable Energy Certificate Transactions With and Without Energy (Aug. 26, 2022), https://www.wspp.org/pages/documents/08_26_22_current_effective_agreement.pdf.

⁶⁶ See ISDA, ISDA U.S. Renewable Energy Certificate Annex (2021).

⁶⁷ See Solar Energy Indus. Ass’n (SEIA), *SAPC Residential Power Purchase Agreement (Aggregated Version)*, at 5 (May 20, 2016), <https://www.seia.org/research-resources/model-leases-and-ppas> (Last visited March 24, 2023).

⁶⁸ See SEIA, *SEIA C&I PPA, version 2.0*, at 2 (Sept. 28, 2017), <https://www.seia.org/research-resources/model-leases-and-ppas>.

⁶⁹ See Ed Holt & Ryan Wiser, *The Treatment of Renewable Energy Certificates, Emissions Allowances and Green Power Programs in State Renewable Portfolio Standards* Lawrence Berkeley National Laboratory (Apr. 2007), <http://www.cesa.org/assets/Uploads/Treatment-RECs-LBNL2007.pdf>

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Evidence Submission 3

Primer: REC Financing Mechanics for Renewable Energy Projects

The Purpose of RECs: Renewable Energy Certificates (RECs) enable the development, financing, construction, and ongoing operation of renewable energy projects. RECs, which are an environmental instrument / environmental commodity, serve two significant purposes when it comes to financing renewable energy projects:

- RECs facilitate actual cashflow to projects alongside the other energy commodities that a project produces. RECs are saleable in either a compliance or voluntary market and generate revenue for a project asset. This revenue can be used to finance a new project or support ongoing maintenance expenses of existing projects to keep them viable overtime.

Investor confidence to underwrite REC revenues in project finance deals has taken over two decades to develop and relies on: (1) access to REC markets for existing projects, and (2) the expectation that REC markets will continue to exist in the future for renewable energy assets. REC-driven financing enables renewable energy project additionality and its positive environmental, economic and social impacts.

Sample Illustration of REC Financing Mechanics for Renewable Energy Projects



- RECs are synonymous with Energy Attribute Certificates (EACs) and provide a way to account for the creation, transfer, and retirement of the project's environmental attributes between producers and buyers. Generally, one REC represents the environmental attributes associated with 1 megawatt-hour (MWh) of renewable electricity generation. RECs are an essential accounting mechanism for renewable energy generation due to the physical nature of how power pools operate: once "green" electricity is delivered to the grid it becomes indistinguishably mixed with other "brown" electrons and therefore, no longer traceable. RECs solve this problem.

Renewable Energy Project Finance 101: Like any other asset, there are two categories of capital for raising finance for a project: equity and debt. Equity capital implies ownership, whereas debt capital does not. Within each of these categories, there are dozens of variations of specific equity and debt instruments that are used to deploy capital into projects. Although the exact types of capital products used to finance projects have considerations that are beyond the scope of this primer, the REC financing mechanics for raising equity and debt largely remain the same: RECs create project income / cashflow that provides a return on investment for equity investors or the repayment of principal and interest to debt lenders.

Renewable Energy Project Finance 201: RECs provide an additional commodity revenue stream for project investors to underwrite to as they consider whether to move forward with a project financing. When it comes to underwriting equity investments in renewable energy projects or lending money to a project, REC cashflows can either be contracted (i.e., already sold to another counterparty at the date of financing), uncontracted, or a mix of both over different tenors of time. Financial proformas for projects are broken into periods, which are aligned with the REC vintage, or the period in which a REC is created (e.g., from electricity generated between January 1st and December 31st). An annual proforma values RECs that will be sold in a particular year and aligns this with the investment mechanics of other revenue streams, such as from power, in the model. Equity investors ascribe different present values to contracted and uncontracted cashflows while debt lenders charge different interest rates. This impacts the revenue and risk profile of a project, which in turn impacts a project's cost of capital, and its ability to be financed or not.

RECs and Project Financing Implications for Practitioners: While project underwriting periods can be any length of time as determined by financing parties, a range of 25 to 50 years is not unreasonable for a long-dated infrastructure project investment. The existence of compliance and voluntary REC markets enables investors to value cashflows from the environmental attributes a project produces, and depending on market conditions in the project's jurisdiction, hedge (contract) these REC cashflows with other counterparties. The value of RECs will fluctuate depending on current market conditions and future expectations of market conditions by participants. In the United States, the current size of REC cashflows across compliance and voluntary markets is estimated to be between \$5 billion and \$10 billion annually. Depending on the REC market, REC revenues can provide anywhere from 10% to 100% of a project's revenues during the underwriting period. This REC revenue is incremental to power market sales and is critical to enabling project economics for the development of new renewable energy assets. Voluntary RECs represent an important underwriting assumption in voluntary REC-only deals and in compliance market financings, which may assume voluntary REC values in a downside scenario. Investor willingness to finance the value of RECs relies on this availability of RECs for existing and new projects (since new projects inevitably become existing projects).

Evidence Submission 4



Voluntary RECs Protect Against Regulatory Risk

Project Information

Transaction Type

Unbundled renewable energy certificate (REC) project financing

Project Size

32.0 MWdc

Annual Generation

52,730 MWh

Commercial Operation Date

2020

Project Capital Expenditure

\$40MM

Project Location

North Carolina, United States

Power Offtake Arrangement

Long-term contract with utility

Renewable Energy Certificates

Merchant voluntary REC market sales

Challenge

DC RPS Modified: In 2018, the DC Tier I REC market changed its RPS eligibility criteria to exclude new projects not located within PJM.

Retroactive Close: DC borders were retroactively closed to new adjacent RTO-sited projects. Previous projects in development that were eligible under the original DC Tier I REC Market, were no longer going to be compliant.

Financial Feasibility: This resulted in the projects no longer being financially feasible in North Carolina (NC), which has no other form of REC incentive from the local, regulated utility.

Solution

Unbundled REC Market: Despite the low voluntary REC prices, the existence of the voluntary unbundled REC market enabled Sol Systems to underwrite 40 years of voluntary REC revenue for each project, thus insulating projects from regulatory change risk.

Outcome

Financing Secured: The expected revenues from the voluntary REC sales allowed for a return on equity high enough to finance the projects and for the projects to be constructed.

Fully Operational: These projects are fully operational today, thereby providing carbon-free electricity in NC that would otherwise not have existed.





Long-Term Voluntary REC Strip Drives Additional Build in Carbon Intensive RTO

Project Portfolio Information

Transaction Type

Hybrid corporate tax equity investment paired with long-term REC offtake

Project Sizes

223 MWdc

Annual Generation

409,451 MWh

Commercial Operation Dates

2022, 2023

Project Capital Expenditure

\$295MM

Project Locations

South Carolina, North Carolina, United States

Power Offtake Arrangement

Unbundled qualifying facility power purchase agreement with local utility (all projects)

Renewable Energy Certificates

Long-term forward voluntary REC offtake

Challenge

Low PURPA Rates: Since there are no compliance REC markets in that region, projects often rely on power tariffs awarded under the Public Utility Regulatory Policies Act of 1978 (PURPA). However, for these projects, PURPA-avoided cost rates alone were too low to allow for project financing and construction.

Solution

Innovative Structuring: Sol Systems worked with a corporate partner to combine a forward long-term REC “strip” in combination with a tax equity investment to enable the projects to move forward.

Outcome

Financing Secured: The voluntary REC revenue in addition to the power offtake with the local utility was necessary to overcome increasing costs of capital and construction expenses (e.g., import tariffs and logistical supply-chain constraints). In this instance, a 15-year REC contract between the tax equity investor and project enabled the developer to raise additional debt proceeds, thereby making project economics viable.

Investment Grade Revenue: Beyond the tax equity investment, the long-term voluntary REC contract provided a source of investment grade contracted revenue that enabled project developers to raise additional debt proceeds and optimize the capital stack.





Voluntary RECs Support Additionality in Compliance REC Markets

Project Portfolio Information

Transaction Type

Distributed Generation (DG) portfolio financing using voluntary renewable energy certificate (REC) swaps

Fund Profile

Asset Sale to various Independent Power Producers

Number of Portfolio Projects

15

Total Size of all Projects

~50 MWdc

Annual Generation of all Projects

~60,000 MWh

Commercial Operation Dates

2016 through 2021

Project Finance Facility Size

\$100MM+

Project Locations

Connecticut, Illinois, Maryland, Massachusetts, New Jersey, United States

Power Offtake Arrangements

Unbundled power purchase agreements (PPAs) with various onsite host offtakers

Renewable Energy Certificates

REC swap transactions (i.e., compliance REC market sales combined with unbundled voluntary REC market purchases)

Project Developer

Sol Systems, LLC

Since 2016, Sol Systems has worked with dozens of corporate and institutional customers to deploy distributed generation onsite solar. Many of these customers are motivated by two goals: ① achieving their sustainability targets, and ② generating power savings onsite. However, due to the challenging economics of onsite solar, many customers are only able to generate savings by opting to sell a project's RECs into a compliance renewable portfolio standard (RPS) REC market. By selling a project's compliance RECs, customer offtakers become unable to claim renewable power even though they are generating it.

To solve this dilemma, Sol Systems helped its portfolio of customers execute voluntary REC swaps. A REC swap is a type of REC transaction associated with a project in which its compliance RECs are sold and simultaneously replaced through an offsetting voluntary REC market purchase. These REC swaps have helped develop over 50 megawatts of Sol Systems onsite projects. Without access to the voluntary REC market, these DG customers would not have been able to achieve their sustainability goals through onsite renewable energy development.



Evidence Submission 5

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AES Announces First-of-Its-Kind Agreement to Supply 24/7 Carbon-Free Energy for Google Data Centers in Virginia

May 04, 2021

This transaction will result in the construction of approximately 500 MW of renewable energy and storage projects to ensure Google's Virginia-based data centers will be 90% carbon-free when measured on an hourly basis

ARLINGTON, Va., May 4, 2021 /PRNewswire/ -- The AES Corporation (NYSE: [AES](#)) announced today that it has signed an agreement to supply the electricity to power Google's (NASDAQ: GOOGL) Virginia-based data centers with 24/7 carbon-free energy under a 10-year supply contract. With this first clean energy procurement deal in the world of its kind, AES will help ensure that the energy powering those data centers will be 90% carbon-free when measured on an hourly basis. AES will become the sole supplier of the data centers' carbon-free energy needs on an annual basis, sourcing energy from a portfolio of wind, solar, hydro and battery storage resources to be developed or contracted by AES. The agreement will start supply later in 2021 and is an important step in meeting Google's previously announced goal to run its business on 100% carbon-free energy on an hourly basis by 2030.



"Last year, Google set an ambitious sustainability goal of committing to 100% 24/7 carbon-free energy by 2030. Today, we are proud that through our collaboration with Google, we are making 24/7 carbon-free energy a reality for their data centers in Virginia," said Andrés Gluski, AES President and CEO. "This first-of-its-kind solution, which we co-created with Google, will set a new sustainability standard for companies and organizations seeking to eliminate carbon from their energy supply."

"Not only is this partnership with AES an important step towards achieving Google's 24/7 carbon-free energy goal, it also lays a blueprint for other companies looking to decarbonize their own operations," says Michael Terrell, Director of Energy at Google. "Our hope is that this model can be replicated to accelerate the clean energy transition, both for companies and, eventually, for power grids."

AES assembled the 500 MW portfolio from a combination of AES' own renewable energy projects and those of third-party developers, which were selected, sized and contracted to meet Google's energy needs across a number of considerations, including cost efficiency, additionality and carbon-free energy profile. The portfolio assembled by AES is expected to require approximately \$600 million of investment and generate 1,200 jobs, both permanent and construction, in the host communities. These efforts will greatly simplify Google's energy procurement and management at a competitive price while decarbonizing Google's load and the broader PJM grid.

This supply agreement follows on the strategic alliance AES and Google formed in November 2019 to leverage Google Cloud technology to accelerate innovation in energy distribution and management and advance the adoption of clean energy. AES is pioneering greener, smarter energy innovations, with the goal of expanding the services available to large-scale corporate customers.

About AES

The AES Corporation (NYSE: AES) is a Fortune 500 global energy company accelerating the future of energy. Together with our many stakeholders, we're improving lives by delivering the greener, smarter energy solutions the world needs. Our diverse workforce is committed to continuous innovation and

operational excellence, while partnering with our customers on their strategic energy transitions and continuing to meet their energy needs today. For more information, visit www.aes.com/products/our-offerings/new-clean-energy/.

Safe Harbor Disclosure

This news release contains forward-looking statements within the meaning of the Securities Act of 1933 and of the Securities Exchange Act of 1934. Such forward-looking statements include, but are not limited to, those related to future earnings, growth and financial and operating performance. Forward-looking statements are not intended to be a guarantee of future results, but instead constitute AES' current expectations based on reasonable assumptions. Forecasted financial information is based on certain material assumptions. These assumptions include, but are not limited to, our expectations regarding the COVID-19 pandemic, accurate projections of future interest rates, commodity price and foreign currency pricing, continued normal levels of operating performance and electricity volume at our distribution companies and operational performance at our generation businesses consistent with historical levels, as well as the execution of PPAs, conversion of our backlog and growth investments at normalized investment levels and rates of return consistent with prior experience.

Actual results could differ materially from those projected in our forward-looking statements due to risks, uncertainties and other factors. Important factors that could affect actual results are discussed in AES' filings with the Securities and Exchange Commission (the "SEC"), including, but not limited to, the risks discussed under Item 1A: "Risk Factors" and Item 7: "Management's Discussion & Analysis" in AES' 2020 Annual Report on Form 10-K and in subsequent reports filed with the SEC. Readers are encouraged to read AES' filings to learn more about the risk factors associated with AES' business. AES undertakes no obligation to update or revise any forward-looking statements, whether as a result of new information, future events or otherwise.

Any Stockholder who desires a copy of the Company's 2020 Annual Report on Form 10-K filed February 24, 2021 with the SEC may obtain a copy (excluding Exhibits) without charge by addressing a request to the Office of the Corporate Secretary, The AES Corporation, 4300 Wilson Boulevard, Arlington, Virginia 22203. Exhibits also may be requested, but a charge equal to the reproduction cost thereof will be made. A copy of the Form 10-K may be obtained by visiting the Company's website at www.aes.com.

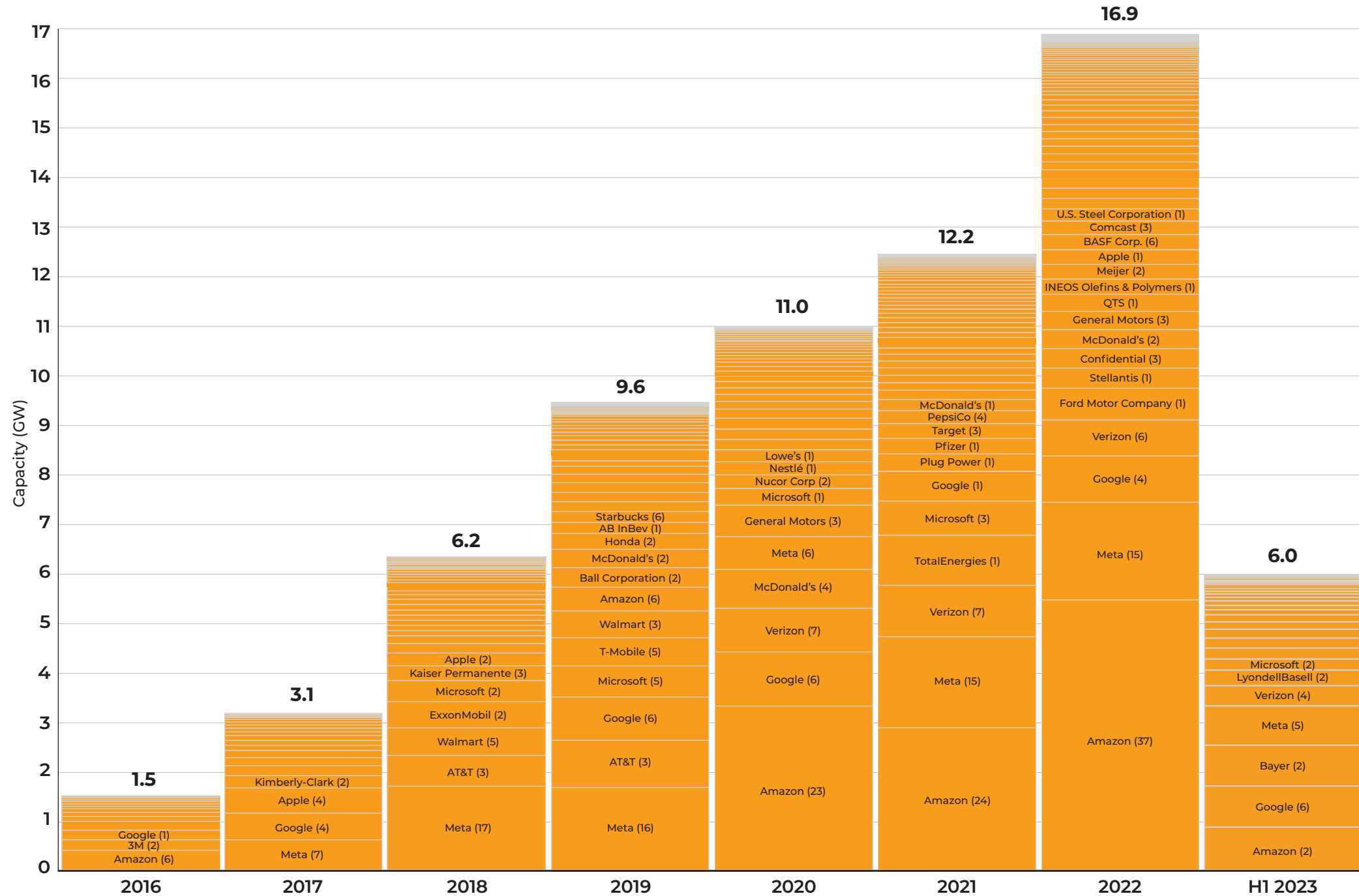
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Evidence Submission 6

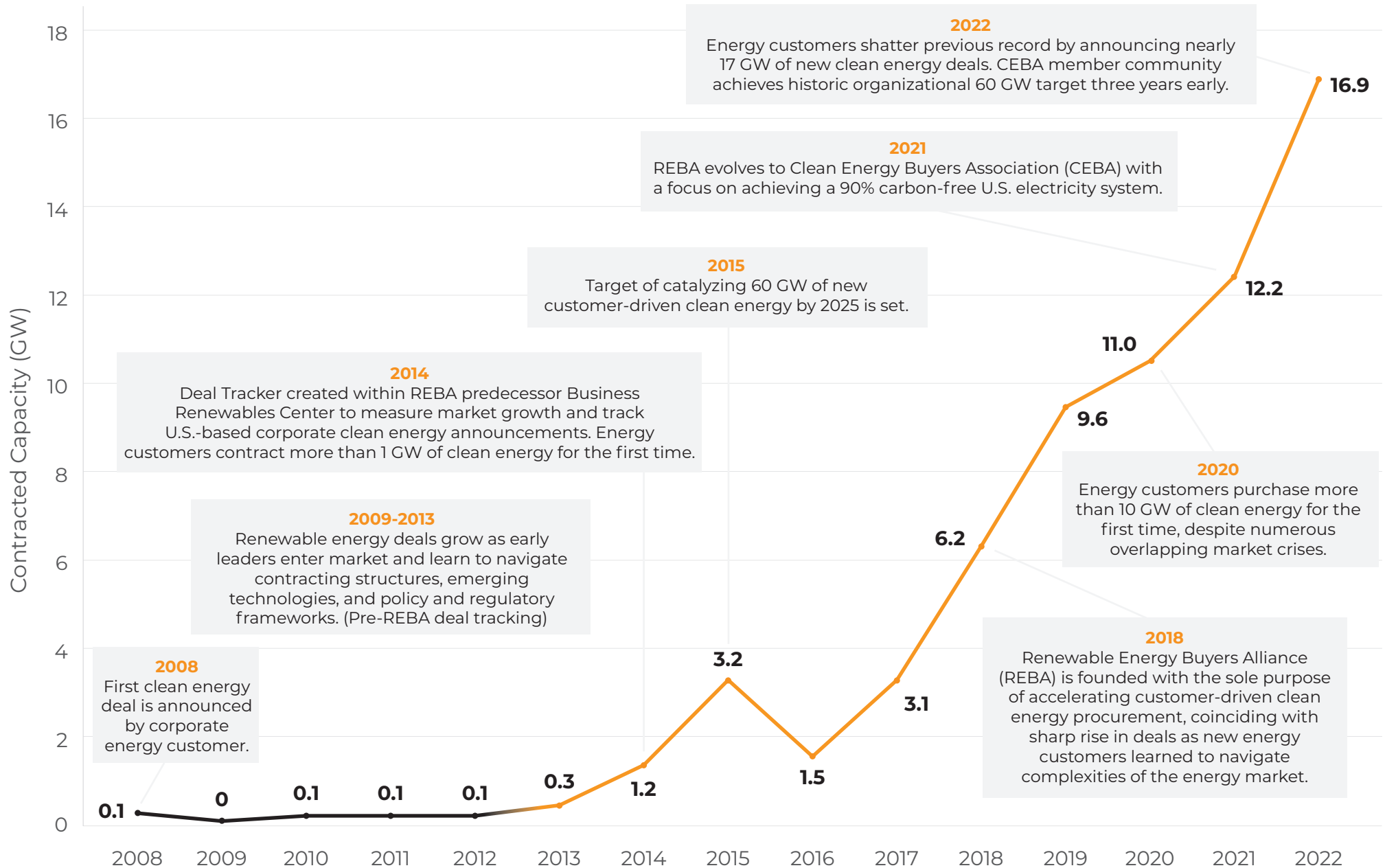
CEBA Deal Tracker 2016 through Q2 2023



As of June 30, 2023. Includes publicly announced corporate clean energy procurement through power purchase agreements, green tariffs, tax equity investments, and project ownership in the U.S. from 2016-2023. Excludes onsite generation <20 MW. (#) indicates number of deals each year by individual companies.

CEBA Deal Tracker Timeline

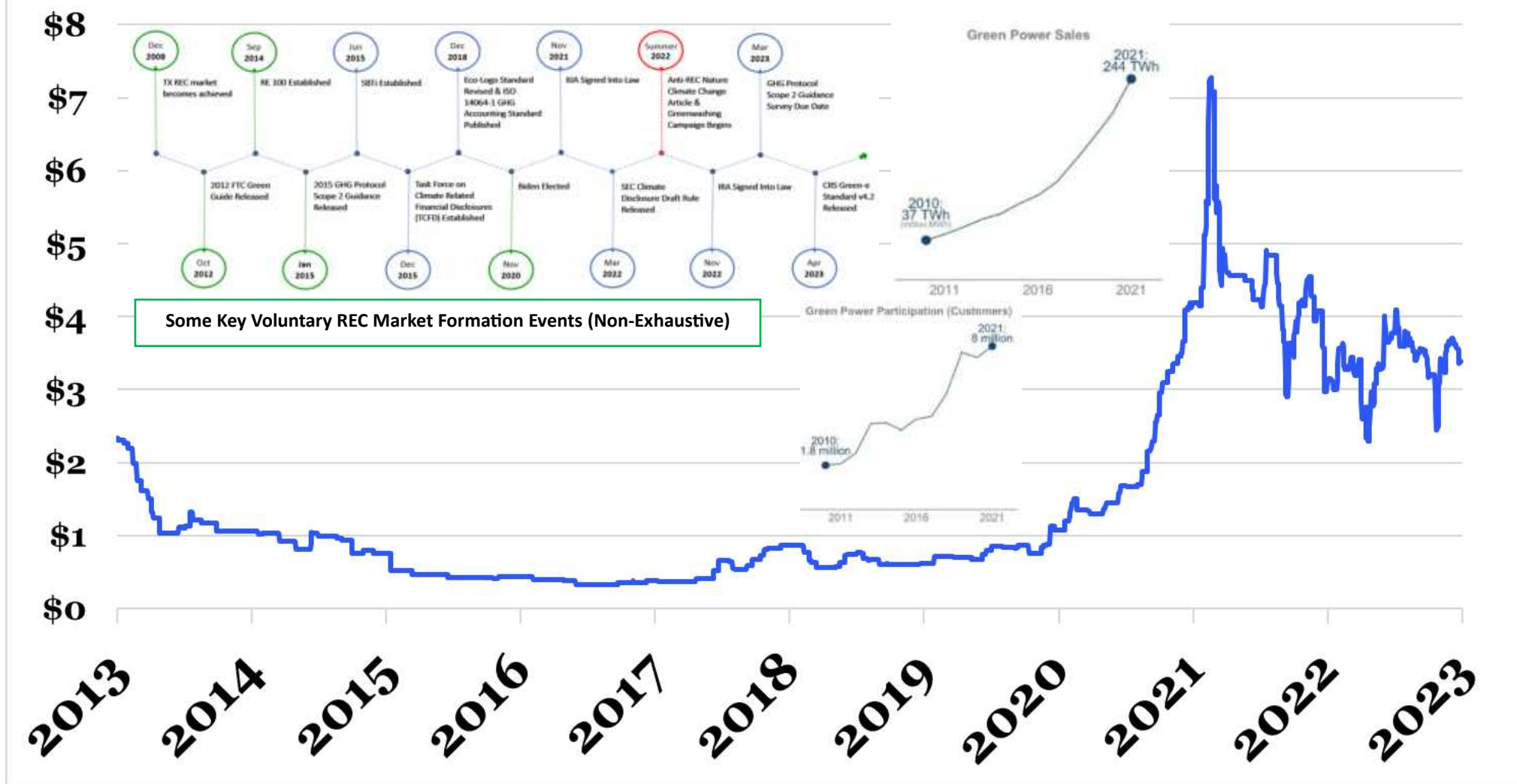
Energy Customers Accelerate Clean Energy Deals



Data through December 31, 2022. Includes publicly announced corporate clean energy procurement through power purchase agreements, green tariffs, tax equity investments, and project ownership in the U.S. from 2008-2023. Excludes onsite generation <20 MW. Copyright 2023 Clean Energy Buyers Association (CEBA)

Evidence Submission 7

U.S. Voluntary REC Pricing - Spot Market (\$/MWh)



Source: Pricing data comes from EMA Member Companies engaged in the market as transaction intermediaries. Market size data comes from NREL.



In 2021, NREL reported 244 TWh of Green Power Sales (all tracked through RECs) and 8 million Green Power Participation customers. In 2021, these REC sales represented approximate revenue of \$1 billion to renewable power producers. The formation of higher voluntary REC pricing coincided with increased market participation that was cultivated by the establishment of a standardized legal basis / REC product definition from regulatory agencies like the EPA, FTC, and FERC, and clearer guidance for how to make REC-based claims. The 2015 Scope 2 GHG Protocol Guidance was a particular turning point in corporate participation as evidenced by CEBA via growth in voluntary PPA / VPPA procurements (which all rely on RECs to credibly evidence a zero-carbon claim). More participation from REC buyers and sellers has led in turn to increased investor confidence to underwrite REC revenues for future project developments, a decade-plus effort in the making.

Evidence Submission 8

US renewable energy credit market size to double to \$26 billion by 2030



Author [Adam Wilson](#), [Tony Lenoir](#)

Theme [Energy](#)

Tags [S&P CapitalIQ Pro](#)

Renewable energy credits, also known as renewable energy certificates, or RECs, are seeing an increase in attention in the U.S. energy market due to expanding state-level renewable and clean energy standards, the growing corporate renewables market and the Inflation Reduction Act. According to S&P Global Commodity Insights' analysis and forecasts, the U.S. REC market as of 2021 was valued at \$11.45 billion but is forecast to swell to \$26.5 billion by the end of the decade.

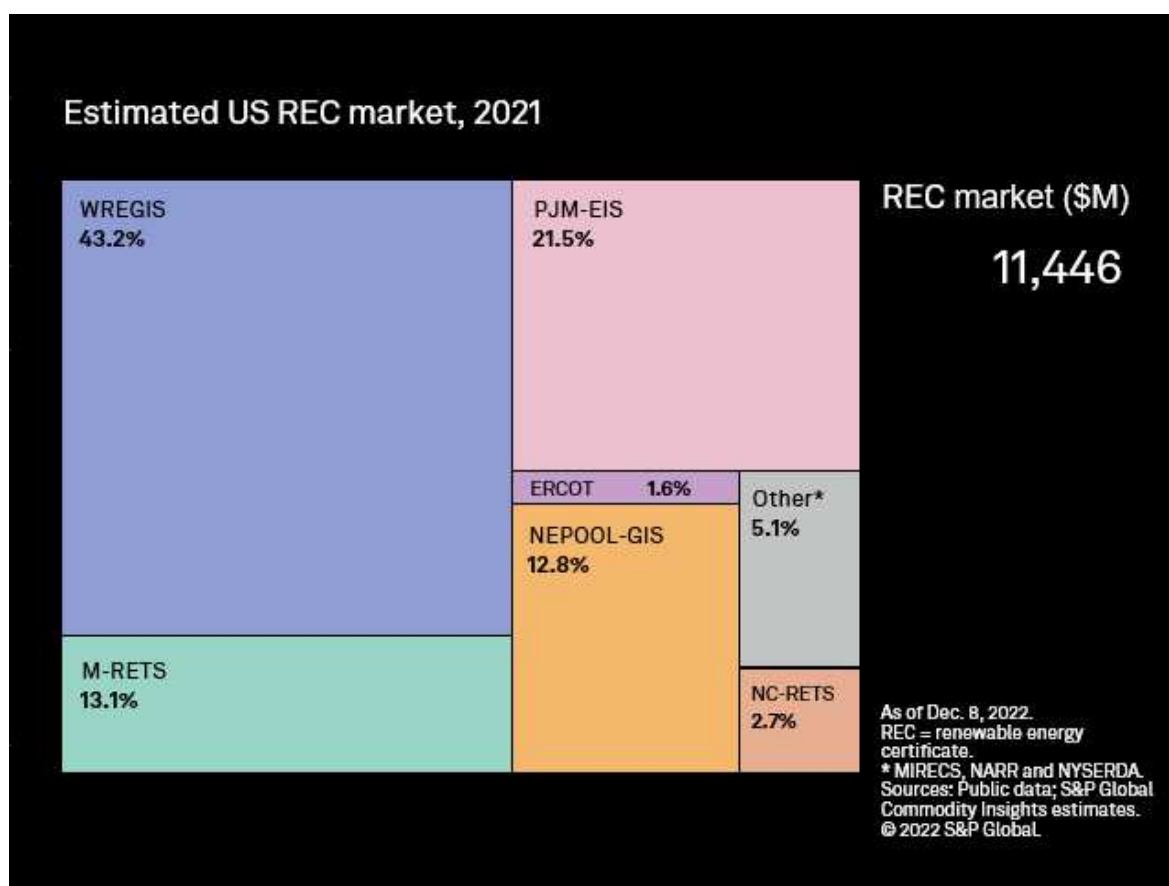
The Take

The REC market as of 2021 was estimated to be \$11.45 billion, with the compliance market making up 95% of that value. The S&P Global Market Intelligence Power Forecast projects the REC market to more than double to \$26.5 billion by 2030. While the compliance market remains dominant, its share over the voluntary market is expected to shrink to 76% by the end of the decade. The solar carve-out is forecast to slowly grow from \$3.2 billion in 2022 to \$3.6 billion by 2030. Driven by robust offshore REC prices, the offshore wind REC market should explode from almost nonexistent to nearly \$3.6 billion by 2030.

Regionally, the West is the largest market, both in terms of generation and market size. Outpacing second-place PJM, the West is forecast to reach \$9.1 billion by 2030, though our upside scenario projects the region surpassing \$13 billion. PJM's REC market is forecast to nearly double from \$2.8 billion to \$5.3 billion. New York ISO, ISO New England and the Midcontinent ISO round out the top five, respectively.

REC market size as of 2021

S&P Global Commodity Insights collected and analyzed data from 10 REC tracking systems and various state and utility compliance reports to estimate the current REC market volume in terms of megawatt-hour and dollar values. Over half a million RECs were estimated to be retired and used in either a compliance or voluntary REC market in 2021, with the total value estimated at \$11.45 billion.



The compliance market, which includes RECs retired to meet state-level renewable portfolio standards, or RPSs, and solar RECs to meet solar carve-out requirements, accounted for nearly two-thirds of the total volume of retired RECs in 2021. In terms of monetary value, however, the compliance market makes up over 95% of the overall market. This is expected, given that compliance RECs are typically priced much higher than their voluntary counterparts. The estimated average cost for compliance RECs in 2021 was \$33.94 per credit compared to \$3.00 per credit for voluntary RECs.

The Western Renewable Energy Generation Information System, or WREGIS, covers most of the Western Interconnect and is the largest of the REC tracking systems by coverage area. Not surprisingly, it ranked as the largest market in 2021 in quantity and total value of RECs. Included

in WREGIS' territory is renewable energy market trailblazer California, along with the burgeoning markets of Colorado, Nevada, New Mexico and Oregon. According to WREGIS, roughly 60% of retired RECs in 2021 went to California, amounting to more than 100 million RECs.

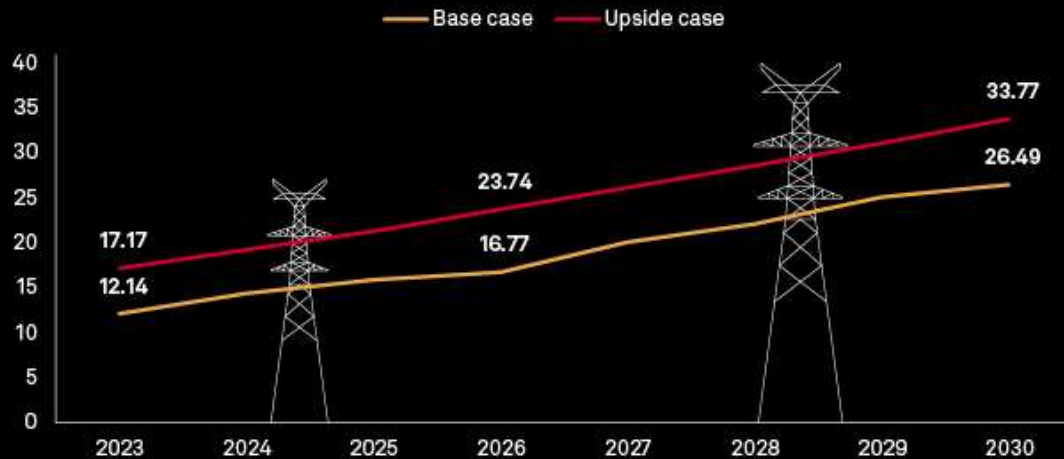
The next-ranked region by 2021 REC market size was PJM Interconnection LLC. The 2021 REC market value in PJM is estimated at just over \$2.4 billion, based on approximately 76 million retired RECs. That represents an estimated average cost of \$32.22 per credit, driven by the RPS compliance markets in Delaware, Maryland, New Jersey, Ohio, Pennsylvania and Virginia.

The Midwest Renewable Energy Tracking System, which tracks most of the REC transfers and retirements within the Midcontinent ISO, ranks second by 2021 REC total, with more than 115 million retired RECs cumulatively valued at nearly \$1.5 billion. The New England Power Pool Generation Information System, or NEPOOL-GIS, covers the ISO New England territory and is comparatively small with 32 million retired RECs in 2021 but is also one of the more lucrative REC markets, ranking fourth among the 10 REC tracking systems in terms of 2021 value at nearly \$1.5 billion and first in terms of cost per REC at an estimated \$45.18. ISO New England is the only multistate system operator in which every state has a mandatory RPS.

REC market forecast

S&P Global Market Intelligence leveraged the REC prices from its Power Forecast to generate an annual projected REC market size through 2030. Referred to in this study as the "base case," this forecast shows the U.S. REC market more than doubling from about \$12.1 billion in 2023 to about \$26.5 billion by 2030. An additional scenario was generated utilizing current REC prices by state and market and applying a steady annual growth rate of 2.5%. This scenario, referred to as the "upside case," shows a more lucrative REC market of more than \$17.1 billion in 2023, growing to nearly \$33.8 billion by 2030.

Projected US REC market, 2023-2030 (\$B)



As of Dec. 8, 2022.

REC = renewable energy certificate.

Sources: M1 Power Forecast data as of Sep. 30, 2022; S&P Global Commodity Insights estimates.

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Compliance market

Renewable portfolio standards drive the REC market as power providers in states with an RPS utilize RECs to demonstrate compliance with local renewable energy requirements. Generally aiming at minimum renewable loads in overall power supply, RPS targets rise over time, essentially showing the way for the overall U.S. REC market. Currently, the S&P Global Market Intelligence Power Forecast models RPS megawatt-hour targets for 27 states. The base REC market case suggests the compliance segment of the U.S. REC market could generate more than \$10.2 billion in 2023 and rise to nearly \$20.1 billion by 2030, while the upside case points to more than \$15.3 billion in 2023 and a little over \$28.1 billion by 2030.

Developments difficult to anticipate, such as the adoption of renewable portfolio standards in states currently without an RPS or the acceleration of targets under existing RPSs, could further steepen the market's trajectory. On the other hand, policymakers in states without an RPS may assess that local mandates to develop renewable energy are no longer necessary, considering green energy commitments in the private market, the Inflation Reduction Act and the energy security imperatives brought to the fore by Russia's invasion of Ukraine and the subsequent impact on global fossil fuel markets.

Solar carve-outs

Solar carve-outs are part and parcel of most renewable portfolio standards, requiring that specific amounts of the mandated renewable power supplies be met by solar energy. For example, Maryland had a solar carve-out of 6% by 2020, with built-in escalators bringing the

metric to 14.5% by 2030. Per its RPS, Washington, D.C., aimed for a 2.175% solar carve-out in 2020, targeting 10% by 2041.

Policymakers originally devised solar carve-outs to promote photovoltaic energy, which historically has trailed wind by a non-negligible margin in the U.S. Today, the mechanism arguably is falling into disuse as renewable energy developers ramp up solar — a generally less expensive, faster-to-develop technology than wind. The U.S. has a utility-scale solar pipeline of approximately 215 GW, compared to 120 GW for wind. This trend is expected to weigh on solar REC prices, keeping the solar REC market in check. Our base forecast shows the solar compliance REC market hovering between \$3.5 billion and \$3.8 billion from 2023 through 2030. Meanwhile, our upside case suggests the segment could top \$4.1 billion by 2030.

Offshore wind

A relatively recent phenomenon, U.S. offshore wind targets aim to bridge the significant gap with Western Europe and China on the maritime wind front. In an online fact sheet published March 29, 2021, the White House announced a target of 30 GW of offshore wind across the U.S. by 2030. Multiple coastal states, notably along the U.S. Atlantic seaboard, have announced offshore wind targets. In New England, for example, Massachusetts is aiming for 5.6 GW of offshore wind by 2035. A bit farther south, New York is working toward at least 9 GW of offshore wind by 2035. Farther to the south, Virginia plans 5.2 GW of offshore wind by 2034, and North Carolina plans 8 GW by 2040.

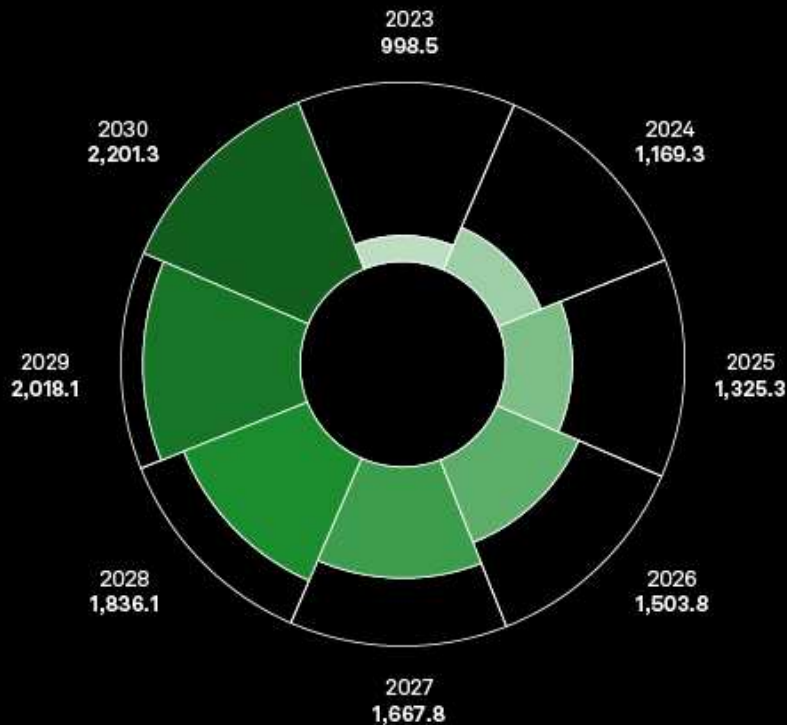
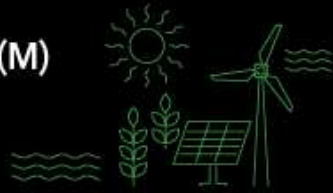
Market Intelligence projects a nearly \$16 million offshore wind REC market for 2023, rising to roughly \$3.6 billion by 2030. Unlike solar, however, offshore wind may require additional support — perhaps even nudges — from policymakers across the outlook, notably to develop the technology in the Gulf of Mexico and on the West Coast. Our compliance offshore wind REC forecast could prove conservative as a result.

Voluntary market

As the name implies, the voluntary market stems from dynamics beyond mandates, notably consumer demand for green energy and commitments by power suppliers, generally on environmental grounds, to transition away from fossil fuels. As discussed above, heightened energy security concerns in the wake of recent geopolitical developments are magnifying these trends. The International Energy Agency, in its "2022 Renewables" report published Dec. 6, anticipates that from 2022 through 2027, global renewable capacity will increase by 2.4 GW, which is 30% higher than the IEA's forecast a year ago.

Voluntary megawatt-hours are expected to account for over 59% of all projected U.S. renewable megawatt-hours in 2023 and to top the two-thirds threshold in the second half of the outlook. Ultimately, however, lower prices make the voluntary REC market less attractive to developers, limiting its growth. It is nonetheless expected to rise quickly during the interval under consideration, from about \$1.9 billion in 2023 to \$6.4 billion by 2030.

Projected US renewable MWh, 2023-2030 (M)



As of Dec. 8, 2022.

Sources: MIPower Forecast data as of Sep. 30, 2022; S&P Global Commodity Insights estimates.

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Regional overview

ISO New England is expected to remain the smallest market among the eight regions delineated in this analysis in terms of megawatt-hour demand for renewable energy despite increasingly aggressive renewable and clean energy targets across the region. Consistently forecast high-priced RECs combined with robust solar carve-out and offshore wind REC markets make it the fourth-largest market in total REC value according to the base scenario, at \$2.9 billion.

Buoyed by an expected surge in offshore wind generation in Maryland, New Jersey and Virginia by the end of the decade, REC quantities in PJM are projected to nearly quadruple from about 78 million in 2023 to slightly over 300 million by 2030. This volume, compounded by robust REC prices for the offshore power and remunerative solar carve-out markets in Maryland and New Jersey, make PJM the second-largest REC market in the country by 2030 at \$5.3 billion in our base scenario. The upside case projects a noteworthy \$8.7 billion REC market in the region within the same time frame. Fueled by the Clean Economy Act, passed in 2020, and its aforementioned offshore wind commitment, Virginia is forecast to have an estimated REC market value of \$1.3 billion by 2030, the largest in PJM.

The West is expected to remain the dominant renewable market in the U.S. through 2030 as the region continues to leverage its unrivaled combination of aggressive clean energy legislation, wind and solar resources, and undeveloped land. Over 480 million RECs are forecast to be generated annually by 2030 in the West, and with many needed for RPS compliance, the market is projected to soar past \$9 billion by the end of the decade. The upside scenario sees a market potential of just over \$13 billion by 2030.

Not surprisingly, California leads all states in the West and the rest of the country, with its REC market value rising to \$5.6 billion by 2030, meaning California alone would make the West the largest REC market in the country. Offshore wind is not currently included in California's market potential as the industry is still in its infancy in the West. The state implemented an offshore wind capacity target of 25 GW by 2045 and has held its first offshore wind auction, which concluded in early December. The maturation of offshore wind activity along the U.S. West Coast will only strengthen California's position as a leader in clean energy deployment.

MISO is forecast to jump to the top in renewable energy generation among the eight regions designated in this analysis, nudging the West out of the lead by 2030. Driven by planned retirements of coal plants and economic renewable development energized by the Inflation Reduction Act, MISO is expected to be one of the most active regions for wind and solar development in the country over the next decade. That said, a substantial portion of the forecast generation in MISO is expected to fall to the voluntary market, capping the market size at \$2.8 billion by 2030, though the upside scenario projects MISO's REC market rising to \$3.6 billion by the same time.

The image below is a video presentation; please click on the image to access controls for play, pause, and moving to specific video frames. To view the video in full screen, please click the square at the bottom right of the video player; to exit full-screen view, please click "x" or press the "Esc" key.

Key takeaways

The energy transition away from fossil fuel will turn RECs into a roughly \$30 billion market in the U.S. by 2030. Compliance is the backbone of the market, but voluntary megawatt-hours are expected to overtake mandatory production in 2023, rising to more than two-thirds of total U.S. renewable generation by 2026 and beyond. With voluntary REC prices significantly lower than their compliance counterpart, however, the compliance dollar volume accounts for between 76% and 84% of the overall U.S. REC market throughout the outlook.

Methodology

Modeling the U.S. REC market involved multiple steps. First, we aggregated the S&P Global Market Intelligence's Power Forecast projections for minimum renewable energy generation to meet RPS targets and overall state-level renewable megawatt-hour production from 2023 through 2030. Second, we leveraged Power Forecast REC price estimates to model the compliance market, then the voluntary segment. Solar carve-outs and offshore wind targets were isolated within broad state-level RPS mandates. Following a similar process, we applied a steady, base annual growth rate of 2.5% to 2021 REC price estimates, yielding an additional "upside" scenario.

For wholesale prices and supply and demand projections, see the S&P Global Market Intelligence Power Forecast.

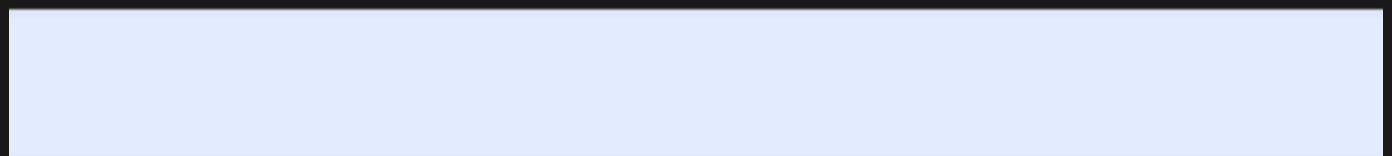
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Evidence Submission 9



Ecohz reports

Unleashing market impact

An estimation of potential renewable electricity production financed by Guarantees of Origin in the EU

Authors: Tom Lindberg, Ivar M. Clausen, Hans Navarro, Alejandro Ruelas

Introduction

2022 changed the Guarantees of Origin (GOs) market. Over the last year, GOs experienced a boom when prices rose from 1.7 EUR/MWh in January to an all-time high close to 10 EUR/MWh in late November. Then, the market stabilised. By mid-2023, prices remained above 7 EUR/MWh for the 2023 vintage,¹ supported by steady demand. While the original price increase was caused by a combination of factors – chief among them the dry weather conditions across Europe that resulted in reduced hydroelectric output² – consumers have shown a sustained willingness to purchase documented renewable electricity, notwithstanding rising costs. The GO market has reached a balance between supply and demand that has substantially increased its overall value.

This article argues that the revenue generated by Guarantees of Origin is not negligible and has the potential to funnel tens of billions of Euros to renewable electricity producers. This additional funding could be reinvested to significantly contribute to Europe's energy transition. We begin by projecting the expansion of GO issuance towards 2030 based on the European Union's (EU) expectations for renewable electricity growth. Then we calculate potential additional revenue generated by the GO market and transform it into additional renewable electricity capacity. Finally, we trace the connections between GO revenue and European renewable electricity targets. This report follows up on a previous article published by Ecohz³ to clarify our methodology and update figures based on the latest market information.

¹ Observed prices at the time of writing in May 2023.

² Primarily in the Nordics and Southern European countries.

³ <https://www.ecohz.com/news/how-demand-for-renewables-can-propel-europes-energy-transition>

Methodology and results

We progress in two stages. First, we show the potential income the GO market could generate in the eight years from 2023 to 2030. Our analysis offers two scenarios based on conservative and current GO pricing. Then, we transform that revenue into possible investments in new renewable electricity capacity.

Calculating Guarantees of Origin (GOs) revenue from 2023 to 2030

In 2022, the EU produced 1 521 TWh of renewable electricity.⁴ Close to 55% of that volume was documented with GOs, putting GO issuance for renewable electricity at 723 million certificates.⁵ Guarantees of Origin represent 1 MWh each.

Under the REPowerEU plan, the EU expects total electricity generation to reach 3 450 TWh in 2030, 72% of which will be renewable electricity.⁶ Our analysis assumes that due to the progressive abandonment of government support schemes for new renewable electricity installations and the EU's push to further reinforce the GO system, virtually all new renewable electricity coming online between now and 2030 will issue GOs. In other words, we estimate the volume of renewable electricity that does not produce GOs will remain constant for the remainder of the decade.⁷ Hence, we forecast that 67% of the 2 484 TWh of total renewable electricity expected in 2030 will generate GOs, equalling a yield of 1.6 billion GOs in that year.

Our model predicts GO issuance to grow by 11% between 2023 and 2030, which goes in line with the positive growth observed in

⁴ <https://www.iea.org/data-and-statistics/data-product/monthly-electricity-statistics>

⁵ <https://www.aib-net.org/facts/market-information/statistics/activity-statistics-all-aib-members>

⁶ https://energy.ec.europa.eu/system/files/2022-06/2022_06_20%20RED%20non-paper%20additional%20modelling.pdf.

The forecast on which we base subsequent analysis represents a conservative (median) estimation of renewable electricity growth under current EU policies.

⁷ Other variables not considered in this study, such as growth in green hydrogen production or changes to national policies, could alter the projections for GO issuance.

the 2017–2021 period⁸ before the dry year in 2022 (Figure 1). Further, we have chosen a linear projection over an exponential curve to reflect the nature of an already maturing market that is experiencing accelerating development.

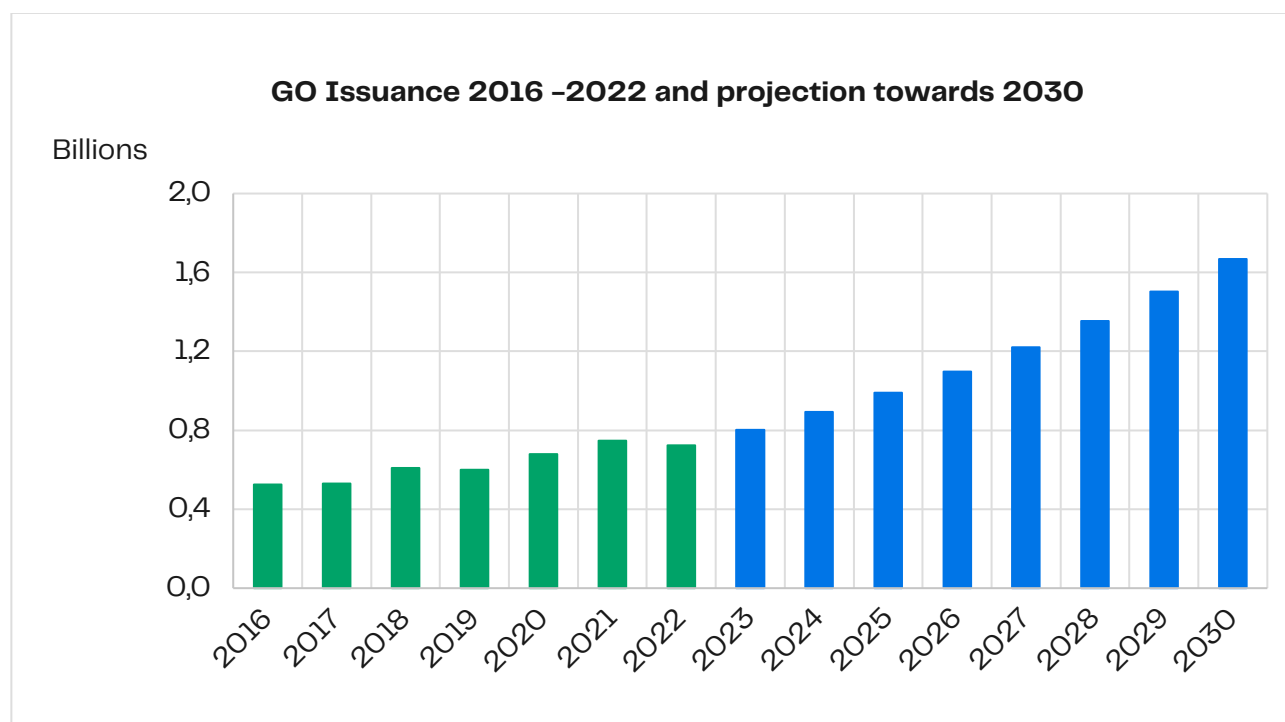


Figure 1: Observed GO production from 2016 to 2022⁹ followed by a linear growth projection towards 2030.

Potential revenue from Guarantees of Origin (GOs)

Based on these issuance predictions, we offer two scenarios for total GO revenue in the chosen period.

A conservative average price of 5.5 EUR/GO, at least 2 EUR/GO below the market price at the time of writing, would generate a total GO revenue of 52.6 billion EUR between 2023 and 2030. Conversely, if we assume that the current market price of 7.5 EUR/GO will remain constant throughout the rest of the decade, GO revenue would total 71.7 billion over the next eight years.

⁸ <https://www.aib-net.org/facts/market-information/statistics/activity-statistics-all-aib-members>

⁹ Ibid.

From Guarantees of Origin (GO) income to new renewable capacity

To determine the potential additional energy production generated from GO revenue towards 2030, we have added a gearing factor to the total potential investment, determined the cost of building new solar or wind capacity, and divided the potential installed capacity by a conservative average of operational hours for wind and solar technology across Europe.

Considering a gearing factor of 75%, our conservative pricing scenario (5.5 EUR/GO) equals a total possible investment of 210 billion EUR over the next eight years. Simultaneously, the current market pricing scenario (7.5 EUR/GO) results in a possible investment of approximately 286 billion EUR over the same period.

Installing 1 MW of new renewable capacity – either wind or solar – currently costs approximately 1 million EUR. This is an average of the costs of building utility-scale solar¹⁰ and wind farms.¹¹ We have chosen to keep these costs flat for the rest of the decade. Moreover, our estimation assumes equal investments in both technologies.

Based on the installed capacity and observed output in 2022¹², we have averaged the operational hours for solar and wind to 1 600 hours per year across Europe. Hence, our first scenario (Figure 2) estimates a conservative projection of GO income could result in 337 TWh/year of additional renewable electricity production by 2030. Our second scenario based on current GO prices (Figure 2) results in 459 TWh/year in the same end year.

¹⁰ <https://www.statista.com/statistics/809796/global-solar-power-installation-cost-per-kilowatt/>

¹¹ <https://windeurope.org/intelligence-platform/product/financing-and-investment-trends-2022/>

¹² <https://www.iea.org/data-and-statistics/data-product/monthly-electricity-statistics>; <https://www.solarpowereurope.org/press-releases/new-report-reveals-eu-solar-power-soars-by-almost-50-in-2022>; <https://windeurope.org/intelligence-platform/product/wind-energy-in-europe-2022-statistics-and-the-outlook-for-2023-2027/#:~:text=Overview,new%20wind%20capacity%20in%202022>

Variables	Scenario 1	Scenario 2
Estimated average GO price towards 2030	5.5 EUR/GO	7.5 EUR/GO
Revenue from GOs 2023–2030	52.6 billion EUR	71.7 billion EUR
Estimated average cost per MW of new installed capacity (solar and wind)	1 million EUR	1 million EUR
Gearing (debt-to-equity ratio)	75%	75%
Average operational hours per year across Europe (solar and wind)	1 600 hours	1 600 hours
Potential yearly electricity production financed by GOs in 2030	337 TWh per year	459 TWh per year

Figure 2: Scenarios for new renewable electricity generation based on potential GO revenue.¹³

¹³ Other variables such as dissimilar output between wind and solar technologies, further variation in construction costs, allocation of investment capital, among others, could alter the results of this model. Our intention is to show the potential of the GO market by providing an estimation based on available information.

Conclusion: consumers can propel Europe's energy transition

Through the Fit-for-55 policy package, EU member states plan to achieve a 55% greenhouse gas emissions reduction by 2030. To that end, the REPowerEU plan predicts the block will need to add approximately 870 TWh of annual clean power production. Based on conservative and current-market-price projections, this paper has shown the potential of the GO market to generate tens of billions of Euros of income for renewable electricity producers. Thus, we argue that GO revenue is far from negligible and could translate into hundreds of TWh of additional clean electricity per year, contributing substantially to reaching EU targets.

Critics of the market-based system long considered GOs inconsequential for investments because they were historically low-priced commodities. However, the newfound market balance that currently keeps the price of GOs above 7 EUR has strengthened the market and is likely to boost the earnings of clean energy producers, thus bolstering the competitiveness of renewables.

GOs allow electricity consumers to choose and verify the source of the energy they use, enabling them to put money into renewables. Our projection shows this energy choice is not trivial and that market-based instruments allow consumers to meaningfully participate in the energy transition.

About Ecohz

For over two decades, Ecohz has pioneered the world of renewable electricity. Harnessing that experience, we work to facilitate companies' journey to net zero by tailoring sustainability solutions.

Our environmental toolbox comprises documented renewable energy, carbon credits, biogas, and digital platforms. But more than putting tools at your disposal, we offer a unique blend of expertise and advise you every step of the way.

In short, we are here to make decarbonisation easy because we believe that simplicity enables urgent climate action – and that what is good for the planet is good for your business too.



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Evidence Submission 10



USING RNG TO MEET VOLUNTARY GHG TARGETS

A PRIMER FOR SUSTAINABILITY DIRECTORS

MAY 2023

Introduction

Renewable natural gas (RNG), also known as biomethane, is a commercially available, low-carbon fuel that has many applications in today's energy transition and a role to play in corporate decarbonization strategies. Produced by capturing methane released by decomposing organic wastes, it is currently the cheapest and most scalable form of renewable gas available. Use of RNG can reduce carbon emissions from assets that use natural gas as a fuel source with few or no equipment upgrades, making it a reliable alternative, carbon-neutral fuel. In fact, depending on the feedstock from which it's derived, RNG can be a *carbon negative* fuel, preventing more emissions than it produces.¹

Methane is a potent greenhouse gas (GHG) having a significantly greater negative impact on the climate than carbon dioxide. Capturing this methane, which would otherwise escape into the atmosphere, and using it for beneficial purposes reduces its climate impact. Beyond its ability to eliminate fossil CO₂ emissions from energy and other industrial processes, RNG also promotes fuel security, local economic benefits, air and water quality improvements, and broader application of circular economy solutions.²

As your company pursues its sustainability journey, it's important to understand how RNG can contribute to your decarbonization goals. This white paper will cover some of the basics, such as how RNG is produced, its climate and sustainability impacts, how it can be utilized in day-to-day operations, and how it can be procured.

What is RNG?

RNG is a carbon neutral, renewable alternative to conventional natural gas that can reduce emissions from transportation, space and water heating, natural gas distribution systems, thermally intensive industrial processes, and where conventional natural gas is used as a chemical feedstock.

When organic materials decay in the absence of oxygen, they release a *biogas* that consists of methane, CO₂, and some other trace gases; this biochemical process is called *anaerobic digestion*. Upgrading that biogas to 95%+ biomethane yields a renewable form of natural gas.

RNG feedstocks include organic materials such as food waste, dairy manure, sewage, and green waste (park and garden clippings). In the instance of food waste, dairy manure or green waste, the feedstock is processed in an *anaerobic digester* to capture the biogasⁱ, which is then upgraded to RNG. Landfills and wastewater treatment plants are also sources for RNG; landfills use gas collection wells to capture the biogas created from decomposing organic waste, while many wastewater treatment facilities have anaerobic digesters that treat the biosolids.

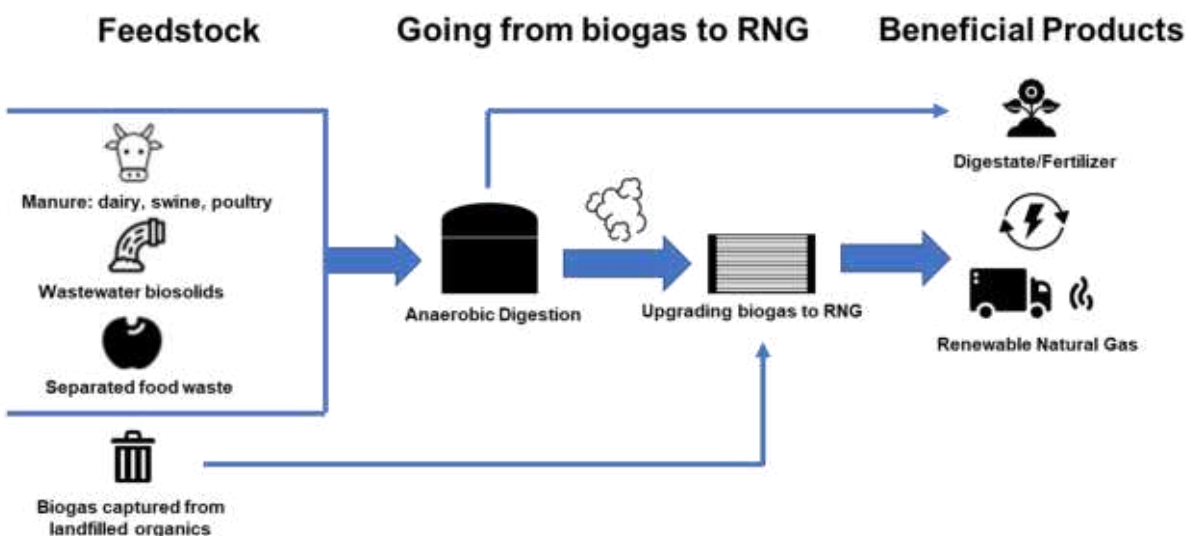
In short, by using RNG, companies are helping reduce methane emissions and improving the broader management and reuse of waste.³

Not only can RNG be used as a substitute for natural gas across many applications, its production results in beneficial byproducts, such as *digestate*, the residual organic materials left

ⁱ For instance, livestock manures that aren't used to produce biogas or RNG are often stored in large open lagoons before being spread on land, releasing methane.

over from the digestion process. Digestate liquids can be used as agricultural fertilizer; the solids can be used as a compost-like soil amendment, as bedding for farm animals, and can even be mixed into construction materials or converted to biochar as a form of carbon sequestration.⁴

Figure 1. RNG Process Flow Example



The Sustainability Impact of RNG

Climate Impact

Conventional natural gas has been buried for millions of years, and using it reintroduces the carbon it contains into today's environment. RNG, on the other hand, represents a closed-loop system, capturing CO₂ recently sequestered by plants as part of the current carbon cycle. By capturing methane from different sources, RNG plays an important role in meeting the Global Methane Pledge.⁵

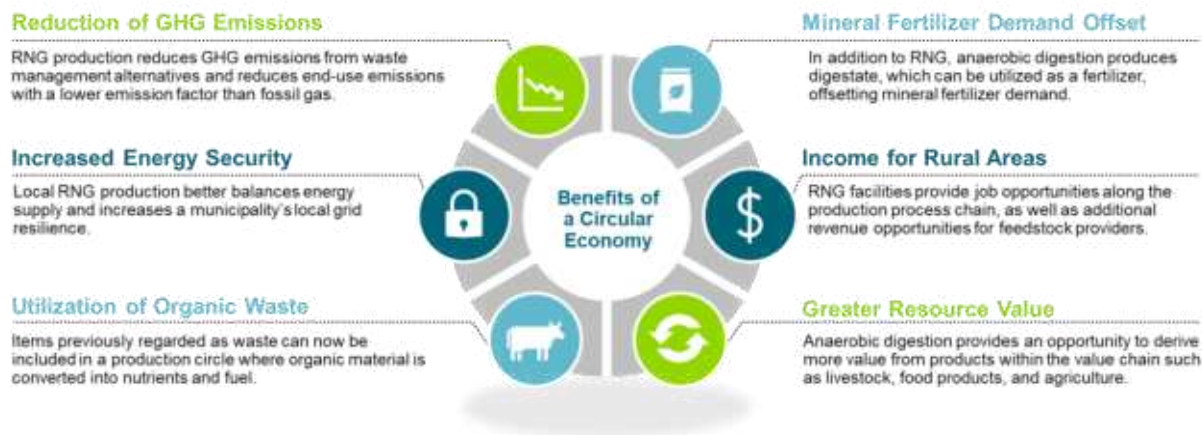
Switching from fossil fuel use to RNG reduces direct operational (Scope 1) emissions for most companies. For example, using RNG instead of diesel to run heavy duty vehicles or using RNG instead of conventional natural gas to power industrial processes are all Scope 1 reductions. The contribution of RNG to an organization's emissions inventory can be considered near zero for reporting purposes;⁶ in standard corporate emissions accounting methodologies, CO₂ from RNG is considered biogenic and therefore neutral, while CO₂ from fossil fuels counts toward Scope emissions.

Circular Economy

Anaerobic digestion plays an important role in creating a circular economy for organic waste (Figure 2) by promoting its proper management and reuse. By converting organic materials with little or no value (i.e., manure, food waste, municipal solid waste and wastewater residues) into RNG, the value of the organic resources remains in the economy for longer. In addition to the beneficial products from the anaerobic digestion process (energy and digestate), RNG

production also provides positive economic and non-climate environmental impacts for local communities and increases energy security.

Figure 2. Circular Economy



Beneficial Byproducts

RNG feedstocks (excluding landfilled municipal solid waste) yield digestate, the residual organic material left over from the anaerobic digestion process, as a byproduct. Solid and liquid digestate both represent nutrient-rich soil health enhancers that fertilize soil and improve the ability of degraded agricultural land to sequester carbon. Recycling the nutrients from the organic feedstocks used in the anaerobic digestion process back into agricultural soil reduces the need for fossil-derived synthetic fertilizer (and the GHG emissions associated with its production).⁷ Application of liquid digestate has also been shown to improve soil structure leading to less runoff,⁸ and decreasing the potential for eutrophicationⁱⁱ in local water sources.⁹

Economic Benefits

RNG development projects have a major positive impact on regional economics. In 2022, 91 trillion BTUs (91 million MMBTUs) of RNG were produced across 254 facilities in North America, a 23% increase in capacity and a 44% increase in the number of facilities from 2021.¹⁰ On average, for every new RNG facility commissioned, 98 jobs associated with the build and seven jobs associated with operations and maintenance are created.¹¹ Notably, these jobs tend to be concentrated in rural communities, with more than half (51%) of operational facilities and more than two-thirds (68%) of those under construction focused on using agricultural residues to produce RNG.

Energy Security

RNG also provides energy security¹² by increasing the diversity of energy supplies, with production and distribution dispersed geographically around the country.¹³ Today there are RNG projects operating or under construction in more than 40 U.S. states; by contrast, 70% of conventional natural gas production is concentrated in just five states.¹⁴ In situations where

ⁱⁱ An overabundance of nutrients—primarily nitrogen and phosphorus—in water starts a process called *eutrophication*. Algae feed on the nutrients, growing, spreading, and turning the water green. Algae blooms can smell bad, block sunlight, and even release toxins in some cases. ([USGS Nutrients and Eutrophication](#))

natural gas is transported over long distances, locally produced biomethane can be connected directly to the local distribution pipeline or end user from the production source.

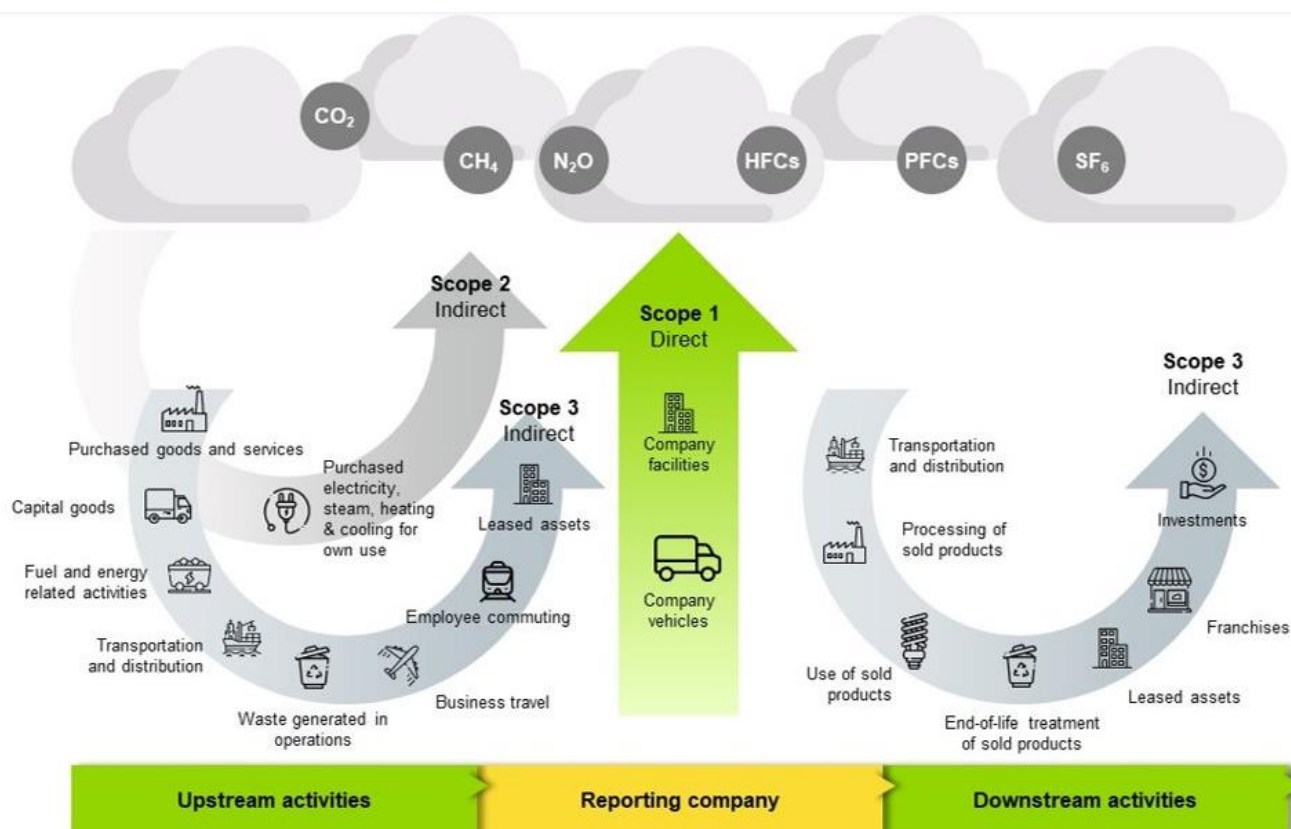
ESG Story

RNG plays a role beyond the energy commodity by providing positive environmental and economic impacts. It offers a solution for reducing carbon emissions, developing economic opportunities for rural communities, and mitigating energy dependency risk. These additional benefits help a company tell investors a positive ESG story that embraces but goes beyond standard metrics, and takes a multifaceted view of sustainability and social goals.

How RNG Can Help You Meet Your Sustainability Goals

Anthropogenic emissions are a main driver for recent changes in global temperatures.¹⁵ A company's operational impact on climate change can be measured through its direct and indirect emissions. Direct emissions are those emitted directly by the company's operations, and which it has the greatest ability to control; indirect are those generated upstream and downstream of the core business. These GHG emissions are classified into three categories, known as Scope 1, 2, and 3 emissions,¹⁶ as depicted in Figure 3¹⁷ and explained below.

Figure 3. Overview of Scope 1, Scope 2, and Scope 3 Emissions



Understanding the magnitude of Scope 1, 2 and 3 emissions is key to reducing the climate impact of a company's operations.¹⁸ By accurately measuring and reporting their emissions, companies can identify opportunities for emission reduction, such as improving energy efficiency, transitioning to renewable energy sources, and optimizing supply chains.

SCOPE 1

Emissions from sources owned or controlled by a company, also referred to as "direct emissions". Sources include but are not limited to fuel combustion, industrial processes, and company-owned vehicles.¹⁹

Organizations can use RNG as a direct substitute for conventional natural gas operations such as heating buildings, fueling on-site power generation, or operating compatible company vehicles. RNG's biogenic origin means its CO₂ emissions are carbon neutral.

SCOPE 2

Scope 2 emissions are indirect emissions associated with the generation of purchased electricity, steam, heating, and cooling consumed by a company.¹⁹

These emissions occur at the facility where energy is produced, rather than at the company's premises.

Purchasing Renewable Energy Credits (RECs) that represent power produced from RNG can reduce Scope 2 emissions while helping to displace fossil-fuel based grid electricity.

SCOPE 3

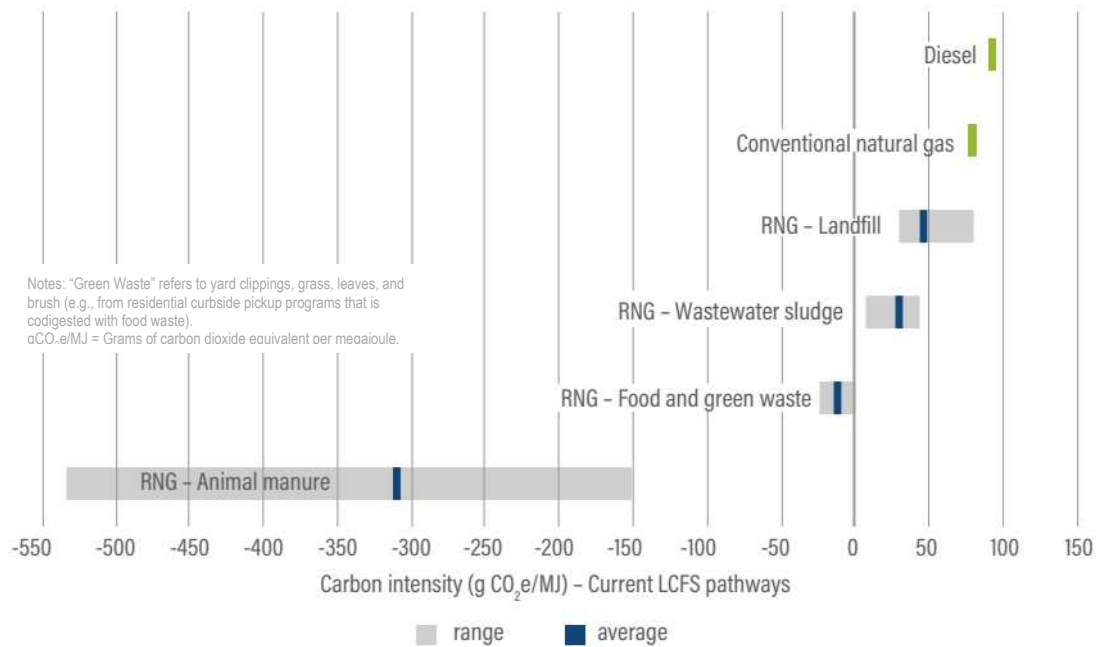
Scope 3 emissions encompass all other indirect emissions that occur throughout a company's value chain, not included in Scope 2 emissions.¹⁹ These emissions can be both upstream (e.g., raw material extraction, manufacturing, and transportation) and downstream (e.g., product use, end-of-life treatment, and disposal). Scope 3 emissions can be lowered by **selecting suppliers that utilize RNG in their operations, lowering emissions from upstream and downstream activities.**

Carbon Negative/Neutral Fuels

RNG that's *carbon negative* or *carbon neutral* can provide companies that use natural gas as a fuel source the option of reducing their carbon emissions with few or no equipment upgrades.

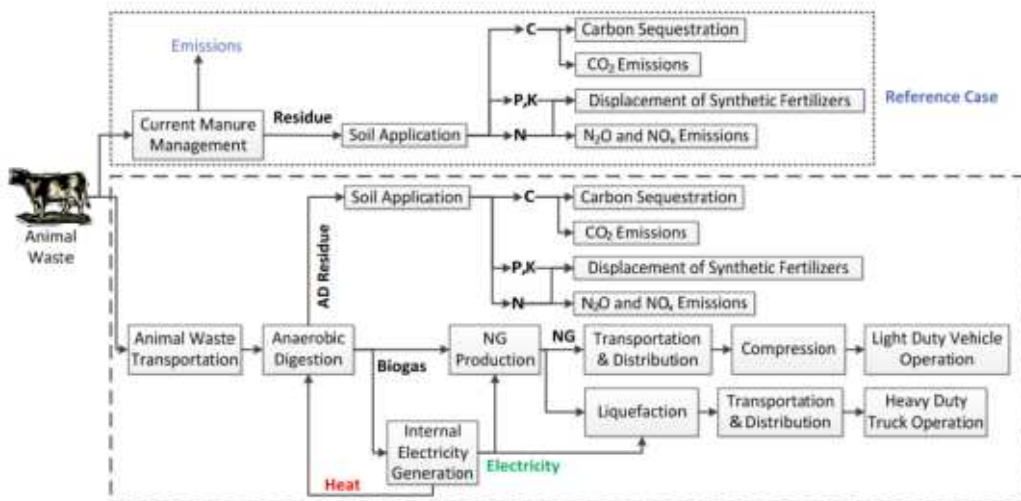
The "carbon intensity" (CI) of fuels is often measured on a *life cycle basis*. This takes into account all emissions (and avoided emissions) associated with a fuel, including its initial production, transportation to the user and final end use. Depending on the feedstock used, RNG's CI score — measured in grams of CO₂-equivalent per unit of energy — can be above or well below zero (see Figure 4).

Figure 4. Carbon Intensities of Different RNG Production Pathways



The CI score of fuels can be measured with life cycle analysis tools, such as the GREET model (Greenhouse gases, Regulated Emissions, and Energy use in Technologies), a publicly available tool sponsored by the Department of Energy's Argonne National Laboratory.¹⁹ As seen in Figure 5,²⁰ which shows an example of RNG from dairy manure used for transportation, GREET takes all parts of the value chain into consideration to generate an overall CI score. The tool is accepted by regulators and GHG disclosure companies for measuring the CI of a fuel used for transportation, but can also be used for bioproducts, and stationary energy systems. Preventing more emissions than they produce, carbon-negative fuels offer the considerable benefit of helping to counterbalance emissions from transportation fleets, space and water heating for buildings, and industrial facilities.

Figure 5. GREET Life Cycle Analysis Sample



How RNG Fits into the Decarbonization Taxonomy

RNG can effectively support the reduction of Scope 1 and 2 emissions while providing additional carbon offsets through methane intervention, and additional non-climate environmental benefits through organic waste processing. RNG is often considered first for a direct replacement to natural gas because it can often be fully interchangeable, but RNG can be even more impactful when substituted for more carbon-intensive fossil fuels, such as diesel.

Transportation

Transportation is currently the primary application of RNG in the US.²¹ Driven by federal renewable fuel policies and by state-level emission reduction policies for the transportation sector,ⁱⁱⁱ in 2022 69% of all on-road fuel used in natural gas vehicles was RNG.²²

Producers either inject RNG into pipelines for supplying off-site transportation users or use it on-site to fuel vehicles themselves.²³ Major waste collection companies have converted refuse collection vehicles to natural gas engines and are using the RNG generated at their landfills to power them.²⁴ In some municipalities, RNG produced at wastewater treatment plants is used to power municipal vehicles. Other fleet users, particularly those with heavy-duty vehicles, source their RNG by contract from producers.²⁵

Case Study: Decarbonizing UPS Transportation with RNG

United Parcel Service (UPS) has a goal of reaching 40% alternative fuel use in their fleet by 2025. Today they operate a global fleet of 13,300 trucks that use alternate fuel and advanced technology. As part of their efforts to decarbonize, UPS has purchased 155 million gallon-equivalents of RNG since 2014, and last year used 63 million gallon-equivalents of RNG.²⁶ To date they have invested more than \$1 billion in alternative fuel and advanced technology. In addition to their ground transportation, they have joined the Sustainable Aviation Buyers Alliance with the goal of decarbonizing flight by 2050.²⁷

Heating

RNG can also be used to provide heat, hot water and cooking gas for buildings. RNG only displaces a small proportion of conventional natural gas used to supply (mostly institutional and commercial) buildings across the country today. The proportion of RNG used for such thermal applications has the potential to increase as cities look to decarbonize energy use in buildings and organizations with sustainability goals seek to get emissions under control. In some buildings, replacing natural gas heating systems with electric systems may not be physically or economically feasible, making RNG a good alternative.²⁸

ⁱⁱⁱ States such as California, Oregon, and Washington have low-carbon fuel standards providing incentives for the production and use of RNG in transportation.

Case Study: Port of Seattle Utilizing RNG for Building Heat

In 2020 the Port of Seattle entered a 10-year supply contract with US Gain to purchase RNG, enabling the Port to reach its 2030 goal a decade early by reducing carbon emissions by 50% compared to its 2005 baseline.²⁹ The RNG, coming from a landfill, will be used to power 100% of the Port's airport bus fleet and heat 55% of the Seattle-Tacoma International Airport (SEA).

Prior to this deal, natural gas made up 75% of the Port's annual GHG emissions. With the substitution of RNG the Port will reduce 11,000 tons of its Scope 1 and Scope 2 GHG emissions annually. SEA has also set a goal of providing 10% of all flights with sustainable aviation fuel (SAF) by 2028 and operating a carbon neutral airport by 2050.

How RNG Can Decarbonize Hard-to-Decarbonize Sectors

As the world seeks to reduce GHG emissions and transition to cleaner energy sources, some sectors remain hard to electrify due to technological limitations and the need for high energy density. RNG is a promising option for these sectors, as it is chemically identical to conventional natural gas and can be utilized without major modifications to existing infrastructure. Hard-to-electrify sectors where RNG can play a role in decarbonization include direct use in industrial applications, companies under compliance programs, and maritime shipping fuel. Additionally, RNG has a potential role as an intermediate component in SAF and hydrogen production.

Industrial Applications

Some industrial applications with high carbon emissions require high temperature, high energy density, or have specific process requirements that make electrification challenging. RNG can be deployed as a direct replacement for conventional natural gas in these situations, with few or no infrastructure and process modifications. Primary applications for this transition are in aluminum, glass, and ceramics manufacturing, with applicability in other processes, including steel production and high temperature furnaces and kilns.

RNG also has the potential to displace conventional natural gas in making chemicals that are subsequently used in the production of plastics, fabrics, cosmetics, and an array of other consumer goods.³⁰

Utilities and RNG

RNG can help utilities meet mandated emissions reduction targets and can help their customers reduce emissions at the same time. For example, utilities in Washington state are mandated to provide voluntary RNG programs to their customers, and in California gas utilities are required to have a percentage of their fuel supply made up of RNG. In these cases, RNG reduces GHG emissions, and supports the broader integration of renewable energy sources. Renewable Portfolio Standards require utilities to procure a certain percentage of their electricity from renewable energy sources; some jurisdictions include RNG as an eligible energy source, particularly for combined heat and power systems for electricity production.³¹

Maritime Shipping Fuel

While the shipping sector plays a critical role in global trade and economic growth, it is also a significant contributor to GHG emissions, responsible for up to 3% of global CO₂ emissions and consuming 330 million metric tons of marine fuel per year.³² Liquified RNG (or “bio-LNG”) can be used as a shipping fuel. Trials of blending 10% bio-LNG with fossil fuel-derived LNG in Rotterdam and the Netherlands have proven to be successful, demonstrating feasibility of bio-LNG blending for maritime shipping fuel. When taking into consideration avoided emissions for the production and use of bio-LNG against the oil baseline, an estimated 47%-72% emissions reductions can be achieved.³³

Methanol is also getting a great deal of attention as a greener maritime fuel.³⁴ Methanol is commonly produced using natural gas,³⁵ but producers have been blending biomethane and conventional natural gas, achieving reductions in GHG emissions of over 50%.³⁶ “Biomethanol” can be produced exclusively with biomethane, and a Danish biofuels manufacturer expects to begin production at a new facility in 2024.³⁷

Intermediate Component (RNG as a feedstock)

Sustainable Aviation Fuel

Aviation fuel needs to provide high energy density and manageable weight. Fuels that provide this combination have historically been carbon-intensive, making aviation a hard-to-abate industry responsible for 9%-12% of the GHG emissions related to travel in the U.S.^{38,39} Alternatives like batteries are currently unsuitable for long flights, making SAF a promising low-carbon alternative for airlines.⁴⁰ Depending on the feedstock and the technology, SAF can reduce the life cycle GHG emissions drastically. RNG can be used to produce SAF, lowering the fuel’s carbon intensity while maintaining compatibility with existing airline infrastructure.⁴¹

RNG for Hydrogen Production⁴²

There are currently two leading forms of low CI hydrogen production: reforming of natural gas with associated CO₂ emissions being captured, and electrolysis powered by carbon-free renewable electricity. Biohydrogen, on the other hand, receives far less attention, despite its considerable benefits. When produced using RNG and renewable energy, hydrogen can be nearly carbon neutral, and when paired with carbon capture and storage, it can become net carbon-negative.

Considerations for Purchase

There are several ways for a company to purchase RNG as part of its sustainability strategy – through a contract with a developer, a broker, or through a utility with a voluntary RNG program. The pathways from the production site to the end-user can vary and may depend on whether purchases are in a compliance or voluntary market. This section touches on the different procurement mechanisms, verification to track the commodity from production to consumption, and accounting in voluntary standards.

Environmental Attributes

Certificates that can facilitate the transfer of “environmental attributes” such as renewable thermal credits (RTCs) and RNG certificates are tradable commodities associated with the production of renewable fuels, including electricity. Since renewably sourced electrons and molecules cannot be distinguished from their conventional counterparts once comingled, the associated environmental attributes provide a fuel with both a stamp of authenticity as to its renewable or low carbon qualities, and a way to track ownership and claim credit for use of the fuel.

A consumer can purchase a fuel commodity together with its environmental attributes in a “bundle” (potentially allowing them to sell the attributes), or they can buy the environmental attributes without the commodity, “unbundled.” The needs of the company and what makes the most business sense will drive the decision to purchase “bundled” or “unbundled.” A “bundled” example is seen in the L’Oréal case study below.

Case Study: RNG Enabled L’Oréal to Become Carbon Neutral, Across All US Sites

L’Oréal achieved carbon neutrality for its Scope 1 & 2 emissions across all 21 of its US sites in 2019. The company uses RNG as a core component of reducing emissions for space and water heating, complementing L’Oréal’s energy optimization efforts and renewable electricity sourcing.⁴³

L’Oréal sources RNG from landfill projects in New York, Texas, and Kentucky. The Kentucky example is notable as part of the decision was to provide fuel for their Florence, Ky facility but also increase economic benefits where they operate. L’Oréal’s commitment to purchase 40% of the RNG produced by the installation over a 15-year period was key to the project securing financing in 2018.⁴⁴

By investing in long-term RNG supply L’Oréal has hedged against fluctuations in the price of heating needed for its operations.

Mechanisms for Procuring RNG

There are different mechanisms for obtaining RNG—the simplest of which is a direct pipeline connection from the RNG facility to the end use site, when the two points are in proximity.

Beyond this, other common mechanisms for procurement are **book-and-claim** and **mass balance**. Each has its own guidelines on how to acquire the RNG, with book-and-claim being the most common and convenient standard. In each mechanism the amount of RNG taken out of the pipeline must equal the amount injected into the pipeline.

- **Book-and-claim:** This procurement mechanism is used under the California Air Resources Board’s low carbon fuel standard (LCFS) and the federal Renewable Fuel Standard, as well as compliance and voluntary non-transportation procurement regimes. Most entities receive their energy from large distribution systems in which specific electrons or gas molecules cannot be traced from producer to buyer, creating



a barrier to direct clean energy procurement. In a book-and-claim system, a contracted amount of clean energy (whether electricity or RNG) is introduced into a distribution system and an equal amount of energy is withdrawn at another location. The “environmental attributes” corresponding to the clean energy are transferred through an exchange of certificates (i.e., RTCs, RECs, RINs, Guarantee of Origin) between the producer and buyer to establish chain of custody and ownership of the energy and associated emissions reductions.^{iv} However, the environmental attributes and the energy commodity are de-coupled in a book and claim system, meaning that certificates can be sold separately from the commodity; the buyer can then use the energy, but can no longer claim its environmental attributes.

- **Mass Balance:** Like book and claim, in a mass balance approach the RNG can be injected and mixed into a pipeline with other gases such as hydrogen and natural gas. A notable difference between the two is that in a mass balance system, the environmental attributes must remain with the commodity; they cannot be traded between parties without trading the energy commodity between the same parties. In addition (depending on the jurisdiction), tracking and documentation may be required not just for the energy, but for the feedstock used to produce it.

Green Tariff Program

A Green Tariff program provides the opportunity for utility customers to purchase RNG for their facility directly from their utility provider. This is commonly done via book-and-claim, and in some instances by direct connection from the development site. Reaching out to a local utility is the best way to understand the options a customer has for taking part in a Green Tariff program.

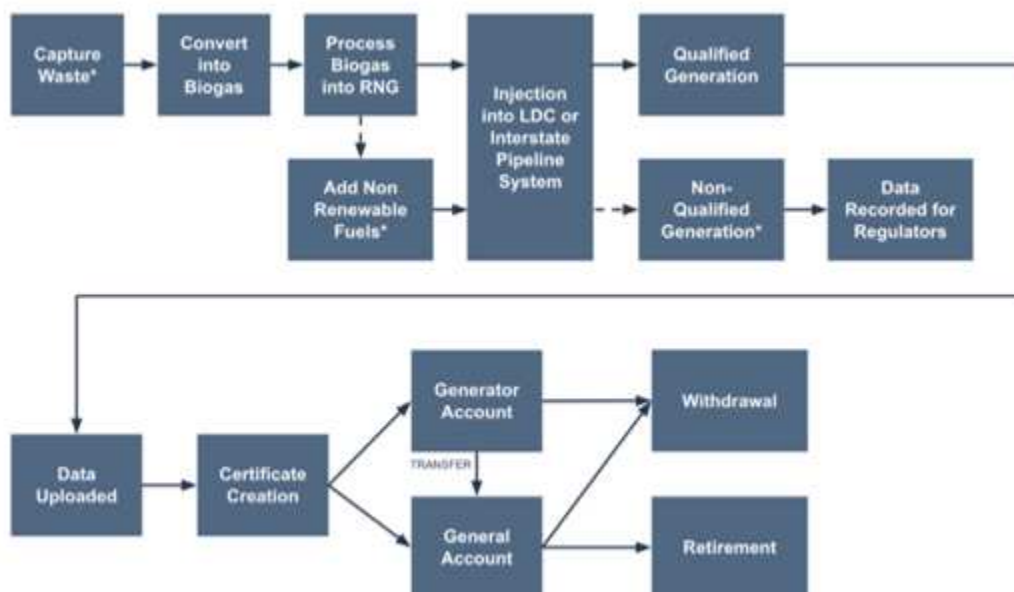
Verification of RNG Procurement

Tracking RNG from injection into a pipeline to the point of consumption (unless through a dedicated RNG pipeline) can be challenging as RNG molecules are being mixed with other gas molecules. Since the physical molecules can't be tracked, there are different verification and tracking platforms for the environmental attributes.

M-RETs is a good example of a platform that connects the producer with the end-user. It provides a trusted environmental attribute and certificate validation and tracking system where companies on the voluntary or compliance markets can track the environmental attributes from production to retirement (as seen in Figure 6).⁴⁵ Each dekatherm is assigned a serial number to generate a certificate that includes location, project, and carbon intensity pathway. Once certificates are in M-RETs they can be sold either through a broker, on an auction/exchange program, or retired.⁴⁶

^{iv} According to the California Air Resources Board, “Book-and-claim accounting refers to the chain-of-custody model in which decoupled environmental attributes are used to represent the ownership and transfer of transportation fuel under the LCFS, without regard to physical traceability.”

Figure 6. M-RETS RTC Creation Schematic



Accounting for use of RNG

Once environmental attributes are in hand, they can be used to claim the environmental benefits for using RNG under leading voluntary standards such as Carbon Disclosure Project, Climate Registry, and RE100 for Scope emissions.⁴⁷ RNG's ability to support GHG reduction is also recognized by the Science Based Targets Initiative (a non-profit that verifies that emissions reduction plans align with the Paris Agreement goals).⁴⁸ Claiming the environmental attributes and what qualifies within different voluntary standards may vary, so understanding the technical criteria for each will be important.

Conclusion

RNG is a growing market, gearing up to support companies on their decarbonization journeys, as illustrated in the profiled case studies. Companies should consider RNG when they weigh-up options for decarbonizing the energy they use in transportation, heating, or industrial processes. In addition to being a carbon neutral energy source, RNG provides secondary and tertiary benefits through positive local economic impacts and improvement to air quality and agriculture that fit well in a company's sustainability goals.

While most of the demand for RNG has come from the transportation sector, there are expectations the voluntary market will drive increased demand for the product as companies look for solutions to decarbonize.⁴⁹

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Evidence Submission 11

RENEWABLE NATURAL GAS AND “BOOK-AND-CLAIM” ACCOUNTING

Renewable Natural Gas (RNG) is made by capturing, and then purifying, methane released from decomposing organic wastes. RNG has a double emissions-reduction benefit:

- it prevents methane, a potent greenhouse gas (GHG), from escaping into the atmosphere and contributing to climate change;
- it can seamlessly displace conventional natural gas, which produces higher CO₂ emissions, across a range of applications.

Because CO₂ emissions associated with using RNG originate in the current carbon cycle, they are considered *carbon neutral*.

As of 2023, there are nearly 300 RNG projects now operational in the United States. As with other sources of renewable energy, facilities that are close enough to the end user for a direct connection are the exception, rather than the rule. Most RNG is transported from its point of production to its end user via existing natural gas infrastructure, using a procurement system called “book-and-claim”—the same kind of system that continues to drive the expansion of solar and wind-generated electricity.

About Environmental Attributes

Book-and-claim accounting for renewable and clean energy procurement involves the “un-bundling” and transfer of the energy’s *environmental attributes*. This is most commonly achieved via contract and/or certificate.

“Environmental attributes” refers to the characteristics of an energy resource that determine the type and extent of its impact on the environment, and that may make it environmentally preferable to another form of energy. These characteristics may include that the fuel is renewable; the nature of the feedstocks from which it’s made; that it is less polluting than conventional fuels; that it captures or avoids GHG emissions; or that it can displace other fuels that generate more CO₂ when used.

When a clean or renewable fuel is produced, its attributes can be documented in a corresponding *certificate*. Such certificates allow buyers and sellers to transact, track and audit ownership of the specified environmental attributes; in a transaction, certificates and fuel are delivered together to the intended consumer. Certificates may take the form of regulatory credits or voluntary certifications. Examples include Renewable Energy Certificates (RECs) for wind or solar electricity under a state Renewable Portfolio Standard (RPS); Renewable Identification Numbers (RINs) for biofuels under the federal Renewable Fuel Standard (RFS); Carbon Credits for low-emissions fuels under California’s transportation-focused Low Carbon Fuel Standard (LCFS); or Renewable Thermal Certificates (RTCs) for clean fuels under state “Clean Heat” programs.

Certificates for environmental attributes play a critical role in helping facilitate auditable transactions – helping consumers to reach fuels, and producers to reach markets, that might otherwise be unavailable because of geographic distance.

About Book & Claim

Energy procurement via book-and-claim systems, based on the transfer of certificates verifying environmental attributes, is the foundation of clean and renewable energy markets.

Most entities—utilities, campuses, buildings, fleets—receive their energy via large distribution systems, making it impossible to trace specific electrons or gas molecules from producer to buyer; this creates a barrier to direct clean energy procurement. Under book-and-claim, a contracted amount of clean energy (whether electricity or RNG) is introduced into a distribution system (booked) at one location, and an equal amount of energy is withdrawn (claimed) at another. The certificates verifying the energy's environmental attributes (RECs, RINs, Carbon Credits, RTCs) are transferred from the producer to the buyer, establishing a “chain of custody” and ownership of the energy *and* the associated emissions reductions.

Certificates and the energy commodity with which they are associated are “un-bundled” or “de-coupled” in a book and claim system, meaning that the certificates are tradeable and can be sold separately from the energy itself.

- The buyer can use the energy *and* the certificates, meaning they get to consume the energy and claim the associated environmental benefits.
- Alternatively, the buyer can use the energy but sell the certificates; this means they can no longer claim the environmental benefits, which pass to the party buying the certificates.
- The buyer can keep the certificates but sell the energy; they claim the environmental benefits, which the party buying the energy can't count towards environmental goals.

Book and claim does not guarantee that a buyer is receiving any solar-generated electrons or actual molecules of renewable natural gas. But it does allow potentially distant buyers to purchase the *certified environmental benefits* of clean/renewable energy that *has documentably been produced*. This gives producers access to much larger markets than they might otherwise have, making projects profitable, and enabling more projects to get built. Entities working to meet environmental targets are able to do so without a direct connection to a clean energy facility.

Book-and-claim has long been standard practice in the renewable/clean energy industries and continues to drive the growth of solar and wind electricity. The whole chain-of-custody process is subject to rigorous oversight to avoid fraud, double-counting and double-claiming.

One simple analogy is banking. The \$20 bills you withdraw from an ATM in one city are almost certainly not the same bills you deposited in another city a few days before. However, they are still legal tender and still yours—and you are only going to be able to spend them once. A book and claim system similarly allows for the efficient banking and deployment of renewable energy.

Not all entities seeking to procure clean and renewable energy have direct or local access to such resources. A book-and-claim system enables geographically separated suppliers and end-users to connect; as a result, clean and renewable energy is being generated in ever-growing quantities, and is being consumed as part of the overall energy supply.

Evidence Submission 12

How Renewable Natural Gas is Helping the Life Sciences Sector Tackle Greenhouse Gas Emissions

This article is Part 3 in a series on how renewable natural gas (RNG) can help unlock environmental and economic benefits across the US economy.

Guidehouse, The Coalition for Renewable Natural Gas

The Life Sciences Sector's Emission Reduction Challenges

Healthcare generates approximately 4.4% of global greenhouse gas (GHG) emissions,ⁱ 20-33% of which is associated with the development and manufacture of new pharmaceuticals and treatments.ⁱⁱ The sector is facing increasing scrutiny regarding its emissions reduction targets, their alignment with the Paris Agreement,ⁱⁱⁱ and the specifics of how it intends to do its part in mitigating the impacts of climate change.^{iv}

Emissions associated with the purchase of goods and services (Scope 3, Category 1) represent the largest GHG emissions liability for the pharmaceutical sector. The upstream manufacturing and distribution of pharmaceutical ingredients is energy-intensive, especially where cold chain shipping and storage is required.^v Pharmaceutical companies are also working to reduce their direct emissions (Scope 1) from fuel use, as well as the emissions associated with the electricity they consume (Scope 2).^{vi}

The majority of large US and European pharmaceutical companies have set either carbon-neutrality or net-zero targets for 2030.^{vii} Companies in the sector are decarbonizing their electricity use at a rate in line with reaching net zero by 2030; however, decarbonizing fuel use (e.g., natural gas) is proving trickier, with the sector currently on track to reach full emissions abatement by 2050 at the earliest.^{viii} As described further in the AstraZeneca case study below, RNG is an effective tool to achieve both the rapid and deep decarbonization of fuel-related GHG emissions.

How RNG Can Support Life Sciences Decarbonization

RNG is a substitute for fossil fuels in hard-to-electrify pharmaceutical manufacturing applications, and also provides sustainable alternatives to feedstocks used in the sector's ingredient supply chains.

RNG can be used as a drop-in replacement for natural gas in existing boilers and cogeneration systems employed by the pharmaceutical sector, with no need for new or upgraded equipment.

Cogeneration, or combined-heat-and-power (CHP) systems, are widely used in the pharmaceutical sector, as they can generate electricity and provide the steam and heating functions needed by different steps of the manufacturing process. These cogeneration systems are difficult to replace given their tight integration with many parts of the manufacturing process, limiting the range of viable decarbonization options to RNG and other low-carbon fuels.

Replacing fossil-based chemical feedstocks (such as conventional natural gas) with green hydrogen, RNG, and other sustainable fuels will drive deep decarbonization of the sector.^{ix} Leaders in the sector are collaborating to address the technical, regulatory and commercial hurdles to increase the renewable content of pharmaceutical ingredients (estimated at only 2%

today).^x For example, recent scientific advances have improved the conversion of methane, either bio-derived or fossil-based, into methanol, an important precursor to many active pharmaceutical ingredients.^{xi} Bio-derived CO₂, a by-product of upgrading biogas to biomethane, may also be an attractive feedstock for the chemicals, including methanol, used by the sector in the future.^{xii}

AstraZeneca Case Study

Pharmaceutical giant AstraZeneca has aggressive emission reduction targets, which include abating 98% of Scope 1 (direct emissions from fuels used on site and in vehicles) and Scope 2 (emissions associated with electricity use) by 2026, against a 2015 baseline. As of 2022, the company had achieved 60% of its emissions abatement targets.^{xiii}

In June 2023, AstraZeneca announced that it would procure renewable natural gas (RNG) for its Delaware campus from Vanguard Renewables. The partnership between these two companies will involve AstraZeneca gaining access to high quality RNG from three of Vanguard Renewables' on-farm anaerobic digester facilities across the US for at least 15 years. By 2026, the annual supply of RNG to AstraZeneca will equal 650,000 MMBTU, which if used to produce electricity could power 17,800 US homes per year.^{xiv}

AstraZeneca sees RNG as a key part of its global decarbonization strategy. In September 2023 the company announced an additional \$124 million investment to secure a 15-year supply of RNG for facilities in the UK's Macclesfield, Cambridge, Luton and Speke areas from Future Biogas.^{xv} Notably, the carbon dioxide produced alongside the RNG will be captured and shipped to Norway for long-term geological storage from 2024.^{xvi}

RNG captured from landfills will also be used by AstraZeneca in Puerto Rico for cogeneration at its plant east of San Juan, decarbonizing both fuel and electricity consumption at the facility.^{xvii}

Last Words

RNG is a practical solution to decarbonizing the pharmaceutical sector and its supply chain. Interchangeable with natural gas, RNG offers a straightforward and rapid pathway to achieving deep decarbonization of manufacturers' Scope 1 emissions. Longer-term, RNG and other bio-derived molecules could help decarbonize the production of pharmaceutical ingredients vital to the health and well-being of present and future generations.

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- xiv [AstraZeneca announces innovative partnership with Vanguard Renewables to decarbonize its United States sites \(astrazeneca-us.com\)](#)
- xv [AstraZeneca advances UK clean heat and energy efficiencies with £100m commitment | Business Wire](#)
- xvi <https://www.edie.net/astrazeneca-to-support-uk-biomethane-and-ccs-project-in-drive-to-decarbonise-heat/>
- xvii [iPR Pharmaceuticals: First pharmaceutical company in Puerto Rico to use Renewable Liquefied Natural Gas to power its cogenerator \(astrazeneca-us.com\)](#)

Evidence Submission 13



OFFICE OF THE PRESIDENT

Energy and Sustainability
1111 Franklin St
Oakland, California 94607-5200
(510) 987-0205

June 13, 2022

To: World Resources Institute (WRI)

From: University of California, Office of the President

Subject: Comments re: Biomethane Annex of Land Sector and Removals Initiative

Dear WRI:

Thank you for your efforts to “develop internationally accepted greenhouse gas (GHG) accounting and reporting standards and tools, and to promote their adoption in order to achieve a low emissions economy worldwide” through the GHG Protocol.¹ The University of California (UC or The University) is charting a path to net carbon neutrality by 2025 and is utilizing electrification, energy efficiency, off-site mitigation, and wholesale renewable electricity and biomethane procurement to meet this target.

As the largest voluntary purchaser of biomethane in the country, the University is writing to express concern with the proposed treatment of biomethane in the recently released First Draft Guidance (“Guidance”) of the Greenhouse Gas Protocol Land Sector and Removals Initiative. Specifically, the proposal to disallow the use of biomethane certificates to mitigate Scope 1 emissions will likely increase global GHG emissions, is inconsistent with existing climate science and carbon accounting frameworks, and eliminates a critical emissions mitigation tool needed to decarbonize. UC has already entered into several, multi-year biomethane contracts with the understanding that biomethane would count toward our Scope 1 emissions reduction goals. As such, the University respectfully requests that the forthcoming second draft of the Guidance be updated to eliminate the language that prevents the use of biomethane to mitigate Scope 1 emissions.

Background: The University of California’s Carbon Neutrality Initiative

UC generates nearly \$82 billion in economic activity in California annually, employs 229,000 faculty and staff, operates the largest academic health system in the country, and maintains approximately 6,000 buildings enclosing 137 million gross square feet.² Through these activities—even after many years of emissions reductions through energy efficiency measures and increasing renewable energy production and procurement—the University still emits approximately 1 million metric tons of Scope 1 and Scope 2 emissions (CO₂e) each year across its 10 campuses and 5 medical centers. Due to the years of successful energy efficiency and renewable energy implementation, over 78% of these remaining emissions come from combusting fossil natural gas at combined heat and power plants located on UC campuses. When they were installed in the 80’s, 90’s, and 2000’s, these plants were the lowest-emission, most cost-effective options available. The plants currently provide cost-effective and reliable power, hot water, and steam, and are an important resilience tool to protect patient lives and billions of dollars in research in the face of increasingly frequent power outages caused by wildfires and grid stress.

To achieve net zero emissions by 2025 and develop scalable solutions for a low carbon future, UC launched its Carbon Neutrality Initiative in 2013.³ Since then, UC has made over a billion dollars in investments in durable, lasting solutions to decarbonize, including:

¹ Green House Gas Protocol, Land Sector Removals Initiative:

https://ghgprotocol.org/sites/default/files/standards/LSR_Overview.pdf

² <https://universityofcalifornia.edu/sites/default/files/economic-impact-report-2021-fact-sheet.pdf> and

<https://accountability.universityofcalifornia.edu/2017/chapters/chapter-13.html>

³ <https://ucop.edu/carbon-neutrality-initiative/index.html>

- **Direct Electrification:** Every campus is actively studying how to electrify vast portions of their infrastructure and several campuses have already launched ambitious direct electrification efforts. UC Davis is engaged in a multi-year infrastructure process to electrify the heat source for the hot water used to heat buildings across campus;⁴ UC Berkeley is drilling test geothermal wells and planning a resilient, all-electric microgrid to power campus;⁵ and the UC Irvine Medical Center is planning to build an all-electric, world-class hospital.⁶ In each instance, extensive techno-feasibility studies have found that direct electrification requires a multi-decade timeframe and hundreds of millions of dollars in project costs at each campus. As such, UC is pursuing additional measures (detailed next) to mitigate emissions in the interim.
- **Energy Efficiency:** The University has executed over 1,100 energy efficiency projects across the campuses and medical centers, reducing UC's energy use by 12% since 2009 on a per square foot basis.
- **Renewable Electricity:** UC has more than 100 renewable energy supplies on-line, including both onsite and offsite installations. In its role as an Electric Service Provider, UC has delivered 100% carbon-free electricity to participating electric accounts since 2019.⁷
- **Biomethane:** UC is procuring biomethane from landfills and food waste sources that was previously vented into the atmosphere or flared. By investing in these projects, UC is able to prevent these emissions at the source and use the captured biomethane to displace the fossil natural gas currently burned at its central cogeneration plants. UC set its volumetric target at 40% of historical natural gas consumption to incentivize electrification and energy efficiency. When this volume is reached, UC estimates that this solution will mitigate approximately one-third of its overall emissions.
- **Offsets:** For those emissions that cannot be addressed by 2025 with electrification, energy efficiency, renewable electricity, and biomethane procurement, the University is securing high-quality offsets that are both third-party verified through existing registry protocols and meet UC's own quality criteria above and beyond those protocols.

In sum, UC is deeply invested in comprehensive, rigorous strategies to decarbonize and is moving rapidly given current technological, operational, and financial realities across the UC system.⁸

Concerns with the First Draft Guidance

UC appreciates the time and effort that have been invested in developing the First Draft Guidance for the Greenhouse Gas Protocol Land Sector and Removals Initiative and believes there is much to complement in the draft. The University, however, has serious concerns with the language proposed in the Biomethane Annex that seeks to disallow the use of biomethane certificates to mitigate Scope 1 emissions.

Market Impact Could Likely Increase Emissions

In addition to helping UC meet its ambitious carbon neutrality goal, the University's biomethane program was created to help develop the biomethane market and foster the larger climate benefits of capturing biogenic methane. This draft Guidance will eliminate the incentive for other institutions, organizations, or corporate buyers to procure biomethane to mitigate their emissions. Who will spend the time and resources identifying fugitive anthropogenic biomethane emissions, investing in the technology to capture it, and putting it to beneficial use if they will be unable to claim credit for the emissions reductions from those investments?

As a result, UC believes the draft Guidance will result in a worse outcome for the climate: continued venting and/or flaring of fugitive methane. Indeed, the 2021 IPCC Working Group I report on the physical science driving climate change, which included authors from the University of California, recommended that the first priority for policy makers to limit near-term warming effects and improve air quality should be "strong, rapid, and sustained reductions in CH₄ emissions."⁹ Capturing biogenic methane (CH₄) that is currently venting or being flared is consistent with this recommendation. The EPA estimates 17% of the methane escaping into the atmosphere comes from landfills—one of the principal sources from which UC is procuring biomethane.¹⁰ As written, the proposed GHG Protocol Guidance to disallow the use of biomethane certificates to mitigate Scope 1 emissions is out-of-step with this climate science and corresponding policy recommendation.

Removing Tools

The draft Guidance provides no viable alternatives to decarbonize operations that are difficult-to-electrify or require decades to mitigate in other ways. Requiring a direct pipeline between the biomethane source and consumption is not technically or financially

⁴ <https://bigshift.ucdavis.edu/>

⁵ <https://cleanenergycampus.berkeley.edu/about>

⁶ <https://news.uci.edu/2021/01/21/uci-to-build-world-class-hospital-on-irvine-campus/>

⁷ Verified through The Climate Registry <https://www.theclimateregistry.org/tools-resources/reporting-protocols/electric-power-sector-protocol/>

⁸ The full analysis of UC's emissions and the proposed suite of solutions to address them are available on UC's Carbon Neutrality Dashboard: <https://cnidashboard.ucop.edu/>.

⁹ https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf, pg 27

¹⁰ <https://www.epa.gov/ghgemissions/overview-greenhouse-gases#methane>

feasible; additionally, there are limited biomethane sources co-located near generation facilities. This approach is akin to mandating all institutions install only onsite solar electricity and disallowing the use of renewable energy certificates (RECs) or other market-based solutions such as green tariffs to mitigate emissions, irrespective of whether the institution possesses the physical space, electrical infrastructure, financial capacity, and relevant utility interconnection to accommodate this requirement.

Inconsistent with Previous Guidance and Existing Protocols

The previous Greenhouse Gas Protocol Scope 2 Guidance allowed for the use of biomethane contractual instruments to mitigate Scope 1 emissions from natural gas combustion.¹¹ Additionally, both The Climate Registry and CDP allow the use of biomethane certificates to mitigate Scope 1 emissions. Reversing this paradigm adds confusion to the market and jeopardizes the substantial investments—including multi-hundred-million-dollar contracts—that UC has made in biomethane from multiple sources. If this Guidance is not adjusted, it will also negate the approximately 350,000 metric tons of CO₂e/year that UC estimates will be addressed by biomethane—a decision UC made based upon previously published and widely accepted carbon accounting protocols.

Choosing Winners and Losers

The draft raises a set of questions: Will this standard be applied to disallow the use of all contractual instruments to mitigate Scope 2 emissions? Will this precedent be applied to emerging decarbonization solutions, such as green hydrogen and sustainable aviation fuel? Why is biomethane being targeted? Until these questions are addressed, the current approach appears to penalize one specific technology: biomethane. Given the direness of the climate crisis and the benefit of capturing fugitive methane emissions, UC believes multiple tools are necessary to decarbonize, rather than selecting winners and losers.

Recommendations

For the reasons stated above, the University respectfully urges that the forthcoming second draft of this Guidance eliminate any suggestion that biomethane certificates cannot be used to mitigate Scope 1 emissions and reaffirm the previous GHG Protocol Guidance that biomethane certificates can be used to mitigate Scope 1 emissions. Taking this step will harmonize this Guidance with historical policy, existing protocols, and the increasingly dire climate science.

UC appreciates your consideration and looks forward to continuing to engage on these critical topics.

Sincerely,



David Phillips
AVP, Energy & Sustainability

¹¹ After multiple years of being in effect, this portion of guidance was removed in February, 2020:
https://ghgprotocol.org/sites/default/files/standards_supporting/List%20of%20Corrections%20to%20the%20Scope%20%20Guidance_0.pdf

Evidence Submission 14

Join RMI CEO Jon Creyts and DOE Director Jigar Shah LIVE on Tuesday, December 12.



Clean Energy 101: Book and Claim

By harnessing the power of consumer demand for decarbonized supply chains through new market mechanisms like book and claim, we can catalyze the most difficult corners of industrial decarbonization.

May 30, 2023

By Thomas Koch Blank, Laura Hutchinson, Oscar Alberto Hernandez, Esther Sicong Li, Alexandra Jardine Wall

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Heavy industry and heavy transport – think steel, concrete, aviation, and shipping, to name a few – are essential to nearly everything we do and everything we consume. They are also a significant source of carbon emissions – taken together, accounting for nearly 30 percent of global greenhouse gas emissions each year. For many companies, these emissions are a part of the carbon footprint of the final good or service they sell – you may have heard this referred to as a product or business’s “embodied carbon,” or, in the case of corporate emissions accounting, as its “Scope 3” emissions.

Corporations are calling loudly and enthusiastically for ways to decrease these emissions in order to do business more sustainably and in response to increasing pressure from customers and shareholders. At the same time, promising decarbonization efforts in heavy industry and heavy transport are struggling to raise funds needed to achieve commercial scale and wider adoption. Is there a way to connect the dots?

RMI is working on the solution in a number of ways. We are providing transparency into supply chain emissions, connecting heavy industry and transport decarbonization leaders to corporate consumers, as well as

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working with investors and policymakers to ensure their actions can help decarbonization happen faster. The newest mechanism we're working on puts all the pieces together.

RMI and our partners have been working to connect the massive corporate demand for Scope 3 emissions savings directly to the market for low-emissions fuels and materials, in order to channel finance and create a market signal for nascent decarbonization technologies. No easy feat. In fact, it has required building a market for a whole other product entirely: turning the emissions benefits of using low-emissions fuels and materials into certificates that corporates can buy, transparently and credibly, and making sure low-emission fuel and materials producers can use these funds to invest and scale up. It's called "book and claim."

What is Book and Claim?

Book and claim is a flexible model for verified information to flow – or chain of custody model – that allows clean fuel or materials producers to "book" the emissions savings of a good they've produced in one place, and customers to "claim" the emissions benefit from these goods for climate disclosures in a different place. But how can it help decarbonize industries?

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Transportation
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US Policy

Book and claim systems can connect ambitious buyers and sellers to decarbonize their value chains together, when physical **offtake** options don't exist or would be prohibitively complex. Let's take the example of a corporation that wants to decrease the climate impact of the flights its goods or employees take. Sustainable aviation fuel (SAF) is fuel made from waste or renewable feedstocks that can be used in a normal jet engine and can decrease the lifecycle emissions of flight by up to 99 percent, but currently its production is extremely limited and costs two to five times more than fossil-based jet fuel.

In this case, this corporate buyer would never ordinarily purchase jet fuel, so won't be able to directly procure SAF, nor ensure that all of the flights its employees and goods take are using SAF. Instead, they can use a book and claim system which tracks the environmental attributes of a volume of SAF through a certificate.

The book and claim system allows corporate consumers to buy SAF certificates (called SAFc) that represent the certified lifecycle emissions reductions from cleanly-fueled trips and then use them in corporate emissions reporting, with an auditable and credible trail of ownership. The completed transactions release funds into a

solution that, if scaled and implemented for widespread use in planes, would achieve the desired decarbonization. Companies can purchase certificates from SAF producers or air transport providers, compensating them – or paying them upfront – for their investment in SAF and allowing them to continue to produce or buy the more costly alternative fuels. This incentivizes airlines to make the switch to climate-friendlier fuels, knowing they can make up the price difference with the sale of certificates. And the more fuel and certificates are purchased, the more suppliers will scale up the production of these new fuels, driving down cost.

Because the market for low-emissions fuel like SAF is nascent, cleaner fuels are more expensive and not always available on routes where a consumer might require their use. Allowing consumers to purchase environmental attributes from clean fuel use means they can ensure a plane, ship or truck somewhere is being fueled by clean energy. The system enables consumers to help transport companies cover their price premium, which otherwise represents a prohibitively high cost. The transaction sends two crucial signals to the market: that there is a demonstrated and bankable demand for alternative, low- to zero-carbon fuels, and that supply needs to scale to meet it.

Accountability Matters

To ensure the system effectively enables decarbonization efforts, book and claim systems need several, carefully-designed parts to ensure standardization and transparency at each step.

The foundation of the system is real decarbonization within the sector. As a critical first step, the physical supply chain must be independently verified to meet sustainability criteria via an established certification process: for example, the Roundtable on Sustainable Biomaterials (RSB) and the International Sustainability and Carbon Certification (ISCC) system's standards for SAF. Next, the product's attributes need to be decoupled and represented as a certificate, like SAFc. This certificate is what is “booked” and “claimed” by different actors, either in a registry or in an individual transaction.

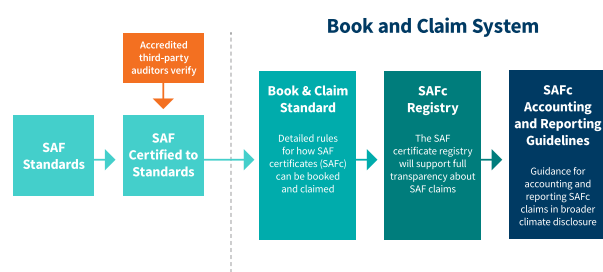


Figure 1: Design of a book and claim system for sustainable aviation fuel (SAF).

A **registry** is a trusted platform that ensures that certificates represent real

impact and are accounted for appropriately. Users need a well-governed system that can repeatably issue certificates with the same rules, track their ownership, and house a transparent record of who has “retired” – and can claim – each unit. A system like this – that adheres to a commonly accepted standard – creates an auditable trail of who can use these emissions reduction claims and actively mitigates double counting risks. Finally, after certificates are retired in a registry, consumers can claim them towards climate disclosure frameworks.

This disclosure process should be done following clear and commonly accepted emissions accounting and reporting guidance, such as accounting and reporting guidelines from Clean Skies for Tomorrow and Smart Freight Centre on SAFc climate disclosure.

Corporate customers, in partnership with air transport providers and SAF providers, are beginning to use this infrastructure as they procure SAF certificates (either bilaterally or via aggregated procurement mechanisms) to provide more structure and verifiability to their transactions. The Sustainable Aviation Buyers Alliance (SABA) facilitated the first ever joint SAFc purchase earlier this year, and just launched a second, 5-year procurement

process. The **Zero Emission Maritime Buyers Alliance (ZEMBA)** launched earlier this year with the goal of pooling corporate demand for decarbonized shipping and will rely on book and claim systems to facilitate their effort. To meet emerging needs like this in the maritime shipping sector, the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping (MMMC), RMI, Danish Shipping, and Mærsk Oil Trading have outlined a **design for a book and claim system**, which MMMC and RMI are planning to move to a pilot phase in the coming months.

Realizing the Potential of Book and Claim

RMI and our partners are focusing efforts on making book and claim a robust, real solution to quickly spur heavy industry and transport into action. But let's be clear: it is not a silver bullet. When available, direct procurement of decarbonized products is far simpler and preferable. However, we're working on book and claim because it does have the potential to enable investment in heavy industrial transformation at unprecedented scale if implemented in a robust and coordinated way. Because of this, we are excited to announce our collaboration with the Smart Freight Centre in convening the **Book and Claim Community**, which will bring together leading efforts in this space.

Book and claim also has the potential to inspire and enable action beyond corporate consumers and supply chain actors. SAF book and claim is already enabling large, joint, and advance offtake agreements and other forward-looking investments from corporate customers and air transport providers, like Microsoft and Alaska Airlines'

investment in Twelve. These strong demand signals are starting to give financial institutions the confidence to invest in new production facilities that will break ground this decade.

Regulators can also use book and claim as a flexible mechanism to enforce compliance obligations for emissions reductions or decarbonized products, especially where an emissions trading scheme doesn't already exist.

Book and claim is fundamentally enabling for companies working to find more tangible means to support the decarbonization of sectors whose services they consume, but that they don't have direct or even indirect control of. The challenge for suppliers, consumers, and civil society in the coming years will be to find the right balance between innovation, pace, standardization, and appropriate safeguards in each application to maximize this tool's potential for widespread recognition and impact.

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Evidence Submission 15

ALL IN ON CLIMATE: THE ROLE OF CARBON CREDITS IN CORPORATE CLIMATE STRATEGIES

OCTOBER 2023



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About Ecosystem Marketplace

Ecosystem Marketplace (EM), a non-profit initiative of Forest Trends, is a leading global source of credible information on environmental finance, markets, and payments for ecosystem services. For nearly two decades, EM has run the world's first and only globally recognized and standardized reporting and transparency platform for voluntary carbon market (VCM) credit pricing data, news, and insights.

EM holds the world's largest repository of valuable carbon market insights and data disclosed by a growing international network of more than 270 "EM Respondents," including project developers, investors, and intermediaries with headquarters in over 40 countries. Respondents share over the counter and exchange/trading platform carbon credit sales on thousands of nature-based and technological carbon projects in over 100 countries.

EM's flagship State of the Voluntary Carbon Markets reports and other analyses on carbon credit market dynamics (e.g., prices, volumes, projects, corporate buyers, sellers, etc.) and carbon standards' issuance and retirement data have become anticipated industry staples. EM also provides a publicly accessible data intelligence dashboard and a news platform for breaking news and market coverage.

EM data on prices, regulation, science, and other relevant issues on environmental services markets and climate finance have been used extensively by companies, journalists, investors, practitioners, natural resource agencies and academics, and local and indigenous communities.

Additionally, EM thanks its core partners, supporters, and collaborators.

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Forest Trends Association is a 501(c)(3) organization founded in 1998. Forest Trends works to conserve forests and other ecosystems through the creation and wide adoption of a broad range of environmental finance, markets, and other payment and incentive mechanisms. Forest Trends does so by 1) providing transparent information on ecosystem values, finance, and markets through knowledge acquisition, analysis, and dissemination; 2) convening diverse coalitions, partners, and communities of practice to promote environmental values and advance development of new markets and payment mechanisms; and 3) demonstrating successful tools, standards, and models of innovative finance for conservation. For up-to-date information on environmental markets, sign up for EM newsletters: http://www.forest-trends.org/dir/em_newsletter.

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Attribution

Please cite this work as follows:

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The primary source of data for this report is the CDP 2022 Climate Change Response dataset. Except where otherwise specified, all data analyzed comes from this dataset. We thank CDP for their help in obtaining and using these data.



ALL IN ON CLIMATE:

THE ROLE OF CARBON CREDITS IN CORPORATE CLIMATE STRATEGIES

OCTOBER 2023

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FOREWORD

EM is pleased to publish this 2023 report, *All in on Climate: The Role of Carbon Credits in Corporate Climate Strategies*, which serves as the first major update since 2016 to its landmark “Taking Stock” report series. When initially launched in 2015, the report illuminated for the first time the realities of how companies are (and are not) using carbon credits to address their climate liabilities and to contribute to their comprehensive climate action and management strategies. We’ve revisited this analysis because our global network of carbon markets stakeholders have lately reported to EM an increase in “greenhushing.” Whether in response to media coverage, environmental group criticism, or the challenges of navigating government policies (or all three), companies are publicly dialing back, delaying, or scrapping their carbon credit buying plans.

This report **is designed to look specifically at the climate-related behavior of companies that are involved in the voluntary carbon market (VCM) versus those who are not.** It should be noted that although we analyzed the data and wrote this report in mid-2023, it has a retrospective lens and an eye on the future, as the CDP data used is from the 2022 Climate Change dataset, which mostly covers corporate activities in 2021.¹

A set of clear implications emerge from the data. First, companies are purchasing voluntary carbon credits as a part of an integrated, comprehensive strategy to accelerate global climate action while also decarbonizing their own businesses. Second, the data do not broadly support the perception that credits are being used to delay or avoid meaningful action on climate.

It’s important to remind ourselves of what we’ve seen in the market since the banner year of 2021, as it adds important context to the findings in this report. EM data show that in 2021 the market ticked up to an all-time high of \$2.1 billion in sales, with global average prices at \$4.03 per ton CO₂e. The following year, we saw a downturn in traded volumes, though an uptick in prices. In early 2023, EM ran a market sentiments survey that found corporate buyers were demonstrating stronger preferences for nature-based and community/household projects with beyond carbon benefits and a willingness to pay higher prices for them.² However, some buyers were also beginning to slow down, if not stop altogether, their engagement in the VCM until key guidance was finalized by the Voluntary Carbon Markets Integrity Initiative (VCMI) and the Integrity Council for the Voluntary Carbon Market (“the Integrity Council”) (Box 1). Some respondents told us that the Science Based Targets Initiative (SBTi)’s position on how companies could claim their retirements of VCM credits for greenhouse gas (GHG) targets was also a factor.

As the months have rolled on from 2022 into 2023, there have been a string of media pieces critical of the VCM. Some charged well-known companies with greenwashing (e.g., Delta, Nestle, Kering, Shell, TotalEnergies, among others). Other articles questioned integrity on the supply side, in particular scrutinizing South Pole, one of the largest carbon project developers; Verra, the world’s largest carbon crediting standard; and project types including REDD+,³ which happens to be the largest source of new credit supply for the VCM. It’s hard to precisely measure the impact of these critiques, but credit retirement data so far in 2023 show that VCM end users have retired a smaller volume of credits in 2023 than in any of the past seven years.

Still, as I write this foreword in September 2023, the general mood in the VCM is generally one of staying the course. For example, of the top 25 voluntary carbon market buyers per CDP (see page 11), the majority appear to have unchanged approaches related to their VCM activities. As we developed this analysis in summer 2023, we found just one organization, the British airline easyJet, that had since 2021 made a firm commitment to cease all VCM activities. Some others have either stated that they (a) will move away from using carbon credits for their GHG targets, but still plan to use them to make up for hard-to-abate emissions or (b) will move away from plans to purchase a defined volume of credits to address their emissions.

EM has been tracking the VCM since 2006 when EM’s first carbon survey was issued. We are a non-profit initiative that does this work because we believe transparency is key to integrity, and, ultimately, a livable planet in the centuries to come. We do not have a financial stake in market growth.

Still, I will step away from our usual position of neutrality for a moment to say this: the findings in this report are good news. Companies are continuing to purchase and retire carbon credits, at the same time that they continue to do the hard, but necessary, work of investing in climate action throughout the value chain and decarbonizing their operations. It is an approach based on “and/and,” not “either/or.” Much work remains to be done to clarify and communicate the role carbon credits play in a science-based climate strategy, but the foundations we build on are solid indeed.



Stephen Donofrio

Managing Director, Ecosystem Marketplace
Forest Trends

¹ At the time of procuring data from CDP in mid-2023, the most current dataset available was the 2022 CDP Climate Change data, which mostly covers calendar year 2021 as the most recent year of data disclosed by companies.

² Ecosystem Marketplace. 2023. EM Insights Briefing: A VCM Status Check (Webinar). <https://www.ecosystemmarketplace.com/articles/em-insights-briefings-vcms-status-check/>

³ “REDD” stands for “Reducing emissions from deforestation and forest degradation in developing countries. The ‘+’ stands for additional forest-related activities that protect the climate, namely sustainable management of forests and the conservation and enhancement of forest carbon stocks.” <https://unfccc.int/topics/land-use/workstreams/redd/what-is-redd>

EXECUTIVE SUMMARY

This report highlights how companies that participate in the voluntary carbon market (VCM) are leading on key climate transparency, ambition, and action efforts that are fundamental to ensuring the credibility of their climate claims.

Our findings result from Ecosystem Marketplace's (EM) analysis of corporate disclosures to CDP by 7,415 organizations reporting data covering at least six months of 2021, as well as of EM's own proprietary voluntary carbon market dataset. We focus on a comparison between companies that purchased voluntary carbon credits versus companies that do not use carbon credits at all and companies that only buy or originate compliance credits. The 2022 CDP Climate Change information request that resulted in these corporate disclosures was sent on behalf of 590 institutional investor signatories with a combined US\$110 trillion in assets, and 200+ major purchasers with over US\$5.5 trillion in procurement spend.

We offer a series of comparative analyses across a variety of metrics for corporate action on climate sustainability, aligned with corporate best practice of first measuring greenhouse gas (GHG) emissions; then taking steps to reduce and avoid direct **and** indirect emissions on a target-based pathway; and finally buying carbon credits to address unavoidable emissions and those beyond the value chain.

Across the board, the evidence shows that participation in the VCM is a signal that a company is likely **already** addressing climate change in their direct operations and throughout their value chains. Far from "buying their way out of the problem", voluntary carbon buyers are taking advantage of the valuable role carbon credits play as one of the available solutions for value chain emissions that cannot be addressed by reducing Scope 1 and 2 emissions.

Companies engaged in the VCM outperform their peers in accelerated climate action. Fifty-nine percent of VCM buyers reported lower gross emissions year-on-year related to reduced emissions and/or renewable energy consumption, compared to 33 percent of companies not participating in the carbon markets. VCM buyers are also 1.3 times more likely to have supplier engagement strategies and spent three times more on emissions reductions activities than the typical non-buyer (see page 18).

Voluntary carbon buyers are more likely to have science-based targets to address climate change, and their targets are more ambitious. Voluntary carbon buyers are 3.4 times more likely to have an approved science-based climate target than companies that do not engage in carbon markets, and three times more likely include Scope 3 Emissions in their climate targets. As the old management adage says, you can't manage what you don't measure (see pages 16-17).

Voluntary carbon buyers lead the pack when it comes to emissions transparency and accountability. Compared to other companies, they are 1.2 times more likely to disclose their emissions to CDP, and the median voluntary credit buyer disclosed more than 2.5 times the volume of emissions with their Scope 3 reporting than companies not engaged in voluntary credits. Ninety-seven percent reported board-level oversight of climate-related activities (see page 13).

In fact, VCM carbon credits represent a very small share of overall corporate GHG emissions. Our data show that the credits companies are buying represent just over 2 percent of their total emissions on average.

Taken together, clear insights emerge from these analyses. Companies are purchasing voluntary carbon credits as a part of an integrated and comprehensive strategy to accelerate global climate action while also decarbonizing their own businesses. In other words, the data do not broadly support the perception that carbon credits are being used to delay or avoid meaningful action on climate. This is important, because intense public scrutiny, paired with a wait for greater clarity from the Voluntary Carbon Markets Integrity Initiative (VCMI) in the form of its forthcoming claims code, has had a dampening effect on the market in 2023. Since 2021, EM's own proprietary data show a decline in credit sale volumes, which has been accompanied by an uptick in EM's global average VCM credit prices, a signal of increasing buyer commitment toward higher quality credits (and a willingness to pay more for them).

Still, voluntary carbon buyer transparency is lagging. Our analysis indicates that only 8.2 percent of the total carbon buyers that confidentially reported to EM are disclosing carbon market engagement to CDP. EM welcomes the work of VCMI to create a standard approach for voluntary carbon buyers' climate ambition and action criteria, as well as how they should report their claims on project-based carbon credits through their soon-to-be-finalized Claims Code.

As the VCM continues to evolve, EM stands ready to continue to drive carbon market transparency, knowledge, and insights as a globally trusted, independent, and neutral non-profit initiative. To continue to do this effectively, we look forward to engaging with the entire carbon market value chain and stakeholder network who have a common vision for high-integrity and well-functioning global carbon markets that achieve results on the ground and in corporate boardrooms.

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ABOUT THE DATA

We used two data sources for this report. The primary data source for this report is the 2022 CDP Climate Change data for the subset of companies that **publicly**⁴ disclosed to CDP. We also used EM voluntary carbon market transactions data to understand the extent of voluntary carbon credit purchases that were not disclosed to CDP. For more detailed information about how we used CDP data to compare the activities of voluntary carbon credit buyers with other organizations, please see the Methodology appendix.

CDP Data

CDP data are self-reported by a variety of organizations, including large corporations, small- and medium-sized enterprises, and quasi-governmental entities such as utilities and postal carriers. CDP's climate change questionnaire collects climate-related data from the world's largest companies and, in 2022, this was on behalf of over 590 institutional investor signatories with a combined US\$110 trillion in assets and 200+ major purchasers with over US\$5.5 trillion in procurement spend.

CDP data include information on greenhouse gas (GHG) emissions by Scopes 1, 2, and 3; emissions targets and progress towards those targets; project-based carbon credits purchased and originated; activities undertaken for the purpose of emissions reduction; and climate-related risks facing organizations, among other datasets. With respect to carbon credit use, these organizations tend to be purchasers of credits, though credit origination for inssetting or sale is also disclosed to CDP.

Figure 1 provides a bird's eye view of the 2022 CDP dataset, which comprises:

- 7,415 total CDP Climate Change respondents for reporting year 2022;
- 6,538 CDP respondents did not buy or originate credits, or did not specify whether credits were used for voluntary or compliance reasons;
- 815 CDP respondents only engaged in voluntary credits as a buyer and/or an originator;
- 55 CDP respondents only engaged in compliance credits as a buyer and/or an originator; and
- Seven CDP respondents engaged in both compliance and voluntary credits as a buyer and/or an originator.

Ecosystem Marketplace Buyer Data

To understand the completeness of CDP data in terms of project-based carbon credit purchases, we used EM's voluntary carbon markets transactions data. EM data, which are reported directly and confidentially by carbon credit project developers and resellers, include names of corporate buyers who are end users.

We cross-checked EM's 2,477 known corporate buyers who were listed as end users of credits from 2020 to 2023⁵ to determine whether they had publicly disclosed climate data to CDP and if they had disclosed purchasing or originating project-based carbon credits. Out of the 2,477 known credit buyers:

- 204 (8.2 percent) disclosed some climate data to CDP in 2022.
- 130 (5.2 percent) disclosed buying or originating project-based carbon credits to CDP in 2022.
- This translates to a 64 percent rate of credit use disclosure among the 204 known buyers responding to CDP in 2022, or conversely, an estimate that 36 percent of CDP respondents that are using carbon credits do not disclose their purchase or origination of credits.

⁴ Not all respondents allow their CDP disclosure data to be reported publicly and used in analyses by external organizations. For the purposes of this report, we used the publicly available dataset only.

⁵ We focused on transactions that occurred from 2020-2023 because of the lag between credit origination, sales, retirements, and public claims.

REPORT GUIDE

In **Part A** of this report, we provide an overview of the 7,415 organizations who disclosed data covering at least six months of 2021 to CDP, highlighting leading voluntary credit purchasers and the overall composition of the CDP dataset.

In **Parts B** and **C**, we focus on a comparison between organizations that purchase voluntary carbon credits and a group which we refer to as “non-voluntary carbon buyers,” a combined group of companies that do not use carbon credits at all and companies that only buy or originate compliance credits. Companies that originate but do not purchase voluntary credits are excluded from these comparisons because of data inconsistencies and because the purpose of such origination is unclear (e.g., to retire for their own purposes vs. to sell into the market as a project developer).

Part D puts voluntary carbon credit purchases into the context of organizational emissions, showing that the typical voluntary buyer is purchasing credits that account for just over 2 percent of their annual disclosed emissions. This is a key finding that, taken together with the evidence in **Parts B** and **C** that voluntary credit buyers are already climate leaders, suggests that corporate buyers are not using carbon credits to avoid responsibility for their emissions, and that credits are mainly being used to offset hard-to-abate emissions.

The **Appendix** features an in-depth discussion of the report’s data analysis methodology and a selection of tables and figures describing the CDP data in more detail.



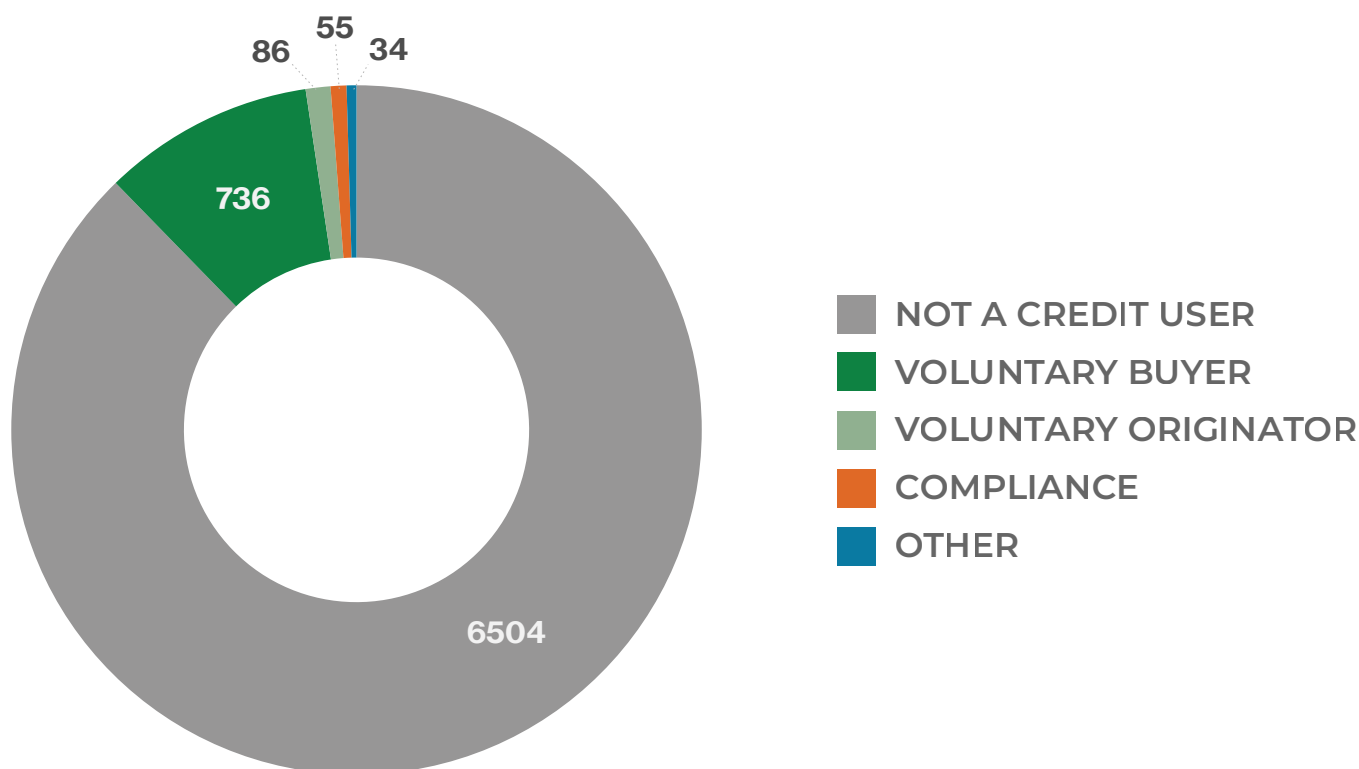
PART A

WHO IS BUYING CARBON CREDITS?

One in ten companies disclosed voluntary carbon market participation in 2021

For the reporting year 2022, largely covering activities in 2021,⁶ 7,415 total companies publicly disclosed⁷ to the CDP Climate Change program. Within this group, 822 companies (11 percent) engaged with voluntary project-based carbon credits as a buyer (736) or an originator (86), and 55 companies engaged with project-based carbon credits for compliance reasons only (Figure 1).

FIGURE 1. OVERVIEW OF CDP RESPONDENTS, BY PROJECT-BASED CARBON MARKET PARTICIPATION STATUS



Source: Ecosystem Marketplace, 2023

Note: Organizations are defined according to the highest level of their engagement with carbon markets. Any organization that purchases both voluntary and compliance credits is considered to be a voluntary market participant, and any organization that both purchases and originates voluntary credits is considered to be a voluntary carbon buyer. In 2021 there were seven companies engaged in both voluntary and compliance carbon; these are included in the 822 voluntary and 62 compliance companies, leaving 815 engaged in voluntary carbon markets only and 55 in compliance carbon markets only. In addition, eight companies were not included in the voluntary market participant totals because they did not provide a volume associated with their purchases and/or origination.

"Other" organizations disclosed originating or purchasing carbon credits but we were not able to definitively classify those credits as voluntary or compliance. The organizations in

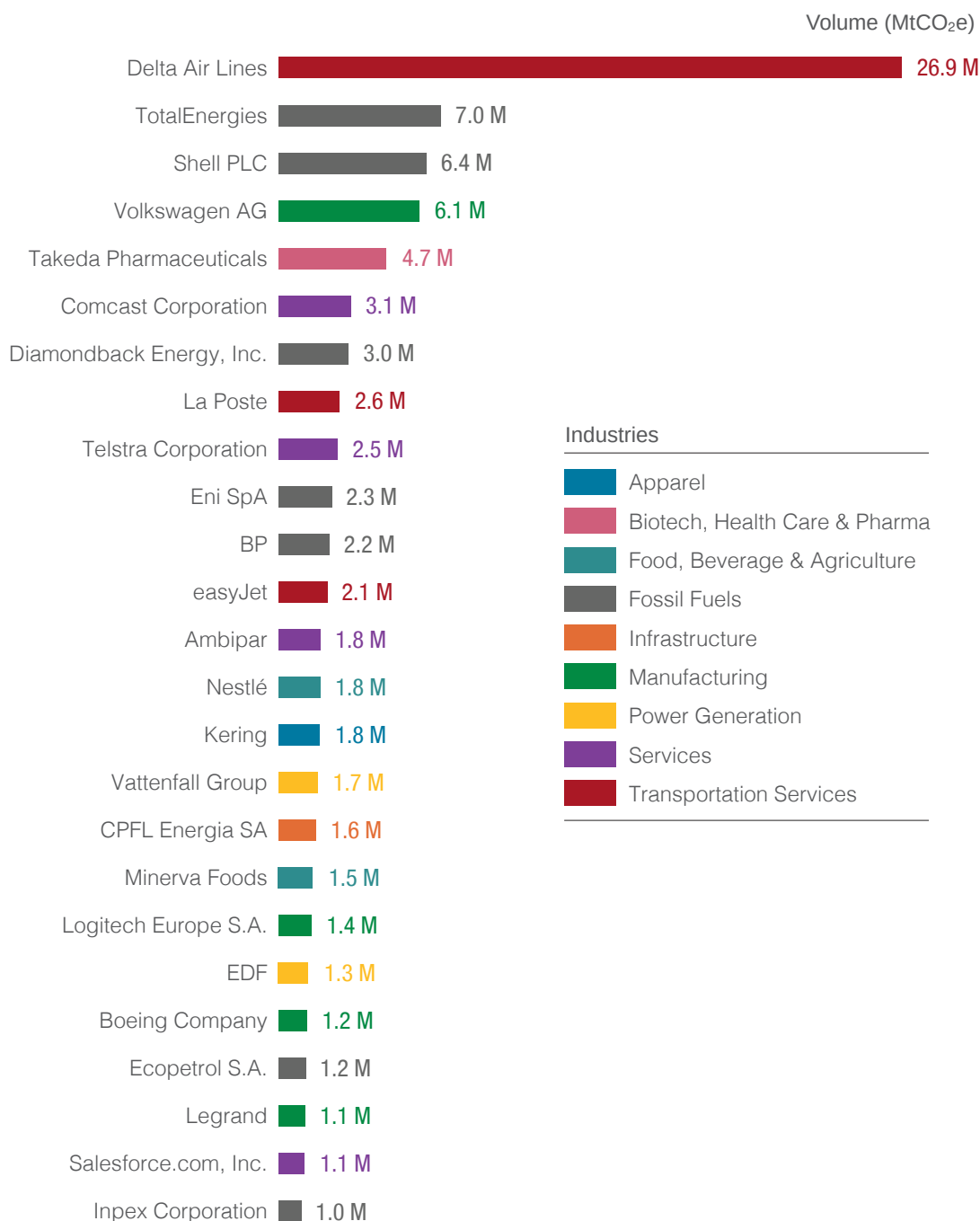
⁶ This report focuses on data published by CDP in 2022. Because CDP data is compiled for the previous calendar year, the focal period for the most recent data is calendar year 2021. Because companies may have reporting periods that do not match up with a calendar year, we included emissions and credit activities for a calendar year if at least six months (181 days) of the reporting period fell within that year.

⁷ This analysis is exclusively focused on the subset of companies using carbon credits that publicly disclose to CDP, unless otherwise noted. As such, the information in this report offers a snapshot of corporate carbon credit use in the context of CDP disclosures, but it represents only a portion of total credit demand.

Led by the services sector and big buyers like Delta, CDP respondents purchased 121.1 MtCO₂e of voluntary carbon credits in 2021

The 768 voluntary carbon buyers disclosing to CDP in 2022 purchased roughly 121.2 MtCO₂e (million metric tons of CO₂) in 2021. The majority of this volume (72 percent) was represented by the top 25 voluntary carbon credit buyers (87.5 MtCO₂e) (Figure 2). Companies in the Services sector make up the largest share of voluntary carbon buyers (Figure 3).

FIGURE 2. TOP 25 BUYERS OF VOLUNTARY CARBON CREDITS, BY VOLUME



Source: Ecosystem Marketplace, 2023

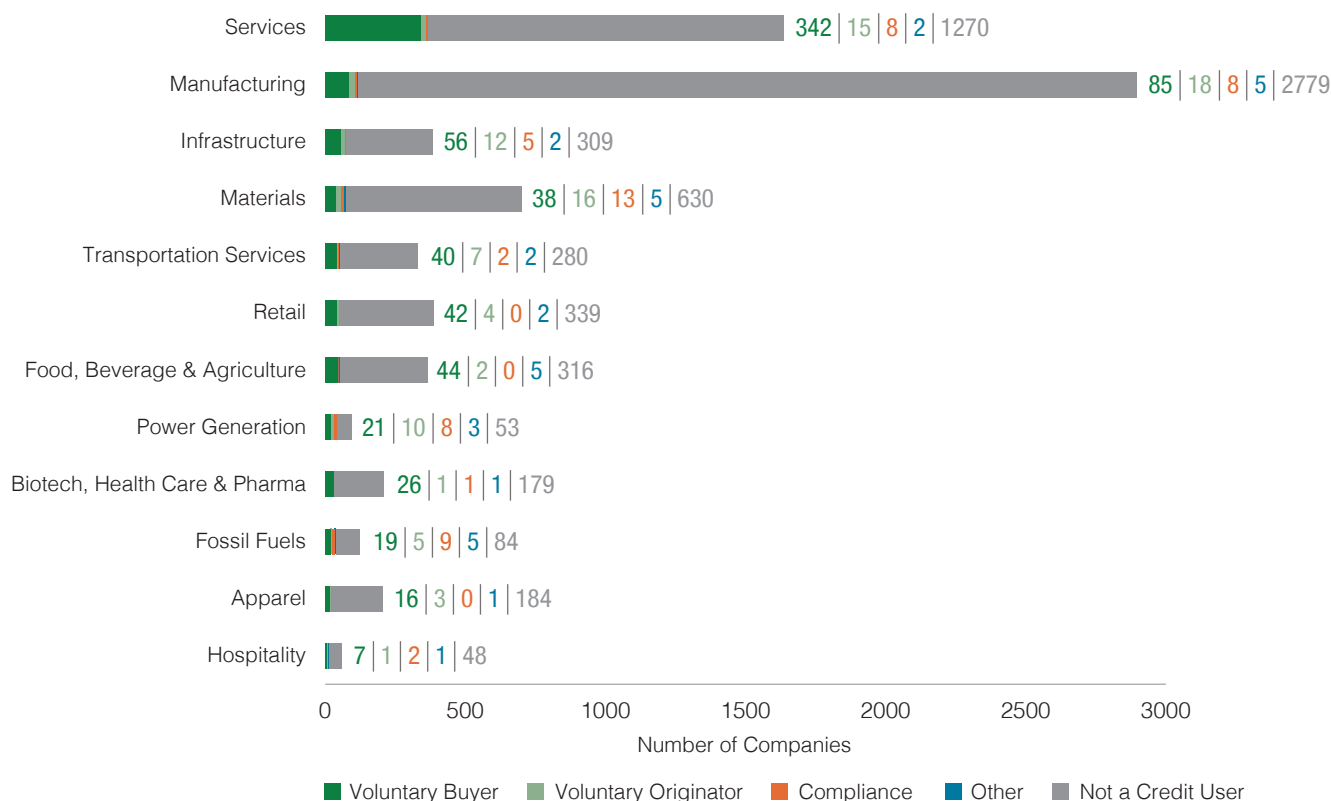
Note: Figure reflects volume of VCM credit purchases only. Companies included above may have also originated voluntary credits or purchased or originated compliance credits, but those volumes were excluded. Industry classifications used in this figure and throughout the report are taken directly from CDP and do not necessarily align with Global Industry Classification Standard (GICS) or other industry classification systems.

BOX 1. CORPORATES CONTINUING CARBON CREDIT PURCHASES, DESPITE INCREASED SCRUTINY

CDP's 2022 Climate Change disclosure data on voluntary project-based carbon credit purchasing focuses on activity in the 2021 calendar year. In 2022 and 2023, some of these corporate buyers began to face heavy scrutiny for their retirement of them to achieve carbon neutrality and net-zero targets. Some of the Top 50 (Appendix) purchasers of carbon credits have faced lawsuits, but most have been targeted with negative press around their carbon neutrality and/or net-zero climate claims. These included major airlines such as Delta, KLM/Air France, and Ryanair, and companies from Oil & Gas to Food and Beverage to Luxury Goods such as Shell, Nestle, and Kering (the parent company of Gucci and Balenciaga).

In most cases, we won't see this reflected in CDP data until 2024 when CDP calls for disclosures on 2023. In the meantime, we investigated the top 50 voluntary carbon credit purchasers in 2021 to understand if they had made a public commitment to stop using carbon credits in 2022 or 2023. While the majority appear to have unchanged approaches related to their VCM activities, we found that one organization, the British low-cost airline easyJet, made a firm commitment to cease all voluntary carbon market activities. Other organizations are changing their approaches to the VCM by stating that they (a) will move away from using carbon credits for their GHG targets, but still plan to use them to make up for hard-to-abate emissions (e.g., Delta, Kering), or (b) will move away from plans to purchase a defined volume of credits to address their emissions (e.g., Shell).

FIGURE 3. CORPORATE ENGAGEMENT WITH CARBON CREDITS, BY INDUSTRY



Source: Ecosystem Marketplace, 2023

Note: Above counts include companies that reported buying or originating credits with no associated volume. Compliance, Other, and Not a Credit User are combined in the "Non-Voluntary Carbon Buyers" category used in comparisons with Voluntary Buyers, and Voluntary Originators are excluded from the rest of the analysis (see Methodology appendix). Industry labels are taken directly from CDP industry classifications and do not necessarily align with GICS or other industry classification systems.

PART B

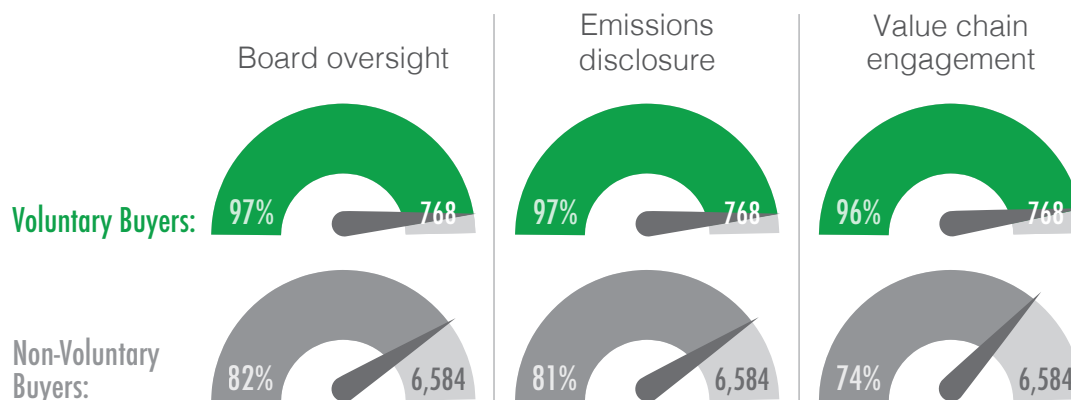
CORPORATE VOLUNTARY CARBON BUYERS LEAD ON TRANSPARENCY, ACCOUNTABILITY, AND AMBITION

Board Level Responsibility for Climate is the Norm for Carbon Buyers

A fundamental indicator of good company governance is how far up the corporate ladder climate change is managed. Governance by management level employees, including the C-suite, is tactical and focuses on the day-to-day management of the business, whereas board and/or board committees' oversight is the most strategic level of attention to climate issues.

Voluntary carbon buyers demonstrated strong leadership in this practice. Ninety-seven percent of these organizations have board-level oversight of climate-related activities (Figure 4). In other words, companies purchasing voluntary carbon credits are 1.2 times more likely to have board oversight of climate-related issues than companies not using voluntary carbon credits.

FIGURE 4. TRANSPARENCY, ACCOUNTABILITY, AND AMBITION INDICATORS: SHARE OF VOLUNTARY CARBON BUYERS VS. NON-VOLUNTARY CARBON BUYERS



Source: Ecosystem Marketplace, 2023

Note: Based on responses from 768 companies that purchased voluntary carbon credits in 2021 and 6,584 companies that either only purchased or originated compliance credits or did not participate in carbon credit markets in 2021 ("Non-Voluntary Carbon Buyers").

Nearly All Companies Engaging in the VCM Report GHG Emissions

Companies that report publicly on their emissions typically adhere to a widely accepted standard like the Greenhouse Gas Protocol's Corporate Accounting and Reporting Standard when national standards are not applicable.⁸

CDP disclosing companies that buy voluntary carbon credits were 1.2 times more likely to disclose their emissions to CDP than companies not engaged in voluntary credits. Furthermore, the typical voluntary credit buyer disclosed more than 2.5 times the volume of emissions with their Scope 3 reporting than companies not engaged in voluntary credits (Figure S1, Table S3).⁹ Ninety-seven percent of voluntary carbon buyers disclosed at least one scope of emissions to CDP for 2021, compared with 80 percent of all other companies (Table 1).

TABLE 1. SHARE OF COMPANIES DISCLOSING GHG EMISSIONS, BY SCOPE

CDP COMPANY SEGMENTATION, BY CARBON MARKET PARTICIPATION STATUS	NUMBER OF COMPANIES	NON-ZERO SCOPE 1 EMISSIONS	NON-ZERO LOCATION-BASED SCOPE 2 EMISSIONS	NON-ZERO MARKET-BASED SCOPE 2 EMISSIONS	NON-ZERO SCOPE 3 EMISSIONS
ALL CDP COMPANY DISCLOSERS	7,415	94.7%	99.0%	97.1%	55.1%
VCM BUYERS AND ORIGINATORS	830	98.1%	99.8%	91.9%	95.7%
COMPLIANCE MARKET BUYERS AND ORIGINATORS	54	100.0%	96.3%	94.4%	94.4%
COMPANIES NOT BUYING/ORIGINATING CREDITS	6,476	94.1%	98.9%	97.8%	49.5%

Source: Ecosystem Marketplace, 2023

A total of 6,082 organizations disclosed some greenhouse gas emissions – an emissions liability equivalent to nearly 106 billion metric tons of CO₂ for 2021 (Scopes 1, 2, and 3 combined). Of these combined emissions, 754 voluntary carbon buyers accounted for 13.5 GtCO₂e (billion metric tons of CO₂). The typical voluntary buyer disclosed a greater emissions liability, inclusive of all Scopes, at 531,819 tons CO₂e, versus the typical non-credit user of 320,554 tons CO₂e. Consistent with EM's previous analyses, most disclosed emissions for voluntary carbon buyers are in the Scope 3 category (value chain emissions), whereas Scope 1 emissions are the largest disclosed emissions liability for non-voluntary carbon buyers, including compliance buyers and originators as well as companies not engaged in project-based carbon credits.

Awareness leads to action. Breaking emissions disclosure down further, we found (consistent with past reports¹⁰) that the proportion of companies disclosing Scope 3 emissions is greater among those purchasing credits from the voluntary carbon market. Both voluntary (95.7 percent) and compliance (94.4 percent) market participants reported Scope 3 emissions at a higher rate than other CDP disclosing companies.

Because Scope 3 emissions constitute the majority of voluntary carbon buyers' emissions, engaging with their value chains on climate-related issues is essential to fully tackle these companies' climate liabilities. In fact, 91 percent of all voluntary carbon buyers' total GHG emissions in 2021 are in Scope 3 (and only 7 percent in Scope 1). In contrast, only 42 percent of other CDP respondents' disclosed emissions were in Scope 3 (and 56 percent of their emissions in Scope 1). The rate of disclosure of Scope 2 emissions is consistent between voluntary carbon buyers and all disclosing organizations, at 1 percent and 2 percent, respectively.

To normalize these data, we narrowed the sample of companies to the 3,925 companies that reported a non-zero emissions quantity for both Scopes 1 and 3, representing 65 percent of the total 6,082 companies that reported at least one scope of emissions. Demonstrating their transparency leadership, 94 percent (708 of 754) of voluntary carbon buyers reported both Scopes 1 and 3. The numbers change slightly but continue to demonstrate a consistent message: 91 percent of all voluntary carbon buyers' GHG emissions are represented by their Scope 3 (and only 7 percent by their scope 1) versus 85 percent of all CDP disclosers emissions represented by Scope 3 (and 12 percent of their emissions being scope 1). The rate of Scope 2 disclosure continues to be consistent between voluntary carbon

⁸ The Corporate Standard is for all organizations to prepare a corporate-level GHG emissions inventory <https://ghgprotocol.org/corporate-standard>. Additional standards and resources from Greenhouse Gas Protocol include the Scope 2 Guidance, Product Life Cycle Accounting and Reporting Standard, Corporate Value Chain (Scope 3) Accounting and Reporting Standard, among others.

⁹ Typical here and throughout when describing a voluntary buyer and/or non-buyer is defined as the median.

¹⁰ Forest Trends' Ecosystem Marketplace. 2015. The Bottom Line: Taking Stock of the Role of Carbon Offsets in Corporate Carbon Strategies. Washington DC: Forest Trends Association ; Forest Trends' Ecosystem Marketplace. 2016. Buying In: Taking Stock of the Role of Carbon Offsets in Corporate Carbon Strategies. Washington DC: Forest Trends Association.

buyers and all disclosers at 1 percent and 3 percent, respectively.

We recognize that one effect of this normalization is that certain sectors may be excluded. For example, high-emitting sectors are less likely to report Scope 3 emissions (e.g., manufacturers' downstream emissions from use of sold products), while companies with an immaterial Scope 1 footprint (e.g., retailers and services) would be less likely to report on Scope 1. For example, total disclosed Scope 1 emissions from all CDP respondents are just over 59.7 GtCO₂e, but this dropped 89 percent to 6.3 GtCO₂e for the CDP respondents with non-zero Scope 1 and 3 emissions. Meanwhile, total disclosed Scope 3 emissions in the normalized sample declined by 72 percent, from 44.6 GtCO₂e to

Voluntary Carbon Buyers Outpace on Value Chain Engagement

As the saying goes, what gets measured gets managed, and what can't be managed directly creates opportunities for value chain engagement and the use of carbon credits. Encouragingly, nearly all voluntary carbon buyers engage their value chain, an indicator that buying carbon credits does not occur without companies also working with suppliers, employees, and customers to address climate impacts. In fact, voluntary carbon buyers are 1.3 times more likely to be engaging their value chain than non-voluntary buyers. This best practice of working with upstream and downstream partners to reduce negative environmental impacts is a barometer for climate leadership.

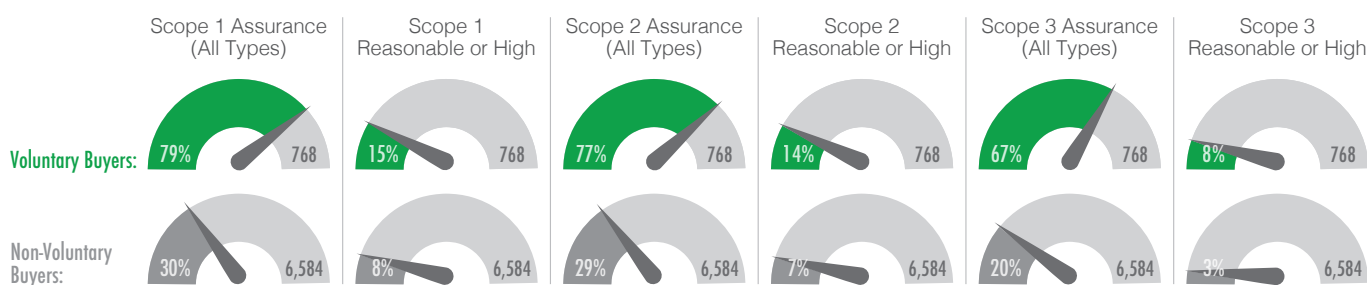
Voluntary Carbon Buyers Are More Likely to Verify their GHG Emissions Data

To instill confidence in stakeholders for the greenhouse gas emissions inventory that they report, companies may take the final step of hiring an independent and accredited third-party entity to perform a verification and assurance of their emissions data. This best practice in emissions reporting ensures the validity of both the calculation methods the company used in quantifying the emissions and the accuracy of disclosed data and processes.

Assurance of emissions, although considered best practice and endorsed by companies leading on climate change, is not a requirement for CDP disclosure, although it does factor into the scores that CDP reports to assess progress towards environmental stewardship. Emissions assurance is required for participation in the Science Based Targets initiative (SBTi), which is encouraged but not yet required by the Voluntary Carbon Markets Integrity Initiative (VCMI).

For Scopes 1, 2, and 3, voluntary carbon buyers are more likely to have assurance for their emissions inventories than all other organizations, inclusive of compliance market actors and non-carbon market participants ([Figure 5](#)).

FIGURE 5. VERIFICATION/ASSURANCE OF GHG EMISSIONS AND SHARE OF VOLUNTARY CARBON BUYERS VS. NON-VOLUNTARY CARBON BUYERS, BY SCOPE



Source: Ecosystem Marketplace, 2023

Note: Based on responses by 768 companies that purchased voluntary carbon credits in 2021 and 6,584 companies that either only purchased or originated compliance credits or did not participate in carbon credit markets in 2021 ("Non-Voluntary Carbon Buyers").

Companies disclosing to CDP are given the opportunity to report if any parts of their CDP Climate Change responses beyond their GHG emissions data are assured. Although the prevalence is very low, it is interesting to see that some companies are already starting to have their carbon credit claims assured ([Table 2](#)). In 2021, it was not a requirement to assure these claims for CDP, and the VCMI Claims Code was only just published in 2023. We will continue to watch this metric to see how companies progress in assuring their voluntary project-based carbon credit purchasing.

TABLE 2. VERIFICATION/ASSURANCE OF CARBON CREDIT DISCLOSURES, SHARE OF VOLUNTARY CARBON BUYERS VS. ALL CREDIT USERS

CDP COMPANY SEGMENTATION BY CARBON MARKET PARTICIPATION STATUS	VOLUNTARY CARBON BUYERS	ALL CREDIT USERS
ASSURANCE ON PROJECT-BASED CREDITS	1.8%	2.1%
TOTAL NUMBER OF COMPANIES	768	920

Source: Ecosystem Marketplace, 2023

Science is Driving the Climate Ambition of Voluntary Carbon Buyers

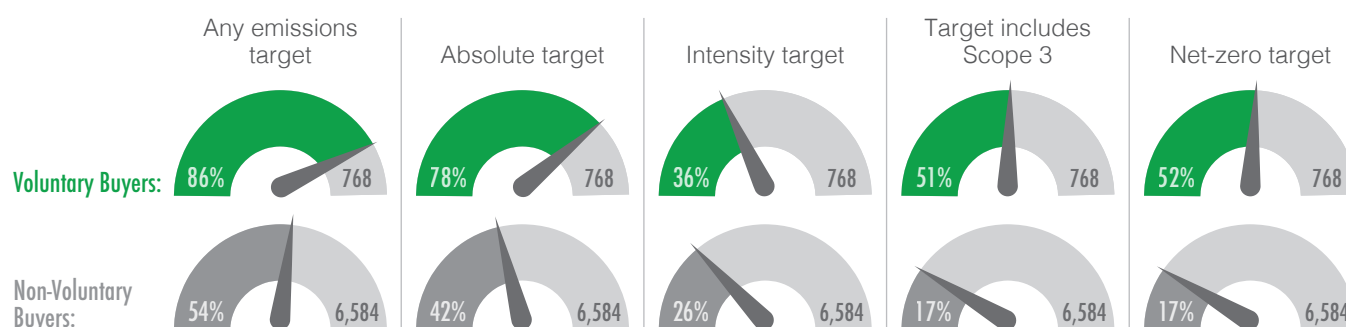
Establishing and publicly announcing a practical and achievable GHG emissions reduction target, especially one that is reported on regularly to gauge progress, is one of the most important steps a company can take towards achieving material climate benefits. Targets provide the basis for companies to strategize and identify investments they can make to achieve emissions reductions. If companies are setting their targets voluntarily (i.e., they are not obligated through a compliance mechanism), it is purely their decision how rigorous to make them, and whether to set an emissions reduction target in the first place.

While critics of voluntary carbon markets warn that buying credits for corporate use delays direct climate action like emissions reduction, EM has consistently found the opposite to be true. EM's analysis of CDP data suggests that buyers of voluntary carbon credits have higher levels of ambition for climate action than non-buyers.

By setting their ambition to address climate change, especially when the decision to make this goal is made at the C-suite or board level, companies set the wheels in motion for nearly every other action they will take to achieve climate sustainability. Without time-bound and quantifiable absolute and/or intensity targets, companies lack direction on the required quantity of emissions reductions and the necessary timeline. Targets have the greatest materiality if they are science-based and will put the company on the global pathway towards the Paris Agreement "stretch" target of limiting global warming to 1.5°C this century. Net-zero targets are an even more specific and prescriptive way to signal a commitment to achieving net-zero emissions by a specific date, ideally no later than 2050.

Voluntary carbon buyers were more likely to have targets to address climate change, and their targets were more ambitious. Most VCM buyers (78 percent of 768 companies) had at least one absolute target (Figure 6), while 52 percent had a net-zero target and 34 percent had a science-based target approved by SBTi (Figure 7), compared with non-buyers, where 42 percent had an absolute target, 17 percent had a net-zero target, and just 10 percent had an approved science-based target.

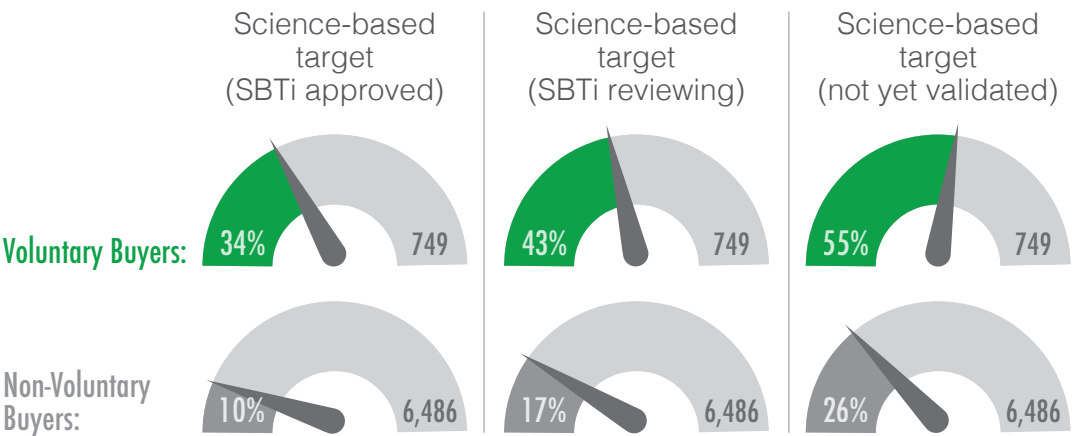
FIGURE 6. GHG TARGETS, SHARE OF VOLUNTARY CARBON BUYERS VS. NON-VOLUNTARY CARBON BUYERS



Source: Ecosystem Marketplace, 2023

Note: Based on responses by 768 companies that purchased voluntary carbon credits in 2021 and 6,584 companies that either only purchased or originated compliance credits or did not participate in carbon credit markets in 2021 ("Non-Voluntary Carbon Buyers").

FIGURE 7. SCIENCE-BASED TARGET STATUS, BY SHARE OF VOLUNTARY CARBON BUYERS VS. NON-VOLUNTARY CARBON BUYERS



Source: Ecosystem Marketplace, 2023

Note: This figure indicates the percentage of organizations that have reached at least the indicated level of science-based target. “SBTi reviewing” includes organizations with targets under review or approved by SBTi, and “not yet validated” includes those organizations as well as those whose science-based target(s) has not yet been validated but has been set. Figures are based on responses by 749 non-fossil fuel industry companies that purchased voluntary carbon credits in 2021 and 6,486 companies that either only purchased or originated compliance credits or did not participate in carbon credit markets in 2021 (“Non-Voluntary Carbon Buyers”). Fossil fuel organizations were excluded from this comparison.

Providing further reassurance that voluntary carbon buyers have a comprehensive strategy in place and are not just buying carbon credits is the clear gap between voluntary carbon buyers (51 percent) and non-voluntary carbon buyers (17 percent) with targets that include Scope 3 emissions (Figure 6). As noted previously, the majority of voluntary carbon buyers’ emissions reside in this scope.



PART C

CARBON BUYERS LEAD ON CLIMATE ACTION

There are investment options for companies to reduce their corporate GHG emissions or avoid them altogether. These options sit on a matrix of cost (to implement) and impact (in terms of GHG emissions reductions). Companies that have moved through the key climate transparency, accountability, and ambition criteria in the preceding section, most notably in reaching the point where they've set science-based targets, will be best positioned to make the most effective use of their funds for the short, medium, and long term.

Typically, companies beginning their climate action and decarbonization journeys will start with the no-cost and cheaper, easier methods that will have the greatest, quickest impact (i.e., the low-hanging fruit). Reducing Scope 1 and 2 emissions is relatively simple: wherever possible, companies can switch to cleaner fuels, install scrubbers to minimize direct emissions, source renewable electricity and/or purchase Renewable Energy Credits (or equivalent).¹¹ Scope 3 emissions are trickier. Since those emissions are generated by the company's suppliers (upstream), customers (downstream), and other companies and organizations, companies have limited control over Scope 3 unless they exert their influence to require these other parties to act on climate. This partly explains why companies typically purchase voluntary carbon credits to address Scope 3. However, an increasing awareness of unavoidable emissions in Scopes 1 and 2 provides an opportunity for companies as well.

Voluntary carbon buyers, while just 17 percent of all companies that disclosed investments into emissions reduction activities, accounted for 40 percent of total investment in emissions reduction activities (Table 3). Said another way, while there are 4.8 times as many non-buyers as companies that are

TABLE 3. INVESTMENT INTO EMISSIONS REDUCTION ACTIVITIES, SHARE OF VOLUNTARY CARBON BUYERS AND NON-VOLUNTARY CARBON BUYERS

CDP COMPANY SEGMENTATION BY CARBON MARKET PARTICIPATION STATUS	VOLUNTARY CARBON BUYERS	NON-CREDIT USERS ¹²
TOTAL NUMBER OF COMPANIES	551 (17%)	2,672 (83%)
MEDIAN INVESTMENT IN EMISSIONS REDUCTION	\$1,338,557	\$447,220
TOTAL INVESTMENT IN EMISSIONS REDUCTION	\$49,490,406,826	\$77,098,139,284
MEDIAN INVESTMENT IN EMISSIONS REDUCTION PER TON CO ₂ e EMITTED (LOCATION-BASED)	\$2.00	\$1.55
MEDIAN INVESTMENT IN EMISSIONS REDUCTION PER TON CO ₂ e EMITTED (MARKET-BASED)	\$2.30	\$1.31
MEDIAN INVESTMENT IN EMISSIONS REDUCTION PER TON CO ₂ e EMITTED, SCOPE 1 + 2 (LOCATION-BASED)	\$15.49	\$9.70
MEDIAN INVESTMENT IN EMISSIONS REDUCTION PER TON CO ₂ e EMITTED, SCOPE 1 + 2 (MARKET-BASED)	\$28.25	\$13.48

Source: Ecosystem Marketplace, 2023

Note: Out of 5,537 organizations who disclosed some emissions reduction activities to CDP, 4,071 (74 percent) provided an estimate of the amount invested into these activities, and 3,487 (63 percent) disclosed non-zero investment amounts. For comparison between average amounts invested into emissions reduction, we consider only the organizations that disclosed nonzero investment amounts. Of the 4,071 organizations providing an estimate of investments into emissions reduction, 2,990 (73 percent) provided an estimate of total emissions. For comparison between average amounts invested normalized by volume of CO₂e emitted, we consider only the organizations that disclosed both investment amounts and

¹¹ e.g., Guarantee of Origin in the European Union

¹² Non-credit users excludes voluntary originators, compliance originators, and compliance buyers as they are, by definition, those companies that emit enough greenhouse gases to be required to invest in emissions reduction activities to meet their carbon regulations.

voluntary buyers, those non-buyers made only 1.55 times as much investment than voluntary buyers.

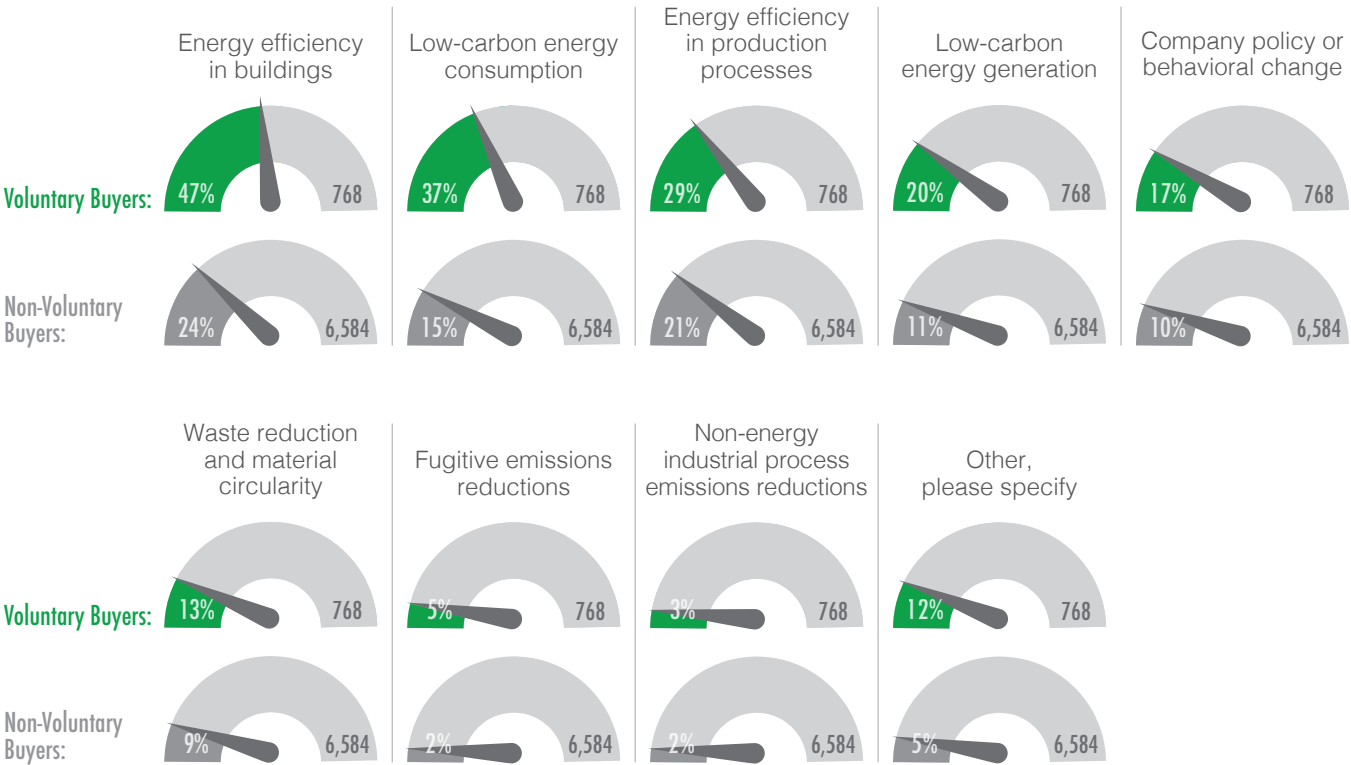
Further, the median voluntary buyer spent three times more on emissions reductions activities (\$1,338,557 versus \$447,220, respectively) and one and a half to two times more per ton of CO₂e emitted (Scopes 1 and 2) than the typical non-buyer

Consistent with EM findings from our 2016 report on this topic, companies that buy credits still out-invest non-buyers. Though companies across the board stepped up their climate investments between 2014 and 2021, the gap in the amount of money spent on emissions reductions activities between buyers and non-buyers narrowed. EM's analysis of 2014 data found that voluntary carbon buyers were spending about ten times more on emissions reductions activities than non-buyers.

This makes sense; awareness of climate change in all levels of society has increased significantly over the past seven years, as has corporate recognition that governments alone cannot solve the climate crisis.

Looking closer at corporate claims of engagement in emissions reduction activities, we found that organizations disclosing to CDP participate in a wide range of initiatives to reduce their GHG emissions (Figure 8). The most prevalent individual activities disclosed to CDP are all in the category of energy efficiency improvements in buildings or production processes, including investments in improved efficiency of lighting (1,568 companies), process optimization (1,295), and HVAC systems (934). These are followed by low-carbon energy generation in the form of photovoltaic solar power (833) and electing to consume a low-carbon energy mix (587). While not all emissions reduction activities are applicable to all organizations (e.g., organizations that do not produce products cannot optimize production processes), looking across CDP activity groups gives a good picture of the most prevalent ways in which companies are seeking to reduce their emissions, particularly across Scope 1 and Scope 2.

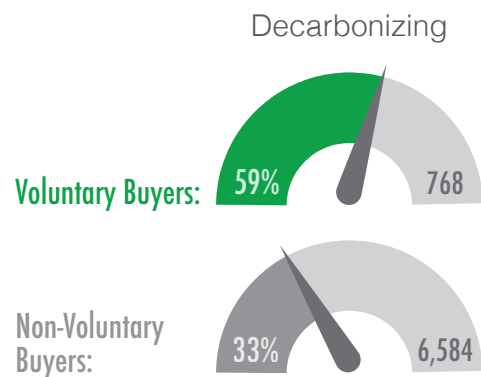
FIGURE 8. ENGAGEMENT IN EMISSIONS REDUCTION, BY ACTIVITY GROUP, SHARE OF VOLUNTARY CARBON BUYERS VS. NON-VOLUNTARY CARBON BUYERS



Source: Ecosystem Marketplace, 2023

Note: Based on responses by 768 companies that purchased voluntary carbon credits in 2021 and 6,584 companies that either only purchased or originated compliance credits or did not participate in carbon credit markets in 2021 ("Non-Voluntary Carbon Buyers"). Respondents could indicate that they were engaged in multiple types of emissions reduction activities. Emissions reduction activity groups are sourced directly from CDP.

FIGURE 9. YEAR-ON-YEAR DECARBONIZATION SUCCESS DISCLOSED BY COMPANIES, SHARE OF VOLUNTARY CARBON BUYERS VS. NON-VOLUNTARY CARBON BUYERS



Source: Ecosystem Marketplace, 2023

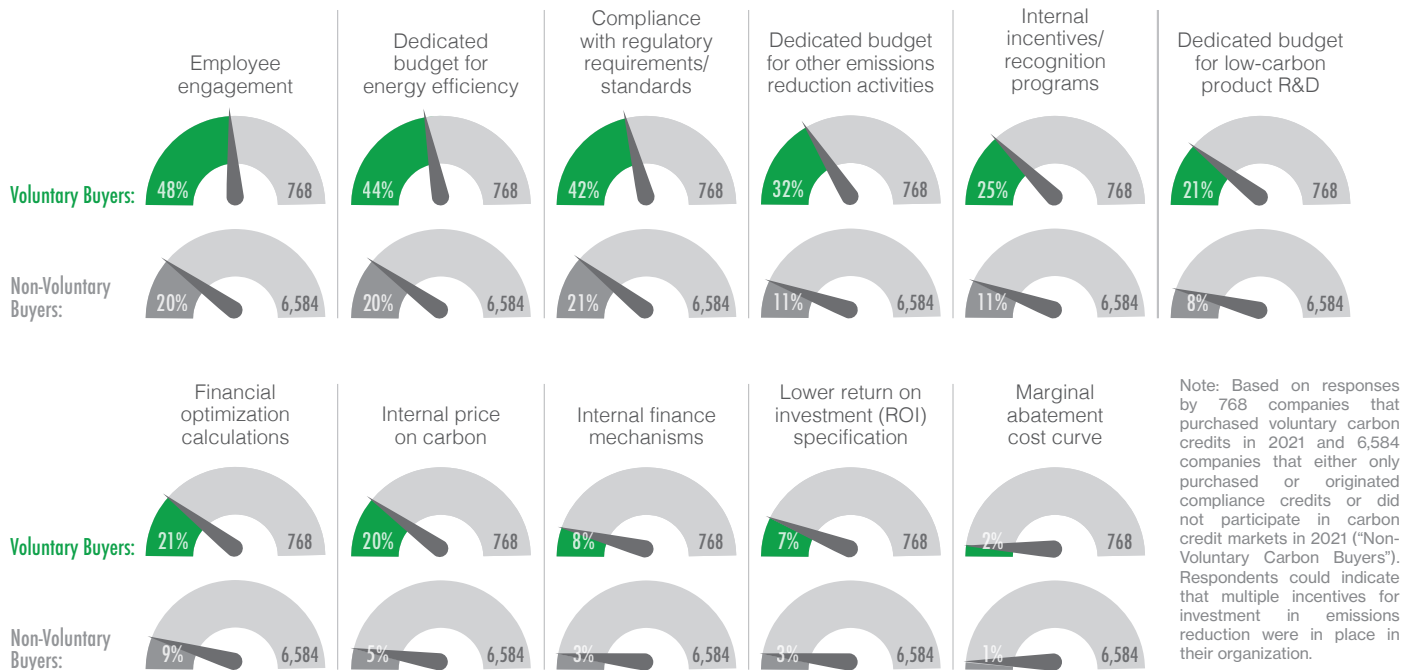
Note: Based on responses by 768 companies that purchased voluntary carbon credits in 2021 and 6,584 companies that either only purchased or originated compliance credits or did not participate in carbon credit markets in 2021 ("Non-Voluntary Carbon Buyers").

In fact, companies who voluntarily buy carbon credits are decarbonizing¹³ faster than companies who do not by investing in emissions reduction activities for their business and operations, including renewable energy consumption and the purchase of Renewable Energy Certificates (RECs) (Figure 9).

What’s Driving Investment in Climate Action?

Of the 7,352 companies that reported a method that drove their investments into emissions reduction activities in 2021, 463 cited an internal price on carbon: 20 percent (156) of voluntary carbon buyers versus 5 percent (307) of non-voluntary carbon buyers (Figure 10).

FIGURE 10. METHODS DRIVING INVESTMENT IN EMISSIONS REDUCTION ACTIVITIES, BY SHARE OF VOLUNTARY CARBON BUYERS VS. NON-VOLUNTARY CARBON BUYERS



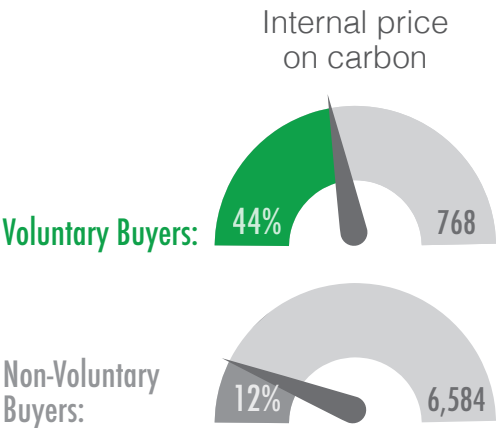
Source: Ecosystem Marketplace, 2023

¹³ "Decarbonizing" is here defined as companies that reported lower gross emissions in 2021 than in 2020 and identified renewable energy consumption or other emissions reduction activities as a contributing cause.

The greatest motivator for the 3,352 companies that invested in emissions reduction activities was to comply with regulatory requirements and standards (1,814), followed by employee engagement (1,770) and a dedicated budget for energy efficiency (1,769).

Interestingly, independent of investments in emissions reduction activities, a total of 1,128 companies – 44 percent (338) of voluntary carbon buyers versus 12 percent (790) of non-buyers – reported separately that they had an internal price on carbon for their business strategies (Figure 11). An internal price in this sense could be used to manage climate-related risks, identify climate-related opportunities, transition to and invest in low-carbon activities, and change internal awareness and behavior within the company. In other words, less than half of all companies that had an internal price on carbon reported that the internal price was a factor in their investment into emissions reduction activities (483/1,128).

FIGURE 11. COMPANIES RELYING ON AN INTERNAL PRICE ON CARBON TO DRIVE THEIR BUSINESS STRATEGY, SHARE OF VOLUNTARY CARBON BUYERS VS. NON-VOLUNTARY CARBON BUYERS



Source: Ecosystem Marketplace, 2023

Note: Based on responses by 768 companies that purchased voluntary carbon credits in 2021 and 6,584 companies that either only purchased or originated compliance credits or did not participate in carbon credit markets in 2021 (“Non-Voluntary Carbon Buyers”).



PART D

SCRATCHING THE SURFACE: JUST OVER 2 PERCENT OF GHG EMISSIONS COVERED BY VOLUNTARY CARBON PURCHASES, VALUED AT \$488 MILLION

The typical carbon market buyer in 2021 purchased credits representing less than two percent (1.85 percent) of its total emissions. This number increases slightly for the category of voluntary carbon buyers who purchased just over two percent (2.16 percent) of their total GHG emissions. This is a far cry from the negative perception that “companies are buying their way out of the problem” with the voluntary carbon market. Stated another way, the volume of voluntary carbon credits reported by CDP companies accounted for less than one percent (0.90 percent) of all voluntary carbon buyers’ emissions – the total volume of voluntary carbon credits purchased (121.2 MtCO₂e) calculated against total emissions from voluntary carbon buyers of 13.5 GtCO₂e (location-based). (Note that total emissions inherently exclude the 157.8 MtCO₂e that were avoided through voluntary carbon buyers’ emissions reduction activities.)

As stated previously, we recognize that the CDP dataset is an incomplete accounting of buyers, as EM recorded over 518.3 MtCO₂e of transactions in 2021. Additionally, EM has received confidential reports of 2,477 known corporate buyers, of which 204 (8.2 percent) disclosed some climate data to CDP in 2022, and 130 (5.2 percent) also disclosed buying or originating project-based carbon credits (see the About the Data section).

Looking at this in the context of emissions reductions discussed in Part C, voluntary carbon buyers purchased 26 percent less carbon credit volume than the reductions they achieved through their emissions reduction activities (157.8 MtCO₂e). Meanwhile, all other companies achieved 112.2 GtCO₂e of emissions reductions through their own activities. If we apply EM’s 2021 Global Carbon Market price/ton of \$4.03 to the volume of carbon credits purchased in 2021, CDP disclosing companies theoretically spent \$488.4 million in the voluntary carbon market.

Returning to the “normalized” sample of 708 voluntary carbon buyers reporting non-zero Scope 1 and Scope 3 emissions (see Part A), the hypothetical total Scope 1 and 2 emissions of this sample of organizations were 1.1 GtCO₂e (includes their reported emissions plus emissions reductions associated with their emissions reduction activities) and Scope 3 emissions were 1.2 GtCO₂e. If we understand that emissions reduction activities are for Scopes 1 and 2, and we assume that carbon credits are applied to Scope 3, which is an overstatement, then emissions reduction activities accounted for 14 percent of hypothetical Scope 1 and 2 emissions, whereas voluntary carbon credits accounts for just one percent of actual Scope 3 emissions.



CONCLUSIONS AND LOOKING FORWARD

Buying voluntary carbon market credits goes hand-in-hand with an integrated and comprehensive corporate strategy to accelerate global climate action and decarbonize their business

With corporate use of carbon credits increasing even as organizations face growing scrutiny of their use of credits in carbon neutrality claims, and with a record volume of carbon credit transactions taking place in 2021, it is more important than ever to understand the climate action and decarbonization behavior of companies who voluntarily purchase carbon credits. It's equally important to understand the behavior of companies that do not engage in the voluntary carbon market.

In 2021, voluntary carbon credit buyers outperformed other companies on transparency and accountability related to climate issues, and demonstrated stronger ambition to become climate leaders, including through actions already being taken to address their climate impacts. These findings are remarkably consistent with previous analyses by EM dating back to 2015. In other words, this report does not document so much of a recent shift toward integrity driven by new scrutiny as much as a trend of continued improvement.

Voluntary carbon market transparency needs investment to drive integrity

Since 2020, EM has invested in and increased its efforts to ensure supply- and sell-side transparency in the global voluntary carbon markets. One of the ways we have enhanced our efforts has been to request disclosure of buyer names, which we maintain confidentially in our secure database and our EM Respondents accounts on our Global Carbon Markets Hub.

With this increased focus on credit end users, our total count of carbon buyers for 2020-2023 year-to-date is nearly 2,500 unique names. However, only 8.2 percent of the total buyers reported to EM are disclosing to CDP, and more buyers' names were identified from our review of carbon standards' registries of credit retirements, indicating a clear gap in buyer transparency that needs to be addressed. Not just for the big corporates but for all of the small and medium sized businesses.

EM welcomes the work of VCMi to create a standard approach for voluntary carbon buyers' climate ambition and action criteria, as well as how companies should report their claims on project-based carbon credits. The VCMi Claims Code was only just published in 2023, with publication of the final version expected in November 2023 (after the publication of this report). Companies should be able to use this guidance to report on their carbon purchases within the context of the rest of their climate action strategies.

As the market continues to evolve, EM stands ready to continue to drive carbon market transparency, knowledge, and insights as a globally trusted, independent, and neutral non-profit initiative. To do this effectively, we look forward to engaging with the entire carbon market value chain and stakeholder network who have a common vision for high-integrity and well-functioning global carbon markets that achieve results on the ground and in corporate boardrooms.



APPENDIX 1: METHODOLOGY

Due to the self-reported nature of CDP data, it is difficult to know with certainty the boundaries and definitions that companies used in disclosure of emissions and engagement with project-based carbon credits. As a result, we took several approaches to standardize the data used for the insights in this report.

Criteria for Inclusion

The CDP Climate Change 2022 Public Disclosure Data captures the activity of organizations in calendar year 2021. Different organizations have different reporting years, so we focused on organizations whose reporting periods covered at least 6 months (181 days) of calendar year 2021. The total number of organizations meeting that criterion was 7,415.

Project-based Carbon Credit Data

Data on project-based carbon credits comes from CDP Climate Change module C11, “Carbon pricing”, specifically questions C11.2 and C11.2a. While reviewing disclosed credit purchases and originations, we identified many irregularities in this self-reported data, likely due to confusion around types of credit schemes, project methodologies, and distinctions between credit purchases and origination.

Improperly reported project-based credits

While examining carbon credit disclosures, we found that several companies misclassified RECs, RINs, and ETS participation as project-based carbon credit purchase or origination. We removed 21 companies that only reported these misclassified credits from the carbon credit data and reclassified them as non-participants in project-based carbon credits. For five other companies that did purchase or originate legitimate project-based credits, we removed any individual disclosures of these misclassified credits. Where credits were disclosed with a volume of zero tons CO₂e, we removed these credits from the carbon credit dataset.

Credit purposes and defining organizational use of credits

CDP respondents have the option to define their purpose in purchasing or originating project-based carbon credits as voluntary, compliance with local or industry requirements and regulations, or another purpose that they could specify. We categorized all credits by purpose into voluntary, compliance, or other by going through all self-specified credit purposes and making a determination as to whether the credit use was voluntary or for compliance. If it was not possible to determine the credit purpose from the description, if the future use of the credits could be either voluntary or compliance, or if voluntary and compliance credits were combined in a single disclosure, we classified the purpose as “other.”

To compare voluntary and compliance users of credits, we defined a company as a voluntary credit user if they disclosed purchasing or originating any volume of voluntary credits, even if the majority of their credit use was for compliance purposes.

Voluntary credit origination

About 7.5 times as many respondents disclose purchasing credits as those who disclose originating credits. When we examined disclosures from 98 companies that reported originating voluntary credits and not purchasing any credits, we found that there was more inconsistency with disclosures about credit origination than credit purchases. In addition to identifying 5 companies that were originating RECs instead of project-based credits, we found 11 circumstances where credit purchases were clearly misidentified as credit origination. We also found 10 credit disclosures that represented credits originated by an external partner and financed through an offtake agreement with the company disclosing to CDP. We reclassified these offtake agreements as credit purchases, because they are originated by a third party and not by the disclosing company itself.

Because of the inconsistencies with credit reporting for organizations that disclosed originating voluntary credits but did not disclose buying any, we chose to focus our comparative analysis of CDP disclosers on voluntary credit buyers, with a control group combining compliance buyers and originators and project-based carbon credit non-users, referred to as non-voluntary credit users. The voluntary originating companies are included in summary tables and charts of all CDP companies, but they are not the focus of the main analysis differentiating between engagement in emissions reduction activities and internal incentive programs, awareness of climate risks, board oversight of climate issues, assurance of emissions and carbon credit activities, target setting,

internal carbon prices, value chain engagement, and decarbonization.

Project methodologies

We found that the CDP typology of project methodologies was not well-aligned with EM's internal taxonomy of project methodologies. In particular, CDP does not distinguish between several forest-based project types such as REDD, ARR, and IFM, lumping these into the non-descriptive category of "Forests." Where it was possible to make a determination based on the project description, we identified REDD and ARR projects and split them into their own categories. We combined projects relating to industrial gas emission avoidance (CDP project types "HFCs," "N₂O," and "PFCs and SF₆") into an "Industrial/refrigerant gases" category. We combined five categories relating to energy distribution and energy efficiency in industry, power generation, service, and supply together with fuel switching projects to create the "Energy efficiency and fuel switching" category. We combined "Energy efficiency: households" with several self-reported projects relating to household and community devices, such as cookstoves, solar cookers, and clean water access, into the "Household devices" category. Respondents also had the option to specify their own project methodology, and we assigned every project with a respondent-specified methodology to its own category, including categories that CDP did not include such as "Blue carbon" and "IFM." Many of these self-specified entries referred to a combination of renewable energy projects, including biofuel energy generation, which we combined into a "Mixed renewables" category.

Emissions Data

Data on greenhouse gas emissions come from CDP Climate Change module C6, emissions data, specifically questions C6.1, C6.3, and C6.5.

Organizations responding to the CDP Climate Change 2022 Disclosure had the option to disclose Scope 1, Scope 2, and Scope 3 emissions in separate questions. Companies were under no obligation to disclose emissions data in any scope. Scope 2 emissions could be reported as a location-based estimate, a market-based estimate accounting for electricity supplier emissions factors and residual emissions factors, or both.

Disclosure of emissions varied both by scope and by company engagement with carbon credits:

- Among 830 voluntary credit buyers and originators, 98 percent reported non-zero Scope 1 emissions, 100 percent reported non-zero location-based Scope 2 emissions, 92 percent reported non-zero market-based Scope 2 emissions, and 96 percent reported non-zero Scope 3 emissions;
- For the 54 organizations that bought or originated compliance credits but no voluntary credits, 100 percent reported nonzero Scope 1 emissions, 96 percent reported non-zero location-based Scope 2 emissions, 94.4 percent reported non-zero market-based Scope 2 emissions, and 94 percent reported non-zero Scope 3 emissions; and
- Out of 6476 organizations not buying or originating credits, 94 percent reported non-zero Scope 1 emissions, 99 percent reported non-zero location-based Scope 2 emissions, 98 percent reported non-zero market-based Scope 2 emissions, and 49.5 percent reported nonzero Scope 3 emissions.

Because there was more variation between carbon credit users' and non-credit users' frequency of disclosing Scope 1 and Scope 3 emissions, and because companies may have zero Scope 2 emissions through purchases of clean energy or RECs, we restricted our analysis of emissions to 3,925 organizations that reported both non-zero Scope 1 and Scope 3 emissions. Tables showing distributions of emissions by scope and median investments in emissions reduction for all respondents are located in the appendix.

It was more common for a responding company to disclose location-based estimates of Scope 2 emissions than market-based estimates, due to unavailability of relevant data or for other reasons. Wherever possible, we report both location-based and market-based estimates for Scope 2 emissions and for total emissions for all scopes. When location-based or market-based estimates are not specified, such as in the table on credit purchase and origination as a proportion of total emissions, we have used location-based estimates of total emissions to include as many companies as possible.

Other CDP Data

In addition to the carbon credit data and emissions data described above, we used CDP Climate Change 2022 Disclosure Data from modules C0, C1, C4, C7, C10, C11, and C12.

From module C0, introduction, we used question C0.2 to define companies' reporting year as either in or out of bounds for inclusion. We used question C0.4 to obtain currency codes to convert reported investments into emissions reduction to dollars.

From module C1, governance, we used question C1.1 to answer whether there was board-level oversight of climate issues within companies.

From module C4, targets and performance, we used questions C4.1a and C4.1b for information on absolute and intensity emissions targets. We used question C4.2 to determine whether companies had net-zero targets. We used question C4.3b for information on emissions reduction initiatives and associated investments, and we used question C4.3c to understand internal organizational methods used to incentivize emissions reduction.

From module C7, emissions breakdown, we used questions C7.9 and C7.9a to define organizations that are decarbonizing.

From module C10, verification, we used questions C10.1a, C10.1b, and C10.1c to understand assurance for Scope 1, Scope 2, and Scope 3 emissions. We used question C10.2a to identify companies that undertook assurance on their use of project-based carbon credits.

From module C11, carbon pricing, we used question C11.3 to determine if companies had an internal carbon price.

From module C12, engagement, we used question C12.1 to determine whether companies engaged other members of their value chains.



APPENDIX 2: ADDITIONAL TABLES & FIGURES

TABLE S1. TOP 50 CORPORATE VOLUNTARY CARBON CREDIT BUYERS, BY VOLUME, 2021 (AS DISCLOSED TO CDP IN 2022)

COMPANY	INDUSTRY	EMISSIONS VOLUME
DELTA AIR LINES	TRANSPORTATION SERVICES	26,943,120
TOTALENERGIES	FOSSIL FUELS	7,000,000
SHELL PLC	FOSSIL FUELS	6,376,857
VOLKSWAGEN AG	MANUFACTURING	6,099,241
TAKEDA PHARMACEUTICAL COMPANY LIMITED	BIOTECH, HEALTH CARE, & PHARMA	4,657,868
COMCAST CORPORATION	SERVICES	3,116,077
DIAMONDBACK ENERGY INC	FOSSIL FUELS	3,000,000
LA POSTE	TRANSPORTATION SERVICES	2,638,202
TELSTRA CORPORATION	SERVICES	2,546,516
ENI SPA	FOSSIL FUELS	2,317,076
BP	FOSSIL FUELS	2,188,030
EASYJET	TRANSPORTATION SERVICES	2,123,278
AMBIPAR PARTICIPACOES E EMPREENDIMENTOS	SERVICES	1,811,578
NESTLÉ	FOOD, BEVERAGE & AGRICULTURE	1,803,273
KERING	APPAREL	1,779,888
VATTENFALL GROUP	POWER GENERATION	1,700,000
CPFL ENERGIA SA	INFRASTRUCTURE	1,624,215
MINERVA FOODS	FOOD, BEVERAGE, & AGRICULTURE	1,477,506
LOGITECH EUROPE S.A.	MANUFACTURING	1,402,370
EDF	POWER GENERATION	1,283,422
BOEING COMPANY	MANUFACTURING	1,207,500
ECOPETROL S.A.	FOSSIL FUELS	1,169,836
LEGRAND	MANUFACTURING	1,139,120
SALESFORCE.COM, INC.	SERVICES	1,096,000
INPEX CORPORATION	FOSSIL FUELS	1,000,000
BARILLA HOLDING SPA	FOOD, BEVERAGE, & AGRICULTURE	909,299
ROBERT BOSCH GMBH	MANUFACTURING	907,118
BMW AG	MANUFACTURING	864,630
THE WALT DISNEY COMPANY	SERVICES	818,500
AIR FRANCE - KLM	TRANSPORTATION SERVICES	764,000

COMPANY	INDUSTRY	EMISSIONS VOLUME
CHANEL	APPAREL	723,333
APPLE INC.	MANUFACTURING	667,000
REMY COINTREAU	FOOD, BEVERAGE, & AGRICULTURE	630,170
BAOSTEEL	MATERIALS	604,606
HERA	INFRASTRUCTURE	582,816
AVIANCA GROUP	TRANSPORTATION SERVICES	573,863
ERNST & YOUNG GLOBAL LTD	SERVICES	528,000
DMG MORI AKTIENGESELLSCHAFT	MANUFACTURING	515,176
ROYAL CARIBBEAN CRUISES LTD	TRANSPORTATION SERVICES	512,840
SAS	TRANSPORTATION SERVICES	507,000
DEUTSCHE POST DHL GROUP	TRANSPORTATION SERVICES	495,508
ETSY, INC.	SERVICES	482,898
ENERJISA ÜRETİM SANTRALLERİ A.Ş.	POWER GENERATION	481,686
BHP	MATERIALS	469,984
CONTACT ENERGY	POWER GENERATION	458,100
ZALANDO SE	RETAIL	438,933
RYANAIR HOLDING PLC	TRANSPORTATION SERVICES	436,110
DANONE	FOOD, BEVERAGE, & AGRICULTURE	409,291
SHOPIFY INC	SERVICES	405,997
CENTRICA	INFRASTRUCTURE	399,193

Source: Ecosystem Marketplace, 2023

TABLE S2. TOP 50 NON-BUYERS OF CARBON CREDITS, BY GHG EMISSIONS

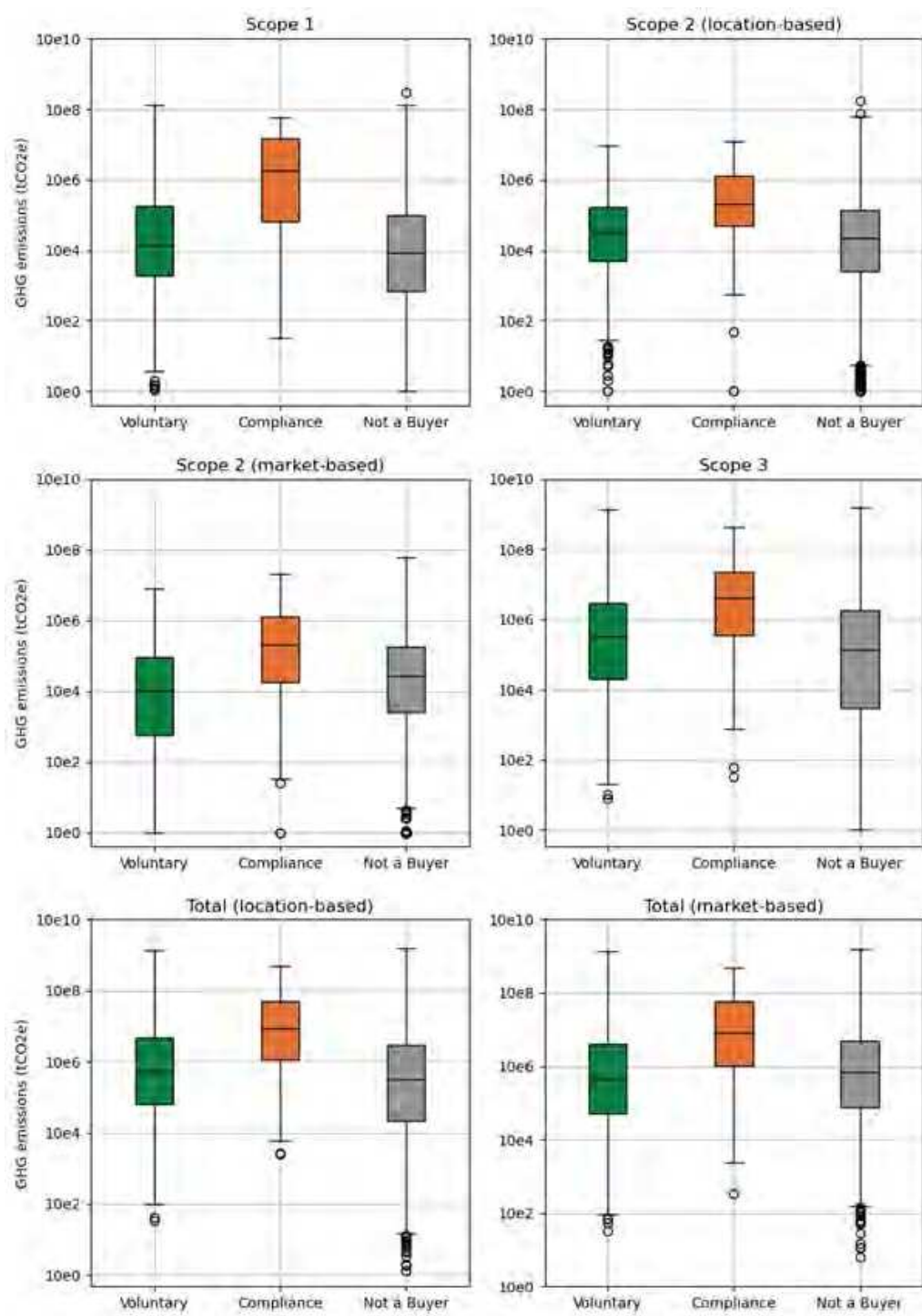
COMPANY	INDUSTRY	EMISSIONS VOLUME
T.ŞİŞE VE CAM FABRİKALARI A.Ş.	MATERIALS	3,025,967,906
MITSUBISHI HEAVY INDUSTRIES, LTD.	MANUFACTURING	1,580,886,336
HNI CORPORATION	MANUFACTURING	1,344,932,778
CUMMINS INC.	MANUFACTURING	1,170,640,962
GIRTEKA	TRANSPORTATION SERVICES	838,493,546
ATENTO BRASIL S/A	SERVICES	772,387,218
EMERSON ELECTRIC CO.	MANUFACTURING	592,095,630
RIO TINTO	MATERIALS	580,400,000
GINGER LOGISTICS INT'L CO.,LTD	TRANSPORTATION SERVICES	546,045,222
BERLIN PACKAGING LLC	RETAIL	544,439,674
VALE SA	MATERIALS	505,698,647
PETRÓLEO BRASILEIRO SA – PETROBRAS	FOSSIL FUELS	504,367,651
SIEMENS AG	MANUFACTURING	470,138,422
KONGSBERG AUTOMOTIVE HOLDING ASA	MANUFACTURING	457,845,076

COMPANY	INDUSTRY	EMISSIONS VOLUME
TOYOTA MOTOR CORPORATION	MANUFACTURING	421,325,452
TRANE TECHNOLOGIES	MANUFACTURING	403,062,084
PJSC LUKOIL	FOSSIL FUELS	393,032,247
DAIKIN INDUSTRIES, LTD.	MANUFACTURING	308,133,874
DANIELI & C OFFICINE MECCANICHE S.P.A.	MANUFACTURING	306,922,490
NTPC LTD	POWER GENERATION	305,264,310
FORD MOTOR COMPANY	MANUFACTURING	303,231,648
PRYSMIAN SPA	MANUFACTURING	285,342,559
HONDA MOTOR CO., LTD.	MANUFACTURING	280,076,640
EBARA CORPORATION	MANUFACTURING	256,447,126
HELLENIC CABLES S.A.	MANUFACTURING	247,414,458
TOSHIBA CORPORATION	INFRASTRUCTURE	243,911,554
CONOCOPHILLIPS	FOSSIL FUELS	243,320,000
BAKER HUGHES COMPANY	SERVICES	237,633,772
FLOREMPAQUE CIA LTDA	MANUFACTURING	237,093,669
GENERAL MOTORS COMPANY	MANUFACTURING	236,937,012
EQUITRANS MIDSTREAM	FOSSIL FUELS	214,998,966
FLSMIDTH & CO. A/S	MANUFACTURING	212,446,346
THE HOME DEPOT, INC.	RETAIL	202,640,892
PROCTER & GAMBLE COMPANY	MATERIALS	199,332,130
WOLFSPEED, INC.	MANUFACTURING	197,204,102
FORTUM OYJ	POWER GENERATION	190,056,500
IHI CORPORATION	MANUFACTURING	184,729,491
FUJI ELECTRIC CO., LTD.	MANUFACTURING	179,937,277
SHYA HSIN PACKAGING INDUSTRY(CHINA)CO.,LTD.	MANUFACTURING	178,629,059
OI S.A	SERVICES	174,820,671
NEXANS	MANUFACTURING	171,848,618
SABIC	MATERIALS	167,625,581
ENGIE	POWER GENERATION	167,114,576
MITSUBISHI ELECTRIC CORPORATION	MANUFACTURING	160,838,562
UNIPER SE	INFRASTRUCTURE	158,349,024
THE GOODYEAR TIRE & RUBBER COMPANY	MANUFACTURING	158,303,743
JERA CO., INC.	INFRASTRUCTURE	153,644,598
KOREA SHIPBUILDING AND OFFSHORE ENGINEERING	MANUFACTURING	151,715,219
PTT	FOSSIL FUELS	145,996,748
CARREFOUR	RETAIL	138,531,036

Source: Ecosystem Marketplace, 2023

Note: Some of these companies may engage in voluntary or compliance carbon credits and not disclose that engagement to CDP. Industry classifications used in this table are taken directly from CDP and do not necessarily align with GICS or other industry classification systems.

FIGURE S1. SCALE AND DISTRIBUTION OF VOLUNTARY, COMPLIANCE, AND NON-BUYER EMISSIONS



Source: Ecosystem Marketplace, 2023

TABLE S3. SCALE AND DISTRIBUTION OF VOLUNTARY/COMPLIANCE/NON-BUYER EMISSIONS

SCOPE	QUARTILE	COMPLIANCE	NON-BUYER	VOLUNTARY
SCOPE 1	MIN	31.00	0.02	0.08
	25%	67,805	705	1,952
	50%	1,870,261	8,545	13,292
	75%	14,719,360	99,356	186,526
	MAX	60,013,220	304,146,024	131,088,288
SCOPE 2 (LOCATION-BASED)	MIN	0	0	0
	25%	50,139	2,446	5,027
	50%	210,820	22,092	33,369
	75%	1,300,000	142,057	163,846
	MAX	12,566,000	174,746,546	9,196,964
SCOPE 2 (MARKET-BASED)	MIN	0	0	0
	25%	21,764	2,544	566
	50%	213,171	26,599	10,178
	75%	1,247,694	180,828	91,301
	MAX	20,829,000	61,350,688	8,152,497
SCOPE 3	MIN	32	0.01	6.8
	25%	364,354	3,093	20,655
	50%	4,263,685	134,035	338,525
	75%	22,931,150	1,789,850	3,000,420
	MAX	438,000,000	1,580,346,107	1,373,897,000
TOTAL EMISSIONS (LOCATION-BASED)	MIN	2,544	0.36	32
	25%	1,173,258	21,464	62,762
	50%	8,646,130	320,554	531,819
	75%	50,700,151	2,869,874	4,778,116
	MAX	477,900,000	1,580,910,810	1,397,890,000
TOTAL EMISSIONS (MARKET-BASED)	MIN	341	5.5	31
	25%	1,034,359	78,338	51,126
	50%	8,336,125	706,925	460,430
	75%	59,089,000	4,998,664	4,168,204
	MAX	477,900,000	1,580,861,861	1,396,890,000

Source: Ecosystem Marketplace, 2023

TABLE S4. ALL CDP ORGANIZATION SECTOR PARTICIPANTS CLUSTERED BY INDUSTRY

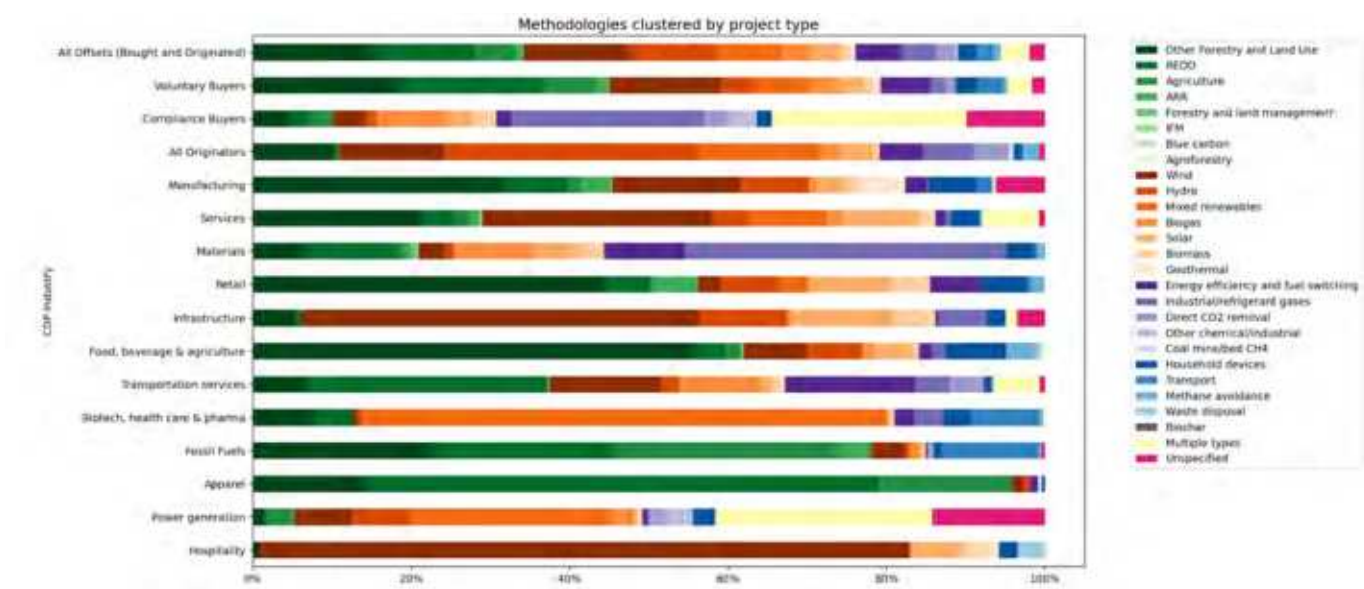
INDUSTRY	SECTOR	NO. OF ORGS.	PROPORTION OF SECTOR BY EMISSIONS	PROPORTION OF SECTOR BY VOLUME OF CARBON CREDITS BOUGHT/ ORIGINATED
APPAREL	TEXTILE & FABRIC GOODS	204	100%	100%
BIOTECH, HEALTH CARE, & PHARMACEUTICALS	BIOTECH & PHARMA	118	64.8%	97.2%
	HEALTH CARE PROVISION	17	5.3%	0%
	MEDICAL EQUIPMENT & SUPPLIES	74	29.9%	2.8%
FOOD, BEVERAGE, & AGRICULTURE	CROP FARMING	23	3.6%	2.84%
	FISH & ANIMAL FARMING	15	3.3%	0.03%
	FOOD & BEVERAGE PROCESSING	314	90.6%	94.5%
	LOGGING & RUBBER TAPPING	2	0.9%	0%
	TOBACCO	15	1.7%	2.7%
FOSSIL FUELS	COAL MINING	6	2.1%	0.9%
	OIL & GAS EXTRACTION, & PRODUCTION	54	18.1%	23.3%
	OIL & GAS PROCESSING	28	70.1%	74.6%
	OIL & GAS RETAILING	19	4.7%	0.5%
	OIL & GAS STORAGE, & TRANSPORTATION	19	4.9%	0.7%
HOSPITALITY	BARs, HOTELS, & RESTAURANTS	41	96.6%	32.6%
	ENTERTAINMENT FACILITIES	18	3.4%	67.4%
INFRASTRUCTURE	CONSTRUCTION	209	24.1%	18.9%
	ENERGY UTILITY NETWORKS	85	70.1%	58.6%
	LAND & PROPERTY OWNERSHIP & DEVELOPMENT	61	1.6%	18.7%
	NON-ENERGY UTILITIES	30	4.2%	3.8%
MANUFACTURING	ELECTRICAL & ELECTRONIC EQUIPMENT	955	22%	38.1%
	LEISURE & HOME MANUFACTURING	108	6.5%	1.2%
	LIGHT MANUFACTURING	129	5.3%	1.3%
	METAL PRODUCTS MANUFACTURING	693	7.5%	5.3%
	PAPER PRODUCTS & PACKAGING	175	0.7%	0.4%
	PLASTIC PRODUCT MANUFACTURING	341	1.7%	0.1%
	POWERED MACHINERY	274	38.1%	6.7%
	RENEWABLE ENERGY EQUIPMENT	27	0.2%	0.2%
	TRANSPORTATION EQUIPMENT	146	18%	46.8%
	WOOD & RUBBER PRODUCTS	51	0.1%	0.01%

INDUSTRY	SECTOR	NO. OF ORGS.	PROPORTION OF SECTOR BY EMISSIONS	PROPORTION OF SECTOR BY VOLUME OF CARBON CREDITS BOUGHT/ ORIGINATED
MATERIALS	CEMENT & CONCRETE	31	10.8%	1.5%
	CHEMICALS	394	39.2%	34%
	METAL SMELTING, REFINING, & FORMING	121	18.5%	58.7%
	METALLIC MINERAL MINING	40	27.9%	4.9%
	OTHER MATERIALS	77	2.5%	0.7%
	OTHER MINERAL MINING	10	0.13%	0.01%
	WOOD & PAPER MATERIALS	30	1.1%	0.3%
POWER GENERATION	NUCLEAR POWER GENERATION	1	4.6%	4.3%
	RENEWABLE POWER GENERATION	39	8.3%	30.6%
	THERMAL POWER GENERATION	56	87.1%	65.1%
RETAIL	CONVENIENCE RETAIL	53	33.9%	20.4%
	DISCRETIONARY RETAIL	116	19.8%	53.7%
	TRADING, WHOLESALE, DISTRIBUTION, RENTAL & LEASING	219	46.3%	25.9%
SERVICES	COMMERCIAL & CONSUMER SERVICES	100	2.8%	2.4%
	FINANCIAL SERVICES	456	54.5%	19.4%
	IT & SOFTWARE DEVELOPMENT	269	3.5%	11.8%
	INDUSTRIAL SUPPORT SERVICES	118	11.3%	0.03%
	MEDIA, TELECOMMUNICATIONS, & DATA CENTER SERVICES	160	16.18%	34.3%
	OTHER SERVICES	58	5.4%	0.2%
	PRINT & PUBLISHING SERVICES	45	0.6%	0.1%
	SPECIALIZED PROFESSIONAL SERVICES	342	3.8%	25.8%
	WEB & MARKETING SERVICES	91	1.9%	6.06%
TRANSPORTATION SERVICES	AIR TRANSPORT	32	21%	84.3%
	INTERMODAL TRANSPORT & LOGISTICS	119	60.9%	12.5%
	MARINE TRANSPORT	32	12.6%	2.8%
	RAIL TRANSPORT	20	4.9%	0.1%
	ROAD TRANSPORT	130	0.7%	0.3%

Source: Ecosystem Marketplace, 2023

Voluntary Carbon Market Companies Prefer Nature-based and Renewables Credits

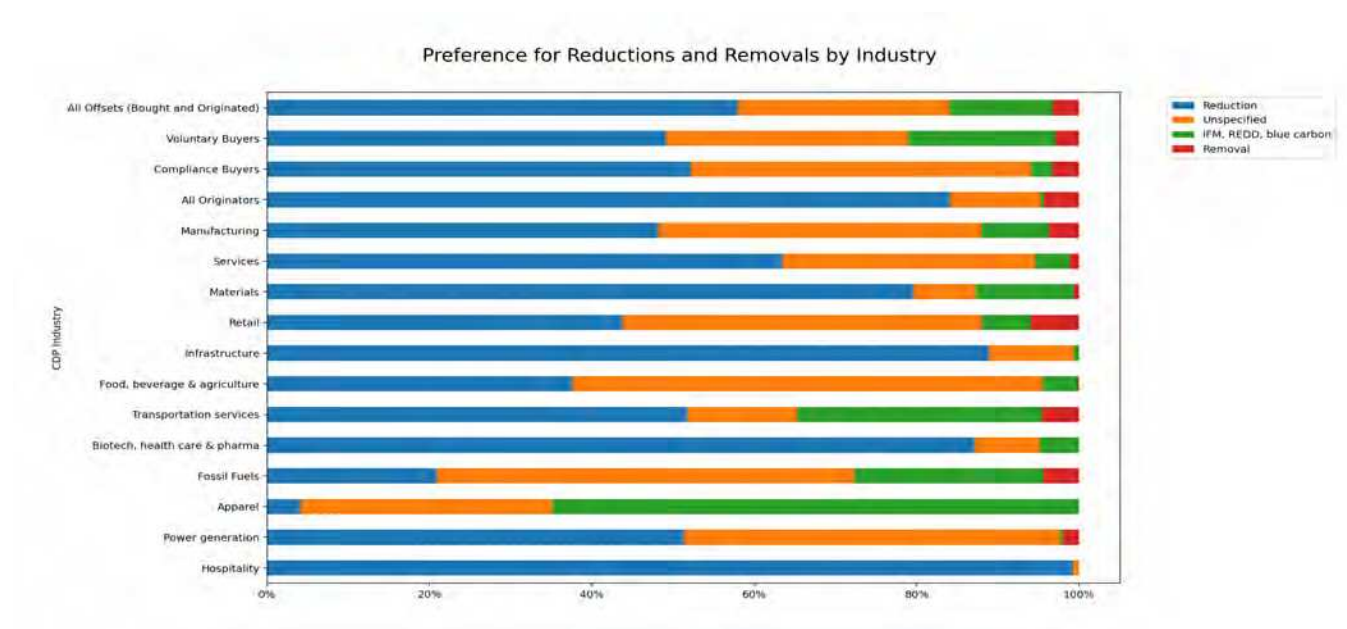
FIGURE S2. BUYER PREFERENCES BY PROJECT METHODOLOGY AND BUYER INDUSTRY (BY VOLUME CO₂e)



Source: Ecosystem Marketplace, 2023

Note: "Multiple types" refers to disclosures that included multiple unrelated project types in a single disclosure (e.g., REDD and solar power installation). Unspecified indicates that the company did not sufficiently specify the project methodology in order for EM to classify it. Project methodologies are clustered by type: green indicates nature-based solutions, orange indicates renewable energy projects, purple indicates industrial process emissions reduction, and blue indicates household efficiency, transportation, and other community emissions reduction projects. Industry classifications used in this table are taken directly from CDP and do not necessarily align with GICS or other industry classification systems.

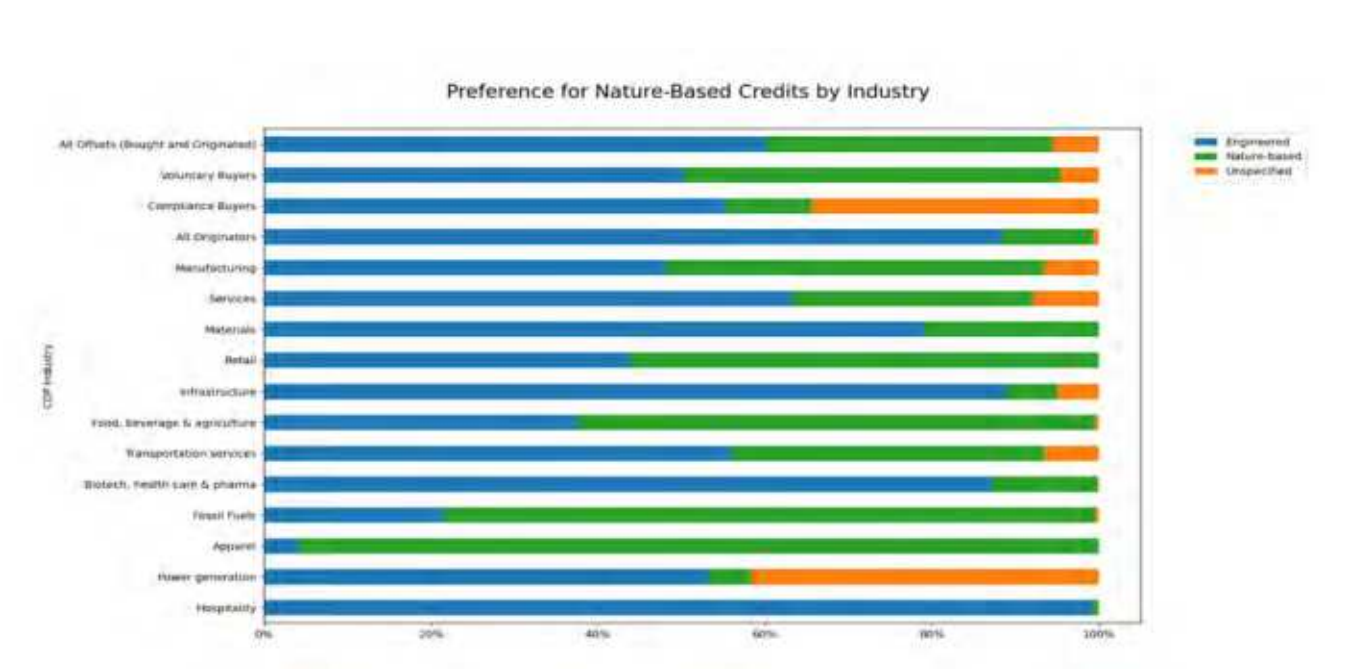
FIGURE S3. PREFERENCES FOR REDUCTIONS VS. REMOVALS, BY BUYER SECTOR (BY VOLUME CO₂e)



Source: Ecosystem Marketplace, 2023

Note: Unspecified indicates that the company did not sufficiently specify the project methodology in order for EM to classify it as a removal or a reduction. IFM, REDD, and blue carbon projects are identified separately because they may include emissions reduction, carbon removals, or both. Industry classifications used in this table are taken directly from CDP and do not necessarily align with GICS or other industry classification systems.

FIGURE S4. PREFERENCES FOR NATURE-BASED AND ENGINEERED PROJECT CREDITS, BY SECTOR (BY VOLUME CO₂e)



Source: Ecosystem Marketplace, 2023

Note: Unspecified indicates that the company did not sufficiently specify the project methodology in order for EM to classify it as nature-based or engineered. Industry classifications used in this table are taken directly from CDP and do not necessarily align with GICS or other industry classification systems.



The Family of Forest Trends Initiatives

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Strengthening local communities' capacity to secure their rights, manage and conserve their forests, and improve their livelihoods

Ecosystem Marketplace

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Evidence Submission 16

The unusual suspects: are well-meaning environmental stakeholders and institutions undercutting the contributions that companies can make to fighting climate change?

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Abstract

There is broad consensus that a significant majority of the capital needed to fund a low carbon transition consistent with science-based decarbonization timelines will have to come from the private sector. While still inadequate, the past decade-plus has seen a nonlinear increase in corporate capital spend in pursuit of voluntary climate goals. In the absence of significant regulatory mandates or meaningful carbon pricing, how this 'corporate climate spend' is directed is influenced—if not largely directed—by an array of emissions accounting rules, third-party defined leadership metrics and methodologies. This 'rules and reward ecosystem' is largely the design of environmental advocates, academics, and other aligned stakeholders and philanthropists. Sitting at the heart of this ecosystem is the Greenhouse Gas Protocol—a purported accounting framework that underpins how companies can undertake climate-based interventions and record progress. Launched by environmental stakeholders in 1998, the Protocol has since become the de facto rulebook used by highly influential third-party corporate leadership and target setting organizations, sustainability rating and evaluation entities serving the investment community, and is being incorporated into emerging mandatory corporate disclosure programs. Ironically, given its architects, today the rules and reward ecosystem results in significant mis-allocations and constraints on corporate climate spend and is reducing the potential climate change-mitigating impact of crucial private capital. This paper explores the flaws in incumbent greenhouse gas accounting and leadership program rules and proposes pathways for change that would better optimize the flow of private capital available and needed to address the climate crisis.

Keywords: Climate change; Greenhouse Gas Protocol; Scope 2; Scope 3; emissions; carbon accounting; clean energy; supply chain decarbonization; science-based targets

Introduction

Over the past two decades, a steadily increasing number of corporations around the world have adopted some level of commitment to address climate change and at the same time, the ambition of company commitments has increased. The reasons for these trends vary. Some may feel pressured to keep up with competitors while others may see taking climate action as a strategic public relations opportunity. More and more companies, however, are finding that adopting and executing on climate commitments can lead to a host of value creation opportunities, including cost savings, risk mitigation, innovation opportunities, talent attraction and retention, stronger brand loyalty, and increased shareholder value. Regardless of the reasons, the relationship between the corporate world and climate change has changed. The private sector is positioned as never before to contribute to the challenge of decarbonization through voluntary actions.

While this is good news from a climate perspective, it is becoming increasingly clear that the actual impact that these companies might make in pursuit of their climate ambitions is being

held back in some very unlikely ways. When a company does undertake voluntary climate measures, it is guided by an array of emissions accounting rules, stakeholder guidelines, third-party defined success metrics, and evaluation methodologies that shape its decisions and investments. While well-intentioned and responsible for much progress, this 'rules-and-rewards ecosystem', designed and administered by environmental nongovernmental organizations and their allies, may no longer be fit to the task of guiding company actions in a way that optimizes benefit to the climate. Two decades on from its inception, the rules-and-rewards ecosystem is due for some much-needed modernization.

Voluntary private sector actions are essential in driving decarbonization

Public sector investments are an indispensable part of meeting the challenge of decarbonizing the global economy and stabilizing global temperature increases at 2°C or less.

In 2022, the United States Congress committed an unprecedented 10-year federal investment of approximately \$40 billion

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per year to combat climate change. Yet, according to a recent McKinsey & Company report, the world will need to invest more than \$9 trillion per year for the next 30 years to reach mid-century climate goals [1]. The International Renewable Energy Agency (IRENA) estimates that energy transition technologies will need investments of around \$131 trillion by 2050, about 80% of which is expected to come from the private sector [2].

In 2022, the United States Congress committed an unprecedented 10-year federal investment of approximately \$40 billion per year to combat climate change. Yet, according to a recent McKinsey & Company report the world will need to invest more than \$9 trillion per year for the next 30 years to reach mid-century climate goals.

While these numbers are daunting, there is a clear and welcome trend underway: More and more companies are setting voluntary climate goals and spending money to meet them. Today, 82% of the global Fortune 500 have announced climate-related targets [3]. The type and aggressiveness of these commitments vary as do the reasons for making them. Some do so grudgingly just to keep up with competitors or to satisfy some of their shareholders; some see climate action as part of being a good corporate citizen; others see opportunities for risk reduction and value creation; or it may be some combination of all of these (and, of course, there are a number—albeit a shrinking number—of companies taking no real actions at all). Regardless of why, over the past decade plus, more and more corporate resources are being dedicated to climate change mitigation. Such measures may include investments in energy efficiency, decarbonizing on-site energy production, procurement of cleaner energy and lower carbon inputs from third parties, investments in research and development for lower carbon technologies, or developing and offering more climate friendly goods and services to the market.

While these numbers are daunting, there is a clear and welcome trend underway: More and more companies are setting voluntary climate goals and spending money to meet them. Today, 82% of the global Fortune 500 have announced climate-related targets.

While allocating human and financial capital to climate goals has become common practice among large companies, corporate climate spending is not a limitless resource. Like any other decision about commitments of human resources and capital, companies face competing priorities and must assess the 'returns' on each potential climate-related investment. While some climate-related spends yield positive returns on investment on a purely economic basis (think switching from fluorescent to LED lighting), other investments may only make sense when considering other advantages, such as 'paybacks' to reputation, investor relations, employee retention, or customer loyalty.

Corporate climate decision-making is influenced by a complex 'rules-and-Rewards ecosystem'

Companies themselves are not scientific institutions or environmental advocacy groups. To understand what goals to set, what actions to take, and which goals and actions will be considered adequate and appropriate leadership by both internal and external stakeholders, companies look elsewhere for guidance. Over the past two decades, a complex rules-and-rewards ecosystem has developed to guide and incentivize corporate climate investment. This array of emissions accounting, disclosure, and recognition programs provides a common set of metrics, goal-setting standards, and leadership-recognition criteria that guide

company decision-making, enabling myriad stakeholders to benchmark and assess performance.

Companies themselves are not scientific institutions or environmental advocacy groups. To understand what goals to set, what actions to take, and to determine what goals and actions will be considered by both internal and external stakeholders as adequate and appropriate leadership, companies look elsewhere for guidance.

Elements of the ecosystem

The greenhouse gas protocol

Sitting at the foundation of the rules-and-rewards ecosystem is the Greenhouse Gas Protocol (the Protocol) [4], an accounting framework that underpins how companies can undertake climate-based interventions and record progress. Launched in 1998 as a joint initiative of the World Resources Institute and the World Business Council for Sustainable Development, the Protocol sought to develop and promote a system of best practices for voluntary accounting and reporting of greenhouse gas (GHG) emissions. In 2001, the Protocol published the first version of its 'Corporate Standard' by which companies could create GHG 'inventories' of the emissions attributed to their activities [5].

Two decades ago, when the Protocol was created, there was a pervasive (and not unjustified) view that the private sector was a reluctant (if not adversarial) partner in meeting the challenge of climate change. Because enacting proscriptive regulation to force GHG emissions reductions was not politically viable, another option was to ask companies to account for and publicly disclose their emissions, with the expectation that this in turn would incentivize them to reduce emissions.

The Protocol serves as the 'rulebook' for the vast majority of voluntary GHG reporting and recognition programs across the globe. The Protocol also forms the basis for mandatory corporate reporting programs in effect in the UK, coming into effect in the EU and will likely form the basis of mandatory reporting requirements expected from the U.S. Securities and Exchange Commission.

Under the Protocol, a company's GHG inventory is broken into three components (or 'scopes'): Scope 1 includes direct emissions from a company's operations and assets (such as emissions from company-owned vehicles or from burning fuel in an on-site boiler); Scope 2 includes indirect emissions from purchased energy (e.g. emissions at the power plant that generates the electricity that a company buys from its utility); and Scope 3, which are emissions not controlled by the company but are in its 'value chain' (e.g. emissions created by suppliers producing goods and services used by the company in conducting its business).

The Protocol serves as the rulebook for the vast majority of voluntary GHG reporting and recognition programs across the globe and as such has a major impact on voluntary climate strategies and interventions. But the Protocol also forms the basis for mandatory corporate reporting programs in effect in the UK and those coming into effect in the EU; it is also likely to be the recommended format for mandatory reporting requirements expected from the US Securities and Exchange Commission [6–8]. The Protocol is essentially evolving into an actual regulatory construct.

Third-party disclosure and leadership programs

As hoped for when the Protocol was developed, companies that calculate and disclose their emission inventories often set public goals to reduce or otherwise mitigate them. Increasingly,

company goals are set in line with the terms and requirements of third-party leadership programs, each of which largely bases measurement and disclosure on the Protocol. A few key programs include:

- CDP (formerly known as the Carbon Disclosure Project), a nongovernmental organization that runs the most widely used platform in the world for companies to disclose their GHG emissions (calculated pursuant to the Protocol).
- RE100, an NGO-sponsored initiative through which companies pledge to match 100% of their electricity use with renewable energy by 2050 or sooner and to disclose their progress.
- Green Power Partnership (EPA GPP), the U.S. Environmental Protection Agency's voluntary rewards-and-reputation program, where companies pledge to procure a minimum amount of new renewable energy based on their size.
- Science-Based Targets Initiative (SBTi), an NGO-organized program that 'mobilizes the private sector to take urgent climate action' by 'guiding companies in science-based target setting' (i.e. emissions reduction targets that SBTi determines to be 'in line with what the latest climate science deems necessary to meet the goals of the Paris Agreement—limiting global warming to 1.5°C above preindustrial levels'.) SBTi instructs companies to base their targets on Scopes 1, 2, and 3 of the Protocol and to report to SBTi progress towards meeting those targets through annual disclosure of their inventories.

The ecosystem strongly influences corporate decision-making and 'climate spend'

Today, nearly three-quarters of S&P 500 companies voluntarily calculate and disclose their GHG emissions, mostly through CDP [9]. RE100 boasts nearly 400 member companies with 100% renewable electricity goals. SBTi has grown from 1000 companies that committed in 2020 to more than 4000 at the end of 2022. Companies with approved or pending-approval SBTi commitments represent over a third of the global economy's market capitalization, and 96% of companies with approved SBTs have targets covering Scope 3 emissions [10, 11].

Though voluntary themselves, the rules of the Protocol and of various disclosure and goal-setting programs (like CDP, RE100, and SBTi) have evolved into a quasi-regulatory system that shapes climate decision-making for a vast and growing number of companies adopting climate strategies. How a company reports and tracks progress under these rules has become the basis upon which it is assessed by the media, climate advocates, sustainability-minded investors, employees, and other stakeholders.¹ Yet, while these ecosystem rules essentially have the power of regulation, they lack the governance structures and procedural safeguards of governmental regulatory requirements, such as transparency, participatory guarantees, or rights to appeal decisions.

Though voluntary themselves, the rules of the Protocol and of various disclosure and goal setting programs like CDP, RE100, and SBTi have become a quasi-regulatory system that shapes the climate decision making of the vast and growing number of companies adopting climate strategies. How companies report and track progress under these rules have become the basis upon which companies are assessed by the media, climate advocates, sustainability-minded investors, employees, and other stakeholders.

The current ecosystem undercuts the potential climate benefits of company interventions

Does the original foundational theory of the protocol still make sense today?

The Greenhouse Gas Protocol's approach to corporate GHG accounting was built around a foundational theory of change: By attributing emissions to a company through the creation of inventories, and then exposing those inventories to the light of day, companies would feel pressure to reduce their calculated and reported emissions (attribution → inventories → disclosure = impact). For a number of reasons, however, it is appropriate to ask whether this 'attributional' approach to GHG accounting is adequate and appropriate two decades on.

When this rules-and-rewards ecosystem was created, the vast majority of companies *needed* to be pressured and coaxed into taking proactive steps to reduce emissions. And while the ecosystem has led more and more companies to calculate and disclose their emissions inventories, it is not at all clear if this remains an optimal approach. Inventories are tools and by themselves have no climate value (the climate does not care which emissions are in whose inventory). The right question today is whether these rules yield the most beneficial climate impact. We must reassess the current ecosystem if for no other reason than because the world remains dangerously behind in making the decarbonization progress called for by science.

When this system was created, the vast majority of companies needed to be pressured and coaxed into taking proactive steps to reduce emissions. Today, many more companies are willing partners in the effort to address climate change.

Unfortunately, despite its achievements, the current rules-and-rewards ecosystem is significantly flawed and out of step with both climate science and the ability of today's leading companies to contribute to addressing the climate crisis.

Despite its achievements, the current rules-and-rewards ecosystem is significantly flawed and out of step with both climate science and the ability of today's leading companies to contribute to addressing the climate crisis.

The ecosystem's approach to Scope 2 emissions undercuts its own theory of change

The idea that real climate impact will flow from creating and disclosing an emissions inventory only holds true if: (i) the inventory itself is an accurate reflection of actual emissions; and (ii) if subsequent interventions to reduce that inventory reflect actual climate benefit. For the rules governing the accounting of emissions from purchased electricity, neither is necessarily true.

Scope 2 accounting rules do not accurately reflect company emissions

Scope 2 inventories are intended to be 'a true and fair account of [a company's] emissions' from purchased and consumed electricity [12]. But the electricity a company uses at any given location or time comes from the mix of generation sources purchased from its local utility or retail electricity supplier. In any given hour, that electricity might come from coal, gas, nuclear, or renewables. There are ways a company can impact the generation mix it buys and uses, such as installing solar panels on its buildings or contracting directly with a nearby renewable energy

facility. Such interventions would and should result in a decrease in attributed emissions from electricity use.

Under the Scope 2 ‘market-based’ accounting rules [13], however, it is perfectly appropriate for a company to report reduced emissions from their electricity use even if it has not changed its actual use in any way. A company can purchase instruments known as energy attribute certificates (EACs)—or, in the USA, renewable energy certificates (RECs)—alongside, and in addition to, electrons generated at a renewable energy generation facility. The idea behind EACs/RECs is that there is value in renewable generation beyond the electrons it produces and sells; its lack of emissions or inherent ‘renewableness’ also has value. Therefore, since renewable generators are producing two things of apparent value, they should be able to get paid for both; creating and selling certificates allows them to do that.

Under the Scope 2 ‘market-based’ accounting rules, it is perfectly appropriate for a company to report reduced emissions from its electricity use even if it has not changed its actual use in any way.

Further, because electrons cannot be physically differentiated once they enter the grid, EACs and RECs provide a way to track and transact for the differentiated value of renewable generation. It is this function that the Protocol seized upon in designing its Scope 2 inventory accounting rules. Companies are instructed that each EAC or REC they own can be used to ‘erase’ from its inventory the actual emissions associated with any megawatt hour of its electricity use within a given year.²

But this allowance undercuts the proposition that the resulting inventory represents ‘a true and fair account’ of emissions from electricity use. A company might be located in Indiana, where over the course of a year the majority of the electricity it consumes comes from coal and gas. But if the company buys enough RECs from wind farms in Texas to match its yearly consumption, it can report an inventory showing zero emissions from its electricity use—even though those wind farms are on an entirely different grid and had no impact on the emissions from the electricity the company actually used in Indiana that year.

When the rules were written, there were justifications for sacrificing the goal of Scope 2 inventories as being a ‘true and fair’ account of emissions from electricity use. At that time, wind and solar were sparsely deployed and expensive relative to fossil energy; it was thought that creating demand for certificates would encourage construction of more wind and solar capacity and thus help the renewable industry to scale and drive down costs. Further, because of legal and market constraints in many jurisdictions, many companies could not put solar on their roof or contract for renewable energy from their electricity provider. Allowing companies to reduce their inventories simply by purchasing EACs was an alternative way for them to invest in clean energy.

This approach worked very well. Today, wind and solar are relatively mature, widely deployed, and cost-competitive technologies. Yet, while a lot more wind and solar need to be deployed in many places, and while direct clean energy procurement options for companies remain very limited in some places, it is not clear that the way Scope 2 accounting utilizes certificates remains the right approach.

A reduction in a Scope 2 inventory may not equate to any actual Real-World emissions reduction

Unlike today, at the time certificate-based accounting rules were developed, wind and solar technologies were sparsely deployed and there was near-certainty that installing new renewable

capacity virtually anywhere would displace fossil generation. Simply giving ‘credit’ for renewable energy capacity was a pretty good proxy for giving credit for actual emissions impact. Today, however, it is increasingly clear that legacy certificate-based Scope 2 accounting severs the links of ‘attribution → inventories → disclosure = impact’.

There is no requirement under Scope 2 accounting rules or third-party leadership programs for a company to show or even evaluate whether a reported decrease in a Scope 2 emissions inventory resulting from a procurement transaction reflects an actual decrease in real-world emissions. And it may be that the reported inventory reduction does not at all correspond to actual emissions reductions. For example, if the RECs used to reduce an inventory come from a new wind farm in West Texas, those MWhs reflected by the RECs likely had very little incremental climate benefit in that wind-saturated region where new renewable generation likely displaces a lot of existing renewable generation. On the other hand, a new wind farm in fossil energy-saturated West Virginia is likely to directly displace coal or gas generation. Yet the RECs from both projects have the same impact on a company’s Scope 2 inventory, despite having very different climate impacts, and will be equally reported—and rewarded—as ‘emissions reductions’ in the company’s inventory. The accounting and leadership rules provide no incentive or reward for a company to create more climate impact by choosing to procure clean energy from a region of higher grid carbon intensity.

There is no requirement under Scope 2 accounting rules or the third-party leadership programs for a company to show or even evaluate whether a reported decrease in a Scope 2 emissions inventory resulting from a procurement transaction reflects an actual decrease in real world emissions. And it may be that the reported inventory reduction does not at all correspond to actual emissions reductions.

The questionable construct of Scope 3

Scope 1 emissions are straightforward: If a company owns a truck, the emissions from that truck are controlled and ‘owned’ by the company. While Scope 2 emissions are indirect and depend on how the electricity purchased and used by a company was generated, companies do have some control over those emissions through supply choices and efficiency measures.

‘Scope 3’ emissions are defined by the Protocol as ‘all indirect emissions (not included in Scope 2) that occur in the value chain of the reporting company’ [14]. If you are a retailer, for example, all the products you sell were manufactured by someone else who created emissions in that process, and that manufacturer in turn had its own supply chain with someone else’s emissions, and so forth. Scope 3 emissions are not directly controlled by a company, and the company typically does not have a clear sightline to all of those emissions. But they are often the largest part of a company’s emissions ‘footprint’. Various estimates show that Scope 3 emissions typically range from 65 to 95% of a company’s total across the three Scopes [15].

Why was Scope 3 created? All of a company’s Scope 3 emissions are *someone else’s* Scope 1 and Scope 2 emissions, but the architects of the ecosystem knew that the number of companies that would sign up for voluntary emissions attribution and disclosure would be limited. And because basing the entire accounting system on the construct of *attribution → inventories → disclosure = impact* only works if companies agree to have their emissions attributed to them, adding the emissions of other non-participating entities’ Scope 1 and Scope 2 emissions to what participating companies would be asked to account for—and then,

hopefully, act to reduce—was essentially a ‘work-around’ to get at some of those nonparticipant emissions.

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In some ways the approach has worked, as Scope 3 reduction commitments are becoming commonplace; 96% of companies with a science-based target approved by SBTi have targets covering Scope 3 [16]. But it is fair to question the effectiveness of this dramatic extension of the attributional theory of change. The climate-critical question is whether the current inventory-first approach to Scope 3 emissions best sets up a company for the final and climate-imperative step of having decarbonization impact. It may not.

For example, extending the attributional theory of change to Scope 3 has proven ineffective because of a flawed assumption made at the time it was created: that the data needed for attribution and creation of an inventory could be found. Accenture estimates that nearly two-thirds of a company’s supply chain emissions come from suppliers the company does not deal with directly, and many companies do not even know all of their suppliers except those with whom they have a direct contractual relationship (referred to as ‘Tier One’ suppliers) [17]. This inventory problem makes getting actual emissions data very difficult, even if all suppliers calculate their own emissions, which they do not. Companies are instructed by the Protocol to engage Tier One suppliers under the assumption that they have the most leverage with these suppliers and might be able to get real data from them [18]. But even if that outreach does yield data, it is often incomplete, unverified, and not standardized.

When it became clear that completing a Scope 3 inventory with actual emissions data was not possible, instead of rethinking their doctrinal view that interventions for impact would and should come only after attribution and the creation of inventories, the Protocol and its reliant third-party programs doubled down. The Protocol’s Scope 3 guidance allows companies to ‘use secondary data to fill data gaps’ in the inventory, including tools and methods by which they can make ‘rough approximation[s]’ of their Scope 3 emissions using estimates, modeling, industry averages, average emissions factors, or generic life-cycle assessments to complete their ‘full Scope 3 footprint’ [18, 19].

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While gathering actual information on emissions from suppliers, for example, can be burdensome, it may be worth the effort. Such real data might allow a company to compare suppliers of comparable inputs and factor those emissions into their supplier choices. Or a company might share best practices and insights to help a supplier set its own targets and make changes to reduce the supplier’s identified emissions. Perhaps more importantly,

identifying actual emissions in a value chain can provide the basis for a host of interventions to achieve impact—if a company is incentivized and empowered to execute those interventions (more on this later).

On the other hand, allocating valuable climate budget to modeling, generic data gathering, and other inventory-building workarounds that yield only ‘rough approximations’ of actual emissions may not be worth it. The test—as for all aspects of the rules-and-rewards ecosystem—should be whether steps companies are asked to take best lead to decarbonization impact. Generic or modeled data using emissions proxies based on referenced data not directly applicable to a given supplier, however, does not provide information on actual emissions sources that might then be the focus of an intervention in a company’s supply chain.

Although assembling a ‘complete’ Scope 3 inventory drains employee bandwidth and budgets for climate initiatives, and so much of the data companies are asked to assemble is unactionable, completing a Scope 3 inventory is what companies are instructed to do. Once a Scope 3 inventory is completed, targets are set and progress is assessed by subsequent changes in that inventory—changes that might only be reflected by changes in proxy, generic, or modeled data. For that reason, the Protocol acknowledges that ‘[c]hanges in a company’s [Scope 3] inventory over time may not always correspond to actual changes in GHG emissions to the atmosphere, since there is not always a direct cause-and-effect relationship between the reporting company’s activities and the resulting GHG emissions’ [20].

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Asking companies to undertake significant effort and expense in assembling inventories with unactionable data, and then taking actions to reduce their inventories that may or may not correspond to actual emissions reductions, is one way the rules-and-rewards ecosystem has tied itself in knots—and undercut climate impact—as it stubbornly insists on extending its attributional theory of change to Scope 3.³ But there are other problems.

Suppose a company, based on actual emissions data, identifies a source of emissions in its supply chain that might be reduced by an intervention (say by replacing gas boilers with electric heat pumps) and considers financing such a project at a supplier’s facility. Despite being a clear and direct opportunity to reduce actual emissions, the company will find that the rules-and-rewards ecosystem presents significant headwinds to such an intervention. First, the Protocol maintains that ‘[a] complete GHG inventory across scope 1, scope 2, and scope 3 is needed to enable companies to understand and manage climate related impacts, risks and opportunities’ [20]. This statement is demonstrably false if the company identified an emissions reduction opportunity before ‘completing’ its entire Scope 3 inventory. Under SBTi’s rules, a company cannot get a science-based target approved without first completing a full Scope 3 inventory. But if the company identifies an emissions reduction opportunity before completing its inventory or getting its science-based target approved, it might well hesitate.

However, even if the company has completed its inventory and has an approved 'science-based target', it will find more barriers to investing to reduce those emissions. In the example above, suppose that replacing a supplier's boiler results in 100 tons of emissions reductions. Under attributional/inventory-based accounting and crediting, those are considered Scope 1 and/or Scope 2 emissions reductions for the supplier. For the company that finances the project, those reductions only proportionally reduce its Scope 3 inventory. If the company accounts for 25% of the supplier's sales, it would only see a 25-ton reduction in its Scope 3 inventory; the rest of the reduction would go to the Scope 3 inventories of other customers of the supplier who did nothing to make the project happen. It is unlikely that the company's CFO will agree to fund the project for such a meager inventory reduction 'return,' and those emissions may remain unabated. This result seems not only suboptimal from a climate perspective but also unfair: if a company pays for the project, it might rightly expect to get credit for the resulting emissions reductions.

Under SBTi's rules, a company cannot get a science-based target approved without first completing a full Scope 3 inventory. But if the company identifies the emissions reduction project opportunity before completing its inventory or getting its science-based target approved, it might well hesitate. Even if the company has completed its inventory and has an approved 'science-based target,' it will find more barriers to investing to reduce those emissions.

The current ecosystem's discouragement of a company investing in these types of emissions reductions stems not only from how the attributional accounting system metes out limited credit to that company's Scope 3 inventory. Project-level interventions to reduce or avoid emissions in a company's value chain are discouraged even more.

[A]mbiguity from SBTi discourages companies from spending the time to find, vet, and underwrite high-impact emissions-abatement projects solely because they fall outside of their direct supply chain.

Suppose a company identifies an emissions reduction project it might be willing to pay for that is located at one of its supplier's facilities (again, e.g. replacing a gas boiler with an electric heat pump). The Protocol would say that any resulting emissions reductions could only be reported outside of the company's inventories. For SBTi, that emissions reduction project would likely be deemed an 'inset' project and might not extend any credit from the project towards a company's science-based target. SBTi's current position is that it will 'assess inseting on a case-by-case basis ... and may not approve their use' [21]. Because its inventory is not reduced and the project would not further the company's effort to meet its science-based target, it will be difficult to get the investment approved. This ambiguity from SBTi discourages companies from spending the time to find, vet, and underwrite high-impact emissions-abatement projects solely because they fall outside of their direct supply chain.

A ton is a ton—wherever it may be and however the intervention is done

It is axiomatic in climate science that a ton of GHGs reduced, avoided, or removed has the same climate value regardless of where that action occurred, who was responsible for the intervention, or whose emissions were impacted. The rules-and-rewards ecosystem, however, has a clear 'hierarchy' for emissions-impacting interventions: Companies should first direct climate spend to reducing emissions in their operations (Scopes 1

and 2) and then address emissions in their value chain (Scope 3). Directing corporate climate spend to emissions reductions outside of inventories is at best not incentivized and often discouraged—irrespective of the fundamental climate science that a ton is a ton. This hierarchy is again the result of the theory of change that *attribution* → *inventories* → *disclosure* = *impact*. But does this quasi-regulatory hierarchy get the most decarbonization impact from the significant—but finite—amount of corporate climate investment?

It is axiomatic in climate science that a ton of GHGs reduced, avoided, or removed has the same climate value regardless of where that action occurred, who was responsible for the intervention, or whose emissions were impacted. The rules-and-rewards ecosystem, however, has a clear 'hierarchy' for emissions-impacting interventions: Companies should first direct climate spend to reducing emissions in their operations (Scope 1 and 2) and then address emissions in their value chain (Scope 3).

That may not be the case if a given amount of corporate climate investment directed at an opportunity inside that company's inventory would yield less decarbonization benefit than if that same amount of investment is made outside its inventory. For example, a company might replace a 5-year old HVAC system at one of its facilities with a slightly more efficient and more airtight system, thus getting inventory reductions in Scope 1 (less refrigerant leakage) and Scope 2 (less electricity needed to power the system). This approach would rightly be encouraged and rewarded under current disclosure and target-setting programs. If, on the other hand, for the same amount of money the company was willing to finance the replacement of a 15-year-old very leaky and highly inefficient HVAC system at somebody's else's facility unrelated to the company (which would result in even more climate benefit), the decarbonization benefit would be assessed very differently.

Such a project would be deemed an 'offset' (or 'carbon credit')—a market-based tool by which a company seeks to claim emissions reductions from an intervention. But offsets are categorically disallowed as a tool to meet an SBTi target, and the Protocol only allows the reporting of project-level emissions reductions outside a company's inventory. This is the case even if the offset project meets all tests regarding the accuracy of emissions impact measurement, avoidance of 'double counting' of the emissions impact by more than one entity, and proof that those emissions reductions would not have happened but for the company's intervention. By not 'crediting' these types of interventions, the Protocol and SBTi disincentivize even interventions that result in significant climate impact per dollar of corporate investment.

When the rules and rewards were designed, the idea of a company proactively looking to spend money in pursuit of the most decarbonization impact from that spend was perhaps not contemplated, since companies were seen as the problem and not potential partners in solving the climate challenge. While the legacy, inventory-focused model may still be the best way to get decarbonization effort from some companies, others are now looking to increase the decarbonization impact from their climate spend—and the system should also be designed to fully encourage and reward them. The fealty of the rules-and-rewards ecosystem to inventories over impact, and its bias against the use of market-based interventions, can lead to highly inefficient use of corporate budgets and suboptimal climate outcomes.

The rules-and-rewards ecosystem can be improved to increase the private sector's contributions to decarbonization

Some argue that we should be hesitant to make any major changes to the Protocol, because it forms the basis for both voluntary and mandatory accounting and disclosure practices around the world. But this is precisely why improving and modernizing the Protocol is so important.

First: prioritize impact over process

All process steps dictated by GHG accounting and the various leadership programs should be evaluated against the principle of getting the most decarbonization impact from corporate climate investment.

The organizing principle of achieving impact through the process of attributing emissions, creating inventories, and disclosing that information should be scrutinized. All process steps dictated by greenhouse gas accounting and the various leadership programs should be evaluated against the principle of getting the most decarbonization impact from corporate climate investment.

Calculating inventories based on the Protocol and responding to the multitude of disclosure and leadership programs that seek and rely on inventory information are very time and budget intensive, consuming significant company resources. A recent ERM survey of companies across sectors found that an average of \$533 000 per year per company was spent on voluntary climate-related data collection (inventories) and disclosures [22]. Similarly, a Duke University study from 2021 provided case studies on the high costs of voluntary climate disclosures and noted further that the questionable quality of much Scope 3 data raised particular concerns among some companies if such disclosures were incorporated into mandatory reporting regimes [23].

Whether the amount of money companies spend on collecting and disclosing emissions data is too much or too little is not the climate-relevant question. Rather, the question is whether the current set of requirements for accounting and disclosure is still the best way to get the most decarbonization impact. The legacy theory of 'inventories and disclosure first, interventions later' is only climate optimized if the result is more decarbonization impact (accounting for the fact that strict and complete inventory construction consumes significant corporate resources).

Attributional accounting and disclosure of inventories can lead to interventions that have real impact. But a climate-optimized corporate rules-and-rewards ecosystem should incentivize and reward companies for interventions that lead to the most decarbonization impact. Yet the current approach to and virtually exclusive focus on inventories undercuts this proposition.

*Attributional accounting and disclosure of inventories can lead to interventions that have real impact. But a climate-optimized corporate rules-and-rewards ecosystem should incentivize and reward companies for the interventions that lead to the **most** decarbonization impact. Yet the current approach to and virtually exclusive focus on inventories undercuts this proposition.*

Second: fix the mis-incentives in Scope 2

As discussed, current Scope 2 accounting rules allow for the creation of inventories that do not accurately reflect emissions from electricity use; and leading recognition and goal-setting programs incentivize and reward changes in inventories without any requirement for evaluating and measuring actual emissions impact

from energy use and procurement interventions. A modernized rules-and-rewards ecosystem should fix these problems.

Scope 2 inventories do have value. Both companies and stakeholders benefit from knowing more about what emissions were caused by a company's actual electricity use, and thus an inventory should, as advertised, represent a 'true and fair' account of those emissions.⁴ At the very least, therefore, clean-energy transactions and interventions on grids that do not supply electricity to a company and thus have no impact whatsoever on its emissions, should not change a Scope 2 inventory.

Perhaps even more important than making Scope 2 inventories a more 'true and fair' account of the emissions resulting from a company's energy use, is to make actual decarbonization impact central to how companies are incentivized and rewarded for their electricity procurement decisions. With only current market-based inventory rules to guide clean energy investment decisions, companies are equally rewarded for a deal done with a West Texas wind farm that has little climate benefit as for a new renewable project in West Virginia that would displace many more fossil emissions.

The rules-and-reward ecosystem should incentivize companies to assess the extent to which a clean generation project will displace fossil emissions, and then encourage (and perhaps eventually require) them to calculate and report the emissions impacts of their clean generation investments. Such new and additional calculations and reporting of the actual emissions impact of company electricity investments can stand alongside improved inventory reporting, but third-party leadership and recognition programs must change so as to encourage and reward interventions based on their beneficial climate impact and not just their 'impact' on Scope 2 inventories (which means that even a company's clean energy transaction done in an entirely different grid region but that has significant emissions impact would be incentivized and credited, even if such a transaction has no effect on its reported emissions from its actual electricity consumption reflected in its Scope 2 inventory).

Third: refocus Scope 3 rules-and-rewards toward emissions impact

The good news is that a host of important efforts are underway among stakeholders to develop improvements to Scope 3 accounting and the treatment of Scope 3 by third-party disclosure and leadership programs. While there are many different views about the key problems and a number of ideas for fixes, there is clearly a growing consensus that real change is needed now.

Any such efforts must be guided by the same laser focus needed for assessing the entire ecosystem: maximizing the contribution that companies can make to decarbonizing the economy—in both the near and longer term. With that focus, a few key ideas must be considered.

The primacy of completing a Scope 3 inventory over identifying and making impact should be reconsidered. Companies should be directed towards and rewarded for actual impact, and not just given credit for inventory assemblage and subsequent changes in inventories that may or may not reflect actual decarbonization impact. Arguably, companies are asked to allocate too much of their climate spend using unactionable proxy information and stumbling around in the 'dark' of inadequate data, instead of being incentivized to shine a flashlight on specific emissions reduction opportunities. When such opportunities are identified, a company should be incentivized and rewarded for seizing those opportunities, even if it has not completed an inventory. That, in turn, means that Scope 3 rules—particularly as

applied by ‘science-based’ leadership programs—should allow the use of market instruments and rigorous consequential accounting to find, execute on, and measure interventions to reduce, avoid, or remove GHG emissions—which is precisely what climate science demands.

The primacy of completing a Scope 3 inventory over identifying and making impact should be reconsidered. Companies should be directed towards and rewarded for actual impact, and not just given credit for inventory assemblage and subsequent changes in inventories that may or may not reflect actual decarbonization impact.

Fourth: elevate ‘consequential accounting’

The actual emissions impact of various types of corporate interventions can almost always be estimated and disclosed. When a new solar farm is put into service, for example, various methods can be used to estimate the actual GHG emissions avoided over a given period of time by calculating emissions from other types of generation sources that the new renewable project displaced. This approach is an example of ‘consequential accounting’. Yes, the Protocol allows reporting of consequential emissions calculations—but it is not required, is rarely used, and is not considered part of leadership and recognition programs.

Moving actual climate impact closer to the heart of the rules-and-rewards ecosystem means elevating the role of consequential accounting from its current status as a little-used aside in GHG accounting guidance and an irrelevance in leadership programs. Adoption of consequential accounting does not mean abandoning inventories and attributional accounting altogether. As described above, market-based attributional accounting of Scope 2 inventories can be improved to more accurately reflect emissions from electricity use, while consequential disclosure can help incentivize and reward buyers choosing procurements with greater real-world impact. In the context of Scope 3 (or, for that matter, Scope 2), consequential calculations and disclosure can be used to demonstrate actual emissions reductions to the atmosphere which in turn could be incentivized and rewarded in leadership and target-setting programs irrespective of how and whether underlying attributional accounting rules are changed.

Moving actual climate impact closer to the heart of the rules-and-rewards ecosystem means elevating the role of consequential accounting from its current status as a little-used aside in GHG accounting guidance and an irrelevance in leadership programs. Market-based attributional accounting of Scope 2 inventories can be improved to more accurately reflect emissions from electricity use, while consequential accounting can help incentivize and reward buyers choosing procurements with greater real-world impact. In the context of Scope 3, consequential accounting can be used to demonstrate the emissions impact of interventions in the value chain based and provide a tool for more fully incentivizing and crediting such interventions.

The methods for calculating consequential impact are not perfect, but the perfect must not be the enemy of the good. Certainly, there are costs associated with consequential accounting. But unlike many other costs incurred by companies today in keeping up with the demands of the rules-and-rewards ecosystem, consequential accounting costs are directly tied to emissions impact. Ideally, these costs can be balanced by relief from some inventory compilation requirements that do not lead directly to, or distract from, getting the most decarbonization benefit.⁵

Fifth: rethink the emissions ‘hierarchy’

The current system is deeply grounded in a ‘hierarchy’ that elevates some interventions over others based on criteria unrelated to their actual decarbonization impact. For example, ‘[t]he SBTi requires that companies set targets based on emission reductions through direct action within their own boundaries or their value chains’ [24] (by ‘emissions reductions’ they mean inventory reductions). But why prefer a ton of verified emissions reduction inside an inventory to a ton of verified emissions reduction outside of an inventory when it makes no difference whatsoever to the climate? If a company’s interventions result in actual reductions in emissions, does it really matter if those reduced emissions were inside its inventory or not?

It might be the case that the best emissions-impact car keys are to be found under the lamp posts of Scope 1, Scope 2, or Scope 3 inventories. But perhaps not. All things being equal, we might prefer (and if the cost is the same, a company would likely prefer) a ton of impact inside an inventory to one outside. But, particularly with the elevation of consequential disclosures, we can broaden the lens beyond impacts just within an inventory to real decarbonization impacts wherever those opportunities may be found. If companies are directly incented and rewarded for achieving more measured emissions impact, they will then try to get the most impact per dollar of climate spend. And if the next marginal dollar of corporate climate spend yields more impact outside of an inventory than inside, that is where the climate wants that dollar to go.

It might be the case that the best emissions-impact car keys are to be found under the lamp posts of Scope 1, Scope 2, or Scope 3 inventories. Perhaps not. All things being equal, we might prefer (and if the cost is the same, a company would likely prefer) a ton of impact inside an inventory to one outside. But particularly with the elevation of consequential disclosures, we can broaden the lens beyond impacts within an inventory to real decarbonization impacts wherever those opportunities may be found.

Sixth: treat market instruments as tools, not taboos

Incenting and rewarding companies for creating climate impact outside of their value chains does not necessarily mean they are creating or purchasing offsets. But market instruments like offsets can be a valuable tool to get more decarbonization impact per dollar of corporate climate spend.

Incenting and rewarding companies for creating climate impact outside of their value chains does not necessarily mean they are creating or purchasing offsets (or ‘carbon credits’). But market instruments like offsets can be a valuable tool to get more decarbonization impact per dollar of corporate climate spend.

As discussed above in the context of the hypothetical HVAC replacement interventions, these tools are, at best, disfavored by the rules-and-rewards ecosystem irrespective of actual emissions impact. Per SBTi: ‘[o]ffsets are only considered to be an option for companies wanting to finance additional emission reductions beyond their science-based target (SBT) or net-zero target’ [25]. Deporting offset interventions from the realm of what companies are today incented to achieve makes them essentially irrelevant. The question should be whether a given emissions reduction is verifiable, not whose supply chain it sits in.

The eschewing of offsets by the ecosystem is intentional. Beyond the judgment that it is more important that companies

reduce their own emissions rather than someone else's, resistance to companies taking actions outside of their inventories is often based on concerns that offsets may not actually represent real emissions reductions or could be based on reductions that would have happened anyway. If a market-based intervention does not result in real emissions reduction, avoidance, or removal that would not have occurred absent that intervention, then it certainly should not be incentivized or rewarded. But the fact that there are bad offsets does not mean that all offsets are bad. While giving 'credit' for a bad offset must be avoided, so should discouraging investment in verified offsets that yield real climate impact. Rigorous measurement and verification are essential to assure that every offset project is yielding real climate benefit that would not have occurred otherwise.

The fact that there are bad offsets does not mean that all offsets are bad. Rigorous measurement and verification that every offset project is yielding real climate benefit that would not have otherwise occurred is essential.

Climate science is clear: All actual tons of carbon are the same, and we need to reduce, avoid, and remove a lot of them very quickly. So why are some tons okay for a 'science-based' target and some are not? Again, the climate does not care where or in whose inventory a ton is reduced, avoided, or removed. If rigorously shown to result in real climate benefit and so long as no single ton is counted toward more than one company's target, there really is no climate-centric reason to dissuade the use of market instruments that lead to real decarbonization impact.

The climate does not care where or in whose inventory a ton is reduced, avoided, or removed. If rigorously shown to result in real climate benefit, there really is no climate-centric reason to dissuade the use of market instruments that lead to real decarbonization impact.

Conclusion

The designers and keepers of the rules-and-rewards ecosystem can take great pride in having played an important role in spurring and guiding the dramatic increase in the number of companies around the world that have made commitments and investments to mitigate climate change. The shortcomings of the status quo are certainly not the result of any ill-intent on the part of those who designed and administer the current rules-and-rewards ecosystem, nor are companies to blame for directing climate spend toward suboptimal climate outcomes when they are simply following the rules and pathways laid out for them.

But it is a very different time today than when the rules and rewards were designed. Although some companies still need to be called out and pressured to take steps to reduce emissions and invest in climate impact, a growing number see climate change as a legitimate business issue and understand that proactive and meaningful climate leadership can lead to risk reduction and value creation. While keeping pressure on the laggards remains important, the ecosystem must modernize in order to better empower and reward the leaders so they can achieve more impact.

Ideally, the Greenhouse Gas Protocol and key leadership programs like SBTi both reform and improve together in order to enable and reward greater impact. But leadership programs can adopt the type of recommendations presented here even without or before changes to the Protocol. The type of stakeholder processes involved in such change can be a challenge, especially when decades of practices have become deeply imbedded and a veritable industry of consultants and providers has been created

to service the status quo. And again, some will resist changing a system that has clearly succeeded in driving change over the past decades.

But if nothing else, change is demanded by the extent and imminence of the climate crisis. Therefore, it is not only fair, but imperative, that we hold every aspect of the rules-and-rewards ecosystem up to the light of urgency and ask if it can be better.

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None declared.

Data availability

The data underlying this article are available in the article and in its online supplementary material.

Notes

1. The terms and metrics of the rules and rewards ecosystem have more recently been proactively used in the design of programs and practices intended to present more corporate climate-related data and information to investors and shareholders—perhaps the most influential stakeholders for public companies. For example, in 2017, the *Financial Stability Board* created the *Task Force on Climate-related Financial Disclosures* (TCFD)—a framework by which companies calculate and disclose climate-related financial information for use by investors, lenders, and insurance underwriters in assessing corporate climate risk. In significant part, TCFD utilizes the data calculation methodologies of the Protocol. TCFD is now being merged into the *International Sustainability Standards Board* (ISSB), the market-leading investor-focused sustainability reporting initiative.
2. As described by the Center for Resource Solutions, 'Whosoever owns the REC can claim those attributes of generation for a megawatt-hour of electricity consumption. In other words, the REC purchaser can claim to be the recipient of or to have used that megawatt-hour of renewable electricity... Since RECs are how we choose and access output from new and existing renewable electricity facilities, RECs are how we switch to a clean electricity product, which reduces our scope 2 emissions and our carbon footprint.' Todd Jones, *Scope 2 Greenhouse Gas Accounting for U.S. Renewable Energy*, pp. 3–4, Center for Resource Solutions (9

January 2015). <https://resource-solutions.org/wp-content/uploads/2015/07/Scope-2-Accounting-For-U.S.-RE.pdf>

3. Scope 3, or 'value chain' emissions, include both 'upstream' emissions (focused on in this paper) as well as 'downstream' emissions (such as emissions from the use of a company's products). Certainly, the exactitude of downstream emissions data calculations is also problematic, but unlike upstream emissions, often the sightline to emissions-impacting interventions is relatively clear. If a company redesigns its widget to be 10% more energy efficient, it can easily apply that performance improvement to its projections of sales and use of its widgets in order to calculate a downstream Scope 3 reduction.
4. And there can be improvements to how emissions from electricity use can be calculated—grid emission data that is temporally and locationally matched to company electricity use can be used to much more accurately measure and report induced emissions. Such data is increasingly available and would create a much more 'fair and accurate' Scope 2 inventory. Growing efforts by some companies to 'match' their load to clean energy generation on a 24-7 basis could be reflected—and recognized—with these enhanced calculations. The Protocol does ask companies to calculate and report a 'location-based' inventory by which companies multiply their electricity load by the average emissions intensity of their grid region. For several reasons, this is an inadequate as a 'fair and accurate' accounting of emissions from electricity use. First, available average emissions data across a grid region is a very rough reflection of the actual emissions characteristics of the region at any given time or location; second, a location-based calculation does not reflect any actions taken by the reporting company even if the transaction directly impacted its emissions from electricity use (such as installing a rooftop solar system); and third, all leadership programs are based on changes to market-based inventories and thus it is changes to that inventory that motivates corporate interventions.
5. The marketplace is rapidly developing increasingly accurate methodologies for calculating the emissions impact of projects and interventions—including new carbon-free generation resources. For example, RESurety uses a 'locational marginal emissions' approach to measure the tons of carbon emissions displaced by one MWh of clean energy injected to the grid at a specific location and a specific point in time. WattTime uses data-driven marginal emissions analyses to measure and compare the avoided emissions of different potential clean energy generation sources.
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Evidence Submission 17

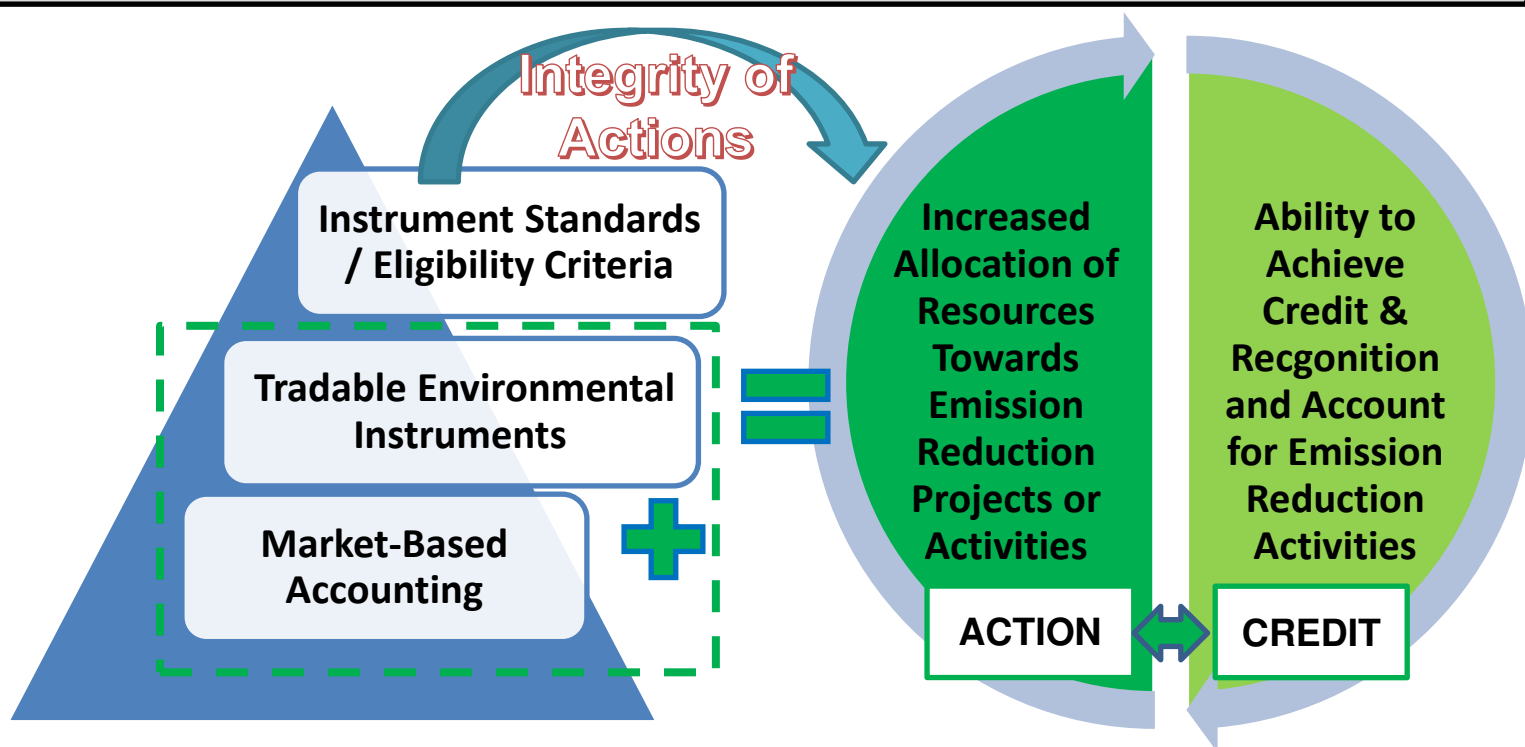
The Importance of Market-Based Accounting and Tradable Environmental Instruments for the Achievement of Scope 1, 2, and 3 Emission Reductions

Market-Based Accounting Methodologies + Tradable Environmental Instruments are critical for enabling and encouraging climate action, whether pro-actively for voluntary / ESG purposes or for mandated regulatory compliance obligations. These frameworks are particularly effective at driving change in sectors where traceability of a differentiated product within that system, such as renewable electricity on the electric grid, is either impractical or physically impossible. This is because environmental instruments / environmental commodities allow for the creation, conveyance, and accounting of environmental attributes associated with investments, purchases, and other resource allocation activities directed towards emission reduction projects and activities. Their existence today is actively allocating capital markets and investment towards climate action.

Average data approaches (e.g., “location-based accounting” in the GHG Protocol’s Scope 2 Guidance) do not, by their inherent design, enable these types of outcomes. Any move away from market-based accounting as an available option for government, non-government, and private entities to account for their climate actions will discourage investment in and action towards emission reduction activities and will materially harm progress towards climate goals.

It is essential that global greenhouse gas accounting methodologies and protocols maintain and enhance the use of market-based accounting. It is the role of standard-setting bodies and policy makers, in coordination with market participants, to ensure that instrument standards and eligibility criteria are established and evolved in a way that ensures the environmental integrity behind emission reduction actions to ensure they are real, verifiable, and permanent.

Market-Based Accounting combined with the use of Tradable Environmental Instruments Is Essential to Facilitating and Encouraging Climate Action

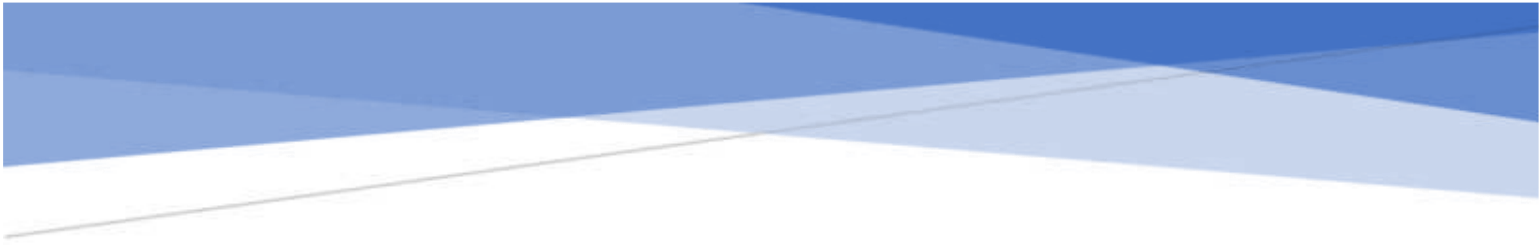


Market-Based Accounting: Methodologies and protocols that allow an entity to report greenhouse gas emissions based on contractual purchases.

Tradable Environmental Instruments: Defined and standardized instruments / commodities that enable the issuance, transfer, and retirement of environmental attributes through electronic environmental registries (e.g., 1 MWh = 1 REC).

Instrument Standards / Eligibility Criteria: Standard-setting bodies and / or regulatory agencies that issue rules and set the eligibility criteria for instrument use in various programs and enforce monitoring, reporting, and verification of instruments to ensure environmental integrity (e.g., no double counting) behind purchases and claims.

Evidence Submission 18



ENVIRONMENTAL ATTRIBUTE CREDITS

Analysis of Program Design Features and Impacts

Version Date: 09/15/2023

Abstract:

This white paper assesses program design features related to the generation and use of environmental attribute credits, their impact on cost, and on the attainment of environmental goals. The analysis presents perspectives and available evidence on requirements for use of tradable credits, time matching, additionality, geographic boundaries, verification and tracking, preference for nascent technologies, and methods to ensure credit value certainty. There is evidence and rationale to support the range of positions being put forward on these issues. Notwithstanding program differences, there is robust evidence that the use of EACs supports market development and facilitates investment in environmentally preferred resources. Increased stringency in program requirements ensures environmental integrity but can also impede resource expansion if compliance with increased stringency requirements becomes too onerous. The optimal balance depends on the design element being considered, the environmental attribute, and the stage of market development.

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White Paper Purpose

The purpose of this white paper is to inform policy decisions regarding program requirements for the creation and use of environmental attribute certificates or credits (EACs) that represent environmental attributes (EAs) as they relate to the emerging and evolving clean energy (power and fuels) programs in the United States and international markets.¹ Environmental Attributes (EAs) are characteristics of energy sources and other activities that define specific environmental or sustainability aspects of those sources and activities. Specifically, with respect to power and fuel, they have been defined as any and all credits, benefits, emissions reductions, offsets, and allowances associated with generation or production of power or fuel.² This assessment examines available data, research, and stakeholder perspectives on the impacts of program features and requirements on EAC program outcomes. The scope focuses on seven key issues under current discussion and debate:

- 1) The extent to which use of tradable EACs should be permitted as a basis for compliance under mandatory programs or environmental claims under voluntary programs;
- 2) Requirements for demonstrating additionality of EA's (or indirect EAs)³ created in generating EACs;
- 3) Requirements for time matching of EAC generation (booking) and use (claiming);
- 4) Appropriate infrastructural and geospatial boundaries on EAC generation and EAC use;
- 5) Requirements for tracking, measurement, and verification (TMV) of environmental attributes;
- 6) The appropriateness of programmatic preferences in the use of EACs for nascent technologies; and
- 7) The need for mechanisms to increase EAC value certainty.

Program features will be assessed with respect to effectiveness in stimulating expansion of clean energy capacity and effectiveness in reaching aggregate program goals for environmental improvement (such as a regional goal or mandate for defined quantities of renewable energy consumption or carbon reduction). The levers that maximize program effectiveness will be considered in the context of technology and market maturity, and the extent to which subsidies or preferences are needed to reach environmental objectives.

Context and Motivation

Various programs and protocols have been established for the creation and certification of instruments, typically credits, that represent the production of a specific quantity of clean energy or reduction of a specified quantity of a pollutant. These instruments, described further below, are used to demonstrate compliance with program requirements, such as renewable portfolio standards (RPSs) and tax credit programs, or to demonstrate voluntary use of clean energy or creation of environmental benefits. Credits convey property rights to environmental attributes (EAs), and they are commonly bought and sold. This white paper focuses primarily on renewable energy certificates as there is current debate and deliberation

¹ For purposes of the discussion, bilateral agreements such as power or fuel purchase agreements in which energy and environmental attributes are conveyed together (bundled) are considered a type of EA transaction.

² <https://resource-solutions.org/wp-content/uploads/2015/09/ETNNA-Environmental-Attribute-Paper-Final.pdf>
https://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/86954-06.htm

³ An indirect environmental attribute is an environmental attribute, such as carbon emissions, that may be derived from a certified attributed such as renewable-source energy.

ongoing in various policy venues regarding the appropriateness of and conditions for the use of such instruments.

For electricity, the most common certified attribute is that the power source is renewable as defined by the program. The associated credits are referred to as Renewable Electricity Certificates (RECs). For renewable natural gas (RNG) and renewable hydrogen (collectively, renewable gas), EAs most often include the qualities which: (i) distinguish renewable gas from geological (fossil) natural gas; (ii) convey the emissions profile of the resource, including the capture or avoidance of greenhouse gas (GHG) emissions; (iii) define the character of the feedstock source of the renewable gas, including whether it meets criteria for being labeled as renewable, sustainable, cellulosic, advanced, biogenic, biomass-based and/or waste-derived; and/or (iv) any attributes which are a necessary prerequisite to the creation of certificates, credits, offsets or allowances. For renewable fuels, various types of credits are used including Renewable Energy Certificates (RECs -- same acronym as for electricity), Renewable Thermal Credits (RTCs), Renewable Thermal Certificates (RTCs), Low Carbon Fuel Standard (LCFS) credits, or Renewable Identification Numbers (RINs). Tax credits related to clean energy are generally referenced by the applicable tax credit code. Each type of credit has specific protocols under which it can be created and certified, and requirements may vary across programs for the same type of energy, such as solar or wind electricity.

As noted above, EACs allow EAs to be separated from the physical power or fuel through which they are created making them a separate, transferable commodity. Transfer of EAs is done under a process known as “book and claim.” EACs can generally be bought and sold through bilateral transactions or via exchanges. The environmental attribute, such as the capture or avoidance of greenhouse gas emissions or the production and use of a unit (e.g., 1 MWh) of renewable electricity, is “booked” at the time and location that the attribute is created, and “claimed” at a later time and different location, usually associated with an action whose emissions profile is improved by application of the claimed attribute.

EACs can facilitate the creation of environmental benefits at the least cost by creating a mechanism by which projects or actions with lower cost to create EAs can generate EAs beyond what they use directly and sell unclaimed EAs to others whose cost to create EAs is higher. In theory, this leads to the least-overall-cost for meeting environmental goals by stimulating the development and operation of least-cost, highest-benefit projects. The ability to monetize EAs is a primary driver of investment in clean energy projects.

Trading programs associated with EAs can help create market liquidity, enable price/cost discovery, and minimize consumer costs through well-functioning competitive markets. They also allow buyers and sellers to create portfolios of different tenor and quantity. These are the same functions as are served by wholesale power exchanges, natural gas and oil commodity markets, and carbon credit exchanges. Unlike conventional commodity markets, EA markets can separate the EA from the underlying commodity (energy). For EACs to serve their function, ensuring the environmental integrity of the certificates and credits is paramount. The creation of verifiable and additional emissions reductions must be certain.

Although the use of RECs in renewable power markets has been ongoing since the late 1990s, and renewable power markets are relatively mature, renewable gas markets are less mature. In theory, EACs would be expected to play a similar role in today’s nascent renewable gas markets as Renewable Energy Certificates (RECs) did for electricity markets more than a decade ago: consumers purchase certificates to claim the environmental benefit of substituting renewable gas for fossil natural gas (thus satisfying

compliance obligations or voluntary sustainability goals), which in turn serves as a demand and price signal to the market, encouraging the buildout of renewable gas production facilities.

When clean energy is more costly than fossil energy, and the cost differential exceeds customers' willingness to pay, there is a need for regulatory or statutory mechanisms to promote adoption through mandates or incentives. EACs can be an important tool to facilitate both mandates and incentives.

The strength of restrictions or conditions in clean energy procurement and certificate programs has been termed degree of "stringency" [1].⁴ There is a natural tension between the producers of clean power or fuels under such programs who desire simplicity and broad eligibility, and program designers concerned with ensuring that the desired environmental benefits underpinning a given program are achieved. . Greater stringency is generally argued as ensuring higher environmental integrity, while less stringency is argued as more supportive of investment in and deployment of environmentally-preferred resources. Optimal policy balances the two desires with through program requirements that best serve both goals.

Summary of Findings

The policy and program design issues under consideration regarding the provisions and requirements for the use of EACs in voluntary and mandatory programs generally relate to finding a balance between provision of effective incentives to stimulate investment in preferred technologies and pathways and the desire to guarantee that desired environmental benefits are attained. At a macro level, these goals need not be in conflict. However, at the implementation level, stringent program requirements have the potential to stifle project development such that the total investment pipeline creates fewer benefits than would be the case under more permissive or inclusive program requirements. This can be particularly consequential for nascent technologies requiring financial support to enter the market and build efficient scale. Alternatively, program requirements that are not stringent enough can result in reduced achievement of environmental benefits. Some considerations on finding an optimal balance are discussed at the end of this paper. High-level findings on the questions addressed are provided below.

Use of Tradeable EACs

- EACs are used universally to demonstrate certified creation of EAs and convey property rights.
- Trading exchanges create market efficiency and stimulate investment.
- There is nearly universal support for the use of EACs among stakeholders, with differences centered on standards and requirements for EAC generation and use.

Additionality

- Buyer or seller incentives that expand demand for environmentally preferred resources stimulate investment in new supply with or without formal additionality requirements.

Time Matching

- Time-matching modeling results put forward by academic and professional research and analysis groups show contradictory results on the extent to which hourly versus longer, such as annual, time matching requirements impact energy costs, system dispatch, and greenhouse gas emissions.

⁴ Note that bracketed numbers refer to citations of reports and academic publications in the bibliography at the end of this document; whereas footnotes are used for web links and explanatory notes

- Observed cost and emissions impacts of actual resource deployments will be needed to determine which modeling approach best predicts investor and energy market behavior, and this may depend on the stage of market evolution and the size of the deployment.
- Under all modeling approaches, the consequences of phasing in time matching depend upon the resource mix in the market in question (e.g., lowest hourly carbon intensity to highest hourly carbon intensity) and regulatory realities, such as presence or absence of a binding renewable portfolio standard.
- Fundamentals lead to the conclusion that hourly matching increases cost, and that to achieve deep levels of decarbonization, physical time matching of zero-carbon supply and demand will be necessary.
- The optimal policy on how and when to implement granular (hourly) time matching requirements comes down to balancing stimulation of market formation and investment and collateral benefits, with acceleration of GHG reduction, and this may differ by market.

Geographic Boundaries

- Wider geographic market boundaries better optimize the overall resource supply portfolio if geographic boundaries constrain lower-cost resources⁵ from supplying the marginal consumer.
- Transportation constraints (e.g., lack of adequate electric transmission capacity) can lead to dispatch of higher cost, higher emitting resources, however, congestion costs provide a price signal to stimulate investment in new transmission (or pipeline) infrastructure.
- Market boundaries cannot impact GHG emissions under a mandatory market-wide cap.

Tracking, Measurement and Verification

- There are trade-offs between TMV cost and enhanced integrity of EACs, including fraud prevention, which need to be balanced.
- Stakeholder processes balanced this trade-off for existing programs, but there was no published analysis found of TMV costs relative to the consequences of more or less stringent requirements (such as intentional or unintentional double-counting of attributes).
- Technology advances in data collection, storage, and analysis will enable more comprehensive TMV over time but not all regional tracking systems have the same level of ability/infrastructure to track with higher granularity, so regional differences in implementation timing are likely.

Support for Nascent Technologies

- Special support mechanisms for preferred emerging technologies have been common and have included programs incentivizing solar electricity within RPS programs (which were initially dominated by wind due to its cost advantage), electric vehicles, zero-emission vehicle infrastructure, distributed generation technologies, energy efficiency measures, and dairy biomethane production, among other technologies.
- These programs have been effective in supporting market launch and scaling of preferred technologies.
- Some technology-preference incentives have used EAC awards or multipliers to convey financial value such that EAC generation departs from the physical creation of EAs with the objective of enabling downstream benefits.

⁵ Including the cost of delivering the power or fuel to the consumer.

- No quantitative analysis of the impact of using EA credits as incentives based on anticipated indirect environmental benefits was found, and qualitative arguments can be made both pro and con.

EAC Value Stabilization

- Suppliers of EACs place certainty in the value of EACs as the top, or a top, priority in program design.
- Program features such as contracts for differences (CFDs) and feed-in tariffs have been used to provide certainty of credit value for investors relying on credit revenues to support project finance.
- Governmental program sponsors may be reluctant to establish such programs due to concerns over financial risk and/or cost to consumers.

Programs in Place

As noted above, environmental attribute certificates or credits represent the creation of a specific and quantified environmental benefit. Certificates and credits are used as instruments to demonstrate compliance with mandates, to support claims of voluntary action, and to represent the monetary value of the underlying environmental attribute. Certificate or credit programs currently in place include those for producing and using renewable electricity, low-carbon fuels, reducing greenhouse gas emissions, and decreasing specific types of pollutants. Mandatory programs include procurement mandates for various types of clean (as defined by the program) resources, and cap and trade programs which allow obligated parties to buy and sell credits under an overall mandatory limit on emissions. Brief summaries of EAC programs currently in place related to clean energy are provided below. Procurement programs are also discussed as they almost universally rely on credits and or certificates to function. Programs and program elements are summarized in greater detail in the Appendix, which also provides links to the source information.

Environmental Certificate and Credit Tracking Systems

Systems are in place throughout the U.S. and in many international markets to verify, issue, and track EACs. The most common are REC tracking and trading systems referred to as RETS. Figure 1 shows a map of the RETS in the North America. There are also carbon credit tracking systems of similar function.

In practice, most RETS function in a similar way: there are rules for what resources are eligible, RECs can only be generated once and claimed once, and RECs often have a vintage over which they are valid. Production of renewable energy must be verified by meter data, documentation of the facility fuel type, and details of the facility interconnection and vintage. REC programs generally employ so-called book-and-claim accounting. The generation of the qualifying environmental attribute is “booked” through the creation of the REC. The attribute is “claimed” when it is retired to convey the attribute at another place and/or time. Program rules determine the limits on when and where RECs can be claimed. Current clean energy programs generally use annual true-up (only RECs generated within the same reporting year can be claimed) and are regional in scale as shown in Figure 1 for renewable electricity. There may also be restrictions on facility vintage.

Certification and Verification Standards and Protocols

While RETS certify that a unit of power, fuel, or heat meets the criteria for being counted as renewable energy (or being produced from renewable energy) set by regional jurisdictions, RETS do not guarantee any other environmental attributes. For example, RETS do not guarantee that purchasing a REC is linked with greenhouse gas or air pollutant emissions reductions, and they do not guarantee that purchasing the

REC encouraged the build of renewable energy facilities that would not have otherwise been built (additionality).

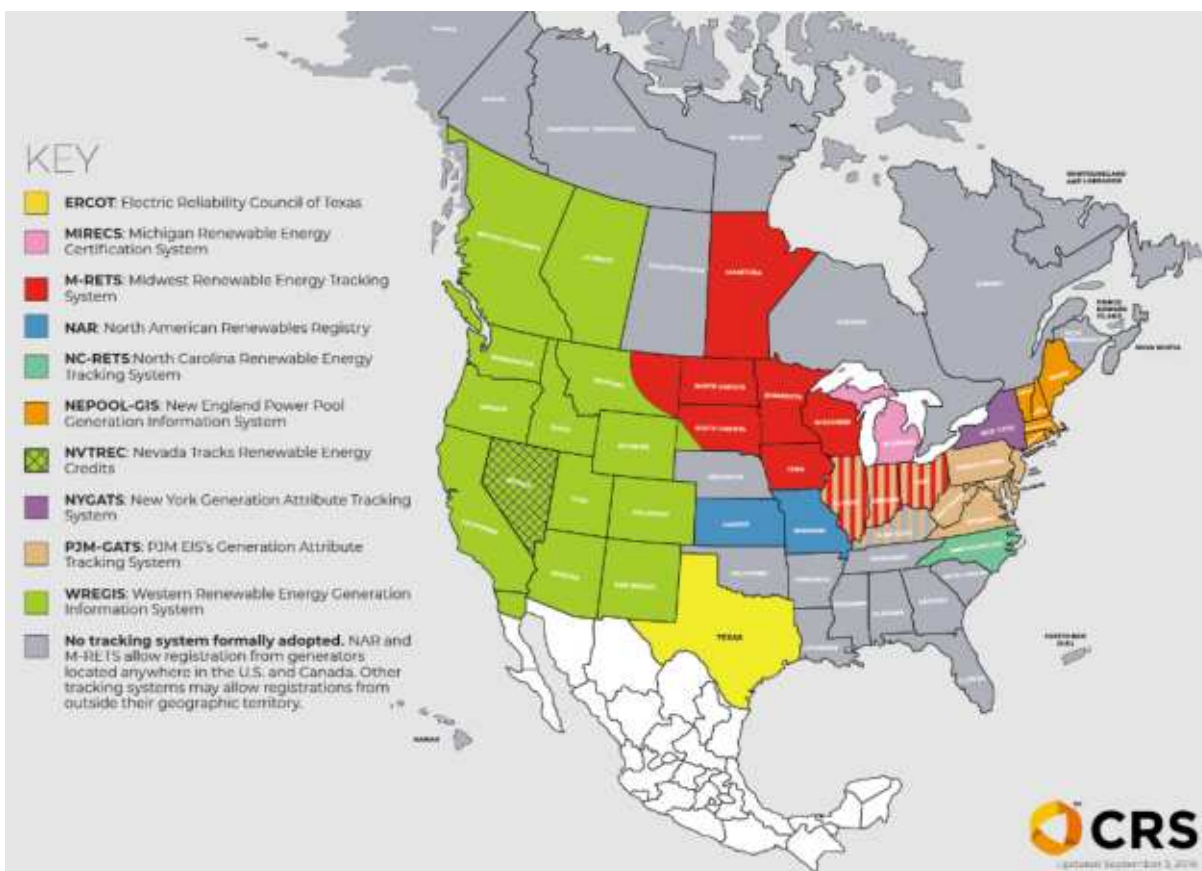


Figure 1. Renewable Energy Certificate Tracking Systems in North America.

<https://resource-solutions.org/wp-content/uploads/2018/02/Tracking-System-Map.png>

The U.S. EPA recommends that purchasers of RECs seek RECs that are specifically certified or verified by a third-party to correspond to a given environmental benefit.⁶ A similar approach is taken in the European Union, where Guarantees of Origin (GOs) can be certified by a third-party. The certification of a REC by a third-party is optional and done at the request of the REC producer. In the U.S., the primary certification for improving confidence in the environmental integrity of a REC is the Green-e certification⁷, administered by the Center for Resource Solutions. Green-e certification is also available for different types of products, such as carbon offsets and renewable fuels. To obtain a Green-e certification for renewable electricity represented by a REC, a renewable electricity producer must meet additional criteria above those required to register in a regional RETS, as described in the Appendix along with discussion of other certifying programs.

Renewable Energy Procurement and Incentive Programs

Twenty-eight states currently have renewable and/or clean electricity procurement mandates, and three have established programs with specific targets but not mandates. Figure 2 shows a coded map of

⁶ <https://www.epa.gov/green-power-markets/certification-and-verification>

⁷ <https://www.green-e.org/programs/energy>

renewable and clean energy programs by state. The map at the host site is interactive with pop-ups providing state-level program specifics. Each state program has specific eligibility requirements, such as qualified resources, technology-specific carve-outs, geographic restrictions, vintage requirements, and presence or absence of an alternative compliance payment option.

Electricity is the most common resource covered under the programs, but three states have established renewable gas procurement standards (and one has set a target), and three have adopted low carbon fuel programs. Some programs also include renewable thermal energy. Only California has a mandatory greenhouse gas cap and associated credit trading program. At the federal level, there is a renewable fuel standard in place, and tax incentives for clean energy have been enacted under the Inflation Reduction Act. Further details on all state and federal clean energy procurement programs and federal tax credits are provided in the Appendix.

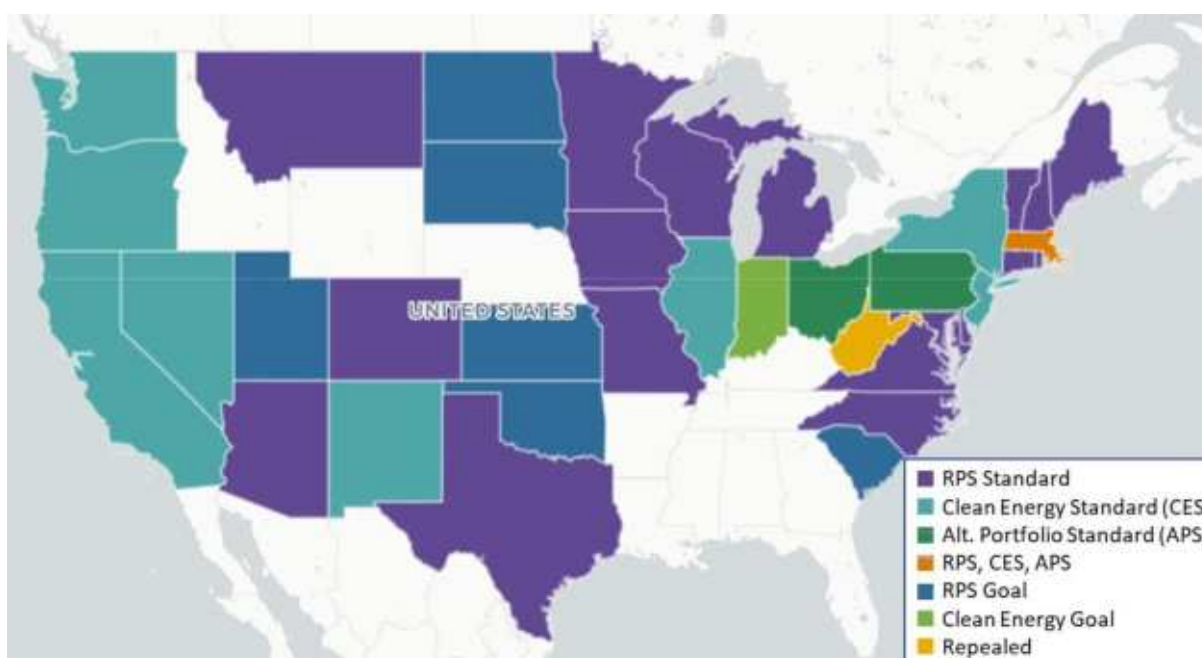


Figure 2. State Renewable and Clean Electricity Procurement Programs. Source: <https://www.c2es.org/document/renewable-and-alternate-energy-portfolio-standards/>

Trading EACs

One function of EACs is to create a tradeable instrument that allows EAC owners to sell their EACs to buyers that require them for compliance with mandates or that wish to purchase them voluntarily to improve the environmental footprint of their operations. Mature commodity markets, such as the Chicago Mercantile Exchange, trade large volumes of commodities on an open exchange that creates price transparency, liquidity (ability of buyers and sellers to transact at will), and low transaction costs. Conventional energy commodities, such as power, gas, and petroleum trade on similar exchanges.

Such systems for clean energy and GHG credits are nascent. Trading volumes are comparatively low, and the number of buyers and sellers in each market is also relatively low. Some of the RETS, such as PJM, facilitate transactions through bulletin boards for buyers and sellers.⁸ There are a few organized exchanges, such as the California Low Carbon Fuel Standard (LCFS) and carbon credit auction processes,

⁸ <https://www.pjm-eis.com/getting-started/how-do-I-sell-recs>

and a number of private platforms. However, brokers facilitate most transactions in the current U.S. EAC markets.

Issues Assessment

The present assessment draws from a range of sources including peer-reviewed articles, reports by research institutions and private organizations, comments to regulatory dockets and stakeholder interviews. We assess seven topics of current interest enumerated in the introduction:

- 1) The extent to which use of tradable EACs should be permitted as a basis for compliance under mandatory programs or environmental claims under voluntary programs;
- 2) Requirements for demonstrating additionality of quantified EA's (or indirect EAs)⁹ created in generating EACs;
- 3) Requirements for time matching of EAC generation (booking) and use (claiming);
- 4) Appropriate geographic boundaries on EAC generation and EAC use;
- 5) Requirements for tracking, measurement, and verification (TMV) of environmental attributes;
- 6) The appropriateness of programmatic preferences in use of EACs for nascent technologies; and
- 7) The need for mechanisms to increase EAC value certainty.

The focus is on renewable and clean fuels, but renewable power is also central to the discussion because of its role as the primary input to electrolytically produced fuels and because of the larger relevant literature on renewable power EACs due to their greater maturity. For each of the issues addressed below, policy alternatives are framed, for most of the issues in terms of arguments for more versus less stringency, followed by presentation of available data and analysis relevant to the issue.

Use of Tradable EACs

The use of certificates and/or credits along with some form of market-based accounting and the ability to trade EACs is universal in current programs in the United States and internationally.¹⁰ However, as the push for greater stringency by some stakeholders has evolved, the question has been raised as to whether EACs and book and claim accounting should be permitted at all. For example, several respondents to the U.S. Treasury Department docket seeking comment on requirements for verifying carbon intensity for Section 45 tax credits oppose any use of book and claim,¹¹ and the draft Greenhouse Gas Protocol being developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) does not recognize the use of book and claim accounting for biomethane.¹²

Framing the Use of Tradeable EACs Issue

Arguments Against the Use of Tradeable EACs: The argument against the use of EACs for reporting is that only physical tracking of energy from production through use of an environmental attribute, such as

⁹ An indirect environmental attribute is an environmental attribute, such as carbon emissions, which may be derived from a certified attributed such as renewable-source energy.

¹⁰ See the Appendix to this white paper for program specific and <https://en.energinet.dk/gas/biomethane/biomethane-go-guidelines/> for a European example.

¹¹ <https://www.bakerbotts.com/thought-leadership/publications/2022/december/finding-tool-for-2022-58>

¹² <https://ghgprotocol.org/survey-need-ghg-protocol-corporate-standards-and-guidance-updates>

carbon emissions from power or fuel, can ensure accurate accounting for emissions. In addition, it is argued that the use of tradable EACs that separate environmental attributes from the time and location of generation or use can shift environmental burdens related to but external to EAC accounting (externalities), for example, pollutant emissions from a renewable energy production facility. Benefits, such as job creation, can also be shifted as a result of EAC trading. In addition, as markets mature and trading interregional trading is allowed over long periods of time, certain regions with high mandated EA levels may begin to slow in in-region production of EAs due to physical constraints (e.g., high penetration of solar leading to curtailment, transmission constraints that limit interconnection of new resources, or insufficient deployment of complementary technologies such as storage).

Arguments in Favor of Using Tradable EACs: Those supporting the use of tradable EACs for emissions accounting and compliance argue that verified creation of certificates according to specific protocols, and verified retirement of credits when claimed, is the best way to ensure that environmental goals are met at least cost. They further argue that EACs are the most feasible way to create property rights to EAs that are fungible and tradable. It is argued that the use of EACs expands investment in environmentally preferred resources and lowers the overall cost of mitigating negative environmental impacts. EACs allow consumers to access environmentally preferred resources even when such resources may not be available or feasible at the consumer's location. They additionally argue that externalities should be regulated outside the EAC regime as with any other type of facility or activity.

Available Evidence for Tradable EAC Use

There is minimal empirical evidence to compare outcomes of programs with and without the use of exchangeable EACs, due to their current effectively universal use. For example, both the California RPS and LCFS operate on credits, and book-and-claim accounting is a key element of both programs. The basis of commodity exchanges using fungible market instruments is that they allow producers and consumers to trade on a common platform that provides liquidity and price discovery. This helps minimize the overall cost of the physical supply and consumption that the exchanges facilitate. This helps explain the prevalence of greenhouse gas credit trading programs. Recent work by Xu et al. [2] predicts that the cost of achieving a 98% decarbonized electric system in the western United States would be 23% lower with a trading market for hourly RECs in comparison to a case where only physical delivery or self-generation were permitted (see Figure 3). Since hourly matching was required in both cases, the cost savings reflect the value of locational flexibility.

EACs have been the primary basis for demonstrating compliance with the LCFS programs in California and Oregon. These programs use credits denominated in tons of CO₂-equivalent emissions reductions. Similarly, the federal RIN program uses gallons of ethanol-equivalent fuel. In these programs, the environmental attribute is separate from the physical fuel produced. The impact of use of tradable fuel credits is illustrated by biomethane (or renewable natural gas (RNG)). As shown in Figure 4, as of mid-2023, there are 300 RNG production facilities across the United States.

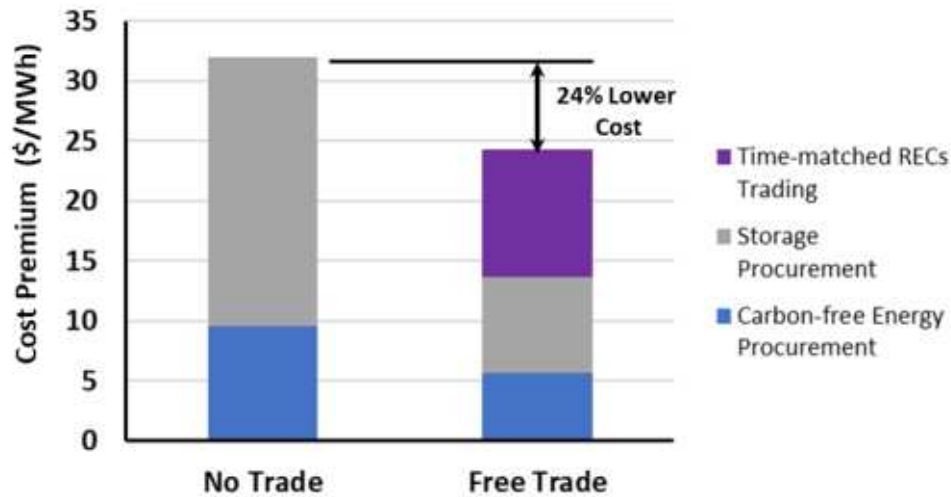


Figure 3. System-wide Cost Reduction Enabled Through Use of Tradeable Hourly RECs. From [2].



Figure 4. Biomethane Facility Count by State (one facility in HI out of frame). Source: Coalition for Renewable Natural Gas.

The facility count has been growing at an average rate of 20% per year over the past decade. Because tradeable credits have been used in all clean fuel programs in North America, direct comparison of a case where tradeable AECs are not allowed is not possible. However, the geographic distribution of production facilities and the location of demand suggests that the locational flexibility enabled by the use of tradeable clean-fuel credits has enabled supply expansion and reduced cost. California is the dominant location of

demand for low-carbon fuel while facilities are distributed nationally. If physical delivery of fuel to the end consumer were required, the common-carrier pipeline system could not be used to deliver RNG. Delivery of biomethane using tube trailers would be several times more costly than delivery via pipeline. Of the 289 biomethane pathways approved under the California LCFS, only 3 deliver RNG without the use of the common-carrier pipeline.¹³

Dong et al. have proposed an international green hydrogen certificate program which their assessment concludes will enable international market expansion [3]. The approach uses hydrogen credits (HCs) based on carbon intensity to create a mechanism for trading unbundled HCs internationally to support global build-out of low-carbon hydrogen production. Their proposed certificate regime is carbon-based and pathway specific with credit generation based on avoided carbon from the incumbent pathway (similar to current LCFS programs in several states). The analysis assumes the presence of a carbon tax on hydrogen, but the mechanism could also operate in the absence of a tax. The European Union Certificates of Origin (CO) program for clean hydrogen (see Appendix) is intended to serve a similar function.

Although the ability to attribute trading to lower the cost of meeting environmental goals is well-founded in theory and empirical evidence, there is risk of over-counting environmental benefits if the rules for generating, trading, and claiming EACs are not fully aligned with proper EA accounting. In the case of GHG emissions, this means that credits must represent full lifecycle emissions within clear system boundaries and timeframes. A recent analysis concludes that reported corporate GHG emissions reductions related to purchases of RECs could over-estimate actual GHG emissions reductions by more than a factor of two over four years, as shown in Figure 5 [4]. Work by the Princeton Zero Lab [5] similarly predicts that use of RECs for carbon accounting without time-stamping can lead to significant under-estimating of the consequential carbon emissions of electrolytic hydrogen. Although disallowing RECs would cure these issues, both analyses referenced conclude that GHG reporting issues can be cured through program changes without abandoning the use of RECs.

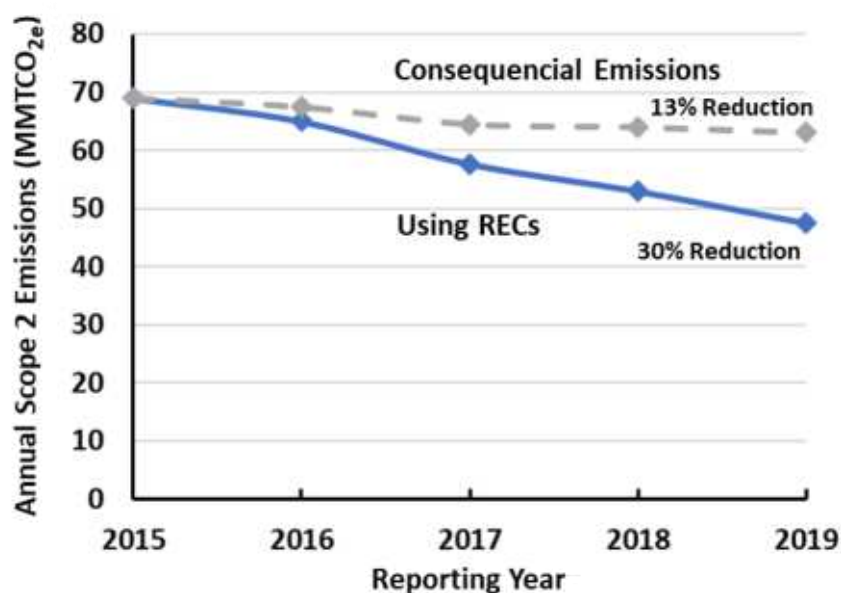


Figure 5. Scope 2 (Purchased Power) Reported Emissions for Sample Corporate Over Four-year Period Using Book-and-Claim versus Attributional (Physical) Accounting. From [4].

¹³ <https://ww2.arb.ca.gov/resources/documents/lcfs-pathway-certified-carbon-intensities>

Additionality

Additionality refers to the requirement that environmental attributes created for the purpose of certificate or credit generation must be created from newly constructed facilities or from actions taken that are additional to a reference scenario. The reference case is generally a “business as usual” scenario or an expected state in the absence of a specified action taken to generate the EAC. In the case of GHG credits, additionality generally means that GHG reduction is achieved by the construction of a voluntary project or commitment to a specific action. In the case of renewable energy, the requirement would be that the renewable energy is generated by a project newly constructed for the purpose of creating EAs. Additionality provisions are well established in carbon credit programs but are not currently common in clean energy credit programs, apart from facility vintage provisions in some programs. Investment-based credits, such as investment tax credits, ensure additionality by the nature of the credit.

Currently, additionality requirements have become an issue under debate with respect to renewable power and fuel production. There is extensive discussion of the issue in comments to the U.S. Department of the Treasury docket on requirements for tax credit eligibility under the IRA.¹⁴ Some stakeholders are suggesting that renewable energy production credit generation should be limited to energy produced from newly constructed facilities, and some stakeholders argue that this additionality provision should extend to renewable electricity used to produce electrolytic hydrogen. There is variation in views on how recently a facility must have been constructed to meet the criteria for additionality. As two points of reference, the EU recently established a requirement that renewable power facilities supplying electrolytic renewable gas producers must have been placed in service no more than 36 months prior to the fuel production facility startup,¹⁵ whereas the California renewable portfolio standard allows projects placed in service January 1, 2005, and the California LCFS program has no facility in-service date restrictions.¹⁶

Framing the Additionality Issue

Arguments for Requiring Additionality: The argument in favor of strict additionality requirements is that only the requirement that renewable energy be produced from new, purpose-built facilities, guarantees that incremental environmental improvement will result from the provision of incentives for the use of renewable energy. The use of existing facilities to generate EACs is argued to potentially divert resources from other uses, resulting in no or diminished environmental benefit. Additionality restrictions also ensure that incentives flow to new facility construction only.

Arguments Against Requiring Additionality: The first argument against additionality requirements is that they are inconsistent with some program designs. Production-based incentives lead to capacity expansion by creating market pull. It is argued that overlaying a requirement that only new facilities are eligible is redundant, and, if incentives for new facilities are intended, they should be part of program design. In addition, it is argued that applying additionality requirements to production inputs (rather than the production facility receiving the inputs) raises cost and thereby reduces overall investment in production capacity.¹⁷ Additionality requirements may also reduce investment by creating real or perceived stranded-asset risk for investors. The fear is that once built, assets may become distressed, if they cannot direct

¹⁴ <https://www.regulations.gov/docket/IRS-2022-0029/comments>

¹⁵ https://ec.europa.eu/commission/presscorner/detail/en/qanda_23_595

¹⁶ See Appendix for program summaries.

¹⁷ A number of parties commenting on Section 45 V tax credit eligibility for electrolytic hydrogen contend that only hydrogen producers receiving power from newly-constructed renewable facilities should be eligible.

supply to attractive new markets. For example, a wind farm with an expiring long-term power purchase agreement (PPA) or that is serving merchant power markets could become a stranded asset even while there is unserved demand for renewable power to make fuels. Some stakeholders are also concerned about the lack of a clear and consistent definition of additionality.

Available Evidence for Additionality

Renewable Power

No renewable electricity (REC) program in the U.S. applies additionality requirements for the certification of RECs,¹⁸ so a direct comparative assessment of capacity additions with and without additionality requirements for REC certification is not possible. Several recent studies have used statistical analysis and/or modeling to assess the impact of various RPS program design features on renewable capacity expansion [1][6][7][7][8][9]. The most directly relevant analysis is that of Carely et al. [1] which specifically assesses the correlation of the use of RECs (among other program features related to stringency) with renewable supply and capacity expansion. The strongest drivers of supply expansion are found to be state renewables endowment (wind and solar resources), mandatory and aggressive standards, and the presence of flexible renewable energy credit provisions. As shown by the data presented below, renewable capacity expansion has significantly exceeded that required to meet RPS targets without the imposition of additionality requirements on the creation of RECs.

The Lawrence Berkeley National Laboratory (LBNL) 2021 U.S. RPS update [10] finds that non-hydro, utility-scale renewable energy supply expansion from 2000 through 2019 has been more than twice that required to meet mandatory RPS requirements, as shown in Figure 6. The National Renewable Energy Laboratory (NREL) recently analyzed voluntary renewable power markets [11]. As seen in Figure 7, roughly 50% of the transactions are via unbundled RECs (RECs separated from the physical delivery of energy), and another 20% use PPAs, which are usually operationalized using bundled RECs.

The LBNL and NREL reports do not establish a definitive causal relationship between the use of RECs and REC provisions on capacity expansion, but the correlation of voluntary REC and PPA volumes with capacity additions is highly suggestive of a causal effect. Moreover, U. S. renewable generation capacity has doubled over the past 10 years and has grown more than twenty times over the past 20 years [12]. Capacity expansion has occurred due to market demand with no formal requirement for additionality.

The California Energy Commission (CEC) issued solicitations for renewable hydrogen production projects in 2019 and 2021.¹⁹ Redacted copies of the submitted grant applications were requested and received from the CEC. Of the 9 bids submitted for electrolytic renewable hydrogen production, 100% of the bidders proposed to add dedicated renewable capacity to supply power to electrolyzers for hydrogen production in the absence of any requirement to add renewable capacity. In total, new renewable generation was proposed totaling more than three times the proposed electrolyzer capacity. The prevailing strategy was to produce more power than needed by the electrolyzers during times of high solar production, generating unbundled RECs (or equivalent net-metering credits) to apply to grid power received during hours of low or no solar production. Overall, the research and data reviewed demonstrate a strong causal relationship between increased demand for renewable power (facilitated by the use of RECs) and renewable capacity expansion.

¹⁸ Although some programs have requirements on the earliest in-service date of eligible resources.

¹⁹ Funding opportunities GFO-17-602 and GFO-20-609.

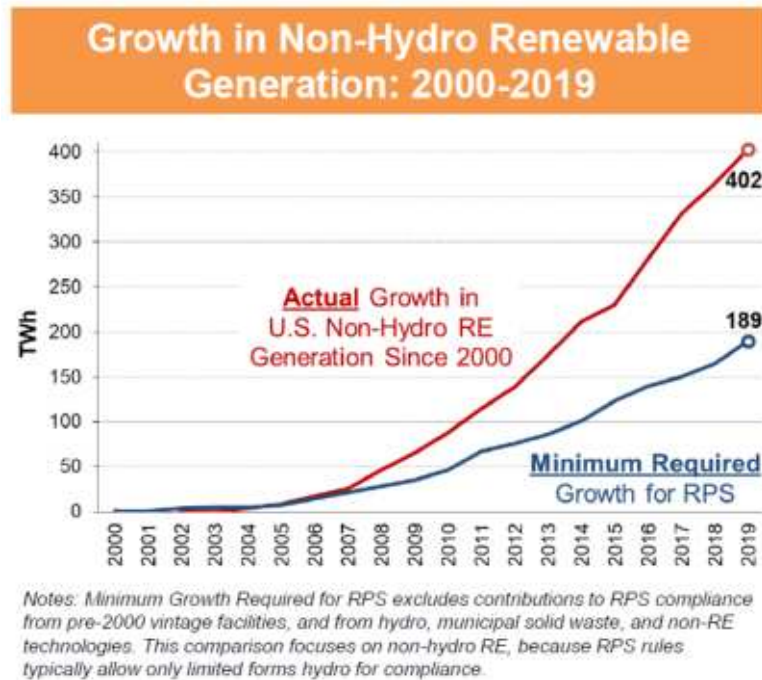


Figure 6. Total Renewable Energy Production versus Minimum Required for RPS Compliance. Source: Lawrence Berkely National Laboratory.[10]

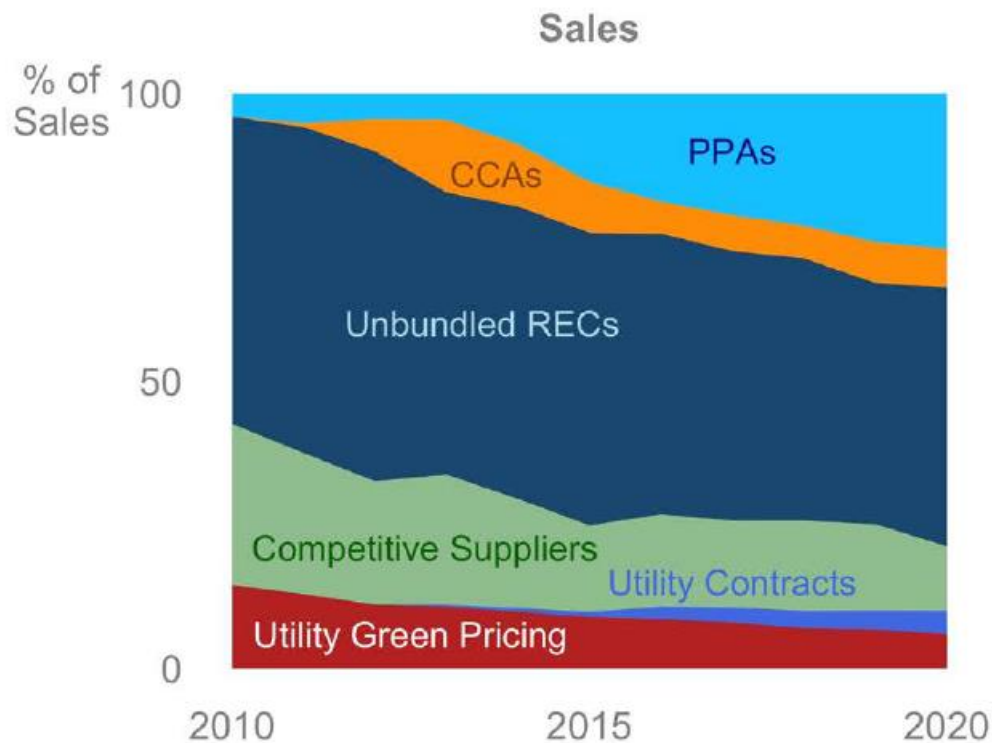


Figure 7. Distribution of U.S. Voluntary Renewable Power Purchases. Source: Heeter et al. [11].

Renewable and Low-carbon Fuels

No low-carbon or renewable fuel program currently active in the United States requires that credits be produced only from new facilities built for the purpose of generating credits under the program. However, there is strong evidence that demand for clean resources either driven by procurement mandates or voluntary action leads to resource additions without formal additionality requirements.

Analysis published in the Utah Law Review [13] finds that the introduction of the U.S. renewable fuel standard program in 2007 was followed by rapid expansion in ethanol production capacity (see Figure 8). Figure 9 shows the evolution of low-carbon fuel volumes used to meet the California Low Carbon Fuel Standard (LCFS) program standards.²⁰ While existing facilities serve a significant amount of ethanol demand, and most electricity comes from existing facilities, capacity growth for biomethane, biodiesel, and renewable diesel has been dramatic without any formal requirement for additionality. Two large renewable hydrogen facilities, one announced and under development and one recently commissioned, were developed for the specific purpose of serving the California LCFS market.²¹ Numerous new dairy methane capture projects have been built or are under construction to serve the LCFS market.²² Some pre-existing facilities, such as ethanol plants, power generation facilities, landfill methane capture facilities and livestock methane projects originally developed for the power market, have supplied fuel to the LCFS market. Although the associated fuel quantities could be argued to be non-additional, these resources have helped provide cost-effective fuel supply to the early low carbon fuel market and have reduced the time required to build fuel volume.

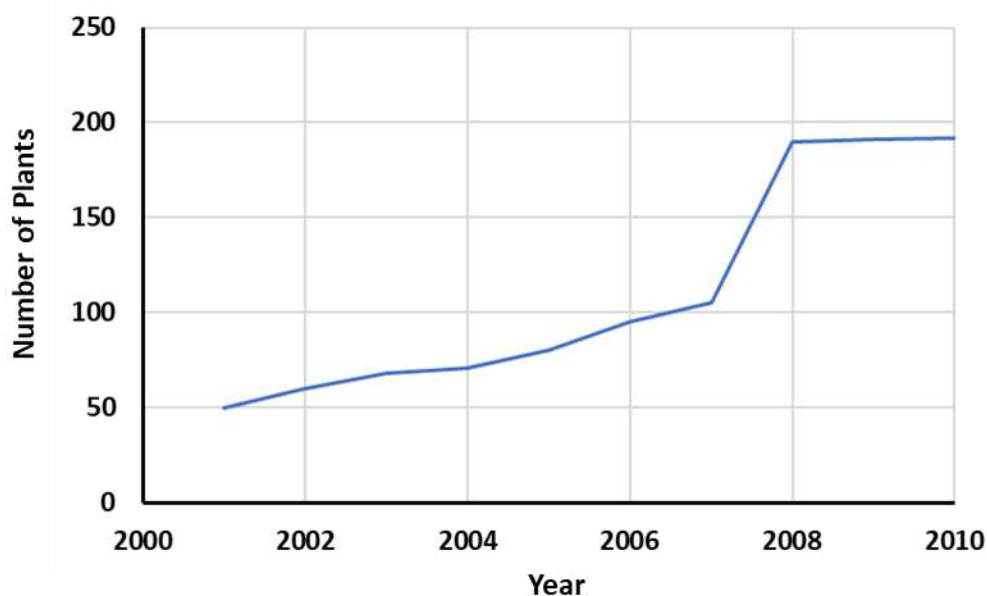


Figure 8 Ethanol Plant Count Trend. Note that the U.S. federal renewable fuel standard was implemented in 2007. Source: Re-plot of data from Kesan et al.[13].

²⁰ <https://ww2.arb.ca.gov/resources/documents/lcfs-data-dashboard>

²¹ <https://www.ir.pluginpower.com/press-releases/news-details/2021/Plug-Power-to-Build-Largest-Green-Hydrogen-Production-Facility-on-the-West-Coast-2021-9-20/default.aspx>
https://usa.airliquide.com/sites/al_us/files/2022-07/nlv_facility_one-pager-bracewell_final_5_24_22.pdf

²² https://www.cdfa.ca.gov/oefi/DDRDP/docs/DDRDP_Project_Level_Data.pdf

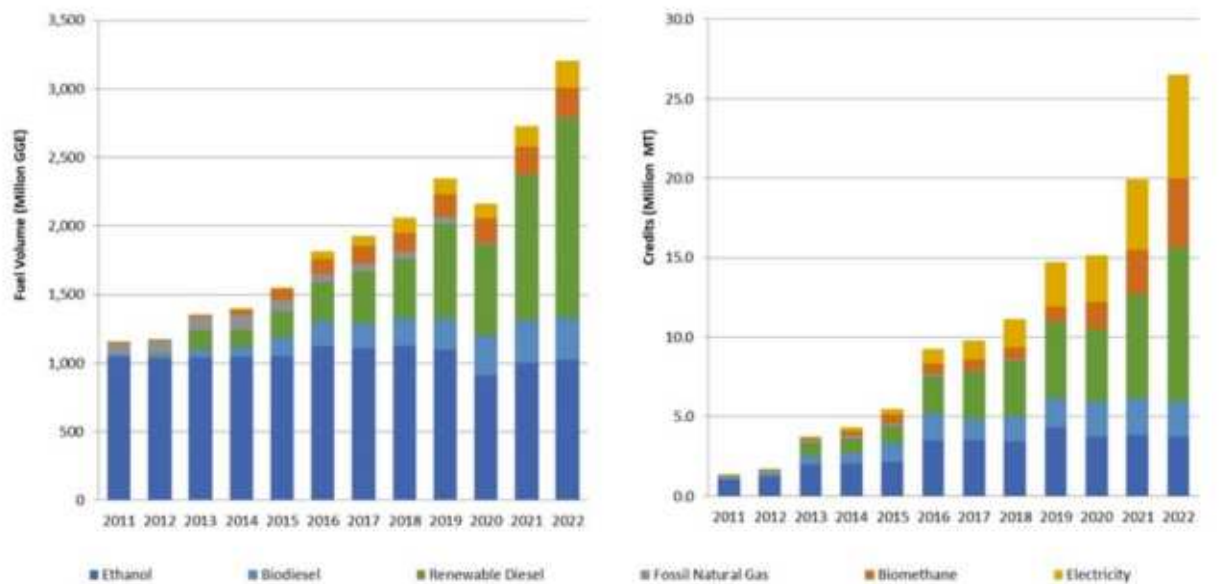


Figure 9. Fuel and Credit Volumes Under the California LCFS. <https://ww2.arb.ca.gov/resources/documents/lcfs-data-dashboard>

Time Matching

Another emerging issue that has been flagged by the U.S. EPA Green Power Markets program is whether requirements should be put in place for RECs to be timestamped on an hourly basis.²³ This approach would restrict REC claiming to RECs timestamped in the same hour. The foundation of the issue is that, without physical storage, power must be delivered to load in real time. If a REC is unbundled from the power by which it was generated, then that power is delivered in real time to a load without the renewable attribute. When the REC is later used to qualify purchased power as renewable, the delivered power can be of any type. While this unbundled REC transaction is balanced (actually delivered the EA required) it can result in incremental carbon emissions under some circumstances by changing the non-renewable supply mix and can also lead to inaccurate carbon reporting by voluntary unbundled REC purchasers purporting to use RECs to report Scope 2 carbon emissions from purchased power [4][14].

In any case where the marginal carbon intensity of the grid into which renewable power is physically delivered is lower than the marginal emissions on the grid at the time and location that the renewable power attribute is claimed, incremental emission of greenhouse gas will occur from the transaction (in comparison to direct delivery of renewable power to the claiming load). It should be pointed out that the inverse is also true and displacement transactions can lead to incremental carbon reductions in some circumstances. For the case when a grid has the same marginal emissions when a credit is booked and when it is claimed, unbundled REC transactions will have zero incremental GHG emissions related to changes in grid dispatch from the REC transaction.

As regional grids evolve to reach high renewable fractions, there are fewer hours in which temporal “swapping” of carbon emissions can occur, and time matching becomes a physical necessity to meet carbon constraints. This can be accomplished through real-time supply of generated renewable power to load (e.g., by transmission and distribution investments that make it possible), or through physical storage of electricity for delivery when demanded. The policy question is at what point in time should time

²³ <https://www.epa.gov/green-power-markets/emerging-issues>

matching requirements be imposed on the use of RECs and to which purchasers (loads) they should be applied.

Framing the Time Matching Issue

Arguments in Favor of Hourly Time Matching: The argument in favor of hourly time matching is that without hourly time matching, unbundled REC transactions can lead to incremental GHG emissions due to changes in the grid dispatch resulting from the unbundled REC transaction. Proponents argue that hourly time matching will have minimal impact on the cost of renewable power, and that tracking systems can be put in place rapidly using interim approaches, such as regional, hourly grid marginal carbon intensity tables, if necessary, as real-time systems are implemented.

Arguments Against Hourly Time Matching: Arguments against hourly matching primarily relate to timing and phase-in. Opponents of immediate implementation of hourly time matching argue that such requirements will increase the cost of renewable power, will not materially impact overall GHG reductions, and cannot be supported with existing tracking and trading systems. Opponents generally acknowledge the need for granular time matching to be implemented over time. They also assert the need to support nascent technologies and the potential market chilling effect of abrupt changes in established protocols and policies.

Available Evidence on Need for Time Matching

Emissions Impact

A key policy question on time matching is the extent to which lower stringency in time matching, such as weekly up to annual matching requirements, lead to increased GHG emissions and, if so, how much. A key and closely related question is the cost impact of differing matching requirements. That will be discussed in the next section. The companion assumptions regarding additionality and deliverability have a significant impact on modeling results for both emissions and cost.

There is no dispute that there can be incremental consequential emissions (increase or decrease) from the use of RECs that are not time stamped. This occurs when the marginal emissions on the grid to which the renewable power is delivered at the time the RECs are generated (booked) differs from the marginal emissions on the grid at the time that the RECs are used (claimed). However, the method by which consequential emissions are calculated is a matter of significant disagreement, and the prevailing differences in approach lead to opposite conclusions on whether matching over longer time horizons, such as annual matching, leads to substantially higher GHG emissions than hourly matching. There is consensus and a vast body of experience in electric-sector integrated resource planning (IRP), among other domains of economic analysis, that a marginal approach is the correct method of analysis. This means that changes in supply and demand on the electric system are assessed based on the incremental impact on emissions and cost.

While there is consensus on the appropriateness of the use of marginal analyses, published analyses of time matching differ on two key dimensions in assessing marginal impacts:

- How the resource portfolio is modeled with respect to future resource additions and retirements
- The time horizon over which the marginal analysis occurs

A recent study by Cybulsky et al. from the Massachusetts Institute of Technology Energy Initiative [18] assesses two approaches to modeling the resource portfolio in the context of adding electrolytic hydrogen production in a market area. They compare an analysis by Ricks and colleagues at the Princeton Zero Lab

[15] with a study by Zeyen et al. [16]. Both assume that contract renewable electricity supply is procured in an amount equal to the electricity consumed to produce renewable hydrogen, and they compare consequential emissions (and costs) of annual versus hourly time matching procurement approaches. Ricks et al. analyzed the power supply in the Western Electric Coordinating Council (WECC) in planning-year 2030 with the hypothetical addition of 1 GW and 5 GW of electrolyzer capacity and the supply system optimized to accommodate that new load. Zeyen et al. modeled additions of a fixed demand for 840 million kilograms (roughly 5 GW of electrolyzer capacity at 100% capacity factor) in the German and Dutch markets in 2025 and 2030.

A key difference between the two methodologies is that Ricks et al. assume that the added electrolyzer demand is included in the optimal resource portfolio design. Electrolyzers with a specified load profile are added to system load, and the resource portfolio and dispatch are optimized under a constraint of zero-carbon operation of the electrolyzers under an annual or hourly time-matching requirement. The electrolyzer owners adopt a cost optimal mix of directly contracted or self-generated (“dedicated”) wind and solar, and renewable power purchased from or sold to the grid.

Zeyen et al. assume that electrolyzers and their contracted or owned renewable resources are added to a grid that is optimized to serve load not including the electrolyzers, in essence, a pre-existing grid. This approach was also used in a similar analysis by Energy and Environmental Economics (E3) and the American Council on Renewable Energy (ACORE) led by Olson [17]. The Ricks et al. approach reduces the added capacity of non-dedicated wind and solar under both time-matching approaches, and, under the hourly-matching scenario reduces natural gas capacity and dispatch.

Another key difference among approaches is how marginal emissions are assessed. Olson et al. use a short-run marginal emissions (SRME) approach in which electrolyzer consequential emissions are based on the grid marginal intensity in each hour. This means that, in a given hour, if a combined cycle power plant is the marginal resource in the economic dispatch, the emissions rate of a combined cycle power plant is attributed to changes in demand or supply in addition to any direct emissions. Figure 10 shows heat maps from the Olson et al. analysis for several U.S. power markets. Many hourly swaps can occur with no incremental impact on GHG emissions. However, some swaps have hourly grid carbon-intensity differences of up to 400 kg-CO₂/MWh resulting in marginal consequential emissions from electrolytic hydrogen production on the order of 20 kg-CO₂ per kilogram of hydrogen.

Ricks et al. use an alternative approach to calculating SRME rates (SRMER). They optimize the resource portfolio including electrolyzers, allowing the electrolyzer load addition to change the installed resource mix as well as how resources are dispatched. They then model the optimal dispatch of electrolyzers to achieve least-cost hydrogen production under the applicable time matching constraint. The consequential GHG emissions impact is defined as the system-wide emissions with the electrolyzer minus that without divided by the difference grid energy to serve the marginal load.

An alternative approach to short-run marginal analysis is to use long-run marginal analysis such as that employed in the NREL Cambium tool.²⁴ Figure 11 shows heat maps of the levelized 2028 – 2048 power grid long-run marginal emissions rates (LRMER) for six states spanning the U.S. and featuring differing resource mixes. The hourly spreads in carbon emissions are substantially higher in most market areas

²⁴ <https://www.nrel.gov/analysis/cambium.html>

using grid average carbon intensities than using marginal intensities. NREL argues that this method is a better planning approach than the SRME for long-horizon changes in supply and load.

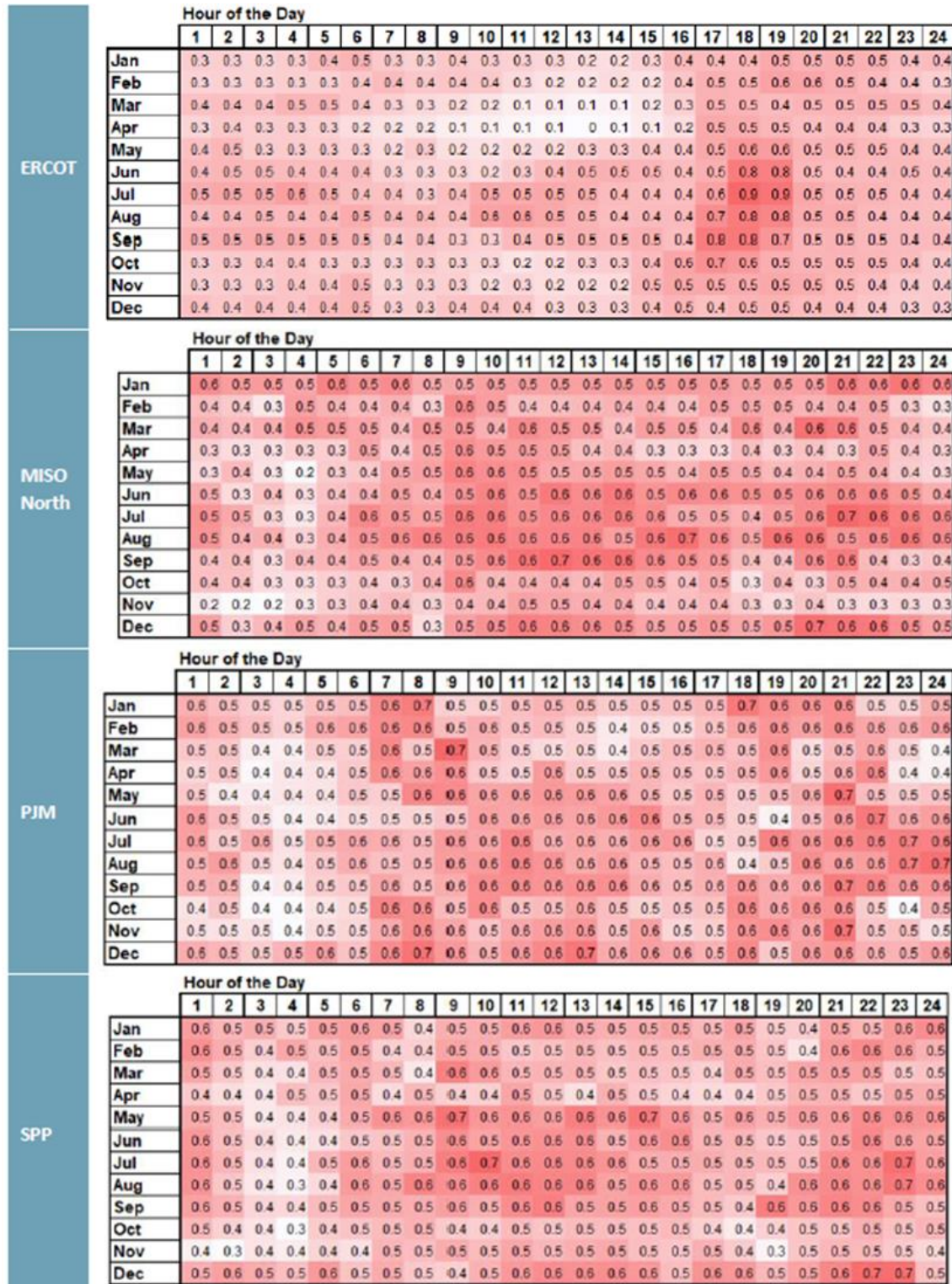


Figure 10. Heat Maps of Grid Carbon Intensity in Several U.S. Power Markets (metric tons CO₂ per MWh). . Source: Olson et al. [17].

Hour of the day	Levelized Hourly LRMER -- Base Scenario						Levelized Hourly LRMER -- Low Carbon Scenario					
	CA	FL	IL	NY	TX	WA	CA	FL	IL	NY	TX	WA
0	41.9	459.8	276.7	39.5	103.8	12.4	46.7	261.3	185.0	42.1	78.7	12.2
1	45.2	482.8	277.3	38.9	104.6	12.6	49.7	289.1	184.4	40.7	78.0	12.4
2	47.4	492.4	278.0	38.2	105.1	12.7	51.6	301.6	186.0	40.5	79.6	12.6
3	47.2	486.6	278.5	38.0	104.9	12.5	51.5	296.6	187.1	40.1	80.1	12.3
4	45.2	466.4	269.4	37.4	103.8	11.8	50.0	272.1	175.9	38.7	79.4	11.8
5	37.1	422.4	235.1	32.1	99.1	10.7	41.0	228.2	149.9	32.6	73.8	10.9
6	24.2	304.4	201.1	25.5	84.4	7.8	26.8	146.5	126.7	26.0	60.7	8.7
7	10.2	192.7	163.8	19.9	70.8	4.7	12.1	81.0	99.7	20.3	49.6	6.1
8	6.4	152.2	149.6	16.5	65.1	3.9	8.0	58.6	90.7	16.4	43.6	5.0
9	6.1	148.9	146.8	15.6	64.5	3.8	7.6	56.0	89.2	15.7	44.5	4.7
10	6.2	147.7	146.0	15.7	66.6	3.7	7.5	55.0	88.0	15.7	48.7	4.7
11	6.5	145.7	145.7	16.0	69.7	3.8	7.8	54.8	87.5	15.8	50.5	4.8
12	6.5	148.6	145.5	16.1	71.7	3.7	7.8	55.9	86.8	16.0	51.7	4.7
13	6.6	152.1	147.0	16.2	71.3	3.8	8.1	57.5	87.4	16.3	51.8	4.8
14	7.3	158.3	157.8	17.0	71.7	4.1	8.5	59.7	94.1	17.2	50.4	4.7
15	13.7	170.3	199.0	20.1	75.5	5.3	15.9	64.4	120.1	20.7	51.1	5.8
16	25.9	226.4	255.8	26.2	96.2	8.6	28.8	89.7	156.5	27.2	66.5	8.7
17	32.6	319.9	301.5	33.5	142.0	10.1	35.8	136.6	184.3	33.9	108.0	10.0
18	37.9	395.8	315.2	42.3	158.6	10.7	42.0	169.1	191.5	42.4	124.7	10.7
19	33.4	385.3	298.8	41.8	135.8	10.4	37.3	166.5	183.6	42.1	100.8	10.5
20	32.5	365.2	290.1	38.4	116.5	10.6	36.3	164.0	177.3	39.7	82.8	10.6
21	34.0	363.9	288.6	37.9	105.3	11.0	38.3	163.9	177.4	39.5	76.9	10.8
22	35.4	386.8	284.7	38.6	102.0	11.7	40.4	181.5	182.6	40.2	75.9	11.5
23	38.5	421.7	278.8	39.9	108.9	12.1	43.8	217.5	186.5	42.2	80.5	11.8
Min to Max	41.3	346.7	169.7	26.7	94.1	9.0	44.1	246.7	104.8	26.7	81.0	7.9
Average to Max	22.4	204.7	76.5	2.8	54.8	0.3	23.6	165.8	48.9	12.8	54.3	4.0

Figure 11. Cambium Model Carbon Intensities (kg-CO₂e per MWh) Levelized from 2028 to 2048 in 6 States Spanning the U.S. Under the Base or Mid-Case (Continuing Current Policies) Scenario and Low-carbon (95% Decarb by 2050) Scenario.

Cybulsky et al. refer to the methodology employed by Ricks et al. as the “Compete” framework and to that of Zeyen and Olson et al. as the “Non-compete” framework. Another way to describe these would be that the Compete framework includes electrolyzers and their dedicated renewable resources within an optimized, integrated resource plan, and the Non-compete framework treats them as exogenous to the planned resource portfolio. As a consequence of the differing modeling approaches, the “Compete” framework predicts a much higher consequential emissions increase between hourly and annual matching than does the “Non-compete” framework. Which approach better predicts future measured emissions depends on many factors related to the regulatory frameworks under which electric-system supply and demand resources are added to or removed from the resource portfolio, who owns them, and the rules under which resource owners can buy and sell power and grid services such as load dispatch.

Cost Impact

Findings from quantitative analysis of the likely impact of hourly time matching on hydrogen production cost are mixed due to differences in modeling methodology as discussed above. In addition, results vary by region, the time point of the analysis, differing assumptions on technology cost, and the presence or absence of mandates or incentives. The results also depend strongly on if and how additional requirements (requirement that power be sourced from new facilities only) are applied. If buyers are able to procure firm, zero-carbon resources, such as hydro or nuclear power, the cost impact of hourly matching may be minimal. However, both regulation and existing rights to these resources limit the ability to procure these resources, and the present discussion assumes that power is procured from wind and solar resources, and that battery storage is an option for time shifting.

As a fundamental matter, achieving a high load factor for any consumer of 100% variable renewable energy requires storage, and storage increases cost. Analysis by the Rocky Mountain Institute [18] of representative data center and building loads projects that applying a 90% time matching requirement in the PJM balancing authority would add \$60/MWh to the price of renewable power, about a 90% increase in price relative to a scenario without a time-matching requirement as seen in Figure 12. Figure 13 shows the projected cost-optimal resource additions on the California grid in a scenario reaching full decarbonization by 2045. Physical storage grows dramatically as the renewable fraction grows beyond 60%, and average constant-dollar generation rates increase by about 15% over the modeled time horizon.²⁵

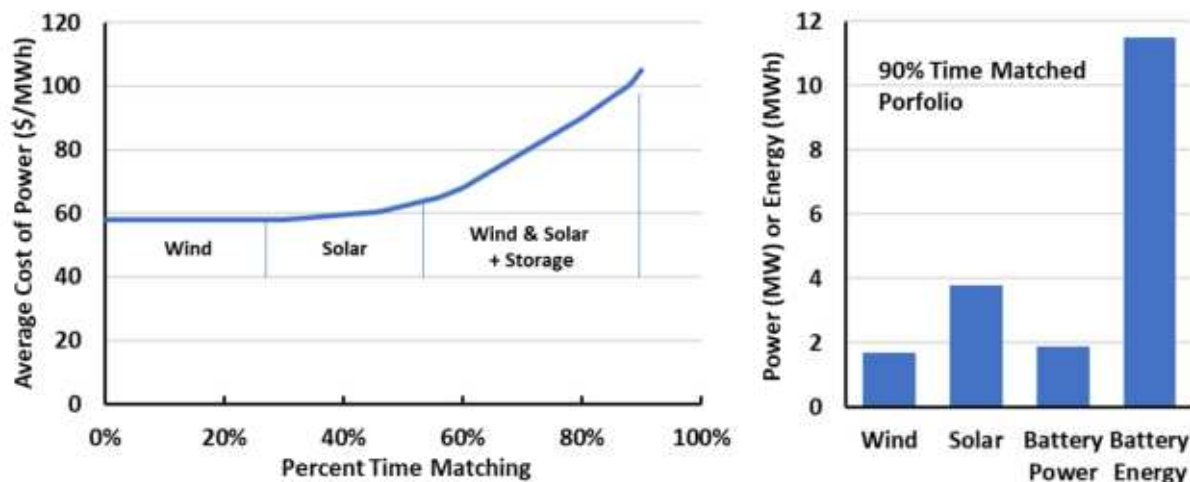


Figure 12. Cost Impact of Time Matching Renewable Power at 90% Match in PJM Balancing Authority. Source: Figure created using data from RMI analysis [18].

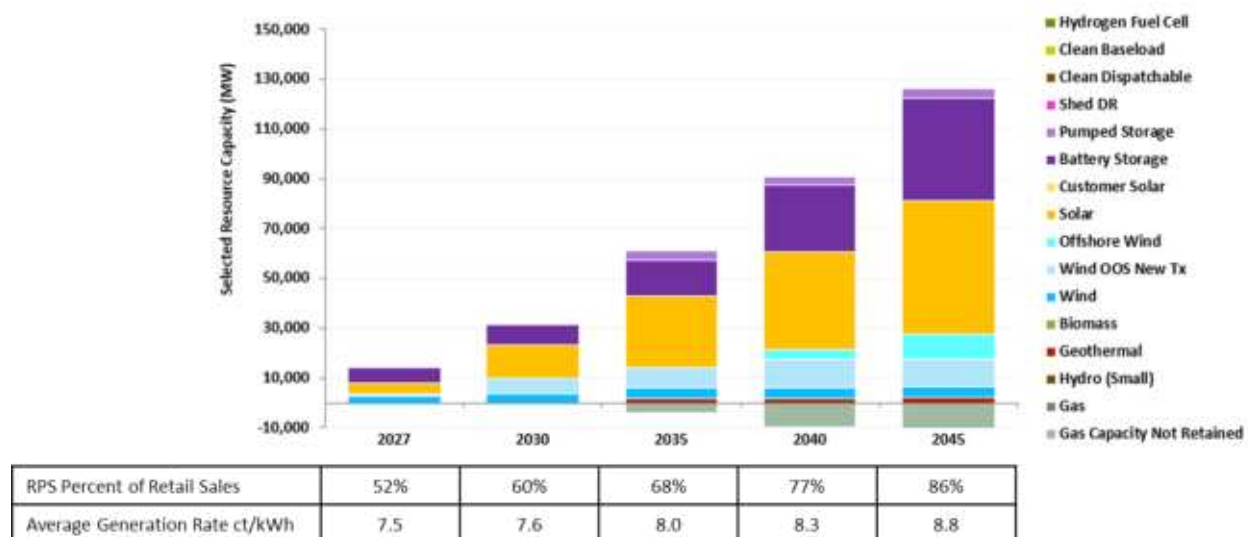


Figure 13. Optimal Resource Additions and Generation Rates Under California Renewable Portfolio Standard. Source: California Energy Commission SB 100 Report and Modeling Scenarios available at <https://www.energy.ca.gov/sb100/sb-100-events-and-documents>.

²⁵ <https://www.energy.ca.gov/sb100/sb-100-events-and-documents>

The studies by Ricks et al. [15], Zeyen et al. [16], Olson et al. [17] described above focus on qualification for the U.S. federal tax credit authorized under the Bipartisan Infrastructure Law, but the conclusions can be applied to other types of load. As with emissions impacts, the approaches yield opposite conclusions on the cost of achieving a near-zero carbon intensity under hourly versus annual matching requirements.

Ricks et al. find that, in most zones modeled, the production cost uplift for electrolytic hydrogen under hourly versus annual matching is minimal (0% to ~5%). The group concludes that hourly matching can be implemented with minimal cost impact. However, the increment reaches \$1/kg in the Northern California market. At the level of \$1/kg, the impact would be significant given an unsubsidized target cost of \$1/kg by 2030 under the U.S. DOE program Hydrogen Shot. A cost point of \$2/kg (net of a \$3/kg subsidy) is more in line with industry expectations. At this cost point, \$1/kg increases the net cost of hydrogen by 50%. The research group advocates strongly for near-term implementation of hourly matching.

Analysis of four regional grids by Olson et al. projects that imposing an hourly versus annual time matching requirement in 2025 and 2030 increases hydrogen production cost by 14% to 108%, with 50% of the cases showing cost increments between 25% and 54% [17]. The group concludes that annual matching reduces cost and can be achieved with minimal emissions impact.

Whether the “within the IRP” versus “outside the IRP” approach, or SRMR versus LRMR modeling approach is more accurate cannot be determined with certainty. Empirical data on costs and measured emissions are necessary to calibrate these models and determine which approach or combination best reflects reality. A necessary next step in the analysis area is to consider the resource planning, ownership models, and market rules, such as ability to procure power on real-time wholesale markets, which will actually apply in the regions analyzed during the launch phase of the renewable electrolytic hydrogen market. In addition, when considering renewable hydrogen, the GHG benefits of the use of hydrogen as a fuel should be reflected in lifecycle GHG analysis and, while outside the system boundary for the U.S. federal tax credit carbon intensity calculation, are highly relevant to determining appropriate policy.

Notwithstanding arguments on appropriate modeling methods, under current economics and market structures, it can be stated with certainty that hourly matching requirements will raise hydrogen production cost significantly. Delivery of energy from variable renewable resources to load requires investment in physical storage, such as batteries, or maintaining a load factor to match the physical production profile of the contracted or owned renewable portfolio. Either approach increases the cost of produced hydrogen. As an illustration, at a capital cost recovery factor of 15% and an electrolyzer installed cost of \$1000/kw (current cost is roughly \$1,200/kw) a reduction in capacity factor from 90% to 45% increases average hydrogen production cost by just over \$1.00/kg. If capacity factor is maintained at 90%, but the levelized cost of stored renewable electricity is 150/MWh, the average production cost is increased by roughly \$3/kg assuming the direct renewable supply costs \$30/MWh.²⁶

²⁶ A current-generation electrolyzer requires roughly 55 kWh of input power per kilogram of hydrogen produced, so a 1 kW electrolyzer would produce 160 kg of hydrogen per year at 100% capacity factor (8760 kWh / 55 kWh/kg). At a fixed annual capital cost charge of \$150/KW, the difference in capital charge per kilogram as $\$150/(45\% \cdot 160 \text{ kg})$ minus $\$150/(90\% \cdot 160 \text{ kg}) = \$1.04/\text{kg}$. In this example, there is no change in the energy cost per kilogram. For the storage case, the cost increase for hydrogen produced from stored electricity is the price difference between direct and storage energy multiplied by the production efficiency: $\$0.12/\text{kWh} \cdot 55 \text{ kWh/kg} = \$6.60/\text{kg}$. The increase in average cost of produced hydrogen is $\$3.30/\text{kg}$ assuming a 50/50 mix of direct and stored electricity powering the electrolyzer.

Feasibility

Several proposals have been put forward for implementing hourly time-stamped RECs [19], [20],[21]. In general, these proposals feature a gradual phase-in and recognize that the systems and data required for tracking, measurement and verification of times-stamped RECs will take time to implement. Establishing the software platforms and protocols could potentially be accomplished over a few years according to the Center for Resource Solutions [22]. The main argument for a longer phase-in is less about technical feasibility of establishing verification and tracking systems, and more about concern that the cost of meeting hourly matching requirements will inhibit the investment that EA credit incentives are intended to create. In addition, as discussed in the next section, existing regulations do not permit generation of RECs in all parts of the U.S. (see Figure 15 below), establishing regulatory frameworks to enable hourly matching will require time even where RECs are used.

The deliberations on this topic in the European Union have led to implementation of hourly matching beginning in 2030, with member states having the option to implement more stringent requirements beginning in 2027. The phase in is intended to allow project developers time to adapt to the new requirements and to expand power sourcing options for electrolytic hydrogen during the launch phase of the green hydrogen market in Europe.²⁷

Geographic Boundaries

Power and fuels markets deliver energy over networks. In such systems, the energy placed on the delivery system is not physically the same electrons or molecules that are delivered to the user. All current renewable energy procurement and credit programs require energy to be delivered to an interconnection or receipt point that is part of the same energy network as that from which the buyer is receiving energy. Some impose tighter limitations on the location of eligible resources with the goal of reducing the risk of increased emissions in locations not subject to program requirements (sometimes called resource shuffling), and/or to concentrate economic development in the area bearing the incremental cost of renewables.

There is currently discussion and debate with respect to both clean fuels and clean electricity on the appropriateness of geographic restrictions on generation and use of EACs. In the most stringent scenario, clean energy production and use would be required to be co-located or physically connected, and physical delivery would be required. Less stringent provisions may place requirements on deliverability (such as source and load on the same network) without requiring physical delivery. The most permissive proposals would allow EACs to be used to book and claim attributes at a large regional or continental scale.

Framing the Issue

Arguments in Favor of Tighter Geographic Restrictions: There are several arguments in favor of more stringent geographic requirements. These relate to local impacts, such as export of jobs and negative local environmental impacts, and constraints on delivery systems that lead to resource substitution with negative environmental consequences. This would occur, for example, if an electric transmission constraint prevented physical flow of renewable power to a buyer leading to the need to dispatch fossil power.

Arguments for Wider Geographic Boundaries: Proponents of broader geographic market boundaries assert that such provisions reduce the overall cost of meeting environmental targets or mandates and

²⁷ https://ec.europa.eu/commission/presscorner/detail/en/ip_23_594

provide market signals to incent investment in fuel and power delivery infrastructure to alleviate constraints. The idea is that larger geographic market areas reduce overall cost by allowing clean energy production to occur where it is most cost-effective, and that program design can minimize negative impacts of locational resource substitution. The argument is essentially that of comparative advantage recognizing that high-quality renewable resource areas may not be co-located with demand.²⁸

Available Evidence

Integrated resource planning (IRP) modeling tools are commonly used to model optimal capacity additions and least-cost dispatch of electric systems at various geographic scales. When least-cost supply resources are remote from load, larger market areas lead to lower costs provided that the resource cost differential exceeds the cost of transporting the energy. California has been on the leading edge of assessing the impact of geographic market boundaries on attainment of its renewable and clean power mandates. The topic of “regionalization” has been actively discussed as an approach to reducing the need for batteries and other electrical energy storage technologies. Figure 14 shows the results for optimal resource additions in California with and without the ability to expand regional import transmission capacity. Restricting regional imports increases the cost of generation plus storage by over \$2 billion per year (or 8%) in 2045. The cost uplift is driven by additional storage costs and increased overbuild of solar resources inside California.

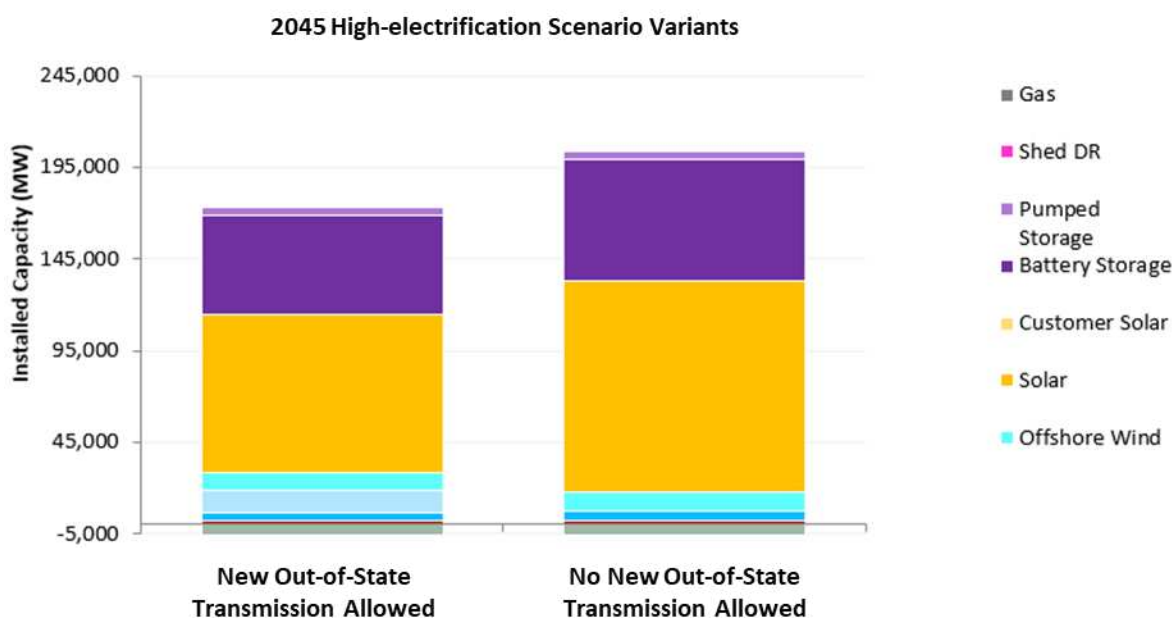


Figure 14. Comparison of California Resource Additions with and without Expanded Regional Power Import Allowed. Source: California Energy Commission SB 100 RESOLVE Modelling Cases. Available at: <https://www.energy.ca.gov/sb100/sb-100-events-and-documents>.

As noted earlier, in the absence of a market-wide carbon cap or RPS mandate, REC transactions can lead to significant incremental GHG emissions. This occurs when the generating source that is backed out of the dispatch when the REC is created has a lower carbon intensity than the resource providing power when the REC is claimed. This is sometimes referred to as resource shuffling. Transmission constraints can

²⁸ Adam Smith wrote in “The Wealth of Nations” (1776), “If a foreign country can supply us with a commodity cheaper than we ourselves can make it, better buy it of them with some part of the produce of our own industry, employed in a way in which we have some advantage” (Book IV, Section ii, 12).

exacerbate this negative environmental impact and should be considered in establishing market boundaries.

Access to the Grid and Power Markets

In the context of geographic boundaries for EAC programs, consideration should be given to the fact that tracking, verification, and trading systems do not cover all areas of the U.S. Ten states in the U.S. are not covered by REC tracking systems (see Figure 1 above), and, as seen in Figure 15, bilateral PPAs are only available in some locations. Universal market coverage for RECs and PPAs would reduce the overall cost of attaining environmental goals as lack of universal coverage restricts both supply and demand.

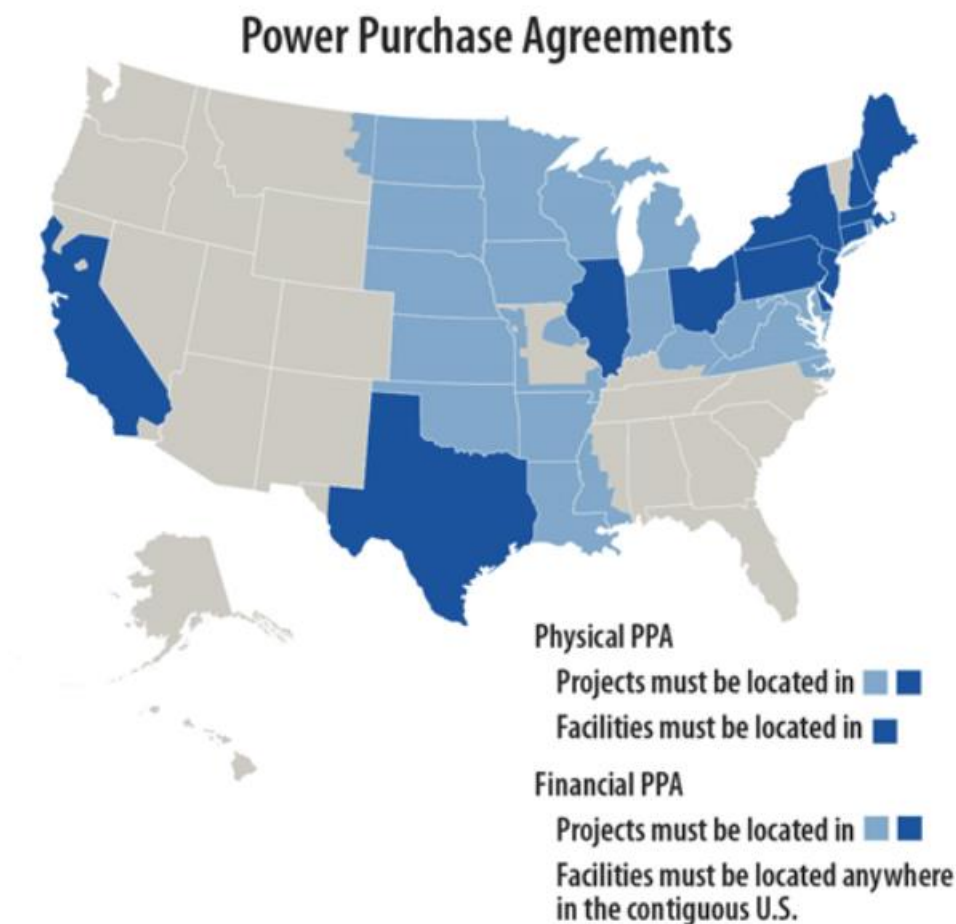


Figure 15. Locational Availability of Bi-lateral Power Purchase Agreements in the U.S. From: <https://www.epa.gov/green-power-markets/us-electricity-grid-markets>

For biomass resources, the least-cost energy production areas may be distant from demand centers. This is similar to what is seen with the current natural gas and oil markets. The U.S. Department of Energy Billion Tons Report [23] assessed the availability of biomass at various recovery cost points across the U.S. Like wind and solar, biomass density varies significantly across regions, as seen in Figure 16. To the extent that the demand for biomass-derived renewable gas and the resource potential are not co-located, and provided that the cost differential between local and remotely-sourced renewable gas exceeds the cost of transporting the fuel, then allowing region-wide or inter-regional supply arrangements lowers cost. In

addition, allowing region-wide or inter-regional sourcing provides a financial incentive to build transmission infrastructure. For gaseous and liquid biofuels, local benefits, such as jobs, and burdens, such as non-GHG pollution, are relevant policy considerations in establishing market boundaries, but resource shuffling is not a significant issue, due to the prevalence of low-cost transport and storage for gaseous and liquid fuels.

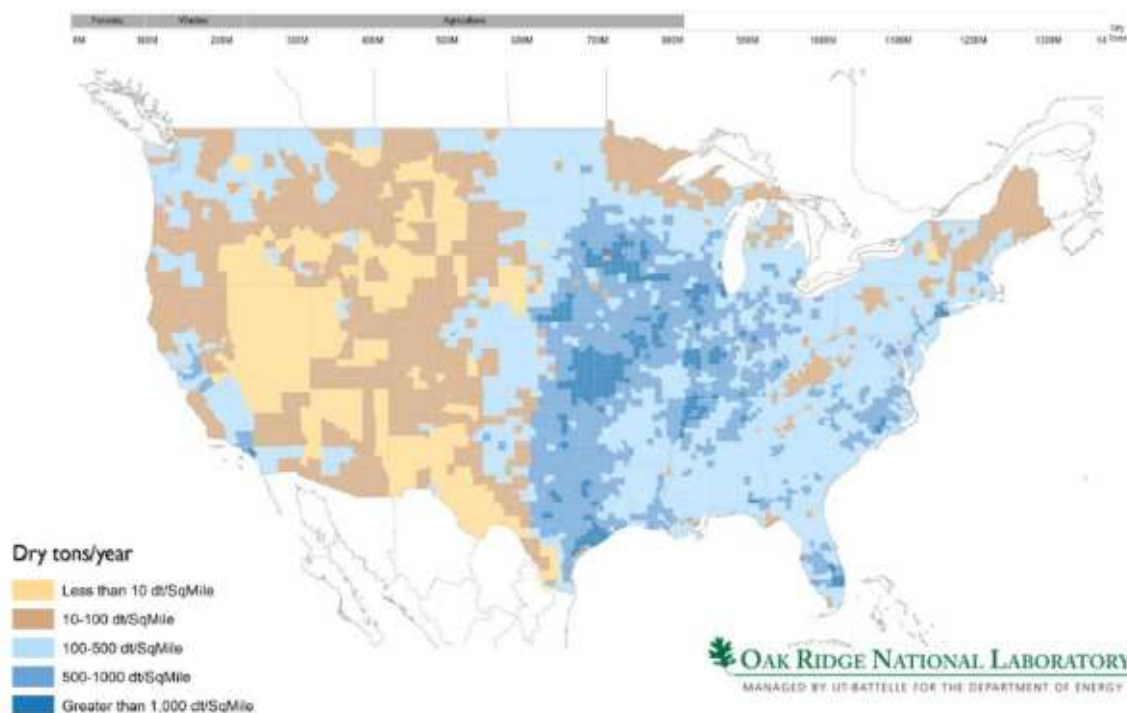


Figure 16. Biomass Resource Density in Dry Tons (dt) per Acre at \$60/ton Recovery Cost. [23]

Wholesale power and gas markets provide empirical evidence that energy markets operating at regional or national scale are cost optimal. Current natural gas markets operate on contract paths (contracts for delivery capacity between buyer and seller) that may be across thousands of miles and do not require physical delivery of molecules from buyer to seller. This is the approach that has been taken to date for biomethane supply contracts.

Tracking, Measurement, and Verification

Tracking, monitoring and verification protocols and systems serve the function of tracking quantities of qualifying energy production for purposes of credit generation and monitoring system performance, inputs, and outputs to verify compliance with applicable standards and protocols. Typically, validation is rigorous and detailed at project commissioning with ongoing monitoring, verification and reporting requirements of frequency and degree of detail dependent upon the specific program. Ultimately the purpose is to ensure that the environmental attribute instrument conveyed under the applicable program meets all program protocols and requirements. Credit invalidation and, in some cases, penalties are imposed, if TMV requirements are not met.

EACs are used not only as instruments to certify environmental attributes, but as instruments to support market transactions among parties. As instruments of value for compliance purposes and instruments carrying market value, EACs carry risk of fraud and inaccurate representation of environmental performance. It is critical from both policy and market perspectives that all parties have faith in the integrity of EACs. The question is the appropriate degree of stringency in tracking, measurement, and

verification protocols. At the highest level of stringency, key inputs, outputs, and process states are measured in real time and reported frequently or remotely monitored. On the less stringent end of the spectrum, project, process, or program elements are verified at initiation of the activity with only high-level measurement of key quantities, such as purchased inputs and metered fuel or power outputs, measured and/or verified on a frequent basis unless there is a major change to the process or equipment.

Framing the Issue

Arguments in Favor of Stringent TMV: The primary arguments in favor of stringent TMV requirements are that they ensure environmental integrity, increase credit market confidence, reduce potential fraud, and, with increasingly low costs for automated measurement, data acquisition and analysis costs and human effort are not burdensome. It is also argued that higher stringency than current practice is needed to implement time matching and deliverability requirements.

Arguments in Favor of Less Stringent TMV: The primary arguments in favor of lower stringency requirements are cost, feasibility, financial risk, and lack of need. Proponents of lower stringency requirements are concerned about the cost of complying with what they view as stringency requirements beyond what they see as necessary to meet program goals and ensure program integrity. Such costs include monitoring and recording equipment, as well as the labor required to gather, synthesize and report required data. Some argue that some proposed requirements would require slow-down or shutdown of otherwise continuous operations to conduct measurement and verification and are infeasible from a practical perspective. The concern over financial risk stems from the potential for EACs to fail certification or face invalidation due to failure to meet TMV requirements that they view as overly onerous. They argue that more light-handed approaches are adequate and that the risk of gaming and fraud are low.

Available Evidence

No rigorous analysis balancing the cost of more stringent TMV requirements against the cost of inaccurate environmental attribute tracking was found through the research conducted for this white paper. Anecdotally, the prevalence of credit disallowance in California carbon credit markets is low²⁹ and invalidation insurance for carbon credits in voluntary markets is relatively inexpensive. These are indicators that TMV protocols are functioning adequately and that new requirements should be focused on technical program changes such as more granular time matching. Some commenters to the U.S. Treasury Department docket on implementation of tax credits authorized under Inflation Reduction Act, such as Constellation Energy,³⁰ have provided specific arguments on why some proposals for more stringent monitoring and verification requirements add cost and pose operational challenges but no analysis was identified that quantifies the cost of alternative approaches to tracking, measurement, and verification. The bottom line is that more rigorous analysis of this topic area is needed to support fact-based policy decisions on the balance between ensuring the environmental integrity of attribute credits and the costs and operational impacts of tracking, measurement, and verification.

Technology Differentiation and Early-Market Preferences

A policy question arises as to what, if any, special provisions, or support are appropriate when nascent clean energy technologies that are in need of scale to reduce cost are introduced into the market. As a

²⁹ <https://ww2.arb.ca.gov/resources/documents/lcfs-enforcement>
<https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program/offset-credit-invalidation>

³⁰ <https://www.regulations.gov/docket/IRS-2022-0029/comments>

general principle, it can be argued that policies should be technology neutral, and market forces should determine winners. This argument is sound but, but technology-neutrality can be viewed over the technology lifecycle. From that perspective, technology-neutral treatment could include similar preferences during the launch and scaling phases for emerging technologies deemed to have the potential to compete on a level playing field in the timeframe needed to reach policy goals. Renewable gaseous fuels are such a nascent resource. The two primary processes for producing renewable methane and hydrogen at scale are thermochemical conversion of biomass and electrolysis of water. Both pathways are significantly more expensive than fossil pathways using carbon capture, and, as can be seen in Figure 17, both project to have the potential to be cost-competitive within five to ten years if deployed at scale. Debate is currently active on the degree of stringency that should be applied for credit generation (tax credits under IRS Section 45V, renewable gas qualification under WRI greenhouse gas reporting protocol, and eligibility in low carbon fuel standard programs) from renewable methane and hydrogen. The key issues are requirements for deliverability, additionality, and in the case of electrofuels, time matching of input RECs for input electricity.

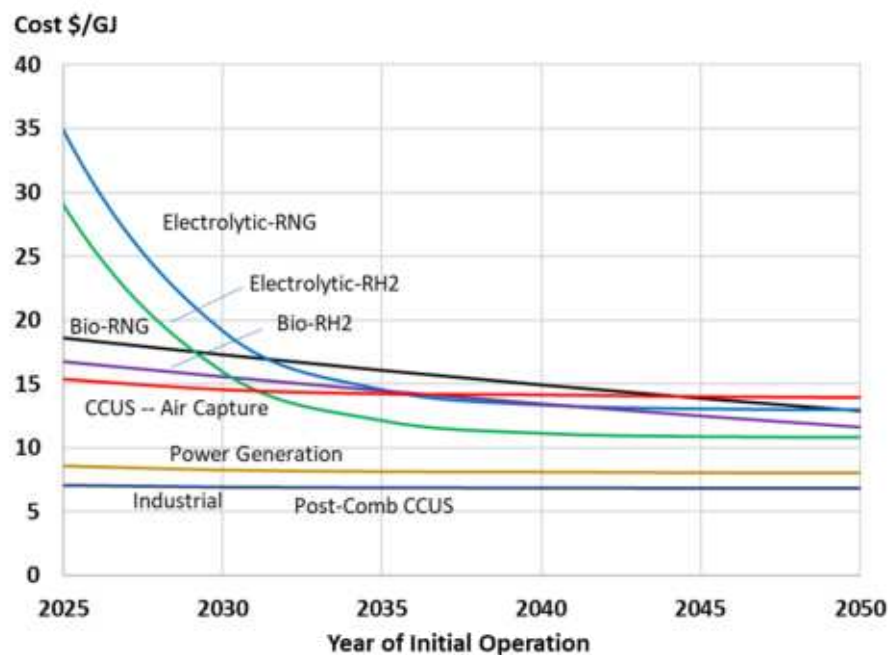


Figure 17. Projected Cost Projection for Renewable Hydrogen and Methane (2020 Constant Dollars). CCUS is carbon capture utilization and storage. RNG is renewable natural gas. [24]

Framing the Issue

Arguments in Favor of Preferences

The argument in favor of preferences for nascent technologies is that special measures to support entry and scaling of new technologies create downstream benefits to justify the preferences. Compliance flexibility and a variety of subsidies have aided wind and solar technologies in reaching a point, absent storage requirements, of cost parity with conventional resources. It is argued that such preferences are consistent with technology neutral policy if applied evenly to new technologies as they enter the market and if preferences have a finite life.

Arguments Against Preferences

The argument against technology-specific preferences is that they interfere with market forces that should properly determine which technologies enter and succeed in the market. Under this view, all clean-technology preferences should be technology neutral. A related argument is that preferences should be transparent and not provided in ways that skew tracking and reporting of environmental benefits, such as GHG reductions.

Available Evidence

Many clean energy programs provide, or have provided in the past, preferences for emerging technologies with the expectation that their cost and performance would improve over time to the degree that preferences would not be needed. Solar photovoltaic technology is the most prevalent example. As of 2021, 19 states have implemented technology preferences (such as credit multipliers) or carve-outs (technology-specific minimums) within RPS programs [10]. The motivation for solar preferences has been that, while wind power costs were significantly lower than solar PV costs until the late 2010s, solar costs were dropping rapidly as deployment volume increased. Separately traded RECs, referred to as solar RECs (SRECs), have been implemented in many cases to facilitate these preferences. Low-carbon fuel standards are another example. Such programs partition the carbon emissions from the transportation sector from other sectors. The objective is to incent investment in zero-emission drive technologies and fuels with the expectation of ultimately achieving cost parity with incumbent technologies. Figure 18 shows the required growth in solar capacity through solar carve-out under state RPS programs. Solar capacity in New Jersey has grown from under 300 MW when the solar carve-out was implemented to 4,000 MW by mid-2022 through a variety of pro-solar policies.³¹

It is worth noting that preferences that use EACs as the vehicle for conveying incentives to preferred resources often depart from pure attribute accounting. For example, REC multipliers for solar resources (implemented in several states) create a situation in which the RECs generated exceed the megawatt-hours of renewable energy delivered. The refueling capacity credits generated under the California LCFS program represent potential future reductions in greenhouse gas enabled by the up-front provision of infrastructure.³² Those credits are a means of providing an incentive but do not represent a metric ton of achieved carbon reduction as other LCFS credits in this program do. A valid argument can be made that incentives should be direct and transparent, and attribute credit generation should not depart from verifiable attribute creation. However, the use of existing instruments to provide resource specific incentives is common when working within established statutory or regulatory frameworks.

³¹ <https://www.nj.gov/bpu/newsroom/2022/approved/20220715.html>

³² <https://ww2.arb.ca.gov/resources/documents/lcfs-zev-infrastructure-crediting>

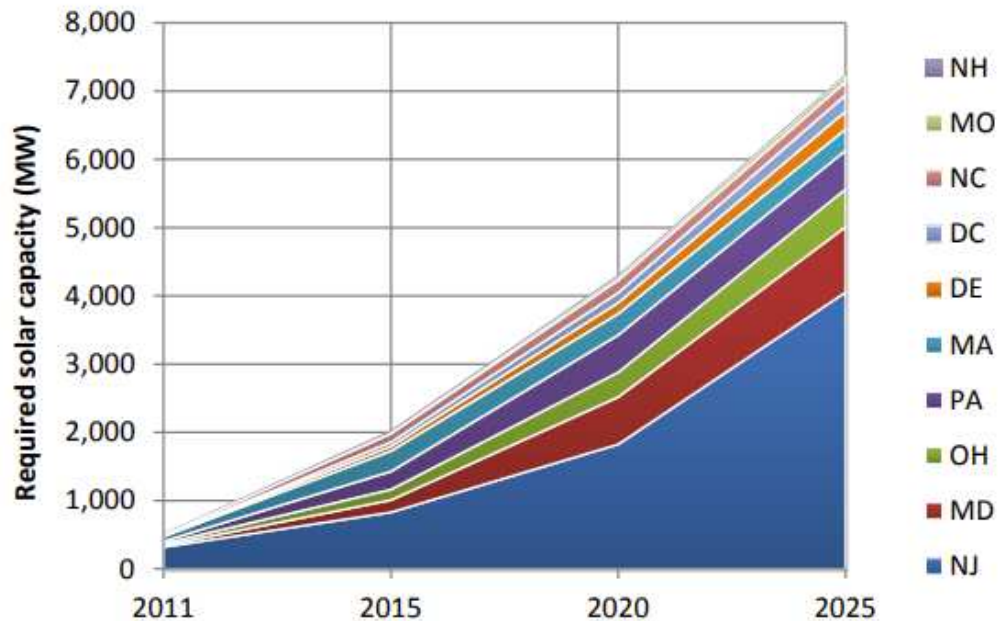


Figure 18. Solar-Specific RPS Requirements in the U.S. Source: NREL [25].

EAC Value Certainty

The conveyance of predictable financial value is critical to attracting investment to clean energy technologies. In the interviews for this white paper, stable supportive policies emerged as the most critical factor in attracting investment. For EACs this means low risk of invalidation, certainty of program continuation, and stable prices for traded attributes. In this section, we discuss price certainty. Grants and tax credits convey a pre-defined financial value. However, EACs such as RECs, LCFS credits, carbon credits, and thermal energy certificates exhibit price volatility as supply and demand fluctuate. This volatility creates investor risk which can stifle investment. Developers of clean energy projects identify uncertainty in credit prices as a significant barrier to investment. Once clean energy and carbon markets are fully mature and traded on traditional exchanges, hedging instruments can be expected to be readily available in the form of futures. The question is whether, in the early phase of these markets, the program sponsors (state or federal agencies) should step in to provide a price-stabilizing function.

Framing the Issue

Arguments in Favor of Regulator Action: The argument in favor of program sponsors establishing mechanisms to stabilize EAC prices is to ensure that program objectives are achieved. EAC programs are put in place to create environmental benefit through funding of environmentally beneficial projects and activities. To the extent that EAC price volatility is hindering investment, establishment of price stabilizing mechanisms may be justified. It is also argued that, in the early stages of market development for tradeable EACs, market guardrails are appropriate as trading volumes and market participation build.

Arguments Against Regulator Action: The argument against program sponsors establishing mechanisms to stabilize EAC prices is that such programs place risk on the sponsors and may distort market forces. Program designs that feature credit trading seek to rely on market forces to optimize investment and are argued to function most efficiently without interference. In addition, providing price guarantees involves risk that is not appropriate for program sponsors to assume.

Available Evidence

Typical of other commodities, EAC price volatility can be significant. Figure 19 through Figure 22 show the price history for a range of EACs. As can be seen in these figures, price volatility is significant across both long (several years) and short (quarterly) time horizons. Statistical analysis and modeling of SRECs in New Jersey finds that price volatility reduces investment [26]. Similar analysis of uncertainty in wind production tax credit continuation show of solar incentives find that uncertainty of continuation of incentives also reduces investment [27][28].

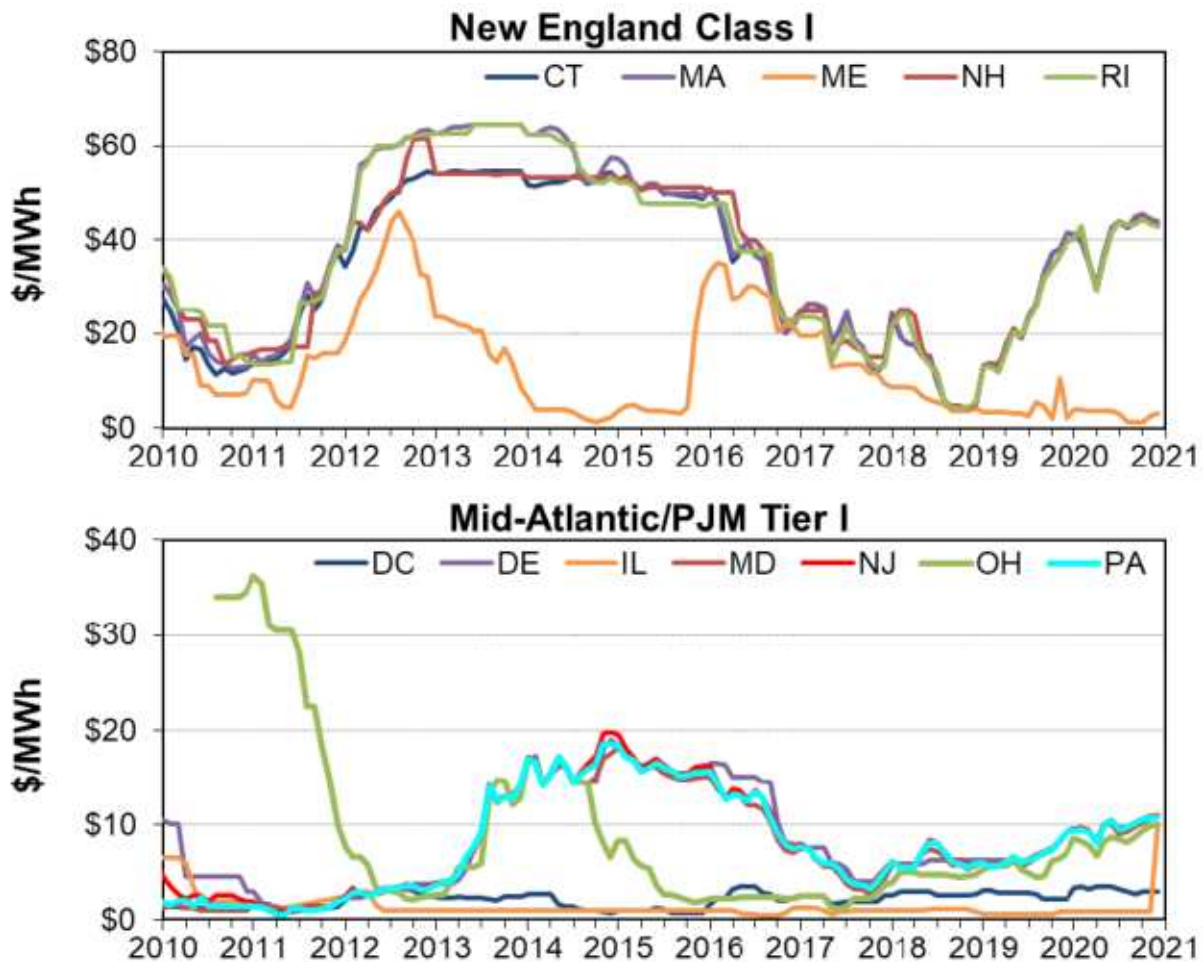


Figure 19 – Historical REC Pricing for meeting primary RPS goals in New England and Mid-Atlantic states, 2010 – 2021. Source: Lawrence Berkeley National Lab, using data from Marex Spectron [10].

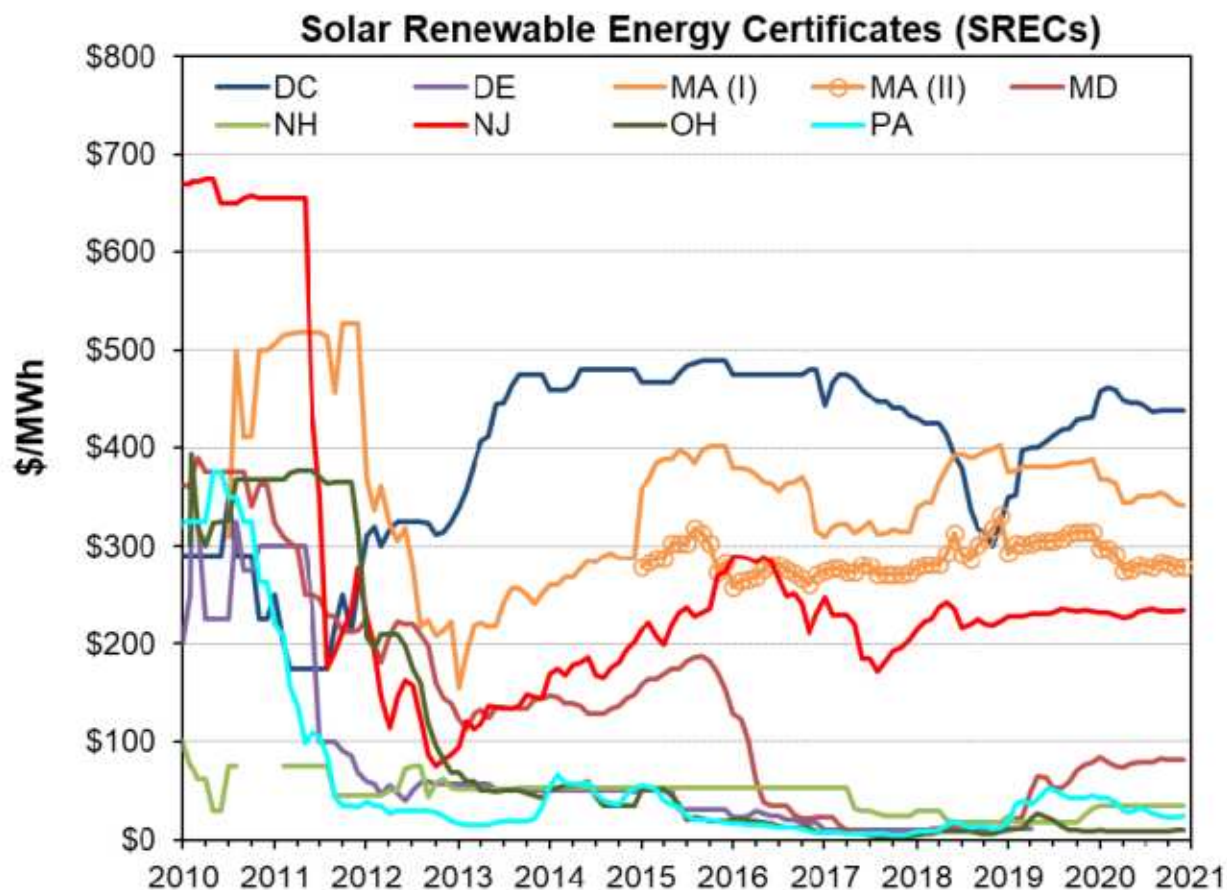


Figure 20 – Historical SREC Pricing for meeting primary RPS goals in New England states, 2010 – 2021. Source: Lawrence Berkeley National Lab, using data from Marex Spectron [10].

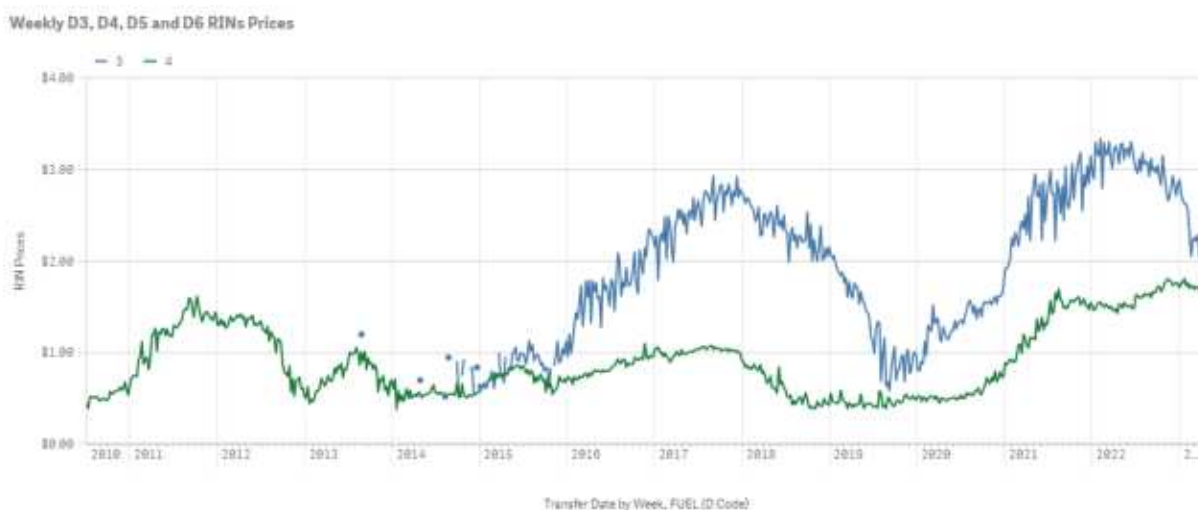


Figure 21 – Historical trends in RIN prices from 2010-2023 for D3 (cellulosic) and D4 (advanced biomass-based diesel) biofuels. Source: U.S. EPA RIN Trades and Price Information <https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rin-trades-and-price-information>

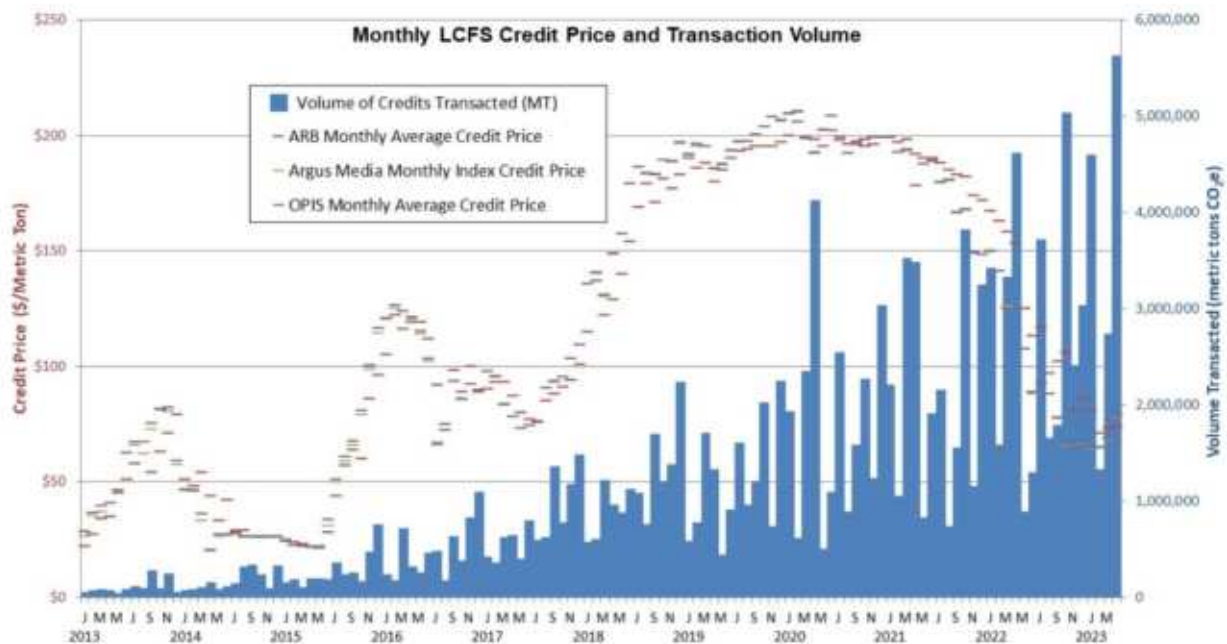
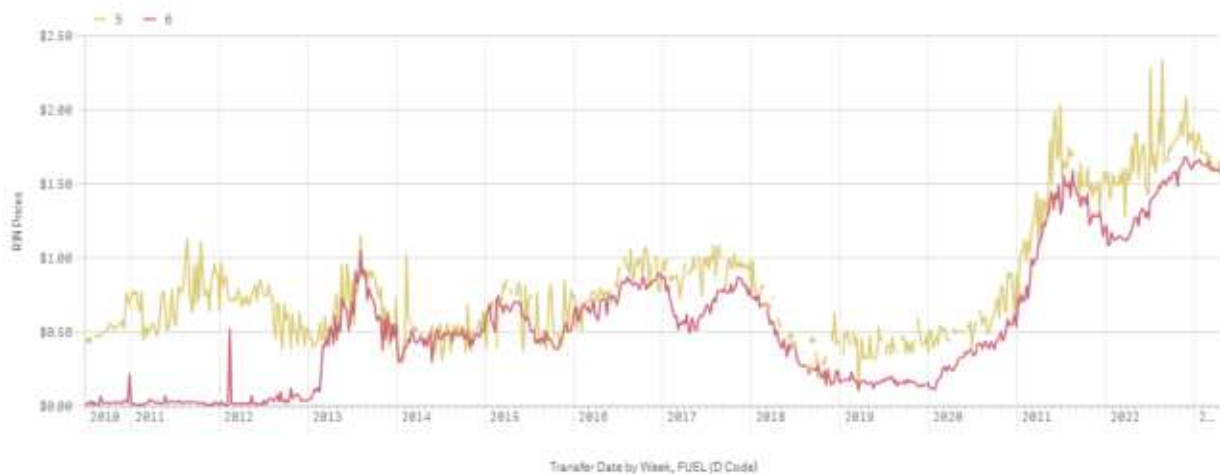


Figure 22 – Historical trends in monthly LCFS credit prices and volume of LCFS transactions. Source: California Air Resources Board, using price data from Argus and OPIS, updated 5/15/2023.
<https://ww2.arb.ca.gov/resources/documents/lcfs-data-dashboard>, updated 5/15/2023

A variety of mechanisms have been used to create price stability and compliance flexibility (in mandatory markets) for EACs. These include feed-in tariffs, contracts for differences (CFD), reserve auction mechanisms, and banking and borrowing provisions.

The contracts for differences program in the U.K. renewable power market has proven successful in providing EAC value certainty for investors. A contract for differences is a contract between two parties, typically a renewable energy producer and a financial counter-party, under which an uncertain credit revenue stream is exchanged for a certain (often constant) revenue stream. In the U.K., the level of the certain revenue stream is negotiated between the two parties or through a reverse auction. Wellisch and Rahmatallah show the effectiveness of the approach in stimulating investment in offshore wind under an

emerging-technology carve-out and suggest some improvements to reduce artificially low clearing prices [29]. Savelli et al. describe an approach to internalizing transmission congestion costs in the CFD framework to create funding to expand transmission capacity to reduce curtailment [30].

Stakeholder Perspectives

Stakeholder perspectives and priorities on the role and requirements for EACs were compiled from several sources. Ten stakeholder interviews were conducted as part of the current study, the roughly 200 comments to the docket in response to the IRS request for comments on requirements for generating Section 45 tax credits enacted under the Inflation Reduction Act were reviewed,³³ and reported findings from 42 stakeholder interviews conducted as part of the Carley et al. study to aid in interpreting their statistical correlations were incorporated [1].

Developer, Investor and Technology Provider Perspectives

The perspective of supply-side stakeholders with few exceptions is that policies should be designed to maximize deployment of preferred technologies. With respect to environmental attribute credits, this means favoring maximization of credit value, flexible program features for the generation of EACs, and certainty in the stability of program features. The ability to finance projects is the key to capacity expansion. Finance is provided based on the pro forma free cash flow of projects which flows from predictable revenue streams.

For clean energy projects, particularly for nascent technologies, EACs may be a primary source of project revenue. Both credit value and credit value certainty are important. Tax credits and direct incentives provide both. Credit exchanges, such as those under cap-and-trade programs, are arguably the most market-efficient mechanisms, but investors will apply a risk premium when depending on returns from these instruments, correlating to the uncertainty in or volatility of prices. To reduce uncertainty, several jurisdictions have explored the use of contracts for differences and other approaches to creating credit-price floors, usually in exchange for capped returns on credit sales. Supply-side stakeholders are strong proponents of such programs. They also advocate strongly against abrupt changes in program features and incentive program “cliffs” and instead favor phased-in or phased-out provisions.

It should also be noted that entities on the clean-energy supply side may advocate strongly for policies that favor their technology class at the expense of competing clean-energy technologies. Due to this competitive dynamic, supply-side stakeholders may take differing positions.

Regulator Perspectives

Regulators are focused on meeting their statutory mandates. This generally translates into achieving regulatory and statutory environmental mandates at least cost. Regulators are charged with balancing stakeholder interests and follow well defined procedures for receiving stakeholder feedback and adjudicating issues impartially in line with policy goals and the public interest. Energy regulators seek to balance stringency with technical feasibility and deployment timelines that enable policy goals to be met. Regional variations on perspective are driven by differences in renewable resource availability and individual state policy frameworks and priorities.

³³ <https://www.regulations.gov/docket/IRS-2022-0029/comments>

Buyer Perspectives

Relative to EACs, there are two primary buyer groups: compliance buyers and voluntary buyers. The primary compliance buyers are electric utilities under mandatory RPS regimes (and a small number of gas utilities under renewable gas procurement mandates), and corporations subject to greenhouse gas cap provisions. The primary voluntary buyers are corporations seeking to reduce their environmental footprints outside of mandated programs and individual consumers participating in voluntary programs, such as green tariffs. Both mandatory (compliance) and voluntary buyers advocate policies that allow them to achieve procurement goals at least cost and little or no risk of credit invalidation.

Third-party Advocates

Third parties are non-regulator entities that are not parties to EAC transactions (buyers or producer/sellers) that assert a stake in the rules for the generation and use of EACs. Regulators are a special class of this group and are treated separately due to their authority. Environmental non-governmental organizations (ENGOS) with varying missions related to improving the environment are a primary stakeholder group in this category. Organized Labor is the other major group in this category. The majority of stakeholders in the ENGO group are strong advocates for stringency in all forms. Labor groups focus on job creation and job quality within their represented trades and geography.

Table 1 below summarizes the typical perspectives of the various stakeholder groups. The majority of stakeholder input relates to the use of EACs representing renewable power or renewable fuel, and much of the input relates to implementation of the tax credits enacted under the Inflation Reduction Act.

Balanced Policy Options

The policy and program design issues under consideration regarding the provisions and requirements for the use EACs in voluntary and mandatory programs generally relate to finding a balance between provision of effective incentives to stimulate investment in preferred technologies and pathways, and the desire to guarantee that desired environmental benefits are attained. At a macro level, these goals need not be in conflict. However, at the implementation level, stringent program requirements have the potential to stifle project development such that the total investment pipeline creates fewer benefits than would be the case under more permissive or inclusive program requirements. Alternatively, program requirements that are not stringent enough can result in reduced environmental benefits being realized. Some considerations on finding an optimal balance are discussed below.

Targeted Support for Nascent Markets and Technologies

In cases where a program goal is to advance a particular resource class predicated on expectation and evidence that it will yield cost-effective environmental benefits once fully established, more permissive program requirements and preferences may be justified. This has been the case, for example, with solar carve-outs in RPS programs, the Hydrogen Refueling Infrastructure credit program in the California LCFS, special subsidized rates for electric vehicles, and net metering programs for renewable resources. Arguments can be made regarding the relative merits of using direct grant incentives, production-based incentives, tax credits, or other vehicles. However, once an incentive approach has been defined, program design should consider the stage of the market for the relevant resource class(es).

Table 1. Typical Stakeholder Positions on EAC Policy Issues.

	Clean Energy Supply Side	Regulator	Buyer	3 rd Party Advocate
Additionality	• Most assert that additionality is ensured by the incentives themselves • Strong concern from green hydrogen producers on overlay of additionality requirement on an input (renewable electricity) • Some are neutral, but are concerned about lack of clear definition of additionality • Some believe support for existing renewable resources is also needed to avoid stranded assets • Build and interconnection timelines are a major concern • Positions driven by expected business impact on supplier / developer	• Energy regulators may view as an impediment to cost-effective achievement of mandates • Concerned about lack of clear definition of additionality	• Both mandatory and voluntary buyers favor compliance flexibility • Voluntary buyers concerned about environmental integrity, so may support provisions ensuring that voluntary demand leads to incremental supply	• ENGOs support imposition of additionality tests for all EACs • Labor generally supports new-build requirements due to associated increase in construction activity
Time Matching	• Most power producers and electrolytic hydrogen producers favor phase-in, typically in the 2030 timeframe due to cost and feasibility concerns • A few favor earlier implementation noting that the trend toward hourly matching is already under way • Storage providers favor rapid implementation	• Support to the extent required to meet mandates -- guided by resource planning models • Concerned about technology readiness of hourly time matching products, with some indicating monthly time matching is presently more technically feasible	• May support in principle but concerned about cost and supply availability • Some large voluntary buyers are entering into time-matched agreements already	• Strongest advocacy for time matching is from ENGOs although positions vary • Strong concern among many over shortfall in attaining GHG reduction goals without hourly time matching
Geographic Restrictions	• Generally, favor broad market boundaries to avoid development impediments and constraints • Support actions to address transmission and interconnection constraints to facilitate larger market areas	• Positions are mixed based on statutory provisions and balance between rate containment and utility labor interests • Some consider geographic restrictions among the simpler to implement	• Both mandatory and voluntary buyers favor compliance flexibility • Voluntary buyers concerned about environmental integrity so may support provisions requiring deliverability	• ENGO positions similar to time matching • Labor positions align with job maximization in the trades and geographic area represented
Tracking, Measurement, and Verification	• Rigorous at project start and minimum ongoing TMV to demonstrate compliance	• Sufficient to ensure statutory requirements	• Sufficient to provide de minimis risk of invalidation	• Rigorous throughout project life and evolution toward real-time automated

Note: Legislators are also key stakeholders but do not have systematic alignment of positions on EACs.

Consistency with Program Purpose

Incentive programs are designed for a variety of purposes. For environmental programs, the purpose is generally to achieve particular environmental goals, but the mechanism varies across programs. A remediation program may focus on immediate and specific action to correct environmental damage, while a program seeking to promote deployment of a preferred technology would focus on maximizing deployment over a particular time horizon predicated on a longer-term view of environmental benefits to accrue from deployment of the technology.

There is current debate over the requirements to be met to qualify for tax credits enacted under the IRA. The stated purpose of the program is to stimulate private investment in clean energy technologies with carbon intensity as a key criterion for qualification for tax credits. For example, the statute provides for tax credit eligibility for clean hydrogen with a carbon intensity below 4 kilograms CO₂e per kilogram of hydrogen and provides additional credits in tiers for CI below the threshold. Much of the controversy is over the use of RECs for calculating Scope 2 emissions (procured power). Similarly, there is debate over how to assess carbon intensity of clean fuels derived from biomass, particularly with respect to indirect land use impacts. While accurate GHG accounting is critical to achieving climate goals, the method of carbon-intensity calculation used in determining tax credit qualification should match that envisioned when the amount and value of tax credits was determined. Delinking credit value and carbon-intensity calculations may lead to failure in stimulating investment in clean energy resource supply. Given that the tax credit amounts are specified in statute and cannot easily be adjusted to reflect changes in carbon-accounting methodology, compromise on implementation of new stringency requirements seems in order.

Importance to Investors of Program Certainty

Clean energy investors identify certainty in program features as a top priority. The underlying desire is to have certainty in EAC revenue to support project finance. Direct stabilization of credit value through feed-in tariffs and contracts for differences have proven effective. A measured pace in program change is also important to investors. The analysis of Carley et al. [1] and others show that programs evolve over time to accommodate technology and market evolution and to enhance program effectiveness. RPS standards have ratcheted up progressively in many jurisdictions, and direct and indirect subsidies, such as solar tax credits and net metering credits, have been ramped down as technology costs near parity with incumbent resources. However, abrupt imposition of new requirements could strand assets and chill investment.

Balanced Allocation of Costs and Benefits

The incremental cost of environmentally beneficial programs does not necessarily accrue to the beneficiaries. Program costs may be borne by utility ratepayers, state taxpayers, federal taxpayers, or voluntary buyers. In addition to potential geographic disparity between costs and benefits, some formulations are regressive and some progressive. Increasingly, program designs are also considering environmental and economic stress through disadvantaged community (DAC) preferences. Program design should seek to quantify distributions of costs and benefits as a key program design consideration. For example, states with strong RPS mandates can reduce their compliance costs by allowing out-of-state resources to participate in the program. This reduces economic development in the RPS state relative to the case where only in-state resources are permitted. The costs and benefits, and their distribution to stakeholders can be assessed quantitatively, for example, through electric system resource models and econometric models of employment and economic output. Using such models may facilitate achieving consensus among stakeholders on program design.

Context of National Policy Evolution

Many of the issues under discussion and debate regarding EAC policy and program design emanate from the patchwork of state and federal programs that govern their use. Different states and regions have differing resource endowments. For this reason, well-functioning, national clean energy markets, like conventional energy markets, would allocate production to the most cost-effective locations and supply based on the national demand distribution and resource transportation cost. The dynamic of wealth transfer based on asymmetric environmental mandates would not be an issue. In addition, under a national GHG program (cap and trade, carbon tax, or other), issues related to voluntary actions and reporting thereof would not be eliminated, but the potential impact would be dramatically reduced as the national glidepath would be mandated in statute. The potential effectiveness of such national policy has been demonstrated through the significant air-quality improvements resulting from the national Clean Air Act.

A recent example of a unified regional policy is the Delegated Acts on Renewable Hydrogen passed by the European Union.³⁴ This legislation specifies criteria for the definition of renewable hydrogen production, specifically: 1) lifecycle GHG emissions of at least 70% below that of fossil natural gas, 2) monthly temporal matching until 2030, then hourly temporal matching from 2030 onwards, and 3) meeting additionality criteria starting in 2028. Additionality here is defined as using renewable electricity from electricity-producing facilities installed within 36 months prior to the fuel production facility startup. These acts provide regulatory certainty for different stakeholders and investors in the renewable fuel production space with which they can plan investment actions with reduced risks.

The EU policy uses phase-in timelines for requiring hourly time-matching and additionality compliance of 7 years and 5 years, respectively. These timelines may be viewed as somewhat long; however, it is important to note that the EU has other, complimentary policies in place that function as safeguards against potential unintended consequences of a long phase-in time. These include but are not limited to an EU-wide cap-and-trade system³⁵ for ensuring emission decline, as well as national renewable electricity targets in EU member states.

In the U.S., however, there is a lack of national safeguards against potential issues of a longer phase-in time, primarily because only certain states have cap-and-trade systems with mandated emissions declines and/or aggressive renewable electricity targets. In states that do have complimentary policies, stringency for renewable fuel programs is important but not as critical, while in other states more stringency may be more critical for ensuring realization of environmental benefits.

³⁴ https://ec.europa.eu/commission/presscorner/detail/en/qanda_23_595

³⁵ https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en

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APPENDIX

Current Environmental Certificate and Credit Tracking

Environmental attribute certificates or credits represent the creation of a specific and quantified environmental benefit. Programs currently in place include those for producing and using renewable power and low-carbon fuels, for reducing greenhouse gas emissions, and for reducing specific types of pollutants. The programs under which certificates or credits are traded can be voluntary or mandatory. Mandatory programs include procurement mandates for various types of clean (as defined by the program) resources, and cap and trade programs which allow obligated parties to buy and sell credits under an overall mandatory limit on emissions. Certificates and credits are used as instruments to demonstrate compliance with mandates, support claims of voluntary action, and financially represent the value of the underlying environmental attribute. Programs are active throughout the U.S. and in many international markets. Figure 23 shows a map of the REC tracking and trading systems in the North America. Each tracking system applies its own requirements and standards for creating certificates.

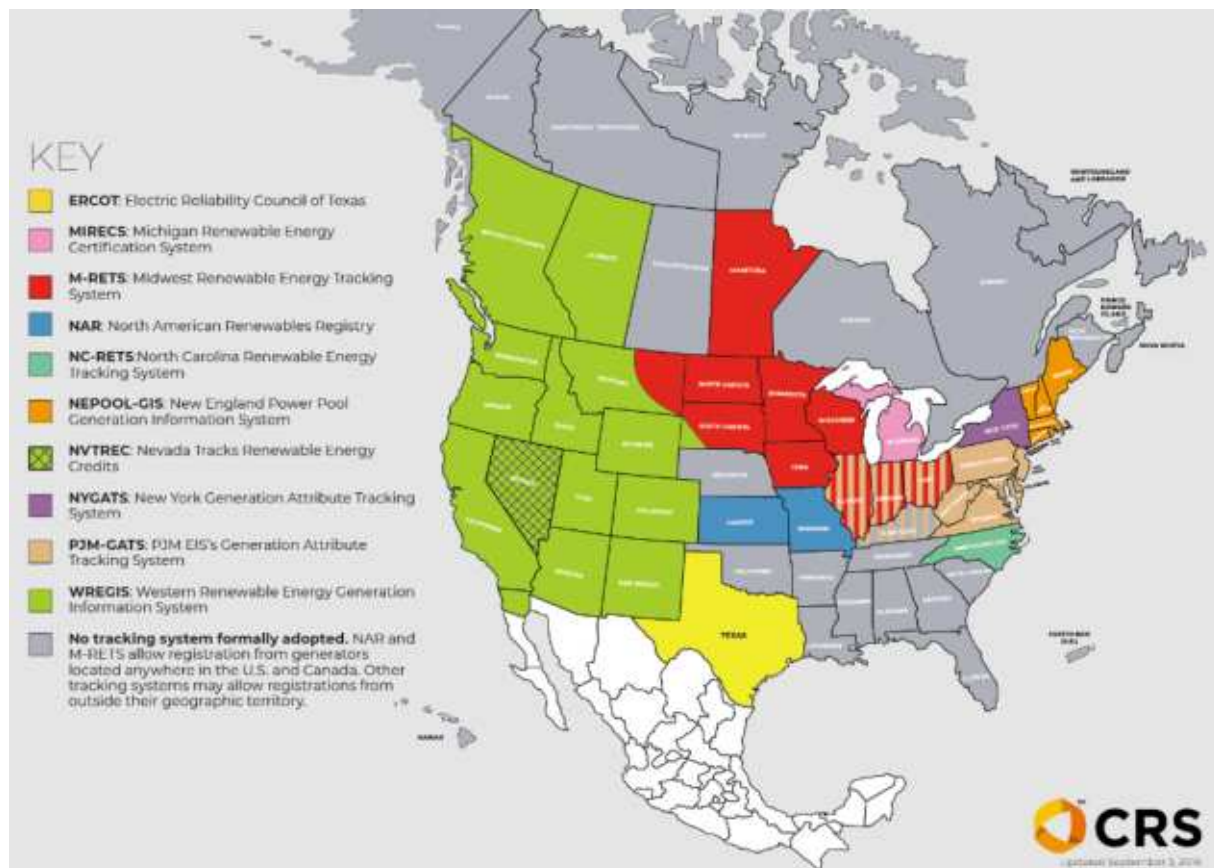


Figure 23. Renewable Energy Certificate Tracking Systems in North America.

<https://resource-solutions.org/wp-content/uploads/2018/02/Tracking-System-Map.png>

Tracking System Name	Facilitating Authority	Traded Attributes	Geographical Constraints	Other Notes
ERCOT Renewable Energy Credit Program ³⁶	Electric Reliability Council of Texas (ERCOT)	1 MWh of renewable electricity	Connected to the ERCOT Grid	- If a facility uses fossil fuel, it must not exceed 25% of the primary energy input. - Excludes energy from waste products of inorganic sources
Michigan Renewable Energy Certification System (MIRECS) ³⁷	Michigan Public Service Commission (MPSC)	1 MWh of renewable electricity	Connected to the State of Michigan	- MIRECS also facilitates trading of other types of energy credits - Hydropower facilities excluded unless it was constructed before MIRECS was established.
Midwest Renewable Energy Tracking System (M-RETS) ³⁸	Midcontinent Independent System Operator (MISO)	1 MWh of renewable electricity 1 Dth of renewable thermal energy	Jurisdiction over North Dakota, South Dakota, Iowa, Minnesota, Wisconsin, Manitoba CA, and part of Montana	- Allows registration of generators outside their key territory - Renewable Thermal Certificates (RTCs) are a novel product, includes hydrogen, heat pumps, RNG, and heat recovery - Eligibility is set by state lawmakers, not internally - Tracks timestamp of REC production since 2019, informative for REC buyers
North American Renewables Registry (NAR) ³⁹	APX, Inc	1 MWh of renewable electricity	Can be used by any entity in North America, currently used by Kansas and Missouri	- Third-party platform that any North American jurisdiction can use - Attempts to standardize information requirements - Integrated with the Green-e REC certification system.
North Carolina Renewable Energy Tracking System (NC-RETS) ⁴⁰	APX, Inc	1 MWh of renewable electricity	Connected to a North Carolina Utility	- Platform administered by same entity as NAR - Registry only, does not facilitate markets. - Note: NC-RETS informational site has not been updated in a few years, information may not be current.
New England Power Pool Generation Information	APX, Inc	1 MWh of renewable electricity	Vermont, New Hampshire, Massachusetts,	- Platform administered by same entity as NAR - Tracks all generation, not only renewable, but is

³⁶ <https://sa.ercot.com/rec/home>

³⁷ <https://mirecs.org/>

³⁸ <https://www.mrets.org/>

³⁹ <https://apx.com/about-nar/>

⁴⁰ <https://ncrets.org/>

Tracking System Name	Facilitating Authority	Traded Attributes	Geographical Constraints	Other Notes
System (NEPOOL-GIS) ⁴¹			Connecticut, Rhode Island, Maine	- responsible for overseeing REC trading. - Provides emissions labeling for generators in its territory
Nevada Tracks Renewable Energy Credits (NVTREC) ⁴²	State of Nevada	1 kWh of renewable electricity	Nevada	- Minimum capacity of 150 kW nameplate - Higher weighting given to solar PV and distributed generation over other renewable energy types
New York Generation Attribute Tracking System (NY-GATS) ⁴³	State of New York	1 MWh of renewable electricity	Within NYISO or contractually connected to NYISO	- New hydropower not eligible - Fuel cells are eligible if verified to use a non-fossil fuel resource
PJM EIS Generation Attribute Tracking System (PJM-GATS) ⁴⁴	PJM Interconnection	1 MWh of renewable electricity	Within or connected to the PJM Interconnect	Tracks timestamp of REC production as of Feb. 2023, informative for REC buyers
Western Renewable Energy Generation Information System (WREGIS) ⁴⁵	Western Electricity Coordinating Council	1 MWh of renewable electricity	Within the WECC territory	- REC eligibility determined by state governments - Registry only does not facilitate REC trading

Power and fuels credit programs have been established to promote the construction of energy provision facilities and supply chains with specific attributes. In these programs, facilities that meet specific attributes are eligible to generate a certificate representing energy produced from that facility that can be bought directly by another entity or sold on in a certificate market. To date, these programs are ubiquitous for renewable electricity production in the form of Renewable Energy Certificates (RECs), aimed at incentivizing developers to construct new renewable electricity production facilities. Programs are also in place for renewable fuels and thermal energy, although these are newer and less widespread than the REC programs.

Greenhouse gas offset programs are also widespread, but they differ from renewable or clean energy programs as they represent the reduction of a specific pollutant and not production of a quantity of energy through a qualified pathway. This distinction is important in the discussion of the use of renewable energy credits for voluntary and compliance GHG reporting purposes.

⁴¹ <https://nepoolgis.com/>

⁴² <https://www.nvtrec.com/>

⁴³ <https://www.nyserda.ny.gov/All-Programs/NYGATS>

⁴⁴ <https://www.pjm-eis.com/>

⁴⁵ <https://www.wecc.org/WREGIS/Pages/Default.aspx>

Markets for RECs and the rules for eligibility, trading, and accounting, are established on a regional basis. Renewable Energy Tracking Systems (RETS)⁴⁶ refer to registries and accounting systems established by regional authorities to set rules for the generation and claiming of RECs, such as eligibility for producing RECs, accounting of REC generation, and claiming to prevent double counting, ensuring that electricity represented by a REC is not separately counted as contributing to other registries, and the documentation needed to verify REC generation and claiming. In the European Union, a similar instrument is termed the Guarantee of Origin (GO)⁴⁷, which functions essentially like a REC but with a wider scope for what types of resources and energy carriers are eligible and facilitated on a national scale instead of a regional scale.

In practice, most RETS function in a similar way: there are rules for what resources are eligible, RECs can only be generated once and claimed once, and RECs often have a vintage over which they are valid. Production of renewable energy must be verified by meter data, documentation of the facility fuel type, and details of the facility interconnection and vintage. REC programs generally employ so-called book-and-claim accounting. The generation of the qualifying environmental attribute is “booked” through the creation of the REC. The attribute is “claimed” when it is retired to convey the attribute at another place and/or time. Program rules determine the limits on when and where RECs can be claimed. Current programs use annual true up (only RECs generated within the same reporting year can be claimed) and are regional in scale. There may also be restrictions on facility vintage.

While different regional RETS vary in the extent of their jurisdictions and rules, all RETS perform a similar function of tracking the generation and claiming of RECs and ensuring accurate accounting of these transactions. Some RETS also facilitate markets, while others act solely as registries. Currently, M-RETS is the only system that is set up for non-electricity renewable energy products.

An important note about the function of RETS is that these systems only guarantee that a unit of electricity produced and injected onto the regional electricity grid meets the regional requirements for being counted as renewable energy. These requirements can vary from region to region. Importantly, however, RETS do not make any guarantees about explicit environmental benefits, such as greenhouse gas emissions reduction or other types of environmental impact reduction, associated with buying a REC.

Therefore, when entities buy RECs from their regional markets and subsequently advertise environmental benefits, the linkages between claiming RECs and purported environmental benefits are posed by the claiming entities (using either internal or third-party analysis), not by the RETS themselves.

Outside of electricity systems, there are other tracking and credit systems that track the production of fuels that meet different criteria, such as the U.S. Environmental Protection Agency Moderated Transaction System (EMTS) for tracking the renewable content of transportation fuels and the California Low Carbon Fuel Standard (CA LCFS) based on carbon intensity.

The EMTS⁴⁸ is a tracking system for transportation fuels to monitor compliance with the U.S. Renewable Fuel Standard using Renewable Identification Numbers (RINs). RINs are numbers assigned to each physical gallon of renewable fuel produced or imported to the U.S. RINs designate the source and time of production of a gallon of renewable fuel, as well as the type of renewable fuel. In practice, the RINs act as

⁴⁶ <https://www.epa.gov/green-power-markets/renewable-energy-tracking-systems#certificate>
<https://resource-solutions.org/wp-content/uploads/2018/02/Tracking-System-Map.pdf>

⁴⁷ <https://www.aib-net.org/certification/certificates-supported/renewable-energy-guarantees-origin>

⁴⁸ <https://www.epa.gov/fuels-registration-reporting-and-compliance-help/how-use-emts-report-transactions-fuel-programs>

credits. Producers of fuels with high renewable content generate RINs that can be sold to producers of fuels that do not have enough renewable content to comply with the Renewable Fuel Standard.

The CA LCFS⁴⁹ is one of the only programs that focuses specifically on tracking the carbon intensity of fuels and is aimed at reducing the use of petroleum in the transportation sector. This differs from other ubiquitous programs that focus on renewable energy content, rather than explicitly on emissions. Specifically, the CA LCFS provides monetary credits to producers of transportation fuels that fall below an annually defined benchmark for carbon intensity. Producers of transportation fuels whose products are above the carbon intensity benchmark must then purchase credits from the former to comply with state regulations. The benchmark carbon intensity decreases over time, incentivizing the production of lower carbon intensity fuels and disincentivizing conventional fuels. Carbon intensity is calculated using life cycle assessment tools, such as CA-GREET, a California-specific version of the Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET) model developed by Argonne National Laboratory. Official reporting for participation in the CA LCFS program is facilitated in the LCFS Reporting Tool and Credit & Bank & Transfer System (LRT-CBTS), which tracks the generation and sale of LCFS credits.

Certification and Verification Standards and Protocols

While RETS certify that a unit of a produced energy carrier meets the criteria for being counted as renewable energy (or being produced from renewable energy) set by regional jurisdictions, as mentioned, RETS do not guarantee any other environmental attributes. For example, RETS do not guarantee that purchasing a REC is linked with greenhouse gas or air pollutant emissions reductions, and they do not guarantee that purchasing the REC encouraged the build of renewable energy facilities that would not have otherwise been built (additionality).

The U.S. EPA recommends that purchasers of RECs seek RECs that are specifically certified or verified by a third-party to correspond to a given environmental benefit. A similar approach is taken in the European Union, where Guarantees of Origin (GOs) can be certified by a third-party. The certification of a REC by a third-party is optional and must be made at the request of the REC producer. In the U.S., the primary certification for improving confidence in the environmental integrity of a REC is the Green-e certification⁵⁰, administered by the Center for Resource Solutions. Green-e certification is also available for different types of products, such as carbon offsets and renewable fuels.

To obtain a Green-e certification for renewable electricity represented by a REC, a renewable electricity producer must meet additional criteria above those required to register in a regional RETS. Key additional criteria include:

- Vintage of the energy producing facility: the facility that produces the energy represented by a REC must not be more than 15 years old. This is aimed at incentivizing new builds of renewable electricity facilities in order to stay eligible for certification and therefore incentivizes additionality, albeit at a relatively slow pace.
- Environmental criteria:
 - Biomass/biogas fuels: Fuels produced from certain types of biomass or environmentally destructive methods are not allowed, and others must demonstrate that their fuels do not contain certain toxic compounds including but not limited to plastics and arsenic.
 - Hydropower: Only existing hydropower is eligible unless a new build meets certification from the Low Impact Hydropower Institute or EcoLogo (Canada), or if the electricity is produced from turbines in human-made conveyance.

⁴⁹ <https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard>

⁵⁰ <https://www.green-e.org/programs/energy>

- Use for Renewable Portfolio Standard Compliance: Renewable energy represented by a REC must not be simultaneously counted as contributing to mandated state goals (i.e., RPS). This ensures that a certified REC does contribute somewhat to additionality, since it would have been built in the absence of a regional mandate. This point is important since many RECs that are tracked in RETS are used by utilities to count as their compliance with state-mandated renewable portfolio standards.

A REC that is Green-e certified is more likely to be tied with lower environmental impacts, and purchasing such a REC is better associated with additional renewable energy production. However, the Green-e certification still does not guarantee any claims about explicit reduction in emissions or other environmental impact criteria. Additionally, Green-e certification does not address the need for produced renewable energy to align temporally with electricity demand in order to contribute to offsetting other (typically fossil-fuel-based) generation.

Green-e certification also exists for renewable fuels,⁵¹ but currently only applies to biomethane. This certification requires that the carbon intensity of a certified fuel must be at least 10% lower than a reference fossil fuel at the point of injection into the gas pipelines, including transportation. Additionally, Green-e certified biomethane cannot be counted as simultaneously meeting a mandated goal, contributing to additionality.

In the European Union, an analogue to the Green-e certification is the EKOenergy label.⁵² EKOenergy certification can also be used for U.S. RECs, as well as GOs in the EU. To obtain an EKOenergy certification for renewable electricity, producers must prove that their facility meets certain environmental impact criteria. The criteria are resource-specific, for example, solar, wind, geothermal, and biomass/biogas facilities have different criteria that they need to meet. However, it should be noted that many of these criteria are qualitative and that there is not a standardized tool or method that is used to demonstrate compliance, rather, entities seeking certification must adequately make their case that they comply with the criteria sufficiently. EKOenergy addresses additionality differently than Green-e, by taking some of the fees for certification and putting them into a fund that finances new renewable energy projects.

EKOenergy also has a certification for renewable gas⁵³ that differs from Green-e in that it also includes hydrogen. For biomethane, restrictions are placed on the type of feedstocks considered and their production methods. For hydrogen, certification is only allowed for hydrogen produced via electrolysis using electricity inputs that are also EKOenergy certified.

While neither the current Green-e and EKOenergy certifications address the issue of temporal matching between renewable energy production and electric load in RECs, there is discussion and motivation to move towards such a framework. First, hourly timestamp information for RECs is not widely available in all RETS. However, the Center for Resource Solutions – which facilitates the Green-e certification – has put together a framework⁵⁴ for data needs and metrics to determine the temporal characteristics of a REC and link these to different environmental benefits, including reductions in Scope 2 greenhouse gas emissions. Questions currently remain, however, regarding differentiating between impacts attributed to raw renewable generation data, estimating avoided emissions at each timestep, and whether hourly procurement can be assigned the same impacts. Currently, only M-RETS and PJM-GATS track hourly production data associated with RECs tracked in their systems.

⁵¹ <https://www.green-e.org/programs/renewable-fuels>

⁵² <https://www.ekoenergy.org/ecolabel/>

⁵³ <https://www.ekoenergy.org/ecolabel/criteria/ekoenergy-gas/>

⁵⁴ <https://resource-solutions.org/document/121420/>

A protocol for better enabling the tracking of hourly generation timestamps associated with RECs is the Energy Tag standard, proposed by the EnergyTag Initiative.⁵⁵ This standard proposes the use of Granular Certificates (GCs) that provide data on the generation time associated with energy represented by a REC, enabling buyers of RECs to potentially enable their purchases with the temporal profile of their own entity's electric load profile and better characterize emissions reductions associated with that purchase. The EnergyTag standard also includes protocols for standardized hourly carbon emissions tracking from regional electricity systems to assist REC buyers in calculating avoided emissions associated with buying a REC. Additionally, the EnergyTag Initiative also includes guidelines for auditing a REC registry for compliance with the standard.⁵⁶

Finally, guidance for translating procurement of instruments, such as RECs by corporations, to changes in corporate Scope 2 greenhouse gas emissions is available from the World Resources Institute GHG Protocol Scope 2 guidance,⁵⁷ as an update to the previous Corporate Standard. Note, however, that this standard represents voluntary guidelines and does not carry an official certification for compliance, and therefore implementation may vary between different REC-buying entities. This standard provides guidance on reporting requirements, emissions factors, and types of instruments that are eligible for counting towards GHG emissions reductions, and electricity consumption data for corporations in order to more accurately characterize GHG emissions reductions associated with RECs or other instruments.

Renewable Energy Procurement and Incentive Programs

Thirty-three states have been identified as having adopted renewable (or clean, with varying qualifications) power procurement mandates or voluntary targets that include or have included at least some types of renewable gas. Four states have renewable gas procurement programs, and three states have low carbon transportation fuel procurement programs. There are also several federal programs that mandate or support procurement of renewable gas for use in various sectors. Most of these programs use a regulatory credit mechanism to account for renewable content. Below is a summary of these various programs.

State Renewable Electricity Procurement Programs

Most states in the U.S. have adopted procurement programs for renewable electricity, since Iowa passed the first law in the nation in 1983 requiring electricity providers to procure power from renewable resources.⁵⁸ The majority of such states require a certain percentage or fixed amount of renewable electricity to be procured, although some, such as Kansas⁵⁹ and South Dakota⁶⁰, have voluntary programs.

Several states include an alternative compliance payment or penalty provision in their renewable electricity procurement programs, which requires electricity providers to pay a fee in lieu of retiring RECs, if they are unable to meet renewable procurement targets in a given compliance period. Some states, such as Pennsylvania,⁶¹ have fixed per megawatt-hour prices for such payments that were set in statute, while several others adjust ACP pricing over time to reflect market changes.

States vary widely in the amount of renewable electricity required or encouraged in their programs, from small portions of the total power portfolio to up to 100%. To date, thirteen states have enacted laws

⁵⁵ <https://energytag.org/wp-content/uploads/2022/03/20220331-EnergyTag-GC-Scheme-Standard-v1-FINAL.pdf>

⁵⁶ <https://energytag.org/wp-content/uploads/2022/09/Audit-process.pdf>

⁵⁷ <https://ghgprotocol.org/sites/default/files/2023-03/Scope%202%20Guidance.pdf>

⁵⁸ <https://www.legis.iowa.gov/docs/publications/iactc/70.1/CH0182.pdf>

⁵⁹ <https://kcc.ks.gov/electric/renewable-energy-standard>

⁶⁰ <https://sdlegislature.gov/Session/Bill/4678>

⁶¹ [PA Act 35 \(HB 1203, 2007\)](#), Section 3.(f); <https://www.pjm-eis.com/program-information/pennsylvania>

requiring 100% renewable or carbon free electricity procurement by mid-century, with some states, such as Hawaii⁶², Maine⁶³, and Rhode Island⁶⁴, specifically mandating 100% renewable resource requirements. All Arizona major utilities also voluntarily committed to achieving 100% carbon free electricity from renewables, hydropower, and nuclear energy by 2050,⁶⁵ which given that the state only generates approximately 30% of power from nuclear resources and 5% from hydropower,⁶⁶ means this goal vastly exceeds the state's Renewable Energy Standard and Tariff (REST), which only requires 15% renewable power procurement by 2025.⁶⁷

Nearly all state renewable electricity procurement programs use RECs (or a similar credit system using a different name) as the regulated currency and compliance tracking mechanism. Most allow both bundled and unbundled RECs, with the exception of a few states, such as Arizona,⁶⁸ that allow bundled RECs only.

New capacity is required by several programs, but additionality is not a test used for RECs and is not included as a requirement in any program that uses this type of credit.⁶⁹ The state of California, however, does require methodology to calculate the GHG emissions intensities associated with retail electricity portfolios reported under a power source disclosure program.⁷⁰ Specified procurement claims from eligible renewable facilities must include the associated RECs. While unbundled RECs may be used to count as a percentage of the power portfolio, they cannot be used to calculate the GHG intensity of the portfolio because unbundled RECs are by nature not attached to renewable electricity procurement.

Several states, such as Arizona,⁷¹ California,⁷² Indiana,⁷³ Maryland,⁷⁴ Maine,⁷⁵ New Hampshire,⁷⁶ New York,⁷⁷ Pennsylvania,⁷⁸ Utah⁷⁹ and Vermont,⁸⁰ place some geographic restrictions on compliance, typically requiring that some or all renewable electricity be generated within or delivered to the state or region.

Requiring time matching is atypical in state renewable power procurement programs, an exception being the state of Washington, which requires that facilities deliver renewable electricity into the state on a

⁶²https://www.capitol.hawaii.gov/session/archives/measure_indiv_Archives.aspx?billtype=SB&billnumber=3057&year=2022

⁶³ <https://www.mainelegislature.org/legis/bills/getPDF.asp?paper=SP0457&item=3&snum=129>

⁶⁴ <https://legiscan.com/RI/text/S2274/2022>

⁶⁵ <https://www.azcc.gov/news/2022/01/27/arizona-electric-utilities-voluntarily-commit-to-100-clean-energy#gsc.tab=0>

⁶⁶ <https://www.eia.gov/state/?sid=AZ#tabs-4>

⁶⁷ <https://www.azcc.gov/utilities/electric/renewable-energy-standard-and-tariff#gsc.tab=0>

⁶⁸ [TITLE 14. PUBLIC SERVICE CORPORATIONS; CORPORATIONS AND ASSOCIATIONS; SECURITIES REGULATION
CHAPTER 2. CORPORATION COMMISSION-FIXED UTILITIES ARTICLE 18. RENEWABLE ENERGY STANDARD AND TARIFF, R14-2-1804.
Annual Renewable Energy Requirement, Appendix A](#)

⁶⁹ According to the U.S. EPA, Additionality is a test(s) used only for project offsets that result in direct emissions accounting and not for RECs or green power purchases; U.S. EPA, p. 11-3, [Guide to Purchasing Green Power Glossary](#).

⁷⁰ <https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure/psd-frequently-asked-questions>

⁷¹ [TITLE 14. PUBLIC SERVICE CORPORATIONS; CORPORATIONS AND ASSOCIATIONS; SECURITIES REGULATION
CHAPTER 2. CORPORATION COMMISSION-FIXED UTILITIES ARTICLE 18. RENEWABLE ENERGY STANDARD AND TARIFF, R14-2-1803.
Renewable Energy Credits \(See Appendix A\)](#)

⁷² <https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/rps/rps-compliance-rules-and-process/60-percent-rps-procurement-rules>

⁷³ <https://legiscan.com/IN/bill/SB0251/2011>

⁷⁴ <https://mgaleg.maryland.gov/2019RS/bills/sb/sb0516E.pdf>

⁷⁵ <https://www.mainelegislature.org/legis/statutes/35-A/title35-Asec3210.html>

⁷⁶ <https://www.energy.nh.gov/renewable-energy/renewable-portfolio-standard>

⁷⁷ <https://legislation.nysenate.gov/pdf/bills/2019/S6599>

⁷⁸ <https://pennaeps.com/about/>

⁷⁹ <https://le.utah.gov/~2008/bills/sbillenr/sb0202.pdf>

⁸⁰ <https://legislature.vermont.gov/Documents/2016/Docs/ACTS/ACT056/ACT056%20As%20Enacted.pdf>

real-time basis in order to comply with the program.⁸¹ Some large corporations, like Google, have also committed to procuring 24/7 clean energy, and while not states, such companies have a large energy footprint and buying power to drive investment into developing technological solutions to meet this challenge.⁸² ⁸³ The federal government, as previously mentioned, has also signaled interest in time matching renewable electricity procurement, as has local electricity provider Peninsula Clean Energy, a San Mateo, CA based Community Choice Aggregator, which in 2017 set a goal of delivering 100% renewable energy to match customer demand on an hour-by-hour basis by 2025 and has developed a modeling system aimed at helping to achieve this.⁸⁴ The EPA reports that 24/7 hourly matching of renewable electricity is an important development to pursue, but also presents many challenges that must be overcome.⁸⁵

Some programs include carve-outs for sizes and locations of renewable electricity facilities, such as distributed generation, or particular renewable technologies like solar. In 2016, California also created two special programs for bio-energy: 1) The BioRAM reverse auction mechanism was established to enable California electrical corporations to meet a requirement to collectively procure over five years 125 MW of cumulative generating capacity from existing biomass projects, primarily from those using forest waste as feedstock.⁸⁶ 2) California also implemented the BioMAT feed-in tariff program, which seeks to drive deployment of 250 MW of small biogas and biomass electricity projects.⁸⁷

Please see Table 1 for more details on state renewable power procurement programs.

Renewable Gas and Low-carbon Fuels Procurement Programs

Several federal and state policies require or seek to encourage the procurement of at least some types of renewable gas. Programs to implement these policies fall predominantly into three categories: 1) Federal incentive programs that seek to expand markets for the production of clean hydrogen or biogas for use in range of applications; 2) State renewable gas procurement programs with targets for increasing renewable content in gas delivery systems; 3) State renewable or low carbon fuel programs with targets for increasing renewable and low carbon content of transportation fuel.

Federal Programs

Among the first federal renewable energy procurement programs to be adopted was the Renewable Fuel Standard, first enacted in 2005 with later revisions, which requires the transportation, heating, and aviation sectors to reduce or replace conventional fuel with set minimum amounts of various types of renewable fuels derived from renewable biomass or a biointermediate produced from renewable biomass. Annual targets started in 2009, when a total of 11 billion gallons of qualifying renewable fuel was required, and increased through 2022, when the target reached 36 billion gallons. The target increases to 37 billion gallons in 2025. Several biogas pathways and landfill gas that meet a standard requirement of 60% GHG reduction compared to baseline petroleum are eligible for compliance.⁸⁸ Since 2014, renewable compressed natural gas and renewable liquefied natural gas, both considered advanced

⁸¹ [SB 5116](#), Sec. 28(12)(a)(ii)

⁸² <https://sustainability.google/progress/energy/>

⁸³ <https://aesocorp2020cr.q4web.com/press-releases/news-details/2021/AES-Announces-First-of-Its-Kind-Agreement-to-Supply-247-Carbon-Free-Energy-for-Google-Data-Centers-in-Virginia/default.aspx>

⁸⁴ <https://www.peninsulacleanenergy.com/our-path-to-24-7-renewable-power-by-2025/>

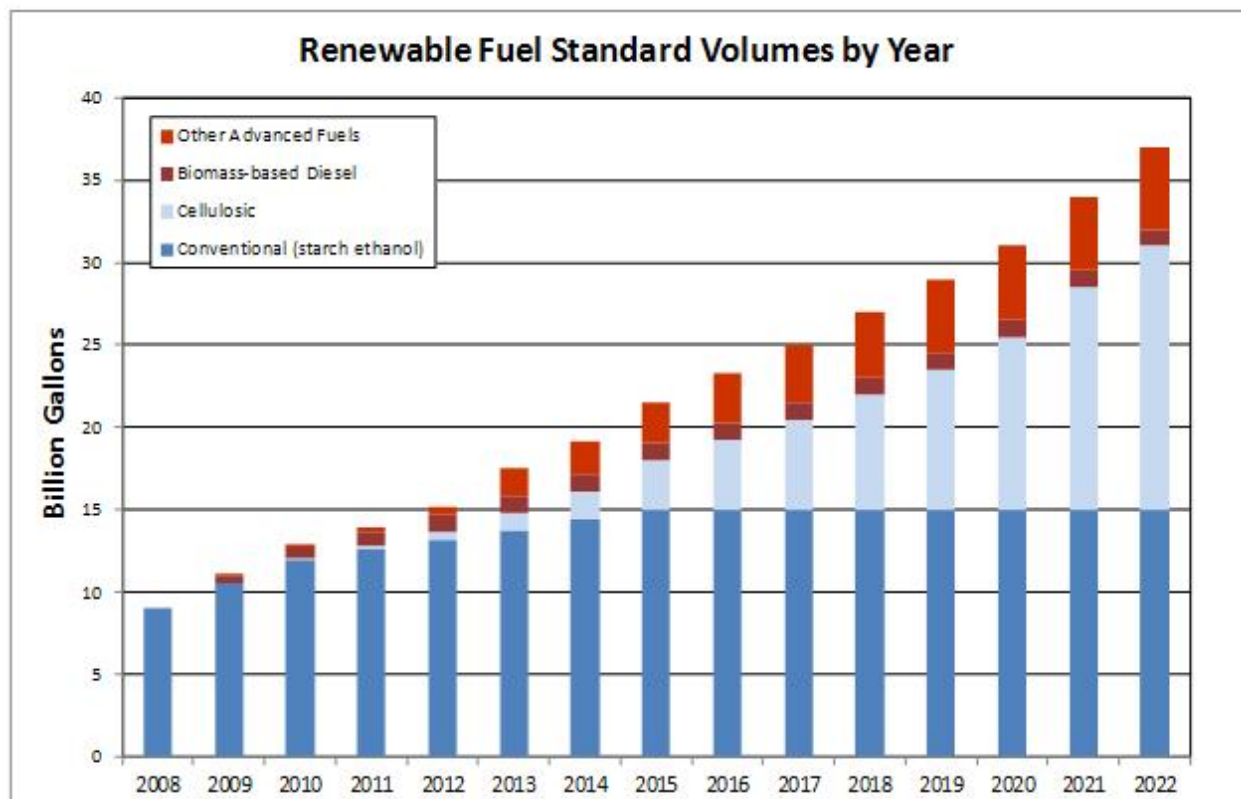
⁸⁵ <https://www.epa.gov/green-power-markets/247-hourly-matching-electricity>

⁸⁶ <https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/rps/rps-procurement-programs/rps-bioram>

⁸⁷ <https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/rps/rps-procurement-programs/rps-sb-1122-biomat>

⁸⁸ <https://www.epa.gov/fuels-registration-reporting-and-compliance-help/lifecycle-greenhouse-gas-results>

biofuel pathways under program rules, have constituted the majority of the EPA cellulosic biofuel volume requirements.⁸⁹



Source: EPA⁹⁰

EPA is considering proposals to allow eligibility for new fuel pathways that use RNG produced from biogas from anaerobic digesters or landfills as a feedstock to produce hydrogen fuel for use in fuel cell electric vehicles (FCEVs).⁹¹

As previously noted in this document, RINs are the regulatory credit that make up the currency for the Renewable Fuels Standard program. These may be either assigned (i.e., purchased with the fuel) or separated (i.e., purchased on their own). The EPA sets the minimum and maximum price for RINs, helping to maintain price stability.⁹²

Other federal laws have recently been enacted that provide tax incentives and grant funding to encourage increased production and procurement of clean (i.e., low or zero carbon) hydrogen and qualified biogas for various end uses, in order to lower greenhouse gas emissions, support American economic and workforce development, and advance energy and social justice. These are:

- *The 2021 Inflation, Infrastructure and Jobs Act (HR 3684)*, which set aside \$8 billion for the deployment of at least four regional clean hydrogen hubs to be deployed over a ten-year period.

⁸⁹ U.S. Environmental Protection Agency, *Public Data for the Renewable Fuel Standard Data*, July 7, 2022, as reported by the Congressional Research Service on p. 2 of [The Renewable Fuel Standard \(RFS\): An Overview](#), August 10, 2022

⁹⁰ <https://afdc.energy.gov/laws/RFS>

⁹¹ <https://www.federalregister.gov/documents/2022/12/30/2022-26499/renewable-fuel-standard-rfs-program-standards-for-2023-2025-and-other-changes>

⁹² <https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rin-trades-and-price-information>

⁹³ The law asserts that clean hydrogen can be made using any renewable resource as a feedstock, including biomass, as well as with nuclear power or carbon capture and storage. The law also specifically aims to reduce the price of electrolytic hydrogen to \$2/kg by 2026, which is in line with the Department of Energy Hydrogen Shot program that seeks to lower the cost of electrolytic hydrogen to \$1/kg by 2031.⁹⁴

- *The 2022 Inflation Reduction Act (HR 5376)*, which additionally provides a production tax credit for clean hydrogen that increases as lifecycle carbon intensity of the hydrogen production declines from 4 kg/CO₂e per kg to zero kg/CO₂e per kg. The law also includes an investment tax credit for clean hydrogen production facilities that do not opt for the production tax credit, as well as for qualifying biogas facilities.⁹⁵ Projects must start construction by December 31, 2024 to be eligible for the investment tax credit and before January 31, 2033 to be eligible for the production tax credit.

Design of credits for clean hydrogen and clean fuel production is currently under review by the Department of the Treasury and the Internal Revenue Service, and a public proceeding was opened in December 2022 to address among other issues, additionality, geographic boundary (“deliverability”), and time matching requirements.⁹⁶ The section in this document on Stakeholder Perspectives contains discussion of the various opinions shared on the docket on these issues.

Federal agencies also have renewable energy procurement targets with which they are required to comply. For example, Executive Order 14057 (2021) requires all US federal agencies to procure 100 percent carbon pollution-free electricity on a net annual basis by 2030. 50 percent of this total is subject to time matching and deliverability requirements, signaling a federal government interest in applying greater stringency in these areas. Specifically, this amount of carbon pollution-free electricity must be procured to match actual electricity consumption on an hourly basis and produced within the same regional grid where the energy is consumed. Federal agencies carry benefits, such as regulatory flexibility and geographic diversity, which make them good test beds to work out issues in preparation for full market readiness of emerging technologies.

Please refer to Table 2 for more details on federal renewable energy procurement laws.

State Renewable Gas Procurement Programs

Several states have passed laws in recent years requiring renewable gas procurement programs to be established that aim to increase the volume of renewable gas in the gas delivery system, in order to provide benefits such as reducing greenhouse gas emissions or lowering air pollution. Most of these programs include both biomethane and renewable hydrogen as eligible resources. California’s program to date only includes biomethane, although state regulators are considering pathways for including renewable hydrogen.

⁹³ See Subtitle B – Hydrogen Research and Development <https://www.congress.gov/bill/117th-congress/house-bill/3684/text>. Clean hydrogen is defined in this bill as hydrogen produced using renewable energy, including biomass, nuclear power, or natural gas with carbon capture and storage and that has a carbon intensity of ≤ 2 kg/CO₂e per kg of hydrogen. Documents such as the *U.S. Department of Energy Clean Hydrogen Production Standard (CHPS) Draft Guidance*, September 22, 2022, suggest that the definition will be harmonized with that used in the Inflation Reduction Act.

⁹⁴ <https://www.energy.gov/eere/fuelcells/hydrogen-shot>

⁹⁵ See IRA Sections [45V](#) and [48](#).

⁹⁶ <https://www.irs.gov/pub/irs-drop/n-22-58.pdf>

Some states, including California, Nevada, and Oregon, have mandated targets, while Minnesota has required establishing renewable gas procurement policies and regulations that support state greenhouse gas reduction targets that may or may not be tied to specific required procurement amounts.⁹⁷ New Hampshire’s renewable gas program encourages voluntary procurement, as long as renewable gas does not exceed 5% of total gas volume delivered, and contracts are no longer than 15 years. RTCs managed by M-RETS are used in Oregon and California to represent environmental attributes of renewable gas purchased by gas utilities for compliance.

Please refer to Table 3 for more information on state renewable gas procurement programs.

State Low Carbon Transportation Fuels Procurement Programs That Include Renewable Gas

Three states in the western US – California, Oregon, and Washington – have adopted clean fuels procurement policies that include renewable gas. All three programs have mandatory carbon intensity reduction targets that tighten over approximately the next decade and use a book and claim system to track compliance.

Oregon has adopted requirements that RECs retired to claim carbon intensity in their clean fuel programs must meet Green-e certification standards, which contain stringent additionality requirements.⁹⁸

Washington is phasing in additionality requirements for RECs used to claim carbon intensity, requiring starting in 2025 that RECs be generated from electric generators placed into service after 2023.⁹⁹ Washington also has stringent real-time matching requirements for RECs.

The California Air Resources Board (CARB) has issued guidance for additionality and deliverability for fuels produced with low carbon electricity.¹⁰⁰ Specifically, low carbon intensity electricity used as a transportation fuel to make hydrogen must be in addition to California RPS requirements (or local renewable requirements for electrolytic hydrogen produced out of state) and must meet CARB RECs retirement and reporting requirements to demonstrate additionality. Low carbon electricity used must also be supplied to the grid by a resource located within a California Balancing Authority (or local balancing authority for electrolytic hydrogen produced out of state). Alternatively, to show electricity generated from an out-of-state resource was supplied to the California grid, the low-CI electricity must meet the deliverability requirements of California Category 1 (bundled, within California Balancing Authority) RECs in the state RPS statute.¹⁰¹

Please refer to Table 4 for more information on state low carbon fuel procurement programs that include renewable gas.

⁹⁸ Oregon Clean Fuel Standard [340-253-0470](#) (5)(a)

⁹⁹ p. 180, Washington Department of Ecology, [Concise Explanatory Statement Chapter 173-424 WAC, Clean Fuels Program Rule & Chapter 173-455 WAC, Air Quality Fee Rule](#), November 2022

¹⁰⁰ https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/guidance/lcfsguidance_19-01.pdf

¹⁰¹ See definition of California Category 1 RECs here: <https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/rps/rps-compliance-rules-and-process/60-percent-rps-procurement-rules>

Table 1-State Renewable Power Procurement Policies

State	Program	Primary Authorizing Law(s)	Target(s) *Mandated	Eligible Renewable Gas Types	Regulatory Credit Mechanism ¹⁰²	New Capacity Requirement	Geographic Requirement	Temporal Requirement for Delivery	ACP/Penalty
AZ	Renewable Energy Standard and Tariff (REST)	2006 Final Rules AAC R14-2-1801 et seq.	*2006 - 1.25% retail electricity sales must be generated from renewable resources *2007 - 1.5% renewable with 5% from distributed resources, with annually increasing targets for both until: *2012 - 3.5% renewable with 30% from distributed resources, with annual increasing target for renewables until: *2025 - 15% with 30% from distributed resources <i>Note that from 2019-2021, all Arizona major utilities also committed to voluntarily achieve 100% carbon free electricity from renewables, hydropower, and nuclear energy by 2050.</i>	• Biogas derived from various pathway • Fuel cells using fuels derived from renew-able sources	• Bundled RECS delivered to state and acquired after 1997 (exceptions for incremental hydropower) • Note pre-2005 installations were eligible for multipliers for solar and in-state manufacturing	Eligible facilities must commence operation on or after January 1, 2005 (CA Pub Util Code Section 25741), with restrictions on hydropower that same online after 2005 and some municipal solid waste that came online after September 1996 (CA Pub Util Code § 399.12) • RECs must be bundled. • No more than 20% of an affected utility's Annual Renewable Energy Requirement may be met with RECs. • Eligible Renewable Energy Resources shall not include facilities installed before January 1, 1997.	Energy produced by eligible renewable energy systems must be deliverable to the state.	N/A	Penalties may be assessed for failure to comply (Sec. R14-2-815 of Renewable Energy Standard and Tariff)
Continued on Next Page									

¹⁰² Note that for simplicity, the term REC in this table is used for any type of credit representing one megawatt-hour (MWh) of electricity generated and delivered to the electricity grid from a program eligible energy resource. Some states include other alternative or clean resources that are not necessarily renewable or call their credit system by another name (e.g., clean energy credit or alternative energy credit).

Table 1-State Renewable Electricity Procurement Policies (continued from previous page)

State	Program	Primary Authorizing Law(s)	Target(s) *Mandated	Eligible Renewable Gas Types	Regulatory Credit Mechanism	New Capacity Requirement	• Geographic Requirement	Temporal Requirement for Delivery	ACP/Penalty
CA	Renewable Portfolio Standards	SB 1078 (2002), SB 1122 (2012), AB 327 (2013), SB 350 (2015), SB 859 (2016), SB 100 (2018), SB 901 (2018), SB 1020 (2022)	*2013 - 20% of retail electricity sales generated from renewable resources *2016 - 25% of retail sales *2020 - 33% of retail sales *2024 - 44% of retail sales *2027 - 52% of retail sales *2030 - 60% retail electricity sales *2035 - 90% retail electricity sales from renewable and zero carbon resources *2040 - 95% retail electricity sales from renewable and zero carbon resources *2045 - 100% retail electricity sales from renewable or zero carbon sources <i>Note that CA climate policy also requires carbon neutrality economy wide by 2045, which will apply to all energy uses, not only retail electricity sales</i> *Bioenergy specific targets Starting in 2016: Electrical corporations shall collectively procure, through financial commitments of five years, their proportionate share of 125 MW from existing bioenergy projects, primarily from byproducts of sustainable forestry in high hazard zones.	• Biogas, digester gas • Landfill gas • Bioenergy using byproducts of sustainable forest mgt	• RECs tracked by WREGIS, with lifetime of 3 years • Since 2011, CPUC has allowed tradeable, unbundled RECs (TRECS) to be used for compliance. • For bioenergy only: Bio-RAM - Reverse Auction Mechanism for large utilities to procure bioenergy from High Hazard Zones to mitigate wildfire (2016, 2018) • Bio-MAT - Feed-In tariff for bioenergy: Starting in 2016, up to 250 MW bioenergy offered monthly or bi-monthly from Bio-MAT feed-in tariff program.	Unbundled RECs (Category 3) capped at: • 2010-2013: 25% of RPS requirement • 2014-2016: 15% • 2016 and after: ≤10% (PUC §399.16(c)(3))	• Since 2010, must be ≥75% from facilities with first point of interconnection within a California Balancing Authority (CBA) • ≤~15% of RECs allowed to be generated from out of state	For Category 1 RECs only: Electricity delivered to first point of connection within a CBA to meet requirement must be so done on an hourly or sub-hourly basis	N/A

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Table 1-State Renewable Electricity Procurement Policies (continued from previous page)

State	Program	Primary Authorizing Law(s)	Target(s) *Mandated	Eligible Renewable Gas Types	Regulatory Credit Mechanism	New Capacity Requirement	• Geographic Requirement	Temporal Requirement for Delivery	ACP/Penalty
CO	Renewable Energy Standards	SB 252 , SB 263	*2020 - 30% (IOUs), 20% for coops serving ≥100k meters, 10% for coops serving 40k-100k meters *2050 - 100% of electricity from clean resources by 2050 for utilities serving 500k or more customers; 10% or 20% for municipalities/electric coops depending on size; includes 3% distributed generation requirements for IOUs, 1% for larger rural coops, .75% for smaller rural coops. <i>*Plus Interim targets</i>	• Synthetic gas produced by pyrolysis of waste • Landfill gas • Waste-water treatment • Anaerobic digestion • Fuel Cells using Renewable Fuels	RECs traded and tracked on the WREGIS system Compliance multipliers of 1.50 for electricity generated at a “community-based project” (others for projects installed prior to 2014-16)	N/A	N/A	N/A	N/A
CT	Renewable Portfolio Standards	Public Act No. 18-50 (2018)	*2030 - 40% electricity sales from Class I renewable energy resources + 4% Class II + 4% Class III, with interim targets	Class I: • Fuel cells • Landfill methane • Biogas Class III: • CHP	Bundled and unbundled RECs, traded and tracked on NEPOOL GIS	N/A	N/A	N/A	3-month grace period (aka 5th Quarter) after which ACP of Class I and II: \$55/ MWh, Class III: \$31/MWh (DSIRE)
DE	Renewable Portfolio Standards	SB 33 (2021)	*2035 - 40% electricity sales derived from renewable resources, including 10% carve out for solar Also includes aggregated generation of < 100 kW, or compliance via customer sited generation	• Fuel cell • Landfill gas • Biogas produced by anaerobic digestion	RECs tracked by PJM GATS - REC multipliers for solar and wind, including for local manufacturing and workforce	N/A	N/A	N/A	ACP: \$25/MWh SACP: \$150/MWh (DSIRE)

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Table 1-State Renewable Electricity Procurement Policies (continued from previous page)

State	Program	Primary Authorizing Law(s)	Target(s) *Mandated	Eligible Renewable Gas Types	Regulatory Credit Mechanism	New Capacity Requirement	Geographic Requirement	Temporal Requirement for Delivery	ACP/Penalty
HI ¹⁰³	Renewable Portfolio Standards	Act 272 (2001), SB 2474 (2004) , HB 1464 (2009), HB 623 (2015), HB 2089 (2022), SB 3057 (2022)	*2010 - 10% of net electricity sales derived from renewable resources *2015 - 15% *2020 - 30% *2030 - 40% *2040 - 70% *2045 - 100%	• Biogas (including landfill and sewage-based digester gas) • H2 produced from renewable energy source	No credit trading system. Compliance tracked by Hawaii Natural Energy Institute peer reviewed study every 5 years.	N/A	N/A	N/A	Utilities that fail to comply are subject to penalties.
IL	Renewable Portfolio Standards	SB 2814 (2016) , SB 2408 (2021)	*2025-26 - 25% of electricity utility sales derived from renewables by 2025-2026, with targets within the total for distributed generation, wind, solar, and 60% of total required by alternative electricity generators *2030 - 40% renewable electricity procurement *2040 - attempt to reach 50% renewable electricity procurement *2050 - 100% of electricity utility sales derived from clean energy sources, which includes renewables, nuclear, and other zero carbon sources, such as hydrogen	• Biogas produced via anaerobic digestion • Hydrogen • Landfill gas	RECs, carbon emission credit, zero emission credit, or carbon mitigation credit Traded and tracked via M-RETS, PJM-GATS	N/A	Resources must be procured from facilities located in IL or states that adjoin Illinois. If resources are not available in IL or in states that adjoin Illinois, then they may be procured elsewhere.	N/A	Previously allowed. (Statute ; Archive)

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¹⁰³ Note that Hawaii also has a [Renewable Hydrogen Program](#) that required the state, from 2007-2010, to develop a plan to transition the island of Hawaii to a hydrogen-fueled economy and to extend the application of the plan throughout the State, e.g. by developing policies to advance hydrogen fueled vehicles and hydrogen infrastructure, including production, storage, and dispensing facilities.

Table 1-State Renewable Electricity Procurement Policies (continued from previous page)

State	Program	Primary Authorizing Law(s)	Target(s) *Mandated	Eligible Renewable Gas Types	Regulatory Credit Mechanism	New Capacity Requirement	Geographic Requirement	Temporal Requirement for Delivery	ACP/Penalty
IN	Voluntary Clean Energy Portfolio Standard	IC-8-1-37, SB 251 (2011)	2013-2018 - Average of 4% of total annual retail electricity to be supplied by clean energy, ≤30% of which can be met with “clean coal” technology, CHP, nuclear energy, natural gas that displaces electricity from coal, or net-metered distributed generation 2019 - Average of 7% 2025 ≥ 10%	• H2 • Bioenergy • Fuel cells (not specified that renewable gas is required) • CHP (any fuel)	Clean Energy Credits	N/A	50% of energy toward target must be produced in state	N/A	N/A
IA	Alternative Energy Law (AEL)	SF 380 (1983)	*105 MW of total annual electricity sales from the state's two electric utilities combined must come from renewable resources	• Landfill Gas • Biogas via anaerobic digestion	None (<i>can only be used for renewable electricity production outside of AEL compliance</i>)	N/A	N/A	N/A	N/A
KS	Renewable Energy Standard	K.S.A. 66-1256 (2016), 66-1257 (2016), and 66-1259 (2015)	2020 - 20% of utility peak electricity demand met with renewable resources	• Methane from landfills or wastewater treatment • Fuel cells using renewable H2	RECs based on capacity and tracked and traded by NAR Multiplier for renewable power facilities installed after 2000	N/A	N/A	N/A	N/A
ME	Renewable Portfolio Standards	S.P. 457 - L.D. 1494 (2019)	*2030 - 80% retail electricity sales from renewable resources, with interim targets *2050 - 100% retail electricity sales from renewable resources, with interim targets <i>Note separate targets for heating/cooling.</i>	• Biogas via anaerobic digestion • Fuel cells (does not specify what type of gas)	GIS Certificates (similar to RECs) traded and tracked by NEPOOL-GIS ¹⁰⁴ Multipliers for community-based energy projects	2008: 1% sales must be new capacity 2017 and after: 10% sales must be new capacity	Starting 2030: 30% of retail renewable electricity sales have to be delivered within the region	Specific goals for offshore wind	N/A

¹⁰⁴ Also traded are Thermal Renewable Energy Certificates for heating and cooling applications

Table 1-State Renewable Electricity Procurement Policies (continued from previous page)

State	Program	Primary Authorizing Law(s)	Target(s) *Mandated	Eligible Renewable Gas Types	Regulatory Credit Mechanism	New Capacity Requirement	Geographic Requirement	Temporal Requirement for Delivery	ACP/Penalty
MD	Renewable Energy Portfolio Standard	SB 516 (2019)	*2030 - 50% of retail electricity must be procured from renewable resources	• Biogas/biomethane via anaerobic digestion • Fuel cell using renewable sources • Landfill gas	RECs traded and tracked by PJM-GATS	N/A	RECs must be derived from renewable electricity generated in in PJM (or designated offshore areas). PJM adjacent generation was eligible until 2011.		• Tier 1 - \$40/MWh through 2016, then \$37.50/MWh in 2017 and 2018, \$30.00 in 2019 through 2023, declining to \$22.35 in 2030 • Tier 2 - \$15/MWh • Solar - \$400/MWh in 2009 through 2014, \$350 in 2015 and 2016, \$195 in 2017, \$175 in 2018, \$100 in 2019 and 2020, \$80 in 2021, \$60 in 2022 through 2024, declining to \$22.50 in 2030 and thereafter (PJM-EIS)
MA	Renewable Energy Portfolio Standard	H.4857 (2017-18)	*2030 - 40% of electricity sales, with and an additional 1% of sales each year thereafter, with no stated expiration date, plus requirements that a portion serve seasonal peak demand	• Fuel cells utilizing renewable fuels • Landfill gas • Biogas	RECs and Clean Peak Energy Certificates traded and tracked by NEPOOL-GIS w/ carve out for solar until 400 MW (~1% of total electricity) installed	N/A	N/A	N/A	Varies by year 2023 ACP: Class I: \$40/MWh Class I Solar Carve Out: \$330/MWh Class I Solar Carve Out II: \$271/MWh Class II: \$33.06/MWh (State of MA)

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Table 1-State Renewable Electricity Procurement Policies (continued from previous page)

State	Program	Primary Authorizing Law(s)	Target(s) *Mandated	Eligible Renewable Gas Types	Regulatory Credit Mechanism	New Capacity Requirement	Geographic Requirement	Temporal Requirement for Delivery	ACP/Penalty
MI	Renewable Energy Standard	Public Act 295 (2008), SB 438 (2016)	*2012: Existing renewable energy baseline (Oct 2007-October 2008) plus 20% of the gap between baseline and 10% *2013: Existing renewable energy baseline plus 33% of the gap between baseline and 10% *2014: Existing renewable energy baseline plus 50% of the gap between baseline and 10% 2015-2019 - 10% of retail electricity portfolio supplied by renewables *2019-20 - 12.5% of retail electricity portfolio supplied by renewables *2021 15% of retail electricity portfolio supplied by renewables	- Landfill gas produced by municipal solid waste - Biogas via anaerobic digestion	RECs tracked and traded on MIRECS Multipliers for solar in service before 2017, non-wind peak suppliers, storage (more for peak), equipment produced in-state, in-state labor	N/A	N/A	N/A	N/A
MN	Carbon Free Standard	SF 4 (2023)	*2030 - 80% carbon free generation or procurement for public utilities; 60% for other electric utilities *2035 - 90% for all electric utilities *2040 - 100% for all electric utilities	- Landfill gas - Anaerobic digestion - Waste-water treatment - Renewable hydrogen	RECs which are tradeable between states, tracked by M-RETS	N/A	N/A	N/A	N/A
MO	Renewable Energy Standard	Missouri Clean Energy Act (Proposition C)(2008)	*Starting in 2021 - 15% generation or purchase by electricity utilities must be from renewable energy resources, including 2% from solar	- Biogas - Pyrolysis/thermal depolymerization - Fuel cells using renewable H2	RECs traded and tracked with the North American Renewables Registry	N/A	N/A	N/A	N/A

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Table 1-State Renewable Electricity Procurement Policies (continued from previous page)

State	Program	Primary Authorizing Law(s)	Target(s) *Mandated	Eligible Renewable Gas Types	Regulatory Credit Mechanism	New Capacity Requirement	Geographic Requirement	Temporal Requirement for Delivery	ACP/Penalty
NH	Electricity Renewable Portfolio Standard	RSA 362-F	*2025 - 25.2% purchase of or acquirement of RECs representing generation from renewable resources, with interim targets	H2 derived from biomass fuels, water, or methane gas if the methane gas energy output is in the form of useful thermal energy, provided unit began operation after January 1, 2013, and increases renewable energy output.	RECs traded and tracked by NEPOOL-GIS (in addition to PUC calculation of in-state net-metered resources that are not required to use RECs)	N/A	Generators must be in New England control area, or adjacent, if the power produced is delivered into the New England control area for consumption by New England customers.	N/A	Varies by year 2022 ACP: Class I non-thermal: \$59.12/MWh Class I thermal: \$26.86/MWh Class II: \$59.12/MWh Class III: \$36.36/MWh Class IV: \$36.59/MWh (NH PUC)
NJ	Renewable Portfolio Standard	AB 3723 (2018) , AB 3455 (2015) , SB 1925 (2012)	*2025 - 30% of electricity sold from Class I renewable resources *2050 - 50% of electricity sold from Class I renewable resources	- Landfill gas - Anaerobic digestion - fuel cells using renewable fuels (All Class I)	RECs tracked and traded by PJM-GATS	Projects must be online 2003 or later to qualify	N/A	N/A	- ACP and Solar ACP vary 2023 ACP \$50 - Solar ACP set at rates ranging from \$638/MWh in 2010 to \$128/MWh in 2033; 2023 solar ACP is \$228
NM	Renewable Portfolio Standard	SB 43 (2004), SB 489 (2019)	*2030 - 50% total retail sales from renewable resources *2050 - 100% total retail sales from carbon-free resources	- Fuel cells that use non-fossil energy - Anaerobic digestion - Landfill gas	RECs tracked and traded by WREGIS	N/A	N/A	N/A	N/A
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Table 1-State Renewable Electricity Procurement Policies (continued from previous page)

State	Program	Primary Authorizing Law(s)	Target(s) *Mandated	Eligible Renewable Gas Types	Regulatory Credit Mechanism	New Capacity Requirement	Geographic Requirement	Temporal Requirement for Delivery	ACP/Penalty
NY	Clean Energy Standard	Climate Leadership and Community Protection Act, SB 6599 (2019)	*2030 - 70% renewable electricity procurement *2040 - 100% carbon-free electricity procurement	Fuel cells that use non-fossil energy resource	RECs tracked by NYGATS and purchased from NYSERDA or another source.	A minimum percentage of eligible renewable generation must be newly added starting in 2016 to reach the following percentages of the total portfolio: 2017 0.6% 2018 1.1% 2019 2.0% 2020 2.84% 2021 2.04% 2022 5.61% 2023 8.20%	RECs associated with production from otherwise Tier 1 eligible RES resource (projects that came online in or after 2015) can satisfy Tier 1 RES obligations, if the resource is (i) physically located within jurisdiction of the NYISO or a control area adjacent to NYISO and (ii) the associated energy is consumed in NY per RES delivery requirement	N/A	ACP varies by year 2023 ACP: \$31.89/MWh (NYSERDA)
NC	Renewable Energy and Energy Efficiency Portfolio Standard (REPS)	SB 3 (2007)	*Starting in 2021 - 12.5% generation or purchase by electricity utilities must be from renewable energy resources. Out-of-state new renewable energy facilities shall not be used to meet more 25% of the RPS requirements, with an exemption for public utilities with <150,000 North Carolina retail jurisdictional customers as of 12/31/2006.	- Landfill gas - Renewable hydrogen	RECs traded by NC-RETS. Triple credit for RECs generated by the first 20 MW of a biomass facility located at a “cleanfields renewable energy demonstration park.”	N/A	N/A	N/A	N/A

Table 1-State Renewable Electricity Procurement Policies (continued from previous page)

State	Program	Primary Authorizing Law(s)	Target(s) *Mandated	Eligible Renewable Gas Types	Regulatory Credit Mechanism	New Capacity Requirement	Geographic Requirement	Temporal Requirement for Delivery	ACP/Penalty
OH	Renewable Energy Portfolio Standard	SB 221 (2008), SB 310 (2014), HB 6 (2019)	*2026 - ≥ 8.5% of electricity sales from generation derived from renewable resources, with interim targets and compliance requirement ending in 2026	- Biologically derived methane gas - Fuel cells	RECs with a lifetime of 5 years, traded and tracked by M-RETS, PJM-GATS. RECs may continue to be purchased and traded after the RPS ends in 2026. Solar carve out ended in 2019 (OH PUC)	N/A	N/A	Eligibility requires generation to be within or delivered to the state.	Non-solar ACP varies by year 2022 non-solar ACP: \$56.99/MWh (OH PUC)
OR	Renewable Portfolio Standard and GHG Free Electricity Law	SB 1547 (2016), HB 2021 (2021), ORS 469A.145	2021 GHG Free Electricity Law *2030 - 80% of retail electricity sales must be below baseline (2010-2012) GHG emissions level. *2035 - 90 % below baseline emissions level. *2040 , and for every subsequent year - 100% baseline emissions level 2016 RPS Law *2025 - 25% of large utility electricity demand met with renewables, Small utilities: 10% by 2025, Smallest utilities: 5% by 2025 *2040 - 50% of large utility electricity demand met with renewables	Landfill and other types of biogas	RECs tracked and traded by WREGIS	Until 2021, unbundled RECs could only meet 20% of large utility compliance obligation and 50% of large consumer-owned utility obligation, and starting in 2021, both can only use up to 20% unbundled RECs to meet compliance obligations. RECS related to net metering facilities and certain public utilities exempt from this limit.	N/A	N/A	ACP set by state PUC, per ORS 469A.180 and ORS 469A.200

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Table 1-State Renewable Electricity Procurement Policies (continued from previous page)

State	Program	Primary Authorizing Law(s)	Target(s) *Mandated	Eligible Renewable Gas Types	Regulatory Credit Mechanism	New Capacity Requirement	Geographic Requirement	Temporal Requirement for Delivery	ACP/Penalty
PA	Alternative Energy Portfolio Standard	Pennsylvania Act 213 (2004), Act 35 (2007), Act 129 (2008), Act 40 (2017), Act 114 (2020)	*2021 - 18% RPS from eligible alternative resources, including 10% from Tier I (new/ existing solar PV, solar-thermal energy, wind, low-impact hydro, geothermal, biomass, wood pulping and mfg. byproducts from energy facilities within state, biologically-derived methane , coal-mine methane, and fuel cells), 8% from Tier II (new and existing alternative fossil fuel resources, distributed generation, demand-side management, out of state facilities that produce electricity from wood pulping and manufacturing byproducts, large hydro, municipal solid waste). Carve outs for PV, to provide .5% of the electricity by 2021.	- Fuel cells - Biologically-derived methane gas	RECs managed by PJM-GATS	N/A	Electricity derived from wood pulping; manufacturing byproducts must be from in state to qualify as Tier I. As of 2017, solar PV must be connected to a PA EDC's transmission system within PA EDC's territory As of 2020, Tier II sources must be located within the state or local service territories	N/A	- Non-solar ACP of \$45/MWh - Solar ACP varies – 200% of the average market value for solar RECs sold in the RTO (PA Code § 75.65, PJM-EIS)
RI	Renewable Portfolio Standard (RI RES)	R.I. Gen. Laws Section 39-26-1-10 (2004), H7413A (2016) SB 2274 (2022)	*2033 - 100% retail electricity from renewable by 2033, with interim targets ranging from 4% to 9.5% increases per year	- Landfill gas - Fuel cells using renewable fuels - Anaerobic digestion	RECs managed by NEPOOL-GIS	N/A	N/A	RECS limited to 2 yr lifetime capped at 30% of current year's obligation	ACP varies 2023 ACP: \$80.59 (RI RES)
SD	R.E. Conservation Portfolio Standard	HB 1123 (2008)	2015 - 10% of retail electricity sales from eligible renewable or conserved energy resources	- Renewable hydrogen - Anaerobic digestion - Landfill gas - CHP	RECs tracked by state PUC	N/A	N/A	N/A	N/A
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Table 1-State Renewable Electricity Procurement Policies (continued from previous page)

State	Program	Primary Authorizing Law(s)	Target(s) *Mandated	Eligible Renewable Gas Types	Regulatory Credit Mechanism	New Capacity Requirement	Geographic Requirement	Temporal Requirement for Delivery	ACP/Penalty
TX	Renewable Portfolio Standard	SB 7 (1999)	*2015 - 5,880 MW (including voluntary target of 500 MW non-wind), with interim targets *2025 - 10,000 MW, with interim targets (<i>2025 target achieved in 2009</i>)	Landfill gas	RECs administered by ERCOT (ended in 2019)	Renewable generation had to be installed after 1999; Opt out for lg. utility customers served by transmission voltage	N/A	N/A	Penalty of \$50/MWh of deficiency for non-compliance (TX PUC Code §25.173)
UT	Renewable Portfolio Standard (Goal)	SB 202 (2008)	*2025 - 20% of retail sales adjusted to total kWh minus kWh from nuclear, DSM, and fossil fuel with carbon sequestration	- Landfill gas - Biogas	- RECs tracked and traded by WREGIS - Multiplier for solar	N/A	Renewable facilities must be within the WECC boundary	N/A	N/A
VT	Renewable Energy Standard	Act 56 (2015)	*2017 - Distribution utilities (DUs) must cover 55% of sales with eligible renewables, including 1% from new, local distributed generation, with a 3/5% increase thereafter until 2032. Also 2% equivalent of retail sales covered by "energy transformation" projects that do not generate electricity but reduce use of fossil fuels (e.g., EV charging, storage, home weatherization, etc.); smaller utilities have until 2019. *2032 - DUs must cover 75% annual sales with eligible renewables, including 10% distributed generation. Additional 12% of energy met with energy transformation projects (10% for smaller utilities).	Methane gas and other flammable gases produced by the decay of sewage treatment plant wastes or landfill wastes and anaerobic digestion of agricultural products, byproducts, or wastes, or of food waste	RECs tracked and traded by NE-GIS	Distributed generation required to be new in compliance year and connected to a Vermont distribution or sub-transmission line	Qualifying facilities must be either in the distributed utility territory, or from plants whose energy is capable of delivery in New England	N/A	ACP varies; 2022 ACP: \$66.94/MWh (ISO NE)

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Table 1-State Renewable Electricity Procurement Policies (continued from previous page)

State	Program	Primary Authorizing Law(s)	Target(s) *Mandated	Eligible Renewable Gas Types	Regulatory Credit Mechanism	New Capacity Requirement	Geographic Requirement	Temporal Requirement for Delivery	ACP/Penalty
VA	Renewable Portfolio Standard	56-585.2 H (2011) - repealed; HB 1526 (2020)	<i>2011-2020 voluntary RPS (repealed and replaced by mandated targets below)</i> *2021 - 6% electricity generation from renewable resources for Phase I Utilities (IOU that, as of July 1, 1999, is not bound by a rate case settlement adopted by the Commission that extended in its application beyond January 1, 2002), 14% for Phase II Utilities (IOU not bound by such settlement), with interim targets until: *2045 - 80% for Phase I Utilities, 100% for Phase II Utilities *2050 - 100% for Phase I Utilities	Landfill gas Waste to energy (law specifies no natural gas)	RECs tracked and traded by PJM-EIS		2021 to 2024: Dominion and Appalachian Power may use RECs from any renewable energy facility located in VA or the PJM region. 2025 and thereafter: ≥75% of RECs used by Dominion must be from RPS resources located in VA		2021 ACP: Renewables: \$45/MWh Distributed Generation (<1 MW) - \$75/MWh Increasing by 1% annually after 2021. (PJM-EIS)
WA	Renewable Portfolio Standard and Conservation	I-937 (Energy Independence Act), SB 5116 (2019)	*2020 - 15% of electricity retail sales of utilities serving >25k customers from renewable resources and cost-effective conservation (achieved) *2045: 100% of retail sales must come from clean electricity, with interim targets including retirement of all coal generation by 2025, carbon neutrality by 2030 some offsets allowed.	Renewable natural gas, renewable hydrogen	RECs traded by WREGIS	Facility must commence operation after March 31, 1999	Electricity must be delivered into Washington State to be eligible	Electricity from must be delivered into Washington State on a real-time basis. RECS bankable for 1 year for future compliance and may be used for prior year's compliance	Penalty of \$50 per MWh shortfall (DSIRE)

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Table 1-State Renewable Electricity Procurement Policies (continued from previous page)

State	Program	Primary Authorizing Law(s)	Target(s) *Mandated	Eligible Renewable Gas Types	Regulatory Credit Mechanism	New Capacity Requirement	Geographic Requirement	Temporal Requirement for Delivery	ACP/Penalty
WV	Alternative Energy Portfolio Standard	HB 3 (2009) , HB 2001 (2015) - repealed HB 3	*2015-2019 - 10% of electricity sales from alternative (various unconventional fossil fuel pathways, pumped hydro, recycled energy) and renewable resources *2025 - 25% of electricity sales from alternative and renewable sources <i>*Targets can be adjusted or eliminated if the Commission finds alternative or renewable energy resources are not available to meet compliance requirements</i>	Biologically derived fuel including methane gas, ethanol not produced from corn, or biodiesel fuel; Fuel cells (not specified that must use renewable fuel)	RECs with multipliers for renewable energy generated in state or service territory, with an adder if located on a surface mine; Additional credits may be purchased to reach compliance targets ; Credits obtained via GHG reduction or offsets verified by Secretary of the Dept of Environmental Protection, as well as by certain demand-side management or efficiency projects	N/A	Alternative energy resource facility located within geographical boundaries of this state or within the service territory of a regional transmission organization, as that term is defined in 18 C.F.R. §35.34, that manages the transmission system in any part of this state	N/A	N/A
WI	Renewable Portfolio Standard	Act 141 (2005) ; s.196.378	*2010-2014 – increase renewable electricity retail sales 2% above baseline *2015 and after - 10% of retail electricity sales from renewable resources	Fuel cell technology (not specified that must use renewable fuel)	·RECs tracked and traded by M-RETS	2006-2009: Maintain baseline 2010-2014: increase renewable percentages to 2% above baseline. 2015 and after: Renewable percentages of 6% above baseline	Renewable electricity generated must be delivered to Wisconsin customers.	N/A	N/A

Table 2- Federal Renewable Gas Procurement Programs

Policy/Program	Target(s) *Mandated	Eligible Renewable Gas Types	Regulatory Credit Mechanism	Deliverability Requirements	Time Matching Requirements
Federal Renewable Fuel Standard	*Out to 2022: 36B gal. renewable fuel derived from renewable biomass or from a biointermediate produced from renewable biomass and that, unless exempt, reduces lifecycle GHG 20%-60% below the petroleum baseline, to replace or reduce petroleum fuels, heating oil or jet fuel. 2023-2025: EPA has proposed additional targets to increase total renewable fuel volumes by 2.05B gal. to 22.68B gal	• Renewable CNG • Renewable LNG • Renewable Electricity produced from biogas from landfills • Anaerobic digesters • Biogas from cellulosic components of biomass processed in other waste digesters (EPA). • These renewable gas pathways must meet a 60% GHG reduction below baseline petroleum fuel	Renewable Identification Numbers (RINs) with penalties assessed by EPA for compliance violations	N/A	N/A
Clean Hydrogen Production Tax Credit	Aligned with federal goals laid out in the Infrastructure Investment and Jobs Act to reduce the cost of electrolytic H2 to \$2/kg by 2026, and the US DOE Hydrogen Shot goal to reduce the cost of clean H2 to \$1/kg by 2031.	Qualified Clean H2 (i.e., H2 produced through a process that • results in lifecycle GHG emissions rate of ≤ 4 kg CO₂e/kg H2 • is produced in US • is in ordinary course of business or trade for the taxpayer, and production, sale, or use of which is verified by an unrelated party • is produced in facilities that start construction before 1/31/2033	Production tax credit (PTC) with rules pending	N/A	N/A
Federal Energy Credit	Aligned with federal electrolytic/clean H2 cost reduction goals cited above	• Biogas property system that converts biomass to gas containing at least 52% methane for sale or productive use and not for combustion • Clean H2 facilities that do not use PTC • Projects that start construction after 12/31/2024 are ineligible.	Investment tax credit (ITC) with rules pending	N/A	N/A
Regional Clean Hydrogen Hubs	• \$8 billion to fund at least 4 regional clean H2 hubs • Reduce cost of clean H2 to $\leq$\$2/kg over course of ~10 yr program	Clean hydrogen produced using renewable energy, nuclear power, or natural gas with carbon capture and storage with a carbon intensity of ≤ 2 kg/Co ₂ e per kg/H ₂ .	Grant program with awards pending	N/A	N/A
Federal Agency 100% Carbon-Pollution Free Electricity Procurement	• 2030 - 100% carbon pollution-free electricity on a net annual basis including 50 percent 24/7 carbon pollution-free electricity			24/7 carbon-pollution free electricity must be produced within same regional grid where energy is consumed.	24/7 carbon pollution-free electricity must be procured to match actual power consumed

Table 3 – State Renewable Gas Procurement Programs

State	Program	Primary Authorizing Law(s)	Target(s) *Mandated	Eligible Renewable Gas Types	Regulatory Credit Mechanism	New Capacity Requirement	Geographic Requirement
CA	Biomethane Procurement Program	SB 1383 (Lara, 2016), SB 1440 (Hueso, 2018)	*2025 - sufficient biomethane to divert 8M tons of organic waste from landfills *2030 - 75.5 MMBtu (72.8 Bcf) biomethane annually (~12.3 % of total annual 2020 statewide gas IOU core customer consumption). <i>Targets intended to further state targets to divert organic waste in landfills, reduce short lived climate pollutants (reduction in methane by 40%, hydrofluorocarbon gases by 40%, and anthropogenic black carbon by 50% below 2013 levels by 2030).</i>	• Biomethane from source other than dairy operations, as long as it meets program cost effectiveness criteria • May be substituted by well gas, if this is a cost effective means of reducing short lived climate pollutants	• Joint Utility Biomethane Procurement Plan • EAs from contracted renewable fuel source of which procuring gas utility must maintain exclusive ownership to avoid double counting • Verifiable renewable thermal certificates traded and tracked via M-RETS	Bundled renewable thermal certificates only	Renewable gas must be delivered to and environmentally benefit CA
MN	Natural Gas Innovation Program	HF 6 (2021)	*2025: Establish policies and regulations to support innovative gas resources helping to meet or exceed state GHG emission goals of 30% below 2005 levels *2050: Do same to reduce GHG 80% below 2005 levels	• Biogas • Renewable natural gas • Power-to-hydrogen • Power-to-ammonia • District energy	Framework to calculate lifecycle GHG intensities of each innovative resource plus potentially other policies to be determined by state PUC.	N/A	N/A
NH	Procurement of Renewable Natural Gas	SB 424 (2022)	Maximum 5% of gas utility total volume delivered, maximum 15-year contracts	• Biogas upgraded to meet gas pipeline quality standards • Fuel produced by biomass gasification processes • H2 derived from clean energy • Methane derived from biogas, H2 and/or carbon oxides derived from renewables or waste CO2.	Utilities may submit RFPs, plus pursue cost recovery mechanism at state PUC.	N/A	N/A
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Table 3 – State Renewable Gas Procurement Programs (continued from previous page)

State	Policy/ Program	Primary Authorizing Law(s)	Target(s) *Mandated	Eligible Renewable Gas Types	Regulatory Credit Mechanism	New Capacity Requirement	Geographic Requirement
NV	Renewable Natural Gas (RNG) Use and Cost Recovery Authorization	SB 154 (2019)	*January 1, 2025 - ≥1% retail sales *January 1, 2030 - ≥2% retail sales **January 1, 2035 - ≥3% retail sales	Procurement of or investment in infrastructure for processed biogas, P2G / electrolysis, so long as the renewable gas contains certain EAs and the meets quality standards applicable to the natural gas pipeline into which the gas will be injected.	Rules may be made by state PUC to allow public utilities or their customers to purchase renewable gas to use or sell, whether or not the gas has EAs, or to participate in a state or federal renewable energy program/ project, if doing so consists of the purchase or sale by the public utility of gas or EA; and reduces the cost of gas produced from a renewable gas facility to the customers of the public utility.	N/A	N/A
OR	Renewable Natural Gas Program	SB 98 (2019)	2020-24 - 5% 2045-50 - 30%	• Biogas upgraded to meet gas pipeline quality standards • Fuel produced by biomass gasification processes • H2 derived from clean energy • Methane derived from biogas, H2 and/or carbon oxides derived from renewables or waste CO2.	"Renewable Thermal Certificate" (RTC), which represent environmental attributes based on CI, which are issued, tracked, traded, and retired through the M-RETS electronic system	N/A	N/A

Table 4 – State Low Carbon Fuel Procurement Programs that Include Renewable Gas

State	Policy/ Program	Primary Authorizing Law(s)	Target(s) *Mandated	Eligible Renewable Gas Types I	Regulator y Credit Mechanis m	Additionality Requirements	Geographic Requirements	Temporal Requirements	Penalty/ ACP
CA 105	Low Carbon Fuel Standard (LCFS)	AB 32 (2006) Scoping Plan	*2018 – H2 dispensed at stations receiving H2 Refueling Incentive (HRI) capacity credits must be produced using 40% RPS eligible renewables *2030 – CI of dispensed transport fuels in CA must be 20% below 2010 baseline, based on an annual declining target.	• RNG • H2	Book and claim (Credits based on CI that are bought and sold to comply with the Clean Fuels Standard)	Per LCFS Guidance 19-01 , low-CI electricity used as transportation fuel to make H2 must be in addition to CA RPS requirements (or local renewable requirements for electrolytic hydrogen produced outside of CA)	Per LCFS Guidance 19-01, low-CI electricity used must be supplied to grid by a resource located within a CA Balancing Authority (or local balancing authority for electrolytic hydrogen produced out of state). Alternatively, to show electricity generated from an out-of-state resource was supplied to the CA grid, the low-CI electricity must meet the deliverability requirements of California PUC code section 399.16 , subdivision (b)(1) which details the deliverability requirements for Portfolio Content Category 1 RECs.	Book-and-claim accounting for low-CI electricity and for biomethane may span only three quarters. i.e. If a quantity of low-CI electricity (and all associated EAs, including a beneficial CI) is supplied to the grid in the first calendar quarter, the quantity claimed for LCFS reporting must be matched to grid electricity used as a transportation fuel or for electrolytic hydrogen production no later than the end of the third calendar quarter.	Penalty commensurate with deficit fined for compliance failure
OR	Clean Fuels Standard	SB 324 (2015)	*2025 - 10% reduction in average CI from 2015 levels *2030 - 20% reduction *2035 - 37% reduction	RNG (Renewable H2 under consideration)	Book and Claim	Requires that RECs ret	RECs must be generated from facilities located in the WECC ¹⁰⁷	N/A	Penalty assessed in proportion to environmental benefit lost by compliance failure (OR SOS/DEQ)
Continued on next page									

¹⁰⁵ Note that per SB 1505, California also requires 33.3% of hydrogen fuel dispensed for transportation to come from renewable resources, which largely been assured by the eligibility criteria and the grant agreements developed through the Energy Commission's grant solicitation process (p. xvii, [2019 Annual Evaluation of Fuel Cell Electric Vehicle Deployment & Hydrogen Fuel Station Network Development](#), CARB). This target has been surpassed, as most recently reported in the [CARB 2022 Annual Evaluation of Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Cell Station Network Development](#).

¹⁰⁶ Oregon Clean Fuel Standard [340-253-0470](#) (5)(a)

¹⁰⁷ Oregon Clean Fuel Standard [340-253-0470](#) (5)(c)

Table 4 – State Low Carbon Fuel Procurement Programs that Include Renewable Gas (continued from previous page)

WA	Clean Fuels Standard	HB 1091 (2021)	*2034 - 20% reduction below 2017 levels in avg. CI	• Bio-CNG • Bio-LNG • Bio-L-CNG • Alt. jet fuel • Renewable propane • Renewable LPG.	Book and Claim	Additionality requirements for RECs used to claim carbon intensity, requiring starting in 2025 that RECS be generated from electric generators placed into service after 2023. ¹⁰⁸	RECs must be generated from facilities located in the western electricity coordinating council ¹⁰⁹	State requires real-time matching for RPS, unclear how this will impact clean fuels standard rules	N/A
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¹⁰⁸ p. 180, Washington Department of Ecology, [Concise Explanatory Statement Chapter 173-424 WAC, Clean Fuels Program Rule & Chapter 173-455 WAC, Air Quality Fee Rule](#), November 2022

¹⁰⁹ [WAC 173-424-630](#) (5)(c)