February 26, 2024

Internal Revenue Service
CC:PA:LPD:PR (REG–117631–23)
Room 5203
P.O. Box 7604
Ben Franklin Station, Washington, DC 20044

RE: Section 45V Credit for Production of Clean Hydrogen; Section 48(a)(15) Election to Treat Clean Hydrogen Production Facilities as Energy Property.

EnergyTag[1] and the undersigned supporting organizations respectfully submit these comments to Proposed Rule for the section 45V Credit for Production of Clean Hydrogen released on December 26th, 2023. We support the proposed time-matching requirement in the Proposed Rule, and believe that a phase in from annual to hourly matching starting in 2028 is both prudent and feasible. These comments focus on the feasibility of transitioning to hourly matching starting in 2028. This transition is feasible due to tremendous progress made in recent years to scale the ecosystem of solutions to enable hourly matching.

The **five key recommendations** are that the US Treasury should:

1. **Maintain the 2028 phase-in date for hourly matching and continue disallowing grandfathering** of annually-matched projects to minimize significant induced grid emissions, in violation of section 45V's statutory requirements.
2. Consider requiring a **standard for the Energy Attribute Certificate (EAC) registries** to follow for annual and hourly EACs. This would help prevent fraud, enhance auditability and help registry interoperability.
3. Reinforce the **2028 phase in for hourly matching as ample time for hourly EAC** registries to scale. Treasury should clarify that once one registry has hourly EAC capability, it should be able to cover any regions that do not yet have the capability as is common practice in the voluntary renewable certificate market today.
4. Allow a **provisional pathway to demonstrating hourly matching** that uses hourly meter data and annual/monthly EACs (in use today) to demonstrate hourly matching where hourly EACs are not available. This form of hourly matching is possible and widespread globally. This would enable hourly matching today even before 2028 for those who wanted to do this voluntarily, and in the unlikely case that hourly EACs are not ready by 2028, is a viable pathway for ensuring compliance with hourly matching until hourly EACs are available.
5. Provide **guidance describing how standalone storage may be used** to time-shift hourly EACs in a robust way that accounts for losses and uses a consistent and transparent allocation methodology. This would enhance options of increased hourly matching.

[1] EnergyTag is an independent not-for-profit organization focussed on promoting and enabling robust electricity accounting standards globally. EnergyTag maintains the world's only voluntary standard detailing how hourly EACs can be issued and used to robustly verify hourly matching claims, including claims of deliverability and incrementality. Our standards are supported and developed alongside major stakeholders working on implementing granular electricity accounting including United Nations Energy, AES, Google, Clean Air Task Force, M-RETs, PWC and Microsoft amongst others. EnergyTag Ltd. has registered offices at 86-90 Paul Street, London, United Kingdom. For more information see https://energytag.org/

These comments are organized in the following sections:

- **Section 1 - Induced grid emissions consequences,** outlines the significant induced grid emissions from hydrogen production, should Treasury further delay the hourly phase-in and/or allow the grandfathering of annual matching over the lifetime of the 45V credit.
- **Section 2 - Verifying Hourly Matching,** discusses the role of hourly EACs in verifying hourly matching claims, and the progress that has been made in the development of hourly EACs in the United States and around the world. **It also discusses how, even in the absence of hourly EACs, alternative solutions are possible to verify hourly matching for the purposes of 45V qualification.**
- **Section 3 - Contracting,** discusses the contracting structures and transaction platforms that are being developed to enable hourly matching and how they can support hydrogen producers in complying with the hourly matching requirement.
- **Section 4 - Technologies,** discusses the clean energy supply technologies and portfolios that can enable hourly matching.
- **Section 5 - Storage,** discusses how to ensure hourly EACs can be time shifted using storage systems.

Section 1 - Induced grid emissions consequences: Delaying the hourly transition and/or allowing the grandfathering of annually-matched projects would increase the risks of significant induced grid emissions from hydrogen production.

Further delaying the phase-in will increase the risks of hydrogen production resulting in significant induced grid emissions and the risks of violating section 45V's emissions thresholds. For example, a study by Princeton ZERO Lab (Table 1 below) finds that a 2030 phase-in would result in *4 times* more emissions relative to the current 2028 phase-in, and a 2032 phase-in would result in *15 times* more emissions relative to a 2028 phase-in. Grandfathering annual matching – as pressed for by some industry groups, would result in significantly worse induced grid emissions. Shifting the 2028 phase-in date currently required in the NPRM to a grandfathering cut-off date in the final rules such that a 2028 date is adopted as a placed-in-service or commence construction date would lead to a *net emissions increase of 60 to 700 million tons* over the lifetime of the 45V credit. This is approximately *6x – 70x* more emissions compared with a phase in by 2028 without grandfathering, outlined in the NPRM. **Treasury should therefore retain the current 2028 phase-in date and continue disallowing the grandfathering of annually matched-projects.**

Table 1 - Net emissions impacts of different hourly matching phase-in schemes by certain dates.[2]

	Total MMT H2 covered by annual matching								
Date of phase-out	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Phase-out (no grandfathering)	0	0	0	0	**1**	2	**4**	8	15
Placed in service (grandfathering)	0	0	1	3	6	11	21	39	69
Commence construction (grandfathering)	6	11	21	39	**69**	103	141	182	227
	Total MMT CO2e induced by phase-in								
Date of phase-out	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Phase-out (no grandfathering)	0	0	1	4	10	21	**42**	81	**150**
Placed in service (grandfathering)	0	0	10	28	59	115	213	387	694
Commence construction (grandfathering)	59	115	213	387	**694**	1033	1405	1815	2266
	Total $B Spent on Annual Matched H2 Subsidies								
Date of phase-out	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Phase-out (no grandfathering)	0	0	0	1	3	6	**13**	24	**45**
Placed in service (grandfathering)	0	0	3	8	18	34	64	116	208
Commence construction (grandfathering)	18	34	64	116	**208**	310	422	545	680

Note: The blue bolded cells represent the EU rules for a phase-in to hourly matching for all projects in 2030 and the red bolded cells represent ACP's proposed exemption for projects that commence construction before the end of 2028.

Recommendation 1 - Maintain 2028 phase-in without Grandfathering
Treasury should maintain the 2028 phase-in date for hourly matching and continue disallowing grandfathering of annually-matched projects to minimize significant induced grid emissions, in violation of section 45V's statutory requirements.

Section 2 - Verifying Hourly Matching: Robust Options are available for Verifying Hourly Matching of Clean Electricity Production to Demand

Hourly matching means that a given volume of (e.g megawatt-hour (MWh[3])) of metered electricity consumption corresponds to an equal volume (i.e MWh) of clean electricity generation that is produced in the same hour within the same grid boundary as the consumption. This is similar to how today's electricity systems and power markets already operate; electricity demand and supply must constantly be in balance across the system, and most power markets clear at hourly or sub-hourly intervals. The table below shows a basic example of how hourly matching works:

[2] Princeton evaluated a hydrogen uptake scenario that parallels the growth achieved during the early years of the U.S. solar PV industry, a plausible analog for a readily achievable scale-up of the nascent electrolysis industry over a similar time period. This scenario begins with only 0.1 million metric tons (MMT) per year of electrolysis capacity installed in 2026, or 0.6 gigawatts of electrolyzer capacity (the same as the annual solar PV capacity installed in 2010). Annual installations then grow at the same average rate from 2026-2032 as the solar sector over 2010-2016 before tapering off to a slower growth rate thereafter (also mirroring the experience in solar PV). This conservative scenario results in only 2 MMT/year of hydrogen production in 2030, well short of the Department of Energy's goal of 10 MMT by the end of the decade.

[3] MWh units are used here for the purpose of simplicity, in reality hourly matching should be done at the Wh or kWh scale to accurately capture matched volumes.

Table 2 - Basic Example of Hourly Matching

Hour	Production (MWh)	Consumption (MWh)	Hourly Matched (MWh)
1	1	1	1
2	2	1	1
3	0.5	1	0.5

In hour 1, the 1 MWh of consumption is fully matched by 1 MWh of production. In hour 2, consumption is also fully matched by production, as the amount of energy produced (2 MWh) exceeds the amount of energy consumed (1 MWh). In hour 3, the production (0.5 MWh) is lower than the consumption (1 MWh), so only 0.5 MWh of the consumption is hourly matched.

Verification Method 1: Hourly EACs

As electricity flows cannot be physically tracked across the grid, energy attribute certificates (EACs) were created to represent the attributes of purchased electricity and create an accounting structure to track that electricity production. EACs have traditionally tracked physical energy production on a monthly or an annual basis, but new tools have been created in the US and elsewhere to track and verify purchased electricity on an hourly basis through hourly EACs, also known as Granular Certificates (GCs).

Qualifying (hourly) EACs are the instrument that the Proposed Rule requires for qualification for the 45V tax credit. Figure illustrates how hourly EACs can be used and required eligibility criteria to become a “qualifying EAC” for 45v tax credit purposes. Regarding the temporal correlation requirements, the key requirement is that the eligible EAC, issued by a Qualified EAC Registry, be stamped with the hour of production beginning in 2028, and that the Qualified Verifier verify that this EAC corresponds to the hour of electrolyzer consumption claiming the 45V tax credit.

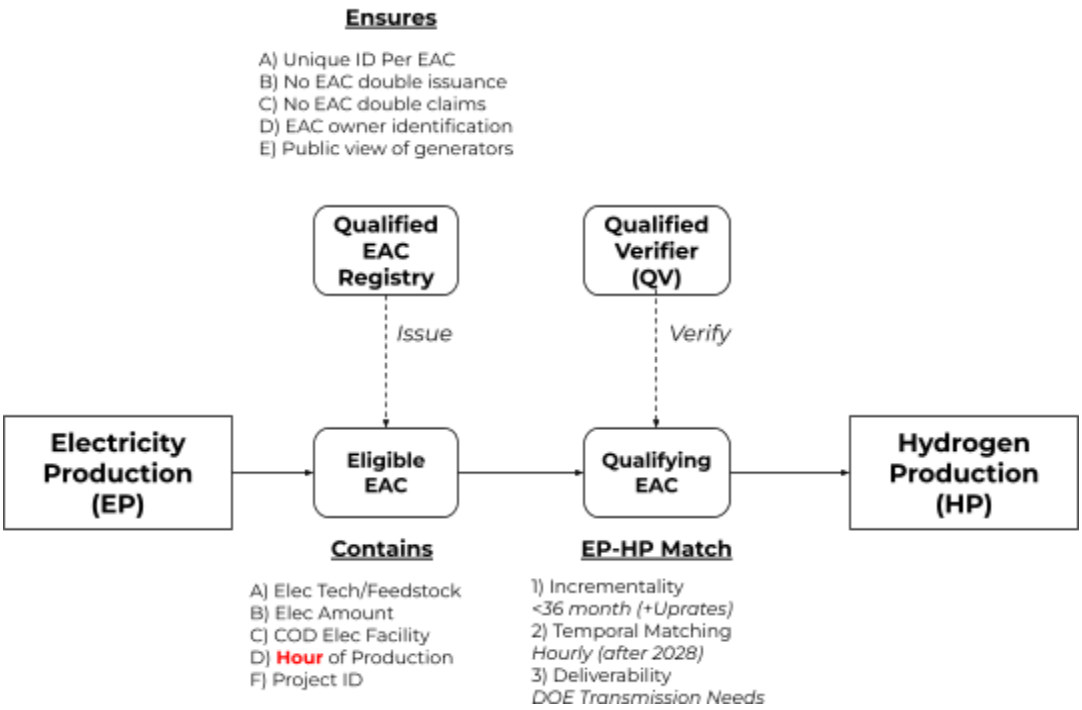

Figure 1 - Hourly Matching with Hourly EACs as detailed in 45v Guidance

The EnergyTag standard[4] provides an open-source common framework to enable Granular Certificates and implement hourly matching. It is supported by over 100 organizations from across the globe, including some of the largest energy consumers and energy providers, such as Google, Microsoft, AES, EDF, Iberdrola, and others.[5] It was developed by the experts who designed the European Guarantee of Origin system, the world's oldest and largest standardized EAC system. The EU has a highly standardized EAC system that is critical to ensuring interoperability between registries, auditability, fraud prevention and ease of use for consumers. EnergyTag recommends that Treasury also require a standardization of the EAC registries (both for annual or hourly EACs) to ensure a robust implementation of the tax credit.

Recommendation 2 - Require Hourly EAC Registry Standard
Treasury should consider requiring a standard for the EAC registries to follow for annual and hourly EACs. This would help prevent fraud, enhance auditability and help registry interoperability.

While not all registries in the United States are able to issue hourly EACs today, a recent report by the Center for Resource Solutions (cited in the 45V guidance) found that nearly all U.S registries could transition from annual to hourly certificates in 2 years.[6] Leading registries like M-RETs and PJM GATS already offer hourly views of monthly EACs and are scaling up their hourly EAC offering. Given these advancements, and the fact that registries such as M-RETs

[4] EnergyTag Standards
[5] For a full list of EnergyTag standard supporters, please see: https://energytag.org/
[6] CRS - Readiness for Hourly RECs

can offer hourly EACs across the US once ready, registries should not be seen as a barrier to implementation of the temporal correlation requirement by 2028.

Recommendation 3 - Maintain 2028 Phase-in for Hourly Matching
Treasury should reinforce the 2028 phase in for hourly matching as ample time for hourly EAC registries to scale. Treasury should clarify that once one registry has hourly EAC capability, it should be able to cover any regions that do not yet have the capability as is common practice in the voluntary renewable certificate market today.

The Proposed Rule lists hourly EACs, issued by Qualified EAC registry, as the sole method for compliance with the temporal correlation requirement and this should be the preferred methodology. Once one of the many US EAC registries offers full hourly EAC functionality, they can do so across 50 states if required. However, there are widely used alternative methods for validating and verifying hourly temporal correlation, in the event that some registries decide not to enable issuance of hourly EACs.

Verification Method 2 (Alternative) : Annual EACs + Hourly Data

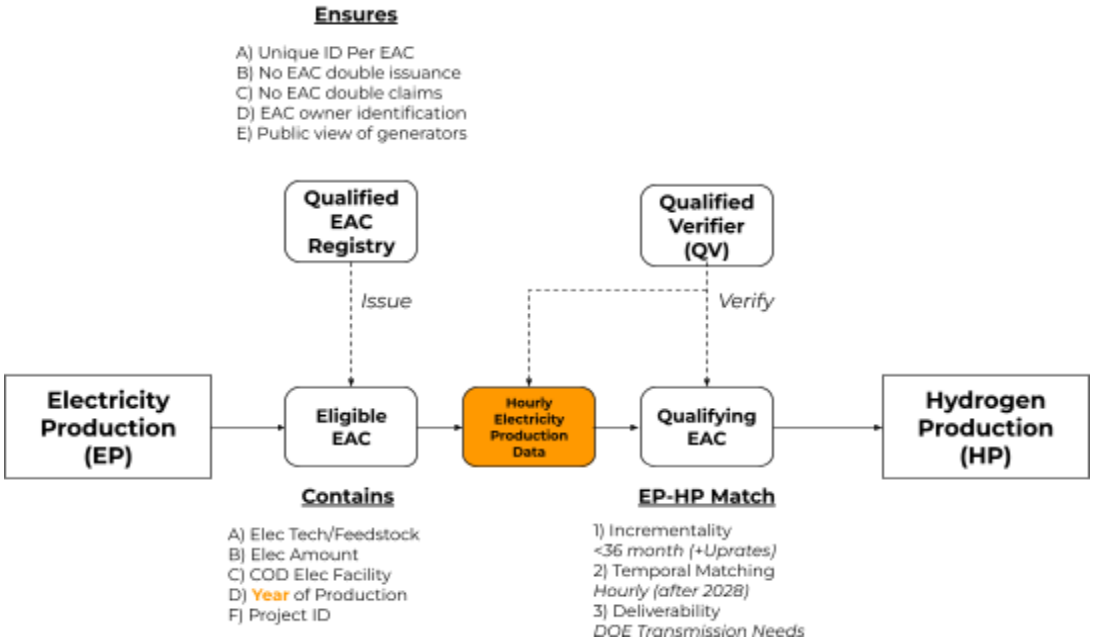

Figure 2 - Alternative Hourly Matching with Annual or Monthly EACs + Hourly Data

The standard way of implementing hourly matching today is to add hourly meter data to Annual (or monthly) EACs (Figure 2). Use of registered annual/monthly EACs ensures that there is no double counting, while additional meter data enables hourly claims. This method of hourly tracking and verification is already being used in the United States and around the world. US registries like M-RETs and PJM GATS already offer this to customers, where hourly data is used to provide an hourly view of annual/monthly EACs.

The map below (Figure 3) shows some hourly matching projects underway across the world, which collectively cover over 1 terawatt-hour (TWh) of electricity and involve some of the world's leading organizations focussed on hourly matching, such as Google, Microsoft, AES, Flexidao and Granular Energy. Some jurisdictions, such as Taiwan, only permit hourly matching for clean energy claims and have done so for years.

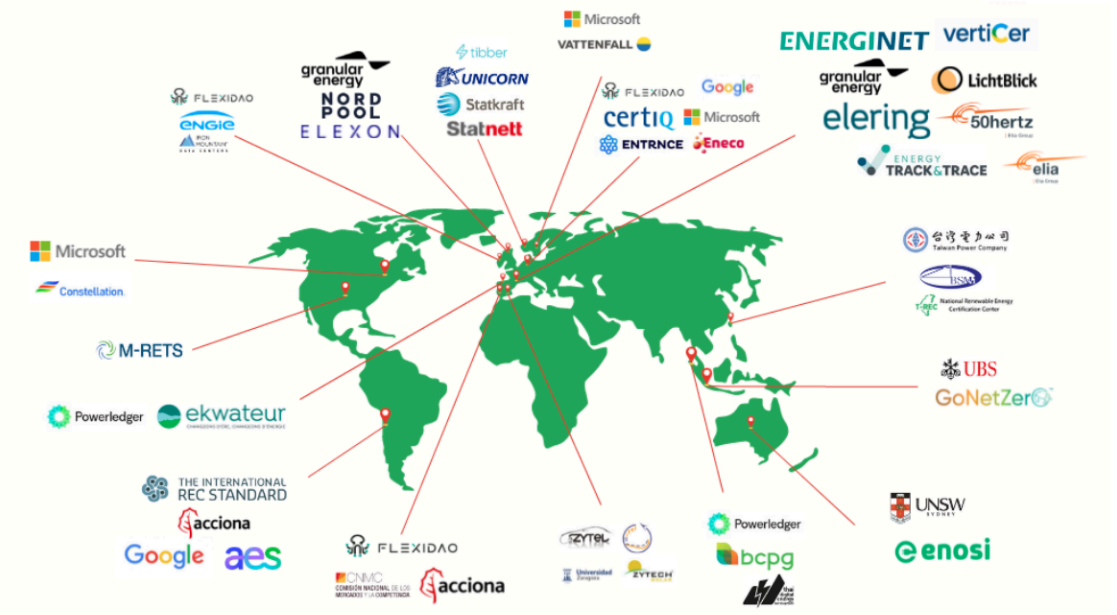

Figure 3 - Case Studies of Hourly Matching Globally (EnergyTag)

In the final 45V rules, using annual or monthly EACs and hourly data should be introduced as an alternative or transitional implementation option for 45V eligibility available to first movers who need certainty prior to 2028 while EAC registries move to enable issuance of hourly EACs. Under this transitional approach, Qualified Verifiers would verify Annual/Monthly EACs to ensure no double counting, together with metered Hourly Production Data and Hourly Consumption data to verify hourly matching. Standards such as EnergyTag, can ensure this is done in a robust way without double counting. This would give certainty *as of today* for clean hydrogen projects looking to finalize investment decisions that the hourly matching accounting will be possible.

Recommendation 4 - Facilitate Provisional Pathway for Hourly Matching
Treasury should allow a provisional pathway to demonstrating hourly matching that uses hourly meter data and annual/monthly EACs (in use today) to demonstrate hourly matching where hourly EACs are not available. This form of hourly matching is possible and widespread globally. This would enable hourly matching today even before 2028 for those who wanted to do this voluntarily, and in the unlikely case that hourly EACs are not ready by 2028, is a viable pathway for ensuring compliance with hourly matching until hourly EACs are available.

Section 3 - Contracting : Contracting Structures for Hourly-Matched Clean Energy Are Largely in place, with innovation for last-mile solutions underway

In order to comply with the temporal correlation requirement, hydrogen electrolyzers must purchase hourly EACs[7] to correspond to each hour of their electricity consumption. It's important to note that hydrogen producers will use the same fundamental clean energy purchasing options - EACs, Power Purchase Agreements (PPAs), and retail energy supply agreements - that are available in today's voluntary clean energy market in the US. The only difference is the additional granular information that tracks and verifies the hour by hour matching under those procurement options. Specifically, there are at least three different contract types that electrolyzers can use to fulfill the hourly temporal correlation requirement:

- *Granular Attribute Purchase Agreement*: This is an agreement under which the seller provides the buyer with granular (hourly) EACs that are unbundled from the corresponding generation. The hourly EACs could be provided to match a pre-agreed consumption profile, or the seller could provide the buyer with hourly EACs from a single project as they are generated.
- *Granular Power Purchase Agreements (PPAs)*: Under this agreement, the seller provides the buyer with both clean energy and granular EACs to match a pre-agreed consumption profile. Typically, the seller will use a portfolio of generation assets in order to provide this service, as combining different clean energy technologies together helps increase the percentage of hourly matching achieved under the agreement. However, existing single technology PPAs can also be accounted for on a granular basis by calculating the consumption that is matched with production under the PPA on a locational and hourly basis.
- *Granular Energy Supply Agreements:* This is an arrangement that provides hourly EACs on top of a retail supply agreement between buyer and seller. The electric utility or retail energy provider typically provides electricity to one specific consumption site (or group of sites). They will track the buyers' hourly consumption at these sites and provide the buyer with hourly EACs to match their load. The hourly EACs could be sourced from projects that are part of the retail energy provider's own generation asset portfolio, or be sourced from other projects that are on the same electricity grid.

Many companies have already executed granular procurement contracts that are structured to achieve hourly matching targets. For instance, Google signed an agreement with AES to deliver 90% hourly matched clean energy in PJM starting in 2024,[8] and a similar agreement with Silicon Valley Clean Energy in California.[9] Microsoft and AES also signed an agreement in PJM to help provide round the clock power[10]. Peninsula Clean Energy, an electricity provider in California, is aiming to provide their customers with 99% hourly matched clean electricity starting in 2025,

[7] Or demonstrate hourly matching data if Verification Method 2 is enabled
[8] https://www.aes.com/sites/default/files/2021-05/AES-Google-Case-Story_0.pdf
[9] https://svcleanenergy.org/news/silicon-valley-clean-energy-and-google-announce-comprehensive-24-7-carbon-free-energy-agreement/
[10] https://www.prnewswire.com/news-releases/microsoft-and-aes-partner-to-bring-around-the-clock-renewable-energy-to-data-centers-301414877.html

and has indicated it can do so at reasonable cost.[11] Under Executive Order 14057, the Biden Administration has also adopted a goal to match 50% of federal electricity consumption on a 24/7 basis by 2030.[12] To move towards this goal, the Administration is working with utilities to develop new energy tariffs to provide hourly matched clean energy in Arkansas,[13] Georgia,[14] Minnesota, Michigan, North Dakota, South Dakota, and Wisconsin.[15]

New platforms are being created that will allow companies to buy and sell Granular EACs to increase their levels of hourly matching. The Granular Certificate Trading Alliance (GCTA), a new effort developed by LevelTen Energy and ICE and launched in partnership with AES, Constellation, Google and Microsoft, will launch in 2024. The GCTA is a Granular EAC trading platform, which will easily connect clean energy buyers to new, flexible granular procurement options, which can also lower the cost of high shares of hourly matching.[16] For example, clean hydrogen producers could use this or other similar platforms to source granular EACs to match their demand where there may be gaps in clean energy PPA arrangements.

Section 4 - Technologies to Achieve Hourly Matching

Hourly matching can be achieved by combining different clean energy resources together to enable 100% hourly matching at a high (e.g over 70%) electrolyzer utilization rate. This is the approximate optimal level of operations for an electrolyzer, as it seeks to avoid operating during hours where electricity prices are highest (as the cost of electricity accounts for the largest cost in electrolytic hydrogen production). A significant body of research has developed in recent years showing that achieving high levels of hourly matching is possible by purchasing clean electricity from an optimally sized portfolio of different technologies, which can include variable renewables, energy storage, and firm, dispatchable carbon-free energy technologies.[17] Research also indicates that flexibility in electricity demand can reduce the costs of high levels of hourly matching,[18] and electrolyzers have the potential to be highly flexible electricity consumers[19].

Regarding achieving hourly matching targets for clean hydrogen production, a meta-analysis performed by Princeton University of different studies - including by hydrogen and renewable developers and electrolyzer manufacturers - analyzing potential requirements for 45V finds that 100% hourly matching for electrolyzer utilization rates greater than 70%, and even exceeding 90%, is possible by oversizing variable renewable energy capacity (i.e. wind and solar) relative to electrolyzer capacity, and that this can be done at a competitive levelized cost of hydrogen (LCOH).[20]

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[11] https://www.peninsulacleanenergy.com/wp-content/uploads/2023/01/24-7-white-paper-2023.pdf
[12] https://www.sustainability.gov/federalsustainabilityplan/
[13] https://www.gsa.gov/about-us/newsroom/news-releases/bidenharris-administration-announces-us-governments-first-initiative-with-a-utility-to-work-toward-247-carbon-pollutionfree-electricity-11152022
[14] https://www.gsa.gov/about-us/newsroom/news-releases/bidenharris-administration-announces-agreement-to-10242023
[15] https://www.gsa.gov/about-us/newsroom/news-releases/bidenharris-administration-announces-agreement-to-10242023
[16] https://www.leveltenenergy.com/alliance
[17] https://zenodo.org/records/10407831
https://www.sciencedirect.com/science/article/abs/pii/S2542435123004993
https://www.iea.org/reports/advancing-decarbonisation-through-clean-electricity-procurement
[18] https://zenodo.org/records/8185850
[19] https://www.sciencedirect.com/science/article/pii/S0360319923000459
[20] https://subscriber.politicopro.com/f/?id=00000187-9bb4-daaa-a5e7-bfbfff120000

Section 5 - Enabling Storage Through Robust Tracking

The ability of storage to time shift clean energy is central to energy consumers with hourly matching targets who already signed contracts with high levels of hourly matching[21]. In this way, storage can also provide significant value to the production of clean hydrogen by increasing rates of hourly clean energy matching[22]:

1. Allowing electrolyzers to expand the number of hours they can consume intermittent renewable energy. E.g. Consuming solar energy at night that was charged into storage during the day.
2. Reducing intermittency of electrolyzer start/stop and ramping.
3. Improving the ability to schedule uptime

Hourly matching systems for batteries have been tested on real world batteries[23], are being addressed by global standard organizations such as EnergyTag[24], have the support of leading registries such as M-RETS, and expand the options for electrolyzer operators to meet the temporal matching requirements of this proposed rule.

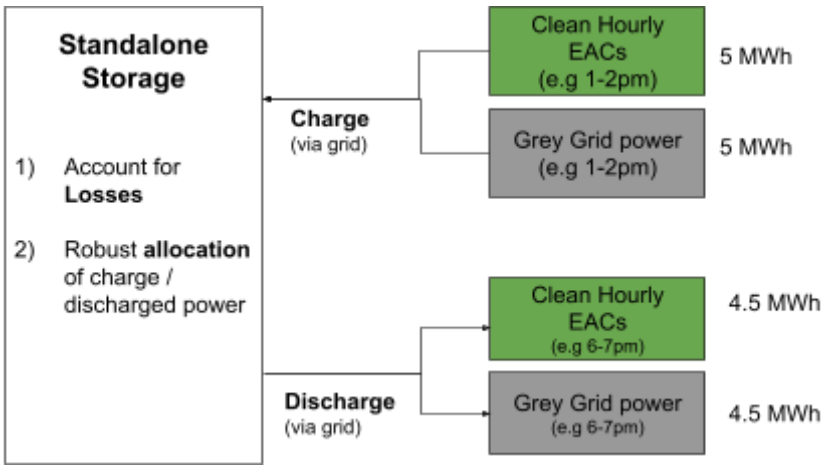

Figure 4 - Example of Storage Tracking

- Where storage is co-located "behind-the-meter" with clean electricity production or clean hydrogen production, this should be specifically permitted.
- For standalone storage, hourly EACs can be sourced from storage discharge provided that the following ***conditions*** are met[25]:

[21] https://www.prnewswire.com/news-releases/aes-announces-first-of-its-kind-agreement-to-supply-247-carbon-free-energy-for-google-data-centers-in-virginia-301282750.html
[22] https://www.utilitydive.com/spons/how-a-bess-can-improve-green-hydrogen-economics/705118/
[23] see Quinbrook's case study https://www.quintrace.com/hourly-case-study
[24] https://energytag.org/standards/
[25] Standards such as EnergyTag provide detailed guidelines on implementation of hourly storage tracking

Process for Temporal Matching

- **Charging:** Hourly EACs from the production of clean electricity are retired during the same hour as storage charge. The volumes of EACs charged into the storage system in an hour cannot exceed the physical electricity charged into storage in that hour.
- **Storage:** Hourly EAC Attributes are stored in the storage system (i.e. reservoir) over time. Losses are applied to all types of energy in the reservoir on an hourly basis (as detailed below). The amount of hourly EACs stored cannot exceed energy stored in the storage device in any given hour.
- **Discharge:** Hourly EACs are re-issued as discharge from the storage and matched to the consumption of the electrolyzer in the same hour as storage discharge. EAC volumes discharged from storage must never exceed electricity discharged from the storage system at any given hour.

Accounting for losses

- The energy lost while the electricity is stored must be accounted for using Round-trip efficiency (RTE) applied each hour to the electricity charged into the storage system and applied proportionately to both clean EACs and gray energy charged into storage.
- The RTE should be calculated on an hourly basis based on measured hourly charge and discharge and storage state of charge data. Hourly calculations are important to avoid large discrepancies between real losses and hourly EAC losses.
    - Where RTE is not or cannot be calculated using meter data, the manufacturer default value for the asset should be used but only for an initial period of 6 months only, following the start-up of a Storage System.
    - If neither measured hourly RTE nor storage system default values are available, a default storage RTE value for the storage technology may be used. This default list should be provided in 45v guidance and should reflect conservative estimates to encourage real measurement of RTE.

Attribute allocation

- A robust, consistent, and auditable methodology must be used to ensure a physically representative flow of clean/gray energy attributes in and out of the storage system.
- One of the methods used for storage tracking could be:
    - **Weighted average** → Discharge clean hourly EACs and gray power based on a weighted average of attributes in storage at the time of discharge.
    - **First in First out** → Discharge clean hourly EACs and gray power based on the order in which they were charged into the storage device
    - **Target Percentage** → Targeting a fixed percentage of renewables and grid energy for each hour, which gives the operator the most certainty of when clean energy will be used by the electrolyzer.
    - **Storage operator decides** → No specific restrictions over which attributes are discharged from storage at any specific time. This gives the most flexibility to the

storage operator but could lead to an imbalance in clean to gray attribute charge and discharge from the storage system.

Recommendation 5 - Provide Guidance on Standalone Storage Implementation
Treasury should provide guidance describing in detail how standalone storage may be used to time-shift hourly EACs in a robust way that accounts for losses and uses a consistent and transparent allocation methodology. This would enhance options of increased hourly matching.

We hope these comments are informative in supporting the robust implementation of proposed 3-pillar rules of hourly matching, deliverability and incrementality that are critical to creating a clean hydrogen economy that delivers deep decarbonisation in the United States. We remain available should you have any questions at killian@energytag.org.

Sincerely,

EnergyTag - Killian Daly, Executive Director
Natural Resources Defense Council - Rachel Fakhry, Policy Director for Emerging Technologies
Quinbrook Infrastructure Partners
Environmental Defense Fund - Morgan Rote, Director, U.S. Climate
M-RETS - Benjamin L. Gerber, President & CEO
Synergetic - Mike Sloan, CEO