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A Path to Supporting Data-Driven Renewable Energy Markets

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Executive Summary

To support 24/7 carbon-free energy initiatives, M-RETS, a renewable energy tracking platform, facilitated the first-ever hourly Renewable Energy Certificate ("REC") claim when Google finalized an hourly REC retirement in January 2021. This is an exciting first step in building out the data available in existing environmental commodity markets like RECs to help facilitate and quantify efforts toward economy-wide decarbonization in both voluntary and compliance markets.

M-RETS believes existing REC markets are uniquely situated to begin and sustain this process in a way that does not disrupt – and hopefully supports – existing markets.

Certain consumers are demanding more granular data integrations on RECs such as hourly data to support evolving sustainability goals. These evolving goals place the highest value on quantifying the benefits of their decisions toward decarbonizing their environmental footprint.

As part of Phase 1, M-RETS accomplished the following:

1. Developed technical tools to collect hourly data beginning in January 2019. At publication, M-RETS has more than 60 million megawatts of hourly generation data and growing.

2. Created an accessible user interface ("UI") to both view hourly generation data in the system and download that data or access it via an application programing interface

("API").
3. Built advanced hourly reporting tools that allow users to aggregate hourly generation from multiple generators over time.
4. Built a retirement process that integrates hourly generation data into the process when a user retires a complete batch of RECs (i.e., not subdivided after issuance).[1]

Hourly generation data access is an important first step in a multi-faceted process to establish data-driven renewable energy markets. In recognition of this, M-RETS suggests a four-phase process to work through the important market implications of the decisions necessary to achieve the growth of globally scalable data-driven renewable energy markets.

Phase two involves providing access to more granular energy market and emissions data. M-RETS hopes to begin working on this in Q1 and Q2 2021. Deciding what market data is important to integrate will depend not only on the availability, but also the accuracy and source of the data. There are important decisions to make within this phase, including whether to include estimated or modeled data.

Phase three involves working with voluntary and compliance market stakeholders to obtain consensus on how to manage the full lifecycle of hourly certificates to support more specific hourly accounting claims. M-RETS hopes to begin work on this in Q3 and Q4 2021. This phase will determine whether REC batches should be broken up and transacted in hourly or smaller increments.

Phase four involves providing a mechanism for more specific hourly claims to also include verified or estimated carbon data, and how to quantify decarbonization efforts on behalf of customers. M-RETs hopes to begin working on this phase in Q1 and Q2 of 2022. This may be a more controversial phase because it requires that stakeholders make important decisions on integrating hourly and other data into existing markets, and how both real and estimated emissions data is reported at the individual and grid level.

The achievement of completing the first hourly retirement in a production REC platform is just the beginning. M-RETS plans to continue leading the development of a process that can scale globally to multiple consumers. M-RETS views this paper and the rollout of this achievement as a call to action for creating an advanced renewable energy commodity market built for and driven by increased data access.

[1] A batch of RECs with hourly data subject to a transfer or transaction that removes even one REC will not qualify for an hourly retirement at this time. However, transfers of a full batch, even if it is between different organizations, does not render a batch ineligible for an hourly retirement.

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Introduction

M-RETS is a mission-driven environmental attribute tracking platform providing the data that is leading the drive toward economy-wide decarbonization. The M-RETS Renewable Energy Certificate ("REC") and Renewable Thermal Certificate ("RTC") registries provide key data that serve new and existing voluntary and compliance markets across North America.[2]

M-RETS occupies a unique space in the registry platform market as an independent 501(c)(4) with a board that includes state regulators, investor-owned, cooperative and municipal utility representatives, and other diverse experts. A key part of the M-RETS mission is to provide leadership in renewable energy markets by providing scalable and replicable solutions that help solve environmental problems at a local, regional, national and global level.

M-RETS facilitates REC markets by issuing a unique, traceable digital certificate (i.e., one REC) for every megawatt hour ("MWh") of verified renewable energy recorded on the platform. Once issued, M-RETS users can choose to transfer (buy/sell), retire, import or export RECs.[3] M-RETS users can retire certificates either to comply with state mandates or to fulfill their voluntary commitments, ensuring that certificates are not double counted. M-RETS registers projects in all U.S. states and Canadian provinces and will support imports and exports with any registry in North America.[4]

Google became the first renewable energy purchaser to make an hourly retirement claim in a production system while using the M-RETS platform in January 2021. While this achievement is something to celebrate, it is just the beginning of a process to enhance global renewable energy markets. The impetus behind this publication is a call to action for creating an advanced renewable energy commodity market built for and driven by increased data access. M-RETS exposes the process utilized to reach this milestone, asks critical questions to stakeholders and lays out a path forward.

Global REC markets rely on a "book and claim model." Book and claim [1] follows the chain-of-custody of environmental attributes decoupled from a physical commodity (e.g., electricity) to represent the claim to the attribute without regard to physical traceability. Through this methodology, under current practice a renewable energy purchaser matches renewable consumption with one or more generators over a month or year and retires the environmental attributes that represent the percentage of the load the renewable energy purchaser wants to claim as renewable. The retirement of an REC by or on behalf of a renewable energy purchaser gives them the right to claim 1 MWh of renewable, zero-carbon energy [2].

[2] M-RETS uses RECs but throughout this paper Guarantee of Origin ("GoO") could act as a substitute term. While written from experience in REC markets, the general themes and questions could apply to different markets such as the International REC Standard. This also applies to terms like retired which are equivalent to canceled in GoO and IREC markets.
[3] *See* Why Use M-RETS, (https://www.mrets.org/about/why-use-m-rets/).
[4] *See* Registries (https://www.mrets.org/registries/). M-RETS supports open and transparent markets. With M-RETS API, M-RETS supports allowing imports and exports between all REC tracking systems in North America, including allowing for the import/export of previously imported or exported RECs. Not every system believes in the same.

Even with a 100% match of generation to load, that consumer (in fact, all customers) will rely on the existing grid for physical energy. Thus, the physical electricity mix delivered to a renewable energy purchaser will always include generation from a mix of renewable, carbon-free, and/or non-renewable carbon emitting generators, until the entire grid is 100% renewable and non-emitting.

Much of the criticism of RECs is fed by a lack of understanding of both their origin and theoretical nature. RECs grew out of a need to quantify and measure renewable energy commitments – which at the outset focused on compliance markets. However, those commitments often had many competing purposes, for example [3] jobs and economic development, renewable subsidies, validating compliance goals, reducing fossil fuels, etc. On top of the many competing interests used to support compliance markets, other factors also fuel misguided criticism of RECs.

REC skeptics often state that RECs do not accurately reflect what is happening on the grid because they do not guarantee the physical delivery of electrons. However, it is not possible to track the physical delivery of electrons; therefore, RECs provide an avenue to track renewable energy goals through the decoupling of the physical electricity commodity from its accompanying environmental attributes. The current dominant practice in REC markets where renewable energy purchasers receive RECs issued monthly and match them to load over a year or longer, fuels skeptics scurrilous claims that RECs are just an attempt at "corporate greenwash" that "drives millions each year away from actions which can genuinely mitigate climate change [4]." This has contributed to a series of innovations over the years, including the growth of the corporate renewable procurement market.

Corporate renewable energy commitments and the voluntary renewable energy market started an evolutionary process in 2015 with the rise in power purchase agreements ("PPAs") [5]. This led to the evolution of the virtual power purchase agreement ("VPPA") where unlike in the traditional PPA, the buyer never takes ownership of physical electrons. Instead, the VPPA is "purely a financial transaction, exchanging a fixed-price cash flow for a variable-priced cash flow and [RECs] [6]." Developments in corporate procurement created a resurgence in interest aimed at existing REC markets, including suggestions on ways to continue developing these markets to meet the evolving needs of new and existing market participants.

In October 2018, another important evolutionary step occurred when Google released the 24/7 White Paper ("24/7 Paper") driven by the goal to fully decarbonize the electric sector [7] [8]. The 24/7 Paper opened a process for companies to begin looking at how to measure and quantify their contributions on an hourly basis with an eye toward greater grid decarbonization benefits. In that paper, Google recognized this process will "require innovations across policy, technology, and business models…[including] policy and market reforms that break down barriers to [CFE] procurement…and appropriately price the attributes of different power sources." In 2020, Google published a new white paper on 24/7 carbon-free energy, with a focus on how it intends to reach the target by 2030 [9]. Most recently, in 2021, the company also issued a paper on the methodologies and metrics it is using to evaluate progress toward carbon-free energy [10].

This is not just an idea adopted by large corporate purchasers, "[t]he Des Moines City Council approved a resolution outlining a series of carbon emissions goals, including a *24/7 clean energy*

by 2035 pledge [11].” While Des Moines is the first city to announce such a goal, the city of Palo Alto is switching from an annual carbon accounting methodology to one based on hourly average emissions factors, recognizing shortfalls in renewable production and consumption [12] [13]. M-RETS anticipates that in 2021 more and more entities – from corporations to government and individuals – will adopt similar 24/7 proposals or decarbonization strategies that achieve a similar goal.

M-RETS recognized that an important first step in providing a path forward to understanding the benefits of 24/7 renewables was to innovate by acquiring and experimenting with greater amounts of data. While obtaining hourly renewable generation data was the first step, M-RETS also explored other data integrations. This is what feeds the idea of data-driven renewable energy markets, including layering more energy market data on top of the existing REC framework. This allowed the M-RETS development team to build out the platform data model to support hourly and peak/off-peak data, as a first step. The Midcontinent Independent System Operator (“MISO”) started providing M-RETS this data for all generators beginning in January 2019.

M-RETS divided the process of establishing data-driven renewable energy markets and integrating more granular data such as hourly generation information into four phases. These phases are as follows with estimated timelines:

1. Phase one involves opening existing REC markets to hourly generation data and completing the first hourly REC retirement in a production system. (January 2019-January 2020) [Complete]

2. Phase two involves whether and how to provide access to more granular energy market data (e.g., marginal fuel, grid mix, etc.) and verified and modeled emissions data (e.g., estimated avoided emissions). (January 2021-June 2021)

3. Phase three involves working with voluntary and compliance market stakeholders to obtain consensus on how to manage the full lifecycle of hourly certificates to support more specific hourly accounting claims. While groups working to build consensus like EnergyTag mostly include voluntary market participants, M-RETS supports regulators joining the process. Any standards must ensure existing markets remain intact. (June 2021-January 2022)

4. Phase four involves providing a mechanism for more specific hourly claims to also include verified or estimated carbon data. Providing the data remains relatively noncontroversial. However, this could lead to confusion around the difference between real or estimated avoided emissions claims, carbon offset claims, and Scope 2 reduction claims. For the market to evolve in an orderly fashion, two things must happen. First, stakeholders must seek to understand whether integrating hourly and other data into these markets requires updating the calculations that provide both real and estimated avoided emissions data. Second, stakeholders must decide whether to update existing claims guidance governing real and estimated avoided emissions given the new hourly and other data integrations. (January 2022-June 2022)

M-RETS worked through the early questions surrounding hourly generation data to arrive at this phased approach. A larger and more complex set of questions emerged around how to structure the market and provide efficient access to a diverse user group. The complexity of the data, although real, did not create significant roadblocks. For example, in contrast to the manageable complexity of hourly data, providing a user interface ("UI") and user experience ("UX") that allows all users – from the most to least experienced – an opportunity to access and use hourly data is one of the more complicated technical problems to solve.

For example, M-RETS created a new hourly reporting feature as shown in Figure 1(A-C). This feature automatically pulls all REC batches that qualify for hourly retirements as they are currently allowed in M-RETS into one screen that allows the user to search and organize the hourly data to their needs. The user can also download the data they select for the reports. This is just the first step in providing more comprehensive reporting and visualization functions within M-RETS.

Figure 1(A)

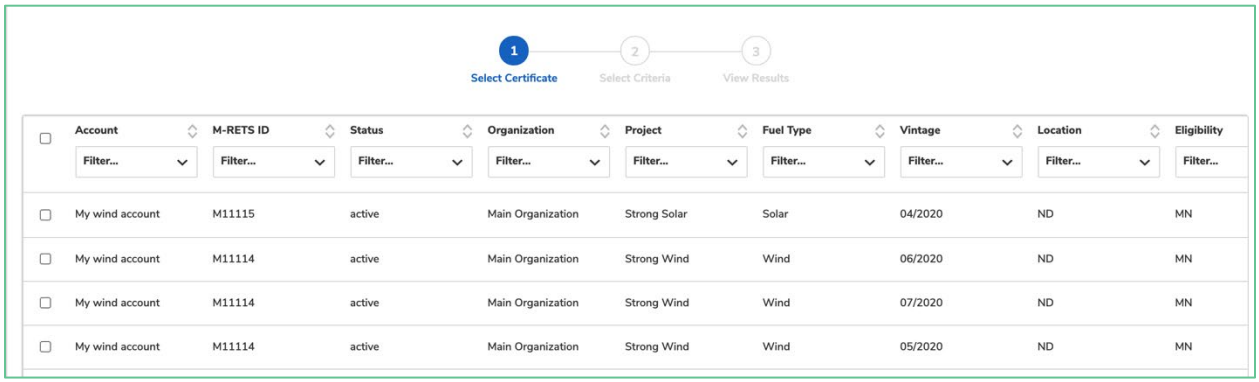


Figure 1(B)

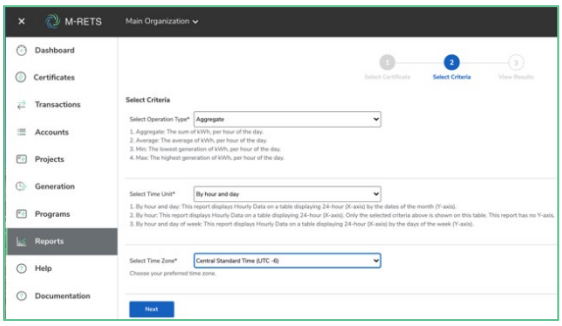


Figure 1(C)

M-RETS self-financed this work, including leading sessions at conferences and engaging state and federal regulatory bodies, industry stakeholders and academic thought leaders collectively and individually. M-RETS spent countless hours talking with these stakeholders, keenly listening for important nuances to their unique needs. The M-RETS team, which includes dedicated full-

time software developers, distilled the knowledge from that process and executed a strategy to address data, UI and UX needs that included customers' feedback, testing and quality assurance.

M-RETS first achievement in 2019 was to include a full month of hourly generation information for generators when the data is directly provided to M-RETS by MISO. Once M-RETS maintained a level of comfort with the data and market needs, M-RETS developed a process to provide for hourly REC retirements. As shown in Figure 2(A-C), this process embeds the hourly production data into the retirement claims process. At this time RECs are not issued in individual hours, due strictly to market limitations and not technical concerns. Instead, the M-RETS process provides access to hourly data that is associated with specific batches.

This exciting achievement does more than just integrate hourly data into the claim. The process verifies that REC batches retired for hourly claims are whole and not split post issuance. Splitting batches post issuance could risk a potential double claim on an hour. The process allows for multiple batches to be retired at once and provides aggregate hourly data by hour, day, and month for the batches subject to the transaction.

Figure 2(A)

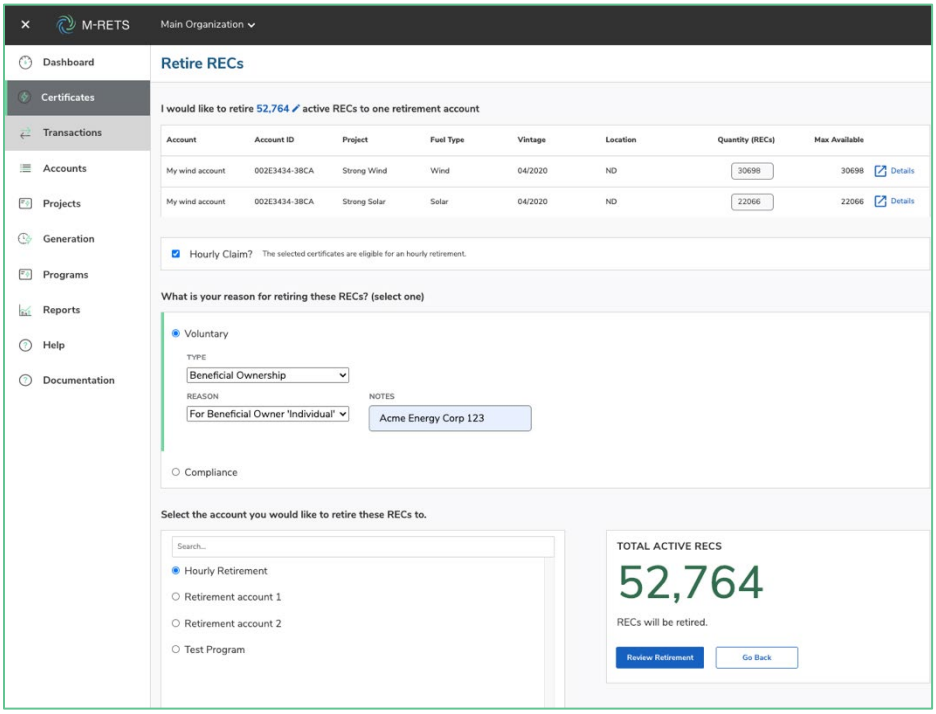


Figure 2(B)

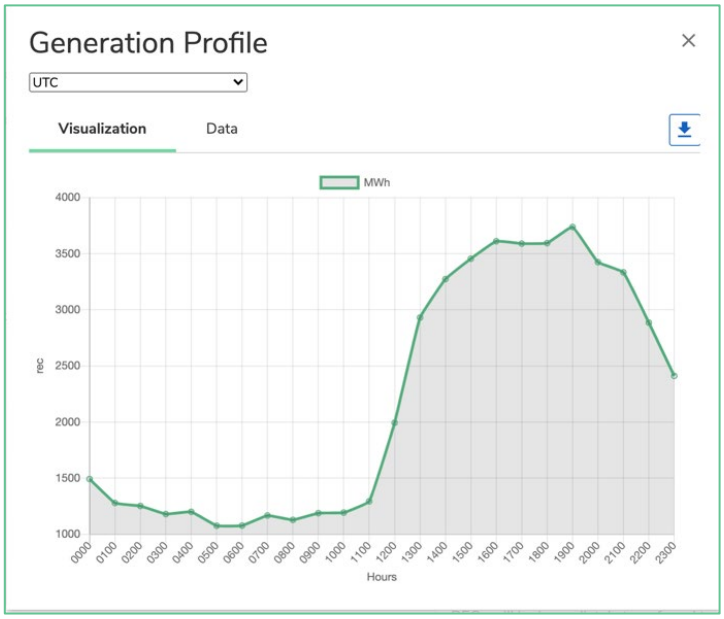


Figure 2(C)

This is by no means a perfect process; however, M-RETS believes that it was important this demonstration occur in an existing production system and not in a pilot or purely demonstrative environment. By detailing this experience, M-RETS hopes this publication provides a strong basis for the industry to begin tackling the many questions and complexities the market must solve to do this in a scalable, replicable and global manner. M-RETS raises potential roadblocks and questions that require discussion and experimentation. Without a deliberate approach, some solutions could create unintended ripple effects in existing renewable energy markets.

Attaching hourly data to RECs and providing for a retirement process that ensures against hourly double claims is a critical first step. However, M-RETS anticipates that with further feedback, the process will evolve. Whether that ends in issuing actual serialized RECs on an hourly basis – 8,760 issuances per year – will evolve as the process develops.

It is time the market focuses the 24/7 discussion on the important market considerations that require attention before adoption of a global standard. M-RETS hopes that moving beyond the technology debate – whether it is blockchain or a traditional database solution is irrelevant as long as the choice supports market needs. This will allow groups like EnergyTag to focus on building international consensus on the important market considerations. A global data standard is critical to this work and the only way data-driven renewable energy markets can scale and provide for efficient data management for both large and small market participants.

The milestone marked herein is just the start in transitioning REC markets into a data-driven commodity that can measure and drive economy-wide decarbonization efforts. M-RETS's vision

is that other entrepreneurial entities will seize the opportunity to build software that works in coordination with existing REC registries to open further market opportunities. Moreover, M-RETS emphasizes the important role registries and other data providers play in ensuring commercial, industrial and residential customers of all sizes can efficiently access data-driven renewable energy markets. Large corporate partners – while incredibly important to this process – will not alone solve the global CO_2 emissions crisis. Therefore, M-RETS envisions a future where 24/7 renewable data and claims strategies that are rooted in a scientific approach to decarbonization are accessible to all energy consumers.

Why Hourly Data?

Hourly generation data access is an important first step in a multi-faceted process to establish data-driven renewable energy markets. A paper published by Jacques A. de Chalendar, a doctoral candidate in energy resources engineering at Stanford University, and Stanford Professor Sally M. Benson in Joule 3 in June 2019 ("Joule Paper") suggests that, "as the fraction of renewable energy in the power grid increases, institutional targets to procure '100% renewable energy' should use hourly accounting to accurately measure the carbon emissions reductions achieved and can result in either less or more than 100% emissions reductions [14]." The Joule Paper concludes that as renewable penetrations increase, a change in marginal emission factors requires the consideration of hourly data to determine impact. In fact, the Joule Paper demonstrates in one example that using annualized data, "overestimated the carbon reductions from purchasing solar by over 50% [14]."

Further the Joule Paper suggests that, "achieving concomitant emissions reductions with renewable generation will also require shifting loads to take advantage of low carbon generation sources by utilizing energy storage and [efficient load shifting]," [14] which is possible and more efficient using hourly generation and grid data to send the correct signals. There are poignant criticisms of the Joule Paper within the renewable energy community. For example, the authors support an approach to carbon accounting that lacks wide acceptance among international corporate carbon accounting bodies. However, obtaining and providing this data should help guide discussions regarding the suitability of current carbon accounting and whether these new data sources challenge the current accepted structures or provide greater support to maintain current practice.

Recent research supports the theory that hourly accounting of indirect grid emissions – "emissions that are a consequence of the activities of the reporting entity but occur at sources owned or controlled by another entity" – is more accurate [15]. A recent paper by Chalendar et. al. that focuses on attributional emissions factors and concludes that "[t]he environmental quality of the electricity flowing through electric grids varies by location, season, and time of day [16]." However, M-RETS recommends against starting with the presumption that because hourly accounting of indirect grid emissions is more accurate, then it must follow that hourly accounting of renewable

energy usage and direct emissions will be more accurate.[5]

In discussions about hourly data and associated direct and indirect grid emissions, the discussions often get caught up in how to determine accuracy, which often end in disagreements. However, perhaps instead of thinking about this in terms of "accuracy," maybe the focus of this process should be thought of in terms of "resolution." The picture you see on a high-definition television is not necessarily more accurate than what you would see on a standard definition television. The higher definition television is better – not more accurate – because it provides more nuance and detail to the viewer. It may be more appropriate to think about hourly RECs and associated grid data in that manner, rather than get lost in linguistic battles over the word accuracy.[6]

Current internationally accepted carbon accounting practice recognizes that annual accounting of renewable energy and emissions is legitimate, and M-RETS does not dispute that. However, recent research suggests that the environmental attributes of electricity vary by season and time of day, and that hourly accounting can provide a more complete picture. In a hypothetical example pointed out by Gregory Miller, if a customer only runs their facility at night but they buy 100% solar from their local utility or through a PPA, is it defensible to claim that customer is actually "powered" by solar?[7] The intent behind the question is not to label current accounting practices that allow this as deficient or inaccurate, but to ask whether new data sources and technology provide an opportunity to update accepted practice. The industry must wrestle with these questions. While it is uncertain whether hourly procurement strategies will yield greater emissions benefits, hourly data and accounting may be able to help answer this question.

As global renewable energy markets continue to undergo significant evolution and modernization, the Joule Paper provides support for evolving and modernizing REC markets by building out more granular data integrations like hourly generation information. Further academic analysis as these markets scale is critical, and M-RETS supports continued robust academic review.

There is a myriad of reasons proffered to support integrating hourly generation information in existing REC markets. Most of the reasons jump right to 24/7 matching. However, there are important differences between access to data, using 24/7 for renewable energy claims accounting, and/or using hourly data as part of a renewable energy procurement strategy. It is important not to conflate these similar sounding terms just because they all rely on enhanced data access. They are in reality very different, as described in the following sections.

[5] The author thanks Todd Jones from the Center for Resource Solutions for stressing this issue in both private and public discussions. Jones created a document titled "Introductory Framework for a Discussion of Objectives for Hourly RECs," published December 10, 2020. In this statement, the term "direct emissions" means, "the amount of emissions, emissions profile, or emissions factor/rate associated with electricity generation. Zero for wind, solar, and hydropower and positive for biomass and some geothermal. This term is used in attributional accounting and is a primary attribute of renewable energy generation."

[6] The author would like to thank Gregory Miller, a PhD student at the University of California Davis, for the helpful insight and providing the high definition vs. standard definition analogy.

[7] Gregory Miller is a PhD student at the University of California Davis and is focusing his research on many of the questions M-RETS discusses in this paper.

Hourly REC accounting

Establishing procedures to allow RECs with associated hourly data to support hourly accounting is what often engenders the greatest excitement within this market. M-RETS believes it took the most conservative approach to facilitating a justifiable hourly accounting claim by working with Google to retire whole certificates with associated hourly data that they could then match outside the system with their own load data. However, potential next steps could include issuing whole batches with associated hourly data and subsequently allowing a user to break the batches into smaller hourly increments or issuing RECs on an hourly basis (up to 8,760 or 8,784 issuances per year/leap year).

Hourly renewable energy certificates could – if designed correctly – become a powerful tool to estimate avoided greenhouse gas ("GHG") emissions associated with renewable energy production and claims by utilizing static and/or dynamic data on top of current REC market data. Providing more detailed avoided emissions data with RECs and further encouraging renewable energy buyers to make procurement decisions based on hourly avoided emissions may blur the line between RECs and carbon offsets, and that is a complicating consequence of this evolving market. However, RECs are different than a claim to a carbon offset because RECs – even with more data – still represent a property right behind a MWh of zero emitting electricity.

Implicit in the future direction of these markets are not just the technical problems to solve, but more importantly the ethical considerations. For example, should existing systems that pride themselves on providing access to verifiable information such as measured generation data also provide access to estimated data? If estimated data is acceptable, what error rates are tolerable and how can the market enact guideposts? A reoccurring theme is the need for the acceptance and enforcement of strict global science-based models (if applicable), source data standards (so there are some reasonable standards of where modeling or grid data originates), and data access standards.

Here are some examples to support hourly REC accounting:

A. Save for the few customers not interconnected to any grid network, customers will rely on the grid in some capacity. There is an untested assumption that there is at least less grid reliance and, therefore, less associated reliance on potentially carbon emitting resources for those following a 24/7 renewable matching process over an annualized process. This is something M-RETS hopes to test over the course of this process.

B. Hourly load matching sends more efficient market signals. As Gregory Miller points out in his publication, "Beyond 100% Renewable: Policy and Practical Pathways to 24/7 Renewable Energy Procurement," "[v]oluntary renewables procurement that does not coincide with the buyer's demand increases both the short- and long-term costs of grid-scale renewable energy generation. Periods of over- and under-supply cause market-destabilizing swings in energy prices, periods of negative pricing (during which grid operators must pay adjacent energy markets to take the energy), and the need to invest in costly storage and transmission upgrades to move the energy [17]." There is an

increasing recognition that independent system operators ("ISO") and regional transmission organizations ("RTO") are not really markets in the classical interpretation, but alternative regulatory structures forced to accommodate a dizzying array of state policy [18] [19]. A fair criticism is that RTO/ISO reform such as revising balancing rules based on serving large, centralized fossil generators, inefficient geographic boundaries, etc. are a better solution to driving greater renewable penetrations than a focus on building greater access to data such as hourly generation and energy market data. Realistically, achieving societal decarbonization goals requires multiple strategies. Both RTO/ISO reform and greater access to hourly generation and energy market data serve important roles and are not mutually exclusive.

C. The ability to understand where renewable power is generated and where it is demanded (i.e., consumed), could allow for better generation development planning. Grid operators are set up to serve economic transmission and dispatch. However, the data provided from hourly markets could help drive renewable development focused more on reducing carbon and not just economic efficiency. A use case under development involves using system information to provide a data-driven approach to maximize investment in renewable generation assets with the greatest carbon reduction potential. Potentially providing access to generation and consumption data that does not compromise user confidentiality or trade secrets could enable the development of tools to evaluate projects on a granular level. In fact, some voluntary customers are already engaged in this type of renewable development analysis. In "More Than a Megawatt: Embedding Social & Environmental Impact in the Renewable Energy Procurement Process," Salesforce states an analysis they completed found that a West Virginia solar project avoided almost three times the emissions of a similar California-based solar project [20]. M-RETS expects to see more renewable generation investments based on this sort of analysis in the future.

D. A data-driven storage market could provide price signals for battery storage. As some battery storage incentive programs seek to provide a market mechanism rather than a set capacity payment, using both hourly generation and location-based grid carbon data could create a data-driven storage market that includes important price signals. For example, pairing specific hours of renewable generation from generators based on time and/or location to specific charging and discharging activity from a storage asset. This could ensure charging and discharging achieve certain goals, such as estimated avoided emissions, reducing reliance on undesirable generation sources and ensuring grid connected storage charges using renewable resources. One process could in theory change the time of a certificate or retire a specific hour from a renewable asset and reissue the same volume which would identify the subject generation as renewable, that it was subject to a storage claim all while maintaining the original generation attributes.

E. Energy efficiency markets and measuring the grid benefits of load shifting may also benefit from access to hourly generation and energy market data. There is a real possibility of valuing actual or estimated avoided emissions from credibly measured energy efficiency and/or load shifting targeted at high carbon intensity grid periods. This is not without criticism and would require transparency across many different players

[21]. A time- and/or location-based energy efficiency market that takes advantage of granular grid data could gain traction as a decarbonization tool with value placed on carbon avoidance or other desired outcomes.

a. Todd Jones from the Center for Resource Solutions ("CRS") describes some potential benefits and challenges and provides an explanation of how load-shifting is not equivalent to hourly procurement [22].

Shifting consumption to times of the day when there is more renewable generation operating may change the marginal impact of electricity consumption, and it may have overall emissions reduction benefits if the load-shifting can lead to greater renewable integration and penetration, which would require a shift of consumption across the entire region. Furthermore, grid operations and regional transmission organization (RTO) markets and processes have broad impacts on what is dispatched and how the grid, and other loads, respond to changes in load on the system, making it a complex task to accurately report the impact of a single customer's load shift on overall grid operations. Load-shifting also requires an understanding of the generation by resource type on an hourly basis. But it is not the same as hourly procurement or procurement of renewable energy to match hourly load. Load-shifting based on hourly grid data is a separate activity that does not affect corporate [renewable energy] usage claims and it can be pursued with long-term and annual corporate renewable energy procurement.

Hourly procurement

Moving to an hourly renewable energy procurement strategy is the least examined part of the hourly generation data discussion. While some voluntary purchasers have increasingly complex procurement capacities, moving from an annual 100% match to an hourly match raises important questions about the impact to all renewable energy purchasers and the market. Absent a storage solution, hourly procurement may require buyers to procure generation from a much wider variety of renewable generators.

The difference between a data center, a large university campus, a large international airport, and a manufacturing facility will create procurement obligations with significant variations in complexity. Under current bilateral power purchase agreements ("PPAs"), moving to an hourly procurement strategy may complicate existing agreements – especially PPAs where more than one consumer is a party to the generator's output. If the contract remains silent on which consumer owns which hours, the parties may need to amend their contracts. That becomes difficult if customers that share output from a project have similar load profiles and certain hours become more valuable. M-RETS has yet to hear of a voluntary consumer that is certain its existing PPA defines what may happen under this circumstance.

Hourly procurement may require managing more complex PPA structures across a greater number of generators and possibly geographies. If consumers are not able to internalize the cost of retiring excess RECs from new or existing PPAs, they will need to find willing buyers. This comes at a time when many market participants are seeking to simplify their 100% goals by including renewable or carbon-free generation already on the grid. For example, the Edison Electric Institute and a group of partners are looking to simplify the process for consumers to obtain renewable production and consumption data from utility providers with the hopes it may provide a pathway to achieving an actual residual mix – but it does not at this time. These customers want to square up their usage perfectly to 100%, which includes Renewable Portfolio Standard ("RPS") and other REC retirements done on behalf of all customers and not just what they procure on their own.[8]

The interest in growing data drive renewable energy markets does not mean existing accepted practice in REC markets is somehow insufficient or unreliable. Nor should one infer that this suggests the markets should assume the benefits of hourly generation and energy market data without proper inquiry.

Certain consumers are demanding more granular data integrations to support their own evolving sustainability goals. These evolving goals place the highest value on quantifying the benefits of their decisions toward decarbonizing their environmental footprint. However, existing global REC markets provide for an incredibly valuable market accepted globally as a legal property right to claim the use of electricity from a zero-emitting resource, thereby reducing the indirect emissions associated with purchased electricity. The evolving decarbonization goals and the existing REC markets are not mutually exclusive.

The only way to understand whether an hourly procurement strategy will lead to greater decarbonization benefits over an annualized strategy is to begin integrating the data into these markets and evaluating how the changes affect the market. It is unclear whether hourly data will drive procurement directed at long-term investments focused on full output of a renewable generation resource and/or on short-term hourly specific purchases that may focus on RECs.

As a data provider and market leader, M-RETS believes existing REC markets have an important role to play in providing the data that can assist market participants in efficiently meeting their decarbonization goals in a way that does not disrupt – and hopefully supports – existing markets. Furthermore, M-RETS' work remains focused on confirming throughout the process whether integrating hourly generation and grid data will drive greater decarbonization benefits. M-RETS seeks to meet the growing demand for access to data in a way that is scalable, is verifiable, does not disrupt the existing markets in any way and provides the greatest protection against double counting.

[8] *See* EEI Unveils Electric Company Carbon Emissions and Resource Mix Reporting Database for Corporate Customers. M-RETS supports this project and is looking at how to bring stakeholders together to provide a United States residual mix across all jurisdictions.

Steps to Enhancing Data-Driven Renewable Energy Markets and 24/7 Data

M-RETS established that practical market considerations and user access introduce considerably more complexity to the process of building data-driven renewable energy markets that are scalable and replicable on a global scale, beyond availability of the data and technology considerations. M-RETS took the approach of breaking this into three steps, which after completing the first step expanded into four steps. Further work on a global scale will likely increase the need for breaking this work into smaller steps along the way.

Within each phase, it is critical to work on the nuance and use exact language with agreed upon goals and outcomes. Otherwise, the road to 24/7 is fraught with complications. It is important to continually ask why certain data points are important and what value will they bring to stakeholders. For example, does the data provide for better decision making and with respect to which objectives? How does the data support or conflict with accepted accounting metrics or procedures? These are just a few of the questions to continually ask.

Phase one: Opening access to data

The goal of phase one was simple: Provide REC markets access to hourly generation data by attaching it as an additional attribute to the existing REC framework. Phase one of this process included loading and managing more than two years of MISO hourly data onto the platform. M-RETS also allows users to upload generation data in in other increments (e.g., five-minute increments) if they are consistent across a whole month. While M-RETS does not anticipate that five-minute load to generation matching will be a near-term goal, five-minute data is becoming more accepted for reporting at the RTO/ISO level.

Phase one in summary:

1. Develop a technical tool to collect hourly data.

2. Create an accessible UI and UX to both view and/or download data and ensure proper API documentation as more advanced registry users will prefer direct API access to the data.

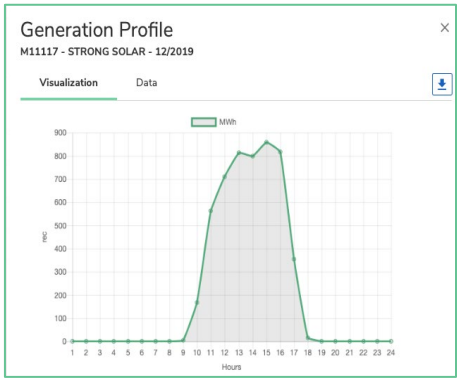
3. Build an advanced hourly reporting tool that allows users to aggregate generation from multiple generators over time.

4. Build a retirement (claims) process that integrates hourly generation data into the process when a user retires a complete batch of RECs that have not been subdivided after issuance. The platform must have code to validate the batch is intact, which prevents the risk of double claims.

Access to hourly generation data can be as simple as including as an additional attribute to a REC or REC batch that reflects the verified hourly production of a renewable generator. A simpler option that M-RETS explored involves providing the average hourly generation profile over a given month. It is possible to see this difference in Figure 3(A) and 3(B), using demonstration data built on a real generator production profile. Figure 3(A) shows generation data for each hour of the day during the generation month. Figure 3(B) shows the monthly production profile. A more granular approach uses the data in Figure 3(A). However, there is an argument that the hourly generator production profiles as seen in Figure 3(A) may be just as important for understanding hourly data and subsequent uses, such as 24/7 matching.

Figure 3(A)[9]

Figure 3(B)



One problem with providing access as in Figure 3(A-B), is that it neglects that many REC registries only issue certificates in whole numbers. The requirement that RECs exist only in whole numbers issued monthly requires holding over and issuing the following month any fractional remainders (i.e., kWh). Fractional remainders will create small variables (i.e., less than one MWh) in the data. To solve this, M-RETS advocates for issuing fractional amounts. However, this is a major market change with real consequences.

This change may complicate existing registry and market participating billing procedures and begs the question whether registries should go back and change past issuances in situations where such a change would not disrupt historic data. Without widespread adoption, this could create disturbances in the import/export market and how states measure and validate compliance market claims. For example, some states allow one REC to serve as a multiplier for certain compliance cases. Would they also then recognize a fractional quantity as well?

[9] In this view, the data highlighted in green is on-peak per the MISO FERC approved tariff. Figure 3(A) shows the data in MWh but goes out to two decimal places.

Figure 4(A)

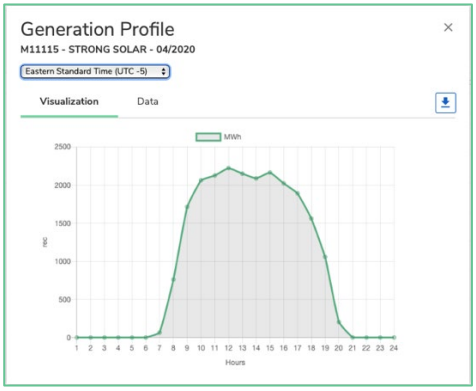
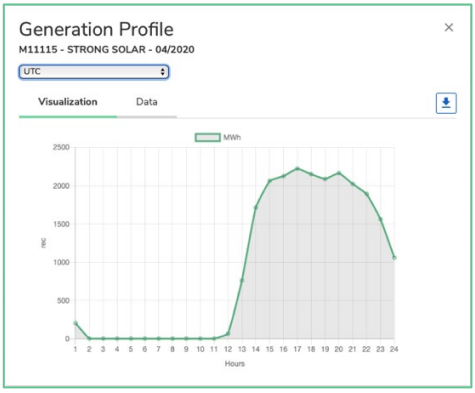


Figure 4(B)



Time is one of the most difficult aspects of software programing, there are countless online forums dedicated to addressing the complexities of time and the havoc getting it wrong can cause software systems. For instance, M-RETS receives all MISO data in Eastern Time, however, many M-RETS generators are in Central. M-RETS stores the data in Universal Coordinated Time ("UTC") but allows users to view the data in other time zones as shown in Figure 4(A-B). Flexibility in displaying the data as shown in Figure 4 will allow users to ensure they are viewing the correct time and storing it in UTC will ensure that they are able to match the correct generation data to a load if they are attempting to match on a 24/7 basis.

M-RETS is not aware of any reasonable objection to providing access to hourly data. However, on one occasion M-RETS did receive concern from a regulator that by providing marginal fuel as an additional attribute on certificates, in theory a market could evolve to sell certificates where coal or other fossils resources were on the margin as the presumption is that renewable displaced the dispatch of a fossil unit. This is a real issue, and it is unwise to discount the inventiveness of this market, even if the opportunity is small. Thus, both compliance and voluntary market regulator buy-in is especially important.

Registries in North American markets typically utilize a feasibility analysis that flags generation that is not within +/- 2% of the expected generation using a generator's capacity factor, nameplate capacity and the hours in the generation period. M-RETS development staff already identified this is a problematic approach regardless of hourly data.[10] Regardless of the decision to pursue hourly data, M-RETS suggests that registries adopt a more flexible approach to validating generation information. This includes, for example, recognizing different seasonal or other unique generator characteristics. However, this will take on greater importance as specific hours become more valuable than others.[11]

[10] An inflexible 2% feasibility does not recognize the unique circumstances of each generator, efficiency degradation (e.g., solar), seasonal variance, etc. M-RETS hopes to evaluate new approaches that would look at historic data that is generator- or fuel type-specific, seasonal variances, and monthly data to flag generation that is out of the ordinary and requires further review.

[11] This will significantly affect renewable energy markets including in the areas of procurement, financing, dispatch, as well as the transactions within the REC commodity markets more specifically.

The final goal in Phase 1 was to complete an hourly retirement with an entity that would retire a wholly intact batch of certificates. This means that the customer should retire a batch or batches of certificates that remain intact (i.e., not subject to any subdivision into smaller batches, transfers or retirements).

Phase two: Providing access to granular energy market and emissions data

The next step – and the goal for phase two – is to integrate relevant energy market data in addition to the existing hourly data. There is a justifiable rationale why integrating market data should be step two instead of breaking up hourly batches into individual certificates. Energy market data – both verifiable and modeled –could dictate whether there is a need to break up certificates as well as the process to achieve this.

Integrating energy market data into RECs holds the potential to create a powerful GHG reduction tool if correctly executed. This data may include, but is not limited to, verifiable data points such as marginal fuel, generation mix, delivered energy[12], [23] marginal unit (depending on whether a data provider considers this trade secret), and/or locational marginal price. Or what may become the most controversial point of this whole endeavor, allowing non-verifiable data (i.e., estimated and/or modeled data). Non-verifiable data that could be relevant to include on RECs may include, but is not limited to, estimated marginal unit (if not accessible), estimated avoided emissions, and estimated price impact.[13] With the right rules and conditions, it is possible and may be necessary to include an hourly residual mix. Corporate purchasers are already looking to acquire similar data at an annual level from utilities in an Edison Electric Institute Initiative [24].

Some registry providers and market participants object to a registry providing estimated or modeled data. This view maintains that the goal of the registry should be to only provide verifiable information. That is an entirely justifiable position, and M-RETS can sympathize with those standing firm on this position. However, equally important is the role of the registry to provide stakeholders all relevant data. If there is rigorous third-party verification of the data, exposure for the data sets that any carbon modeling uses such as EPA e-GRID, published and acceptable error rates, and explicit language warning consumers in the system and the greater market, estimated or modeled data may play an important role in developing data-driven renewable energy markets.

M-RETS remains committed to remaining an open platform where application developers can build products to enhance supported environmental commodity markets. M-RETS also believes that as registry providers look at integrating third-party applications to provide estimated or

[12] *See* Energy Intensity Indicators: Terminology and Definitions. M-RETS stresses the importance of distinguishing between delivered energy and the grid mix. Delivered energy is defined here as, "the amount of energy consumed at the point of sale (e.g., that enters the home, building, or establishment) without adjustment for any energy loss in the generation, transmission, and distribution of that energy. As such, it is the sum of fossil and renewable fuels (e.g., biomass or fuel wood) and purchased electricity. Delivered energy is sometimes referred to as 'site' energy."

[13] While not relevant to GHG accounting, estimated avoided savings could be used to justify price/tonCO_2 abated, justify investment decisions, or communicate financial benefits of renewable procurements more broadly.

modeled data, it is critical that those data providers adhere to the same open and transparent standards. For example, any third-party providing estimated data must engage in a rigorous academic or scientific review of the data inputs and application processes.

Energy and carbon model outputs are only as good as their inputs. Leaning on the proprietary nature of an algorithm is not acceptable when the data from these third-party providers may support legally binding claims. These markets should never accept a refusal to undergo rigorous third-party review or refusal to provide unfettered access to the relied upon data to operate an estimation tool. Furthermore, all providers should publish and maintain acceptable error rates as well as strict guidance on how to use the information to substantiate any claims if allowed.

M-RETS has partnered with Singularity Energy, a Harvard spinoff that has built an intelligent carbon tracing software platform named Carbonara, because we value their open approach to carbon data and transparency to external review. Additionally, M-RETS strongly suggests organizations immediately start working on global standards to address the data, processes, transparency, and third-party review these tools should be subject to achieve an appropriate level of accuracy, transparency and uniformity acceptable to the market.

Phase three: Reaching an industry consensus on managing the full lifecycle of hourly certificates to support more specific hourly accounting claims and procurement strategies

Renewable energy markets must come to a consensus on how to handle the full life cycle of certificates if they decide participants should be able to separate and sell or retire select hours from within a month. A robust market of buying and selling RECs as a commodity exists for a reason, much like pork bellies and natural gas. While some may debate whether wind, solar, hydroelectric is better for a variety of reasons, they all provide for zero direct emissions and represent 1 MWh of renewable energy.

If an hourly REC becomes detached from its issuance batch so the owner can sell or retire it, the REC still represents 1 MWh of renewable energy. However, it starts to shed the characteristics that make it act more like a commodity in the traditional sense. In current form, it is possible to split a monthly batch of 25 solar RECs into 25 separate 1-MWh chunks that retain a traditional commodity price and tradeable market, like splitting a 25-ounce gold nugget into 25 separate one ounce pieces.

If the markets agree that the path forward should allow for splitting RECs into separate hourly increments, REC markets become more complicated. There is a reason head of cattle are bought and sold as a commodity. Once a cow is sold, it is processed at a packing plant and then to a supermarket where it is sold at retail as ribs, flank, sirloin, etc. The least desirable parts go into pet food, and hopefully whatever ends up on the “butchers’ floor” goes to an anerobic digestor and becomes biogas or renewable natural gas.

To continue with this analogy, splitting RECs into separate hourly increments is more like what happens to a head of cattle after going to market for actual beef processing, and finally to the butcher than the above gold example. Certain hours will become more valuable like a filet mignon cut, while others will not make the cut for pet food. While this may in fact be a desired outcome as the price signal drives investment in hours that need it most; nevertheless, it still complicates the market. Stakeholders must continue to press whether this results in a better grid decarbonization outcome. And while it may lead to better grid decarbonization outcomes in theory, are there practical implications (e.g., project finance risks) that could disincentivize certain renewable energy project investment. In the United States, Massachusetts is the only state with a policy most akin to hourly accounting under the Clean Peak Standard [25]. However, Clean Peak Certificates are multiplied depending on the season and do not include the actual hourly data as part of the attribute [25].

Even considering the additional complications imposed upon the market by potentially allowing RECs to be split into smaller hourly batches, there may be advantages to doing this. One important advantage may be that it will provide hourly matching to more customers, to the extent that it can be demonstrated that broader use of hourly matching yields significant benefits. Allowing the removal of one or more hours from a batch will open access to those that are unable to internalize the cost of retiring more than their actual load or those that lack access to aggregators that can match hours to load on behalf of many customers.[14] Thus, M-RETS will explore whether users may split hourly and retire or sell those batches separately. This will require complex database, UI and UX processes, not to mention important market considerations.

Questions to consider in phase three:

- Is this the right priority for the markets? For example, given the need to grow renewable energy to meet decarbonization goals, will significant time invested in providing more access to hourly and energy market data grow access to more customers? Will it scale the market faster and more accurately than annual REC accounting?
- What are the precise benefits of hourly REC matching and emissions accounting compared with an annual process?
- Should a REC generated during an hour of higher grid emissions have a higher price than a REC generated during an hour of low grid emissions? Should this be a goal of designing the market? How will price implications affect the market, especially non-participating entities?[15]
- How do hourly RECs facilitate hourly emissions accounting?
- What are the specific benefits of hourly procurement?
- What is the role of attributional versus consequential accounting?

[14] While RECs may be comparatively inexpensive for some renewable energy customers, without the ability to remove certain hours customers, would need to locate intact batches that match exactly their load or buy and retire more than they need. That will require a lot of time and/or cost, a luxury not every renewable energy customer may have.
[15] This question is explicitly aimed at market participants as registry providers should be agnostic to the price of RECs and other commodities they track.

Phase four: Providing a mechanism for more specific hourly claims to also include claims to associated other benefits such as carbon

Phase four will center around how to provide the appropriate grid data on an hourly basis so that the platform can provide users greater understanding of their decarbonization efforts. As the world moves to value decarbonization as well more traditional annual renewable energy usage goals, M-RETS believes RECs can serve that purpose as it relates to renewable energy usage. M-RETS will focus on providing all relevant available data and identifying data that may not be public (e.g., marginal unit) and ways to address any data deficiencies.

Implicit within this phase are decisions regarding whether hourly retirements should also include energy market data. For example, should registries facilitate a process so that a batch of hourly REC retirements provide information on the estimated avoided emissions of that full batch at an aggregated hourly, day, month, and/or year level? It is one thing for third parties to offer that data outside the system; however, should this data come from the registry directly or through API integrations with third parties? What type of data and the standards around that data must exist (e.g., level of transparency, accuracy, etc.)?

Phase four will be the ideal time to bring in groups like Climate Disclosure Project (CDP), World Resources Institute (WRI) and CRS, to facilitate the right conversation and build understanding over whether there should be changes to the existing REC and carbon accounting claims process. This does not mean these, and any other relevant partners, should not play an important role throughout. However,

Questions to consider in phase four:

- Does hourly procurement help maximize avoided emissions?
- Will this approach assist with storage? How?
- How will hourly RECs provide a closer link with renewable energy investment, power markets and carbon markets?
- If companies begin to procure renewable energy hourly, will that produce desired outcomes?
- Does hourly procurement help address grid integration and reliability challenges associated with higher renewable penetrations?
- Do hourly RECs help to quantify the environmental benefits of load shifting? If so, how, and what is needed to ensure intended outcomes?
- Do hourly RECs provide a closer link to operational power markets? How does this benefit power market development, renewable energy development and decarbonization?
- What type of energy market data (e.g., real or estimated) and the standards around that data must exist (e.g., level of transparency, accuracy, etc.)?

Conclusion

The achievement of completing the first hourly retirement in a production REC platform is just the beginning. M-RETS is grateful for the time Google spent working on the process with M-RETS staff in both the planning and software development phase. However, this achievement and this paper are just the beginning in advancing data-driven renewable energy markets. M-RETS plans to continue leading the development of a process that can scale globally to multiple consumers. M-RETS views this paper and the rollout of this achievement a call to action for creating an advanced renewable energy commodity market built for and driven by increased data access.

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Biography

Benjamin Gerber is the President and Chief Executive Officer of M-RETS. Under his leadership M-RETS developed and successfully implemented an industry leading environmental attribute registry. Initially this allowed M-RETS to increase its footprint from 15 states and Manitoba to all North America. The M-RETS platform brings unprecedented innovation to the industry as well as access to data in pioneering ways such as hourly production data and peak period production data.

M-RETS recently launched a renewable thermal tracking system. This first of its kind system in North America facilitates market transparency, liquidity, and prevents double counting by issuing a unique, traceable digital certificate for every dekatherm produced by a renewable thermal technology. M-RETS users retire certificates to comply with state policy or to serve the voluntary market and to ensure that certificates are not double-counted.

Ben is a sought-after speaker on issues related to environmental commodities as well as innovation in the utility sector. He has been published by energy news outlets such as Utility Dive, appeared as a guest on local and national media, and is regularly asked to present at national and international conferences on renewable energy, decarbonization, and the role of technology and innovation in the utility sector.

Prior to his appointment as CEO of M-RETS, he served as Director of Energy and Labor/Management Policy at the Minnesota Chamber of Commerce. He joined that organization in January 2012, representing the Chamber's energy interests at both the Legislature and the Public Utilities Commission. Prior to that, he was an oil and gas attorney and handled Fredrikson & Byron's government relations operation in North Dakota, focusing on mining, energy, and tax legislation. His Minnesota experience includes time spent at a Minneapolis government relations office, and public policy and legal work for National Wind, LLC, a large-scale community wind developer.

Ben owned an asphalt maintenance company while attending college at the University of Michigan where he graduated with a degree in political science in 2005. He graduated from William Mitchell College of law *cum laude* in 2010 and is admitted to the Minnesota State Bar. Ben is the Vice Chair of the Minnesota State Bar Association Public Utilities Law Section and is a founding board member of the Minnesota Conservative Energy Forum. In 2019 Ben received the Arthur T. Pfeffer Memorial Award, an awarded given to a Jewish law student or young lawyer who demonstrate accomplishment and show great scholarly, professional, and philanthropic potential.

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