RAP
REGULATORY ASSISTANCE PROJECT

PREVIEW EDITION: FEBRUARY 2024

24/7 Carbon-Free Electricity Transition Tariffs

A Regulatory Tool for Accelerating Decarbonization

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Introduction[1]

An increasing number of national, state and local government leaders recognize that rapidly decarbonizing the electricity grid is necessary to slow the disruptive effects of a changing climate. At the same time, our lives and livelihoods have never been more dependent on reliable and affordable electricity, as electrification in the building, transportation and industrial sectors accelerates. The challenge for utilities and regulators lies in how to simultaneously fuel economic growth with increased electricity supply while ensuring the electricity is clean and resilient.

Renewable portfolio standards, carbon reduction goals and green power tariffs, among other policy and regulatory tools deployed in recent years, have slowed the aggregate growth of carbon emissions. Public sector and business leaders are now focused on solving three more specific challenges:

1. Decarbonizing high-emissions hours, seasons and places.
2. Building local and national competitive advantage by expanding the hourly availability of clean, resilient electricity supply.
3. Growing carbon-free electricity (CFE) supply that can offer energy and reliability services at times when fossil-fueled resources are currently depended upon.

[1] This document is a preview of a report describing the findings and recommendations developed during a nearly yearlong stakeholder process led by the Regulatory Assistance Project. The full report, with four appendices as well as acknowledgments of our partners and key contributors, is forthcoming.

Meeting these challenges will require new targeted policies to drive resource investments, infrastructure investments and operating practice improvements.

A Princeton University study estimated that the United States needs to invest $2.5 trillion to achieve the carbon reductions required by 2030 to avoid the worst effects of climate change.[2] Public sector leaders have stepped forward to boost investment by advancing the Inflation Reduction Act and Energy Infrastructure Reinvestment loan program and by supporting utility and regulatory commitments to grid-modernization investments in dozens of states through the Grid Resilience and Innovation Partnerships Program.[3] At the local level, governments are offering support for investments in carbon-free distributed energy technologies in their communities.[4] Private sector customers have also stepped forward. For example, many customers have opted in to voluntary "green tariff" programs, offered by utilities to enable customers to support additional investments in renewable energy. Such programs were first approved in Nevada and North Carolina in 2013, and more than 50 programs have now been initiated nationwide.[5] Green tariffs have driven growth of renewable energy on the grid and helped to meet the growing demand for clean power from businesses seeking to achieve their sustainability goals. The success of these programs demonstrates that customer interest in clean energy is at an all-time high, with many willing to pay a premium to participate.

A coordinated approach to public sector, private sector and utility investment that targets high-emissions times and places will clarify the investments required from each entity, avoid duplicative investments and keep costs more manageable for all utility customers. This level of coordination requires investments that are more targeted than those induced by legacy green tariff programs. Technology is available now to help, and a more targeted tariff can bring public, private and utility capital together to decarbonize the grid more effectively, equitably and reliably. A 24/7 carbon-free electricity transition tariff is a tool to accelerate decarbonization generally while addressing times and places on the grid where emissions have been most difficult to reduce.

Figure 1 illustrates the opportunity presented by a 24/7 transition tariff, and the text box defines how a 24/7 transition tariff differs from a legacy green tariff using annual matching.

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[2] St. John, J. (2020, December 17). *Princeton study charts a $2.5T pathway to a net-zero carbon US*. Greentech Media. https://www.greentechmedia.com/articles/read/princeton-study-charts-a-2.5t-pathway-to-a-net-zero-carbon-u.s

[3] For more on these programs, see: The White House. (2023, January). *Building a clean energy economy: A guidebook to the Inflation Reduction Act's investments in clean energy and climate action* (Version 2). https://www.whitehouse.gov/cleanenergy/inflation-reduction-act-guidebook/; U.S. Department of Energy. (n.d.). *Energy infrastructure reinvestment*. https://www.energy.gov/lpo/energy-infrastructure-reinvestment; and U.S. Department of Energy. (n.d.). *Grid Resilience and Innovation Partnerships (GRIP) Program*. https://www.energy.gov/gdo/grid-resilience-and-innovation-partnerships-grip-program

[4] For example, local governments served by Sonoma Clean Power, a community choice aggregator in California, have opted in to its 24/7 carbon-free electricity tariff. Sonoma Clean Power. (n.d.). *Electrify everything*. https://sonomacleanpower.org/uploads/documents/Annual-Report-2021-FINAL.pdf

[5] Clean Energy Buyers Association. (2023). *U.S. utility green tariff report*. https://cebuyers.org/wp-content/uploads/2023/04/Final-CEBA_Green-Tariff-Report.pdf

Figure 1. Hourly matching tariffs induce investment that is more targeted

How is a 24/7 carbon-free electricity transition tariff different?

24/7 carbon-free electricity transition tariffs are different from the green tariffs that match annual consumption with annual renewable energy production. 24/7 transition tariffs seek to match a customer's hourly consumption with deliverable carbon-free electricity provision in each hour of the year. We refer to this concept as a "transition" tariff because it is designed to accelerate the transition of the electric grid to carbon-free sources. Complete hourly matching will require investments and changes in operating practices that address high-emitting hours and high-emitting locations on the grid, where generation still depends on fossil resources, and full decarbonization of the grid requires these investments and changes in operating practices. Annual-matching green tariffs do not induce these investments or change practices, but with the move toward more granular time matching, 24/7 transition tariffs can accelerate progress toward full decarbonization.

Fortunately, progress is already underway. The federal government and some U.S. states and local governments have adopted new zero-carbon energy policies since 2015. At the same time, corporate customers have procured over 95 GW of new renewables. These public, private and community electricity customers in aggregate represent a large amount of electric load and bring significant investment capital to accelerate decarbonization. Over the last few years, some of these public and private sector customers have started negotiating tariffs with their host utilities that move in the direction of the 24/7 transition concept.

The opportunity to standardize tariffs to accelerate offerings and adoption in many more places led the Regulatory Assistance Project (RAP) to initiate the project described in this report, a comprehensive initiative to define the optimal design of 24/7 transition tariffs and contracts for participants and broader electricity systems. Throughout 2023, RAP worked with a group of stakeholders to develop guidance on how green tariff programs may evolve to best meet the needs of today's grid. The goal was to make a set of recommendations for 24/7 transition tariffs that could accelerate decarbonization while incentivizing investments that bolster grid reliability and resilience.

When well-designed, a 24/7 transition tariff can empower utilities and customers to collaborate on accelerating the grid's shift to clean energy. By focusing on the grid's hourly operations, a transition tariff allows customers to move toward matching their electricity consumption with carbon-free resources on an hour-by-hour basis — revealing previously neglected opportunities to reduce emissions at particular times or places. Throughout this process, we carefully considered diverse market structures and customer priorities to ensure broad applicability. This report details our process, findings and recommendations for fundamental principles to guide the development of effective 24/7 carbon-free electricity transition tariffs.

The 24/7 Transition Tariff Project Process

Between March and November 2023, RAP hosted monthly meetings with a diverse and highly engaged group of stakeholders, offering multiple avenues for feedback on draft documents and presentations. Utilities, a variety of end users, federal and state governments, and nonprofits across the country actively participated. With an average of 60 attendees per meeting and 140 stakeholders on our distribution list, the process garnered significant input and benefited from broad representation.

To ensure that stakeholders were identifying and prioritizing key questions, we organized participants into three specialized working groups, each also joined by relevant subject-matter experts. Each group delved into a specific topic pertinent to the successful implementation of 24/7 transition tariffs. The findings and recommendations of the working groups, along with research undertaken by RAP staff, are explored in more detail in four appendices [publication forthcoming].

Appendix A: Resource Planning Requirements describes the planning processes to guide optimal integration of 24/7 CFE portfolios into ongoing utility and system planning. This appendix concludes with recommendations for improving planning to support better tariffs in the near term.

Appendix B: Emissions Tracking and Verification describes best practices for tracking and matching emissions to generation, and practices required to ensure 24/7 CFE portfolios produce the intended emissions outcomes. This appendix offers recommendations for improving emissions tracking in the near term.

Appendix C: Rate-Making, Pricing and Resource Compensation offers best practices for rate-making and discusses how they apply in various 24/7 CFE contexts. This appendix then turns to near-term recommendations for improving 24/7 transition tariffs.

Appendix D: Operational Requirements describes the requirements to effectively implement integrated 24/7 CFE portfolios in distribution and bulk system operations. This appendix concludes with recommendations for improving operations to support better tariffs in the near term.

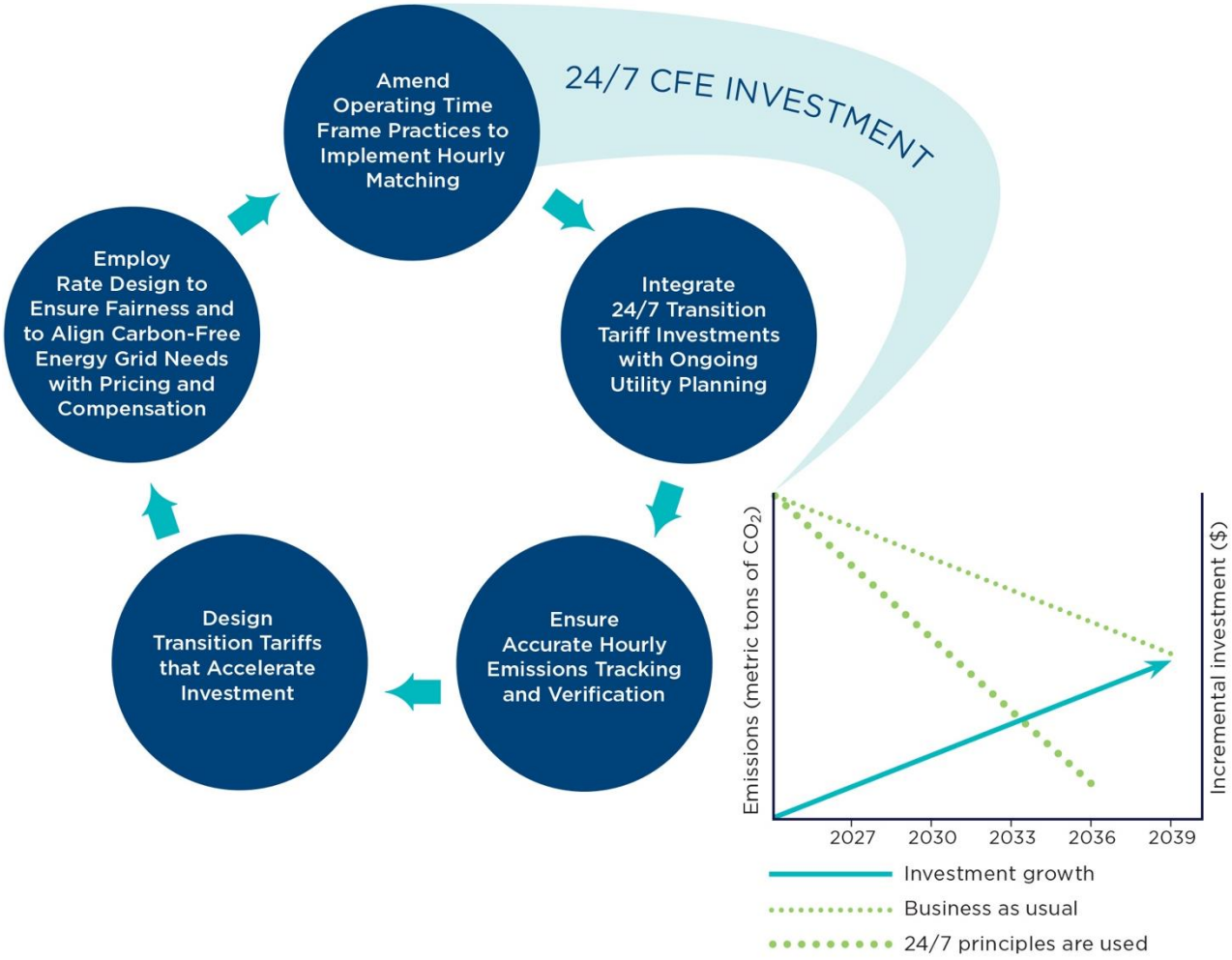
RAP's extensive research and guidance from the stakeholder working groups resulted in the identification of key elements that provide the basis for the fundamental design recommendations made in this report. These fundamentals are intended to help regulators, utilities and customers develop 24/7 transition tariff offerings that can accelerate decarbonization while advancing the public interest.

Five Fundamentals

Our research and stakeholder engagement have identified five fundamentals that should serve as the foundation of a well-designed 24/7 carbon-free electricity transition tariff. These can create a robust and impactful tariff design, adaptable to individual market needs and tailored to specific customer and policymaker objectives.

The five fundamentals are summarized in Figure 2. Applying them in the initial design of a 24/7 transition tariff induces a first round of investment and policy changes that incentivize accelerated decarbonization of the grid on an hourly basis. Every three years or so, the design process should be revisited to encourage subsequent rounds of investment and policy changes that build upon the previous period. Over time, the repeated application of these fundamentals will increase focused investment in carbon-free resources that firm up electricity supply and build local carbon-free resilience, while accelerating progress toward aggregate carbon emissions reductions.

Figure 2. The fundamentals of a 24/7 transition tariff in action



Fundamental 1: Integrate Transition Tariff Investments With Ongoing Utility Planning

24/7 CFE portfolios need to be co-optimized and aligned with a comprehensive planning approach. Adapting the planning process to integrate 24/7 portfolios will take time, but it is never too early to improve planning to enhance alignment. 24/7 portfolios may increase or decrease costs relative to the legacy plan. They may also introduce incremental benefits relative to the legacy plan. Therefore, accurately assessing benefits and costs requires integration of the 24/7 portfolio into a comprehensive planning process, such as one consistent with the recommendations of the Task Force on Comprehensive Electricity Planning convened by the National Association of Regulatory Utility Commissioners (NARUC) and the National Association of State Energy Officials (NASEO).[6]

[6] National Association of Regulatory Utility Commissioners. (n.d.). *Task force on comprehensive electricity planning*. https://www.naruc.org/committees/task-forces-working-groups/retired-task-forces/task-force-on-comprehensive-electricity-planning/home/

From a technical perspective, an effort should be made to identify the resources that support the tariff and co-optimize these carbon-free resources with existing resources. From an administrative perspective, it's important to map the pricing, terms, conditions and implementation details that are necessary to administer the tariff. Finally, regulators must weigh the various goals of stakeholders, balance their interests and determine how the 24/7 portfolio affects the benefits and costs experienced by all customers.

Annual-matching green tariffs lead to least-cost-per-kWh investment without regard to the time and place of power generation, which leads to large-scale wind and solar development, often in remote locations. Although developing these resources is necessary and beneficial, addressing the hourly and seasonal challenges in specific regions and in specific distribution utility footprints requires investment in carbon-free electricity that is more targeted. Advanced geothermal energy, long-duration energy storage, green hydrogen, advanced nuclear and aggregated distributed energy resources each offer location-specific carbon-free solutions but tend to be overlooked in annual-matching programs.

A well-designed process that co-optimizes utility planning and procurement with 24/7 transition tariff planning and implementation can combine customer and utility investment to develop local resources most cost-effectively for the benefit of all customers. A 24/7 transition tariff should reflect the NARUC-NASEO task force's recommended planning process and the principles of 24/7 carbon-free electricity described below in Recommendation 1.

Recommendation 1: Implement transition tariffs that are based on 24/7 carbon-free electricity principles and integrate them with utility resource planning.

- Table 1 lists the principles that should be adopted to support the development of reliable, affordable and clean 24/7 transition tariff portfolios. These principles need to be recognized and integrated with legacy utility planning practices to support the co-optimization of transition tariff and utility resource planning.

Table 1. Carbon-free electricity principles for 24/7 transition tariff design

Principle	Application
Aggregated supply matched to aggregated demand	CFE tariffs require a series of one-to-one obligations (load-serving entity* to customer) that are collectively met using a many-to-many relationship (i.e., many supplies to many demands).
Time-matched procurement	CFE tariffs attribute the emissions from electricity generation to the same hour as the customer's consumption.
Geographic deliverability	CFE tariffs identify the market and geographic boundaries within which the utility or load-serving entity will procure generation resources to match with customer load.
Technology neutrality	CFE tariffs may include any carbon-free electricity technology.
Enabling of new resources	CFE tariffs focus on enabling new clean electricity generation that supports the rapid decarbonization of electricity systems.
Attributional market-based emissions accounting	CFE tariffs use "attributional, market-based" emissions accounting that proceeds from the bottom up, where actual, individual resource-by-resource generation is attributed using the contractual obligations between the owners of individual resources and their customers.
Measurable system impact	Resource planning uses both attributional and consequential accounting to estimate the emissions impact of the new CFE resources that are supporting the tariff or product offering.
Fairness to all participants	CFE resources will have benefits and costs, and these should be allocated fairly between participants and nonparticipants alike.

** We use the term "load-serving entity" to include utilities in regulated jurisdictions and utilities and retail suppliers in restructured jurisdictions.*

Recommendation 2: Implement the three-part process recommended by the NARUC-NASEO energy planning task force as 24/7 transition tariffs are integrated, with an eye toward immediate progress and longer-term alignment.

- The planning steps relevant to this design process recommended by NARUC-NASEO[7] include early stakeholder engagement, integration of distribution system planning with bulk system planning, and alignment of planning with the market and regulatory structure in the applicable utility and bulk market service territories.

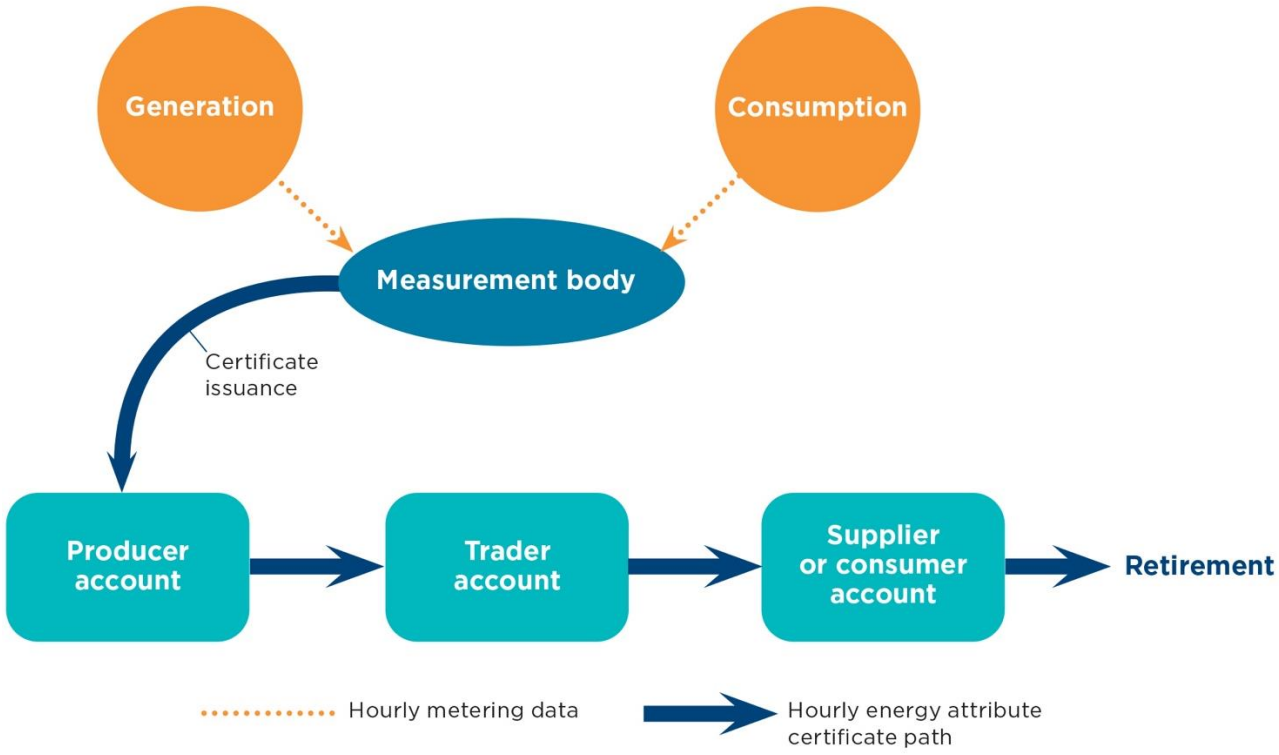
[7] NARUC-NASEO Task Force on Comprehensive Electricity Planning. (2021). *Blueprint for state action*. National Association of Regulatory Utility Commissioners and National Association of State Energy Officials. https://pubs.naruc.org/pub/14F19AC8-155D-0A36-311F-4002BC140969

Fundamental 2: Ensure Accurate Hourly Emissions Tracking and Verification

A successful 24/7 transition tariff requires the ability to match hourly customer load with hourly electricity supply. To enable such matching, a load-serving entity would need to produce hourly customer load data that could be matched with time-stamped (hourly) energy attribute certificates, ideally from a standardized, national, all-generation tracking system or systems, as illustrated in Figure 3.[8]

The functions necessary to enable 24/7 hourly matching include connecting corresponding hourly consumption data with energy data and the issuing, tracking and retirement of the related certificates. With this capability, a load-serving entity can demonstrate that the generation and related hourly emissions from its resource portfolio are matched with the time and location of the customer's energy use.

Figure 3. Functions in hourly carbon-free electricity matching



Source: Adapted from EnergyTag. (2021). *EnergyTag and Granular Energy Certificates: Accelerating the Transition to 24/7 Clean Power*

[8] Adapted from EnergyTag. (2021). *EnergyTag and granular energy certificates: Accelerating the transition to 24/7 clean power.* https://www.energytag.org/wp-content/uploads/2021/05/EnergyTag-and-granular-energy-certificates.pdf

A national, all-generation tracking system (or systems) would provide an ideal platform to meet the accounting and tracking requirements needed for a 24/7 transition tariff. While the United States currently has no one system capable of doing this, several registries across the country — M-RETS in the Midwest, PJM's Generation Attribute Tracking System and the North American Renewables Registry — have begun to implement hourly tracking in some capacity.

A productive near-term approach, one that has been adopted in Europe, would be for existing tracking systems to meet the same standards and follow similar practices.[9] Developing this capacity at load-serving entities will require the standardization and adoption of a series of emissions tracking procedures and related practices, including standardized approaches to CFE certificate production, emissions tracking, customer load data provision, market boundary establishment, and allocation of existing CFE. These topics are outlined briefly below in five recommendations.

Recommendation 1: Load-serving entities should provide hourly customer load data in a standardized format.

- For customers to understand their energy use and for systems to be interoperable across different jurisdictions developing 24/7 transition tariffs, utilities should adopt accounting systems with consistent reporting formats.

Recommendation 2: Employ consequential and attributional accounting to understand, respectively, the effects on system emissions and the emissions characteristics of resources procured to match consumer load.

- Load-serving entities should recognize that complementary emissions accounting approaches are required to understand the implications of adopting 24/7 tariffs.

Recommendation 3: Rely on the publicly available emissions data or best available calculated emissions and energy data to populate energy attribute certificates.

- In populating emissions accounting systems, load-serving entities should recognize that relevant emissions data is generally publicly available. If it is not, they should calculate emissions and energy data based on the best available information.

[9] The European Union allows member states to have their own tracking system, but each system must work within the Association of Issuing Bodies framework. This framework contains common standards for all tracking systems — for example, the requirement that they audit each other annually for compliance and accountability purposes. Association of Issuing Bodies. (n.d.). *AIB guaranteeing the origin of European energy*. https://www.aib-net.org/

Recommendation 4: Define geographic market boundaries based on energy delivered, or capable of being delivered, into one's local service area.

- Articulating market boundaries and promoting energy delivery are important in voluntary clean energy markets where buyers claim to consume the clean energy that they purchase.

Recommendation 5: States should ensure that participating and nonparticipating consumers are treated fairly in the allocation of existing carbon-free electricity in a load-serving entity's resource mix to customers under a 24/7 tariff.

- As states explore the adoption of 24/7 tariffs, it is important to support first movers, but also to avoid harming nonparticipants.

Fundamental 3: Design Transition Tariffs To Accelerate Complementary Investments

A well-designed 24/7 transition tariff program should consider existing and planned utility investments to ensure that customer-driven investments add value. By using these existing resources as a baseline, the program can effectively incentivize investments in the resources and infrastructure most needed to accelerate grid decarbonization without compromising reliability or resilience.

For instance, a utility focused on decarbonization might already have significant investments in solar photovoltaics. In such cases, additional customer-specific procurement of solar may have minimal impact on incremental carbon reduction. To address this, the program should build on the existing and planned utility portfolio as the starting point and enable customers to understand and quantify how much their energy usage aligns with hourly clean energy, even without the tariff. This "clean energy load share" information helps regulators and policymakers assess the true impact of customer-specific resources on the system.

Recommendation: Factor in existing investments while providing transparency to customers, so that the program can ensure that customer-driven investments are truly complementary and accelerate decarbonization.

- Customers need to be able to clearly understand when clean energy will be available from the grid when making their investment decisions.

Fundamental 4: Employ Rate Design To Ensure Fairness and To Align Carbon-Free Electricity Grid Needs With Pricing and Compensation

Ensuring equitable rate-making and compensation depends upon coordinating existing and ongoing utility plans as tariff terms and conditions are determined. Four of the principles of carbon-free electricity articulated in this paper — Nos. 1, 2, 3 and 5 — will determine the investments needed to implement and align 24/7 CFE portfolios with legacy utility planning and operations. The rate-making process will, in turn, establish fair cost allocation, pricing and compensation decisions that advance the public interest. These rate-making decisions are especially important because the pricing and compensation decisions will drive future utility and non-utility investment decisions. Pricing and compensation decisions thus affect both fairness in the near term and the pace of progress toward efficient, equitable and reliable decarbonization in the years to come.

In practical rate-making, policymakers and stakeholders must balance a range of objectives that are frequently in tension with each other, including (1) effective recovery of the utility's revenue requirement, (2) customer understanding of their rates and bills, (3) equitable allocation of costs among customers and (4) efficient price signals. As with any specific tariff, fair and reasonable rates will be a function of the specific market context and should be fully vetted by the stakeholders in that market.

From a regulatory perspective, the simplest rate-making context for customer adoption of 24/7 CFE resources is in restructured jurisdictions. In those jurisdictions, customers are already empowered to negotiate alternative supply arrangements with non-utility suppliers, and existing rate-making structures enable the utility to recover the costs it incurs for delivering this electricity and providing metering, billing and other services.

Table 2 shows the issues that come into play in implementing a 24/7 transition tariff in vertically integrated jurisdictions.

Table 2. Issues and options for 24/7 transition tariff rates in vertically integrated jurisdictions

Issue	Options	Comments
Foundation for rate structure	• Full existing rate • Existing transmission and distribution rate plus new program-specific generation rate • Entirely new rate	Additional charges and credits can be structured around these foundational options.
Eligible load	• New load only • Existing load only • New or existing load	Categories of eligible load may influence what types of incremental charges may reasonably be placed on participating customers.
Incremental costs from 24/7 CFE program	• Administrative costs • Interconnection fee for new resources • Incremental transmission costs • Grid integration costs • Utility incentives • Certain costs for existing generation assets	Any incremental costs should be properly documented and evaluated for appropriate cost allocation across participating and nonparticipating customers.
Incremental benefits from 24/7 CFE resources	• Fuel and purchased power cost or wholesale market energy cost reduction • Generation resource adequacy contribution or wholesale market capacity cost reduction • Transmission or distribution cost reduction • Resilience benefits • Environmental and public health benefits	Incremental benefits should be properly estimated based on a reasonable value of the resources with appropriate reforms to forward-looking planning.
Length of arrangement	• Term of contract (e.g., 10 years) • Charges for switching back to utility from alternative supply	Additional restrictions may impede 24/7 transition tariff adoption but provide greater certainty for the utility and nonparticipating customers.

** Changes in investment requirements associated with 24/7 CFE portfolio implementation may make some legacy investments uneconomic and may make planned investments unnecessary. Whether this creates a net cost or a net benefit for nonparticipating ratepayers is an important issue that requires quantitative analysis with planning scenarios.*

Some customers adopting 24/7 CFE may wish to include their own on-site clean distributed energy resources in their portfolios. Their decision to do so may be influenced by state-level net metering policies or other compensation policies for on-site distributed energy resources.

There are numerous reasonable combinations of choices on these issues, but several key recommendations stand out.

Recommendation 1: Determine net costs using integrated planning.

- The net costs of designated CFE resources, as well as their system benefits, should be informed by an integrated assessment of the host utility resource plan and the proposed CFE resource portfolio in those jurisdictions where the utility prepares an integrated resource plan.

Recommendation 2: Allocate net costs of CFE to participating customers.

- Participating customers should cover the net costs of the designated CFE resources after all costs and benefits to nonparticipating customers have been accounted for.

Recommendation 3: Design incentives to manage the demand side.

- The transaction should be structured to provide reasonable incentives for the management of customer load, and the system benefits provided by well-managed load should be compensated fairly.

Recommendation 4: Plan to co-optimize customer and utility investments.

- Opportunities for co-optimizing participating customer investments and utility investments should be evaluated and implemented for the benefit of all consumers.

Fundamental 5: Integrate Operating Systems To Implement Hourly Matching

Hourly matching is a key feature of any CFE resource portfolio, and it implies that the supply of CFE matches the electricity demand at hourly or sub-hourly intervals. However, CFE supplies and electricity demand do not need to be perfectly matched[10] in every hour to offer a CFE product. The purpose of transition tariffs is to make progress toward 100% CFE and to report the level of CFE matching to the customers who subscribe to the product in the interim.

In any case, implementing hourly matching will require greater levels of system integration and interoperability. The data and functional requirements that will enable hourly matching are being collaboratively developed under the leadership of organizations like the National

[10] Matching CFE supplies to demand 100% of the time is not yet an operational reality in regions without large surpluses of hydroelectricity to serve as storage that can be dispatched later.

Institute for Standards and Technology (NIST) and EnergyTag.[11] These collaborations and the standards that they publish are essential resources and will be important to consult as CFE portfolios are being designed and implemented.

Multiple operating systems must be integrated over several functional areas. These systems can be grouped into seven "domains" as described by NIST in Table 3.[12]

Table 3. Operating system domains

Domain	Roles/services in the domain
Customer	The end users of electricity. May also generate, store and manage the use of energy. Traditionally, three customer types are discussed, each with its own subdomain: residential, commercial and industrial.
Markets	The facilitators and participants in electricity markets and other economic mechanisms used to drive action and optimize system outcomes.
Service provider	The organizations providing services to electrical customers and to utilities.
Operations	The managers of the movement of electricity.
Generation, including distributed energy resources	The producers of electricity. May also store energy for later distribution. This domain includes traditional generation sources and distributed energy resources. At a logical level, "generation" includes those traditional larger-scale technologies usually attached to the transmission system, such as conventional thermal generation, large-scale hydro generation and utility-scale renewable installations. Distributed energy resources are associated with generation, storage and demand response provided in the customer and distribution domains and with service provider-aggregated energy resources.
Transmission	The carriers of high voltage electricity over long distances. May also store and generate electricity.
Distribution	The distributors of electricity to and from customers. May also store and generate electricity.

Source: Gopstein, A., Nguyen, C., O'Fallon, C., Hastings, N., & Wollman, D. (2021, February). *NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 4.0*

[11] In addition, LF Energy Standards and Specifications (https://lfess.energy) is developing the open-source Carbon Data Specification project, which introduces specifications to enable more streamlined and standardized customer data and power systems data access to serve a 24/7 accounting use case.

[12] Gopstein, A., Nguyen, C., O'Fallon, C., Hastings, N., & Wollman, D. (2021, February). *NIST framework and roadmap for smart grid interoperability standards, release 4.0*, Table 1, p. 16. National Institute for Standards and Technology. https://www.nist.gov/publications/nist-framework-and-roadmap-smart-grid-interoperability-standards-release-40

Making all these domains interoperable is desirable over time, but it is not necessary for a 24/7 transition tariff. Significant progress can be made in advance of that future state by increasing the time granularity of existing systems in the customer domain and integrating them with existing systems in the market domain that are already time granular.

For example, the simplest 24/7 transition tariff would be a completely static product where the level of CFE is reported after the operating day is complete. This type of 24/7 transition tariff would represent an *ex post* product, as it would not attempt to dispatch supply or demand in real time. As a result, it would essentially be offering customers a portfolio-design and reporting service. This kind of service could use the customer's monthly bill to report the percentage of CFE that was delivered into the local utility service area in each hour. The systems that would be required to match supply with demand could be limited to three systems: (1) the customer's metering system, which measures demand, (2) the energy market clearinghouse, which measures supply and (3) the service provider(s) who provide the hourly matching and billing systems.

The most dynamic 24/7 transition tariff would be one where CFE supply and electricity demand are scheduled in advance of the operating day and dispatched in real time. This kind of service would be offered on an *ex ante* basis and would probably rely on high levels of system integration among all seven functional areas. Naturally, there is a range of intermediate cases that would require a less comprehensive level of system integration.

Regardless of the type of product being offered, three high-level recommendations should be followed when designing and implementing the operating systems that support 24/7 transition tariffs.

Recommendation 1: Consult the latest standards when developing CFE products.

- Following standards from NIST, EnergyTag and others helps ensure that CFE products can be seamlessly tracked and traded between power marketers, utilities and the balancing authorities charged with ensuring local reliability.

Recommendation 2: Implement CFE products based on actual data first.

- *Ex post* implementations of CFE products represent a relatively straightforward and necessary first step in CFE tracking and system development.

Recommendation 3: Implement CFE products based on forecast data second.

- *Ex ante* implementations of CFE products will be needed to reach 100% CFE, which implies the need for high levels of system integration.

Conclusion: Designing 24/7 Transition Tariffs That Accelerate Decarbonization

Legacy decarbonization and renewable energy policies have contributed to a cleaner grid, but accelerating this shift requires new policies and regulatory tools that can address gaps in the decarbonization progress. Well-designed 24/7 carbon-free electricity transition tariffs have the potential to speed up change because they address several challenges that current policies have not solved. These tariffs can:

- Induce carbon-free electricity resource and infrastructure investments to displace fossil generation in high-emitting hours and places.
- Coordinate utility and non-utility investments for the benefit of all consumers, including 24/7 participants and nonparticipants.
- Drive development of carbon-free electricity resources that offer energy and reliability services currently provided mostly by fossil-fueled generation.

Fortunately, some customers and utilities have already partnered on 24/7 transition tariffs. These customers include the federal government, state and local governments, community choice aggregators and certain large customers. Despite strong customer interest, relatively few tariffs have been established, and many customers do not yet have access to a well-designed 24/7 transition tariff. There are lessons to be learned from the efforts to date. RAP's 24/7 transition tariff investigation and stakeholder process has examined the early adoptions to establish guidance for regulators, utilities and electricity customers on designing 24/7 transition tariffs.

RAP identified five fundamentals that can lower the transaction costs of establishing new tariffs while producing tariffs that induce reliability, resiliency and cost benefits for 24/7 participants and nonparticipants alike. The five fundamentals are:

1. Integrate transition tariff investments with ongoing utility planning.
2. Ensure accurate hourly emissions tracking and verification.
3. Design transition tariffs to accelerate complementary investments.
4. Employ rate design to ensure fairness and to align carbon-free electricity grid needs with pricing and compensation.
5. Integrate operating systems to implement hourly matching.

Well-designed 24/7 transition tariffs are a tool available to customers, utilities and regulators that can accelerate decarbonization by addressing gaps in progress more-established approaches have been unable to bridge.

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