

**Cooperación Público-Privada entre Soventix y GIZ en el marco del proyecto apoyado por H2Uppp:**

***“SolarNH3-Pool Chile: Conceptos para el desarrollo de un parque industrial sostenible de hidrógeno/amoniaco verde en la región de Antofagasta (Chile)”***

Este documento se ha realizado en el marco del Programa Internacional de Fomento del Hidrógeno (H2Uppp) del Ministerio Federal de Economía y Protección del Clima (BMWK) de Alemania que promueve proyectos y el desarrollo del mercado del hidrógeno verde en determinados países en desarrollo y emergentes como parte de la Estrategia Nacional del Hidrógeno.

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## *Monetization Opportunities of Green Hydrogen and Ammonia*

Work Package 3 for Soventix

Version 1.0

June 27<sup>th</sup>, 2023



Climate Strategies



Compensation/  
Neutralization



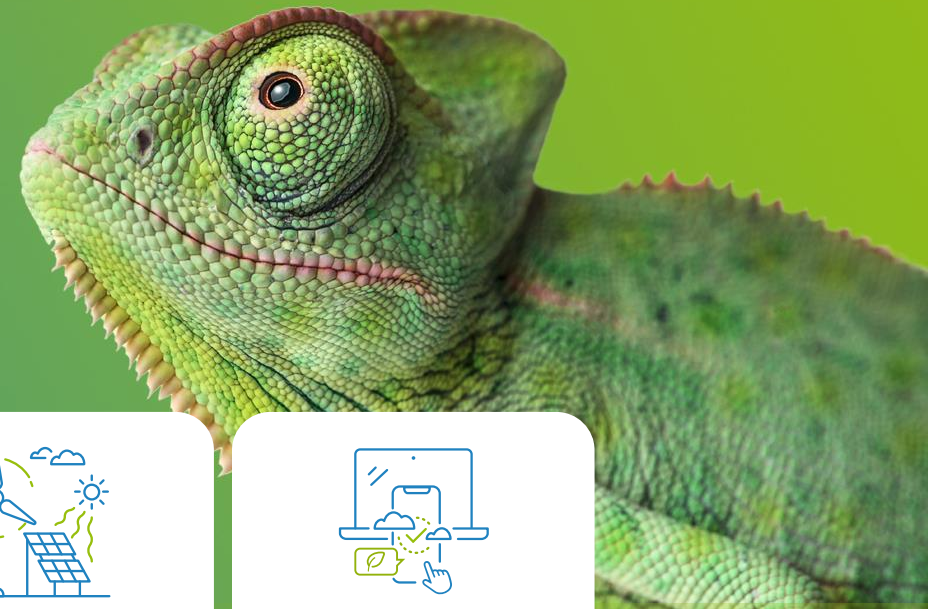
Climate Protection  
Projects



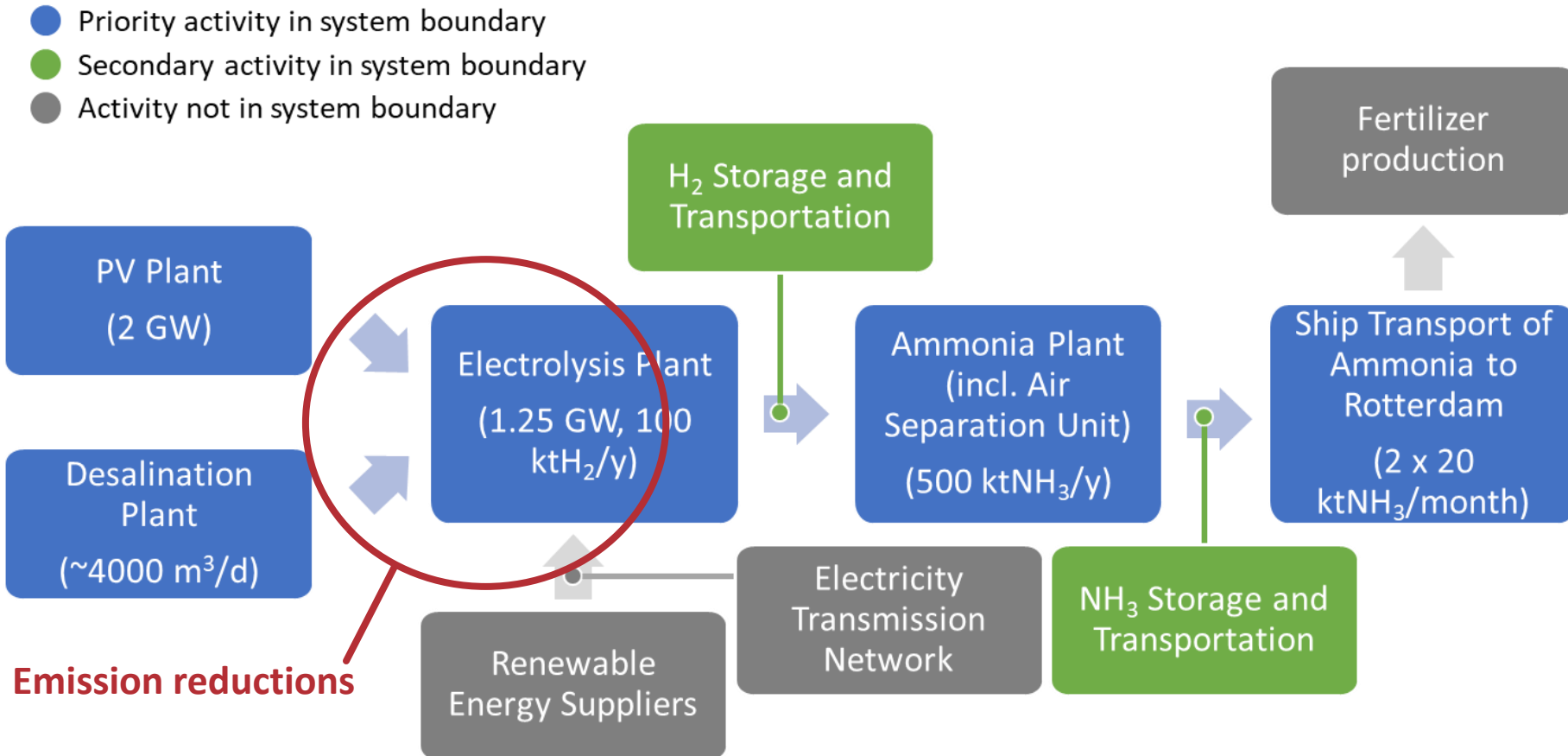
Green Energy



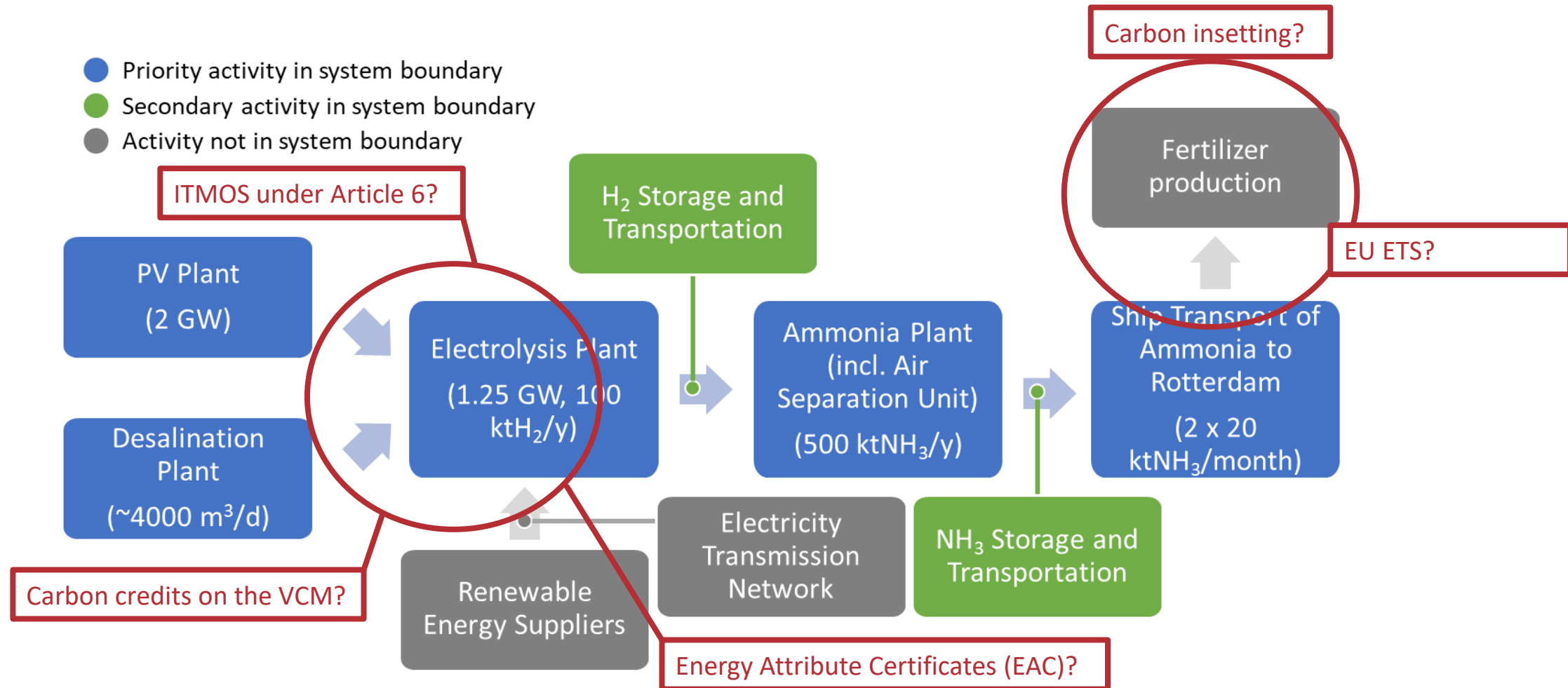
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# Value Chain of Fertilizer Production from Green Hydrogen



# Value Chain of Fertilizer Production from Green Hydrogen



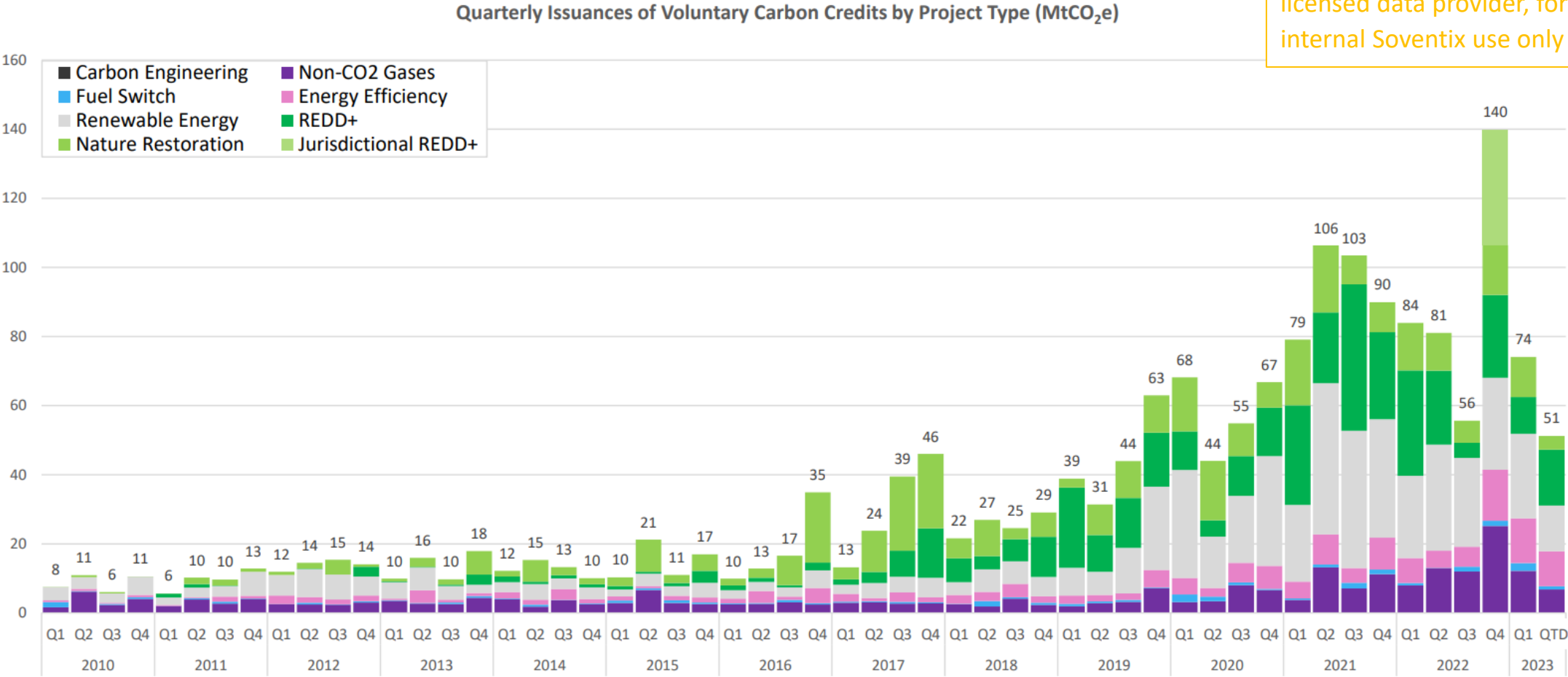




# *Opportunities on the Voluntary Carbon Market (VCM)*

# The Voluntary Carbon Market – Share of Project Types

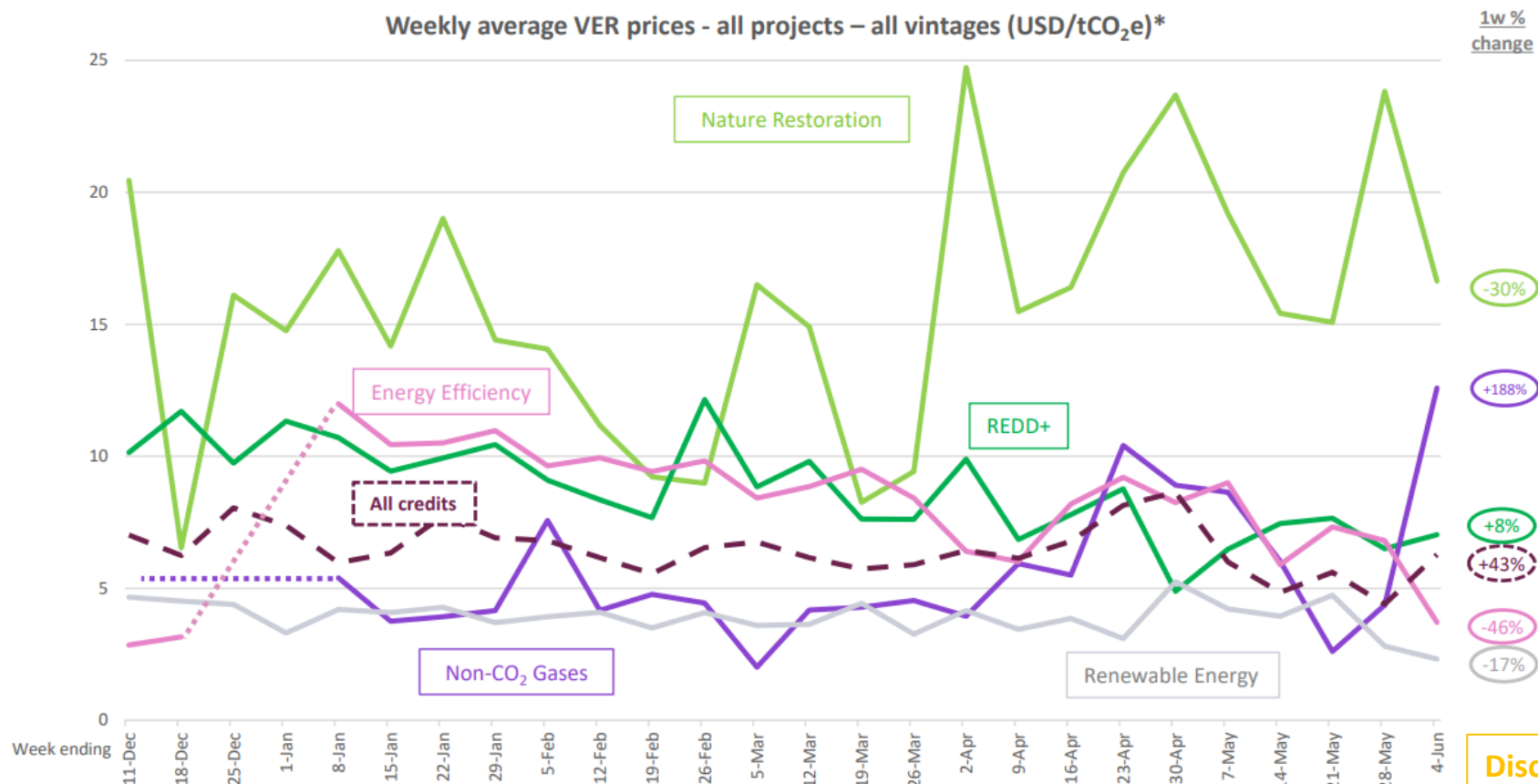
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Source: [Voluntary Carbon Credit Supply: Monthly Update \(trove-research.com\)](https://trove-research.com)

# The Voluntary Carbon Market – Current Prices (Dec 2022-Jun 2023)

Average credit prices rebounded from recent lows on the back of resurgent Non-CO<sub>2</sub> Gas prices.



Source: PowerPoint Presentation (trove-research.com)

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## Registered projects related to hydrogen on the VCM

Project	Registry	Methodology	Location	Status
<u>FUEL REPLACEMENT WITH WASTE GAS STREAM CONTAINING HYDROGEN AND BIOMASS AT THE CMPC</u>	VCS	ACM0012 (Waste Energy Recovery); AMS-I.C. (Thermal energy production with or without electricity)	Chile	Registered (2020), Crediting Period has expired (2010-2020)
<u>Hydrogen based steam generation at New Johnsonville</u>	VCS	AMS-III.B. (Switching Fossil Fuels)	US	Under development

### Take-aways:

- Currently, there are no projects registered on the VCM that certify the production of green hydrogen from the electrolysis of water.
- Existing methodologies (such as fuel switch) are not applicable to the production of green hydrogen from the electrolysis of water.

## Existing initiatives / methodologies related to hydrogen on the VCM

Registry	Methodology	Comment
Gold Standard	None	H2NZ initiative planning to have a first registered methodology by Q4 2023
VERRA	None	H2NZ initiative planning to have a first registered methodology by Q4 2023
CDM	<u>NM0381: Emission reduction by hydrogen production from renewable energy sources</u>	Methodology submitted in May 2022, submission not approved in March 2023
Global Carbon Council (GCC)	None	Methodologies under discussion (May 2022)
ISO 14064	None	
CAR	None	
ACR	None	

### Take-aways:

- Currently, there is no methodology on the VCM for crediting the emission reductions of green hydrogen.
- The most important standards on the VCM (VERRA & GS) are working together on the development of a methodology. CDM has a draft methodology that has not yet been approved. It is expected that there will be at least one applicable methodology in the near future.

# *Details on CDM Methodology NM0381: Emission reduction by hydrogen production from renewable energy sources*

- **Scope:** the methodology is applicable to project activities where hydrogen is produced by electrolysis of water, and where in the absence of the project activity the hydrogen would be produced through steam reforming of syngas produced by the gasification of coal, or through steam reforming of natural gas. The electricity consumed by the electrolyser hydrogen production plant shall be sourced from a captive renewable power plant only or from a captive renewable power plant and the electric grid.
- **Applicability:**
  - Only applicable to activities involving the construction of a new solar or wind captive renewable power plant & a new electrolyser hydrogen production plant.
  - The project shall use no more than 5 per cent of the water available locally.
  - The project participant shall demonstrate that double counting of emission reductions will not occur, e.g. via a contractual agreement with the consumer of the hydrogen produced.
- **Project boundary:** The spatial extent of the project boundary encompasses: (a) The electrolyser hydrogen production plant; (b) The captive renewable power plant; and (c) All power plants/units connected physically to the electric grid to which the hydrogen production plant is connected.
- **Status:** submitted in May 2022, recommended for approval by the board in Feb 2022, not approved in March 2023 for unknown reasons

**Take-aways:** if the methodology is resubmitted and approved, may be applicable to Solar NH<sub>3</sub>-Pool Chile

Sources: [CDM: NM0381: Emission reduction by hydrogen production from renewable energy sources \(unfccc.int\)](#) & [MP90\\_EA01\\_NM0381\\_Draft\\_Methodology\\_rev \(unfccc.int\)](#)

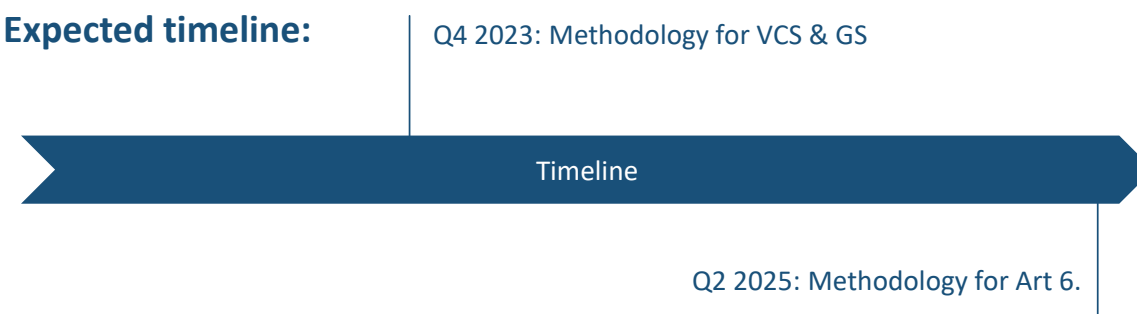
## Details on Hydrogen for Net Zero (H2NZ) Initiative

- Joint initiative between South Pole, perspectives, Gold Standard and VERRA
- Mission of the initiative is to unlock carbon finance for hydrogen projects by developing the first methodologies for the VCM that will credit the full suite of low-carbon hydrogen activities and by serving as a platform to engage stakeholders
- Methodologies will cover the complete hydrogen supply chain from production and processing to transport, storage and application in various sectors – such as heavy industry, chemicals, fertilizer production, transport and aviation, among others.
- Modular structure of methodologies: modules can be reused for other use cases, additional model can be added
- Creates a stakeholder engagement platform where players from different parts of the hydrogen supply chain will be connected for potential projects and developments in the hydrogen sector (policies, standards, support schemes, corporate net-zero strategies).
- Open for core partners that optimally bring in hydrogen use cases (outside EU) (status: June 2022)

### Take-aways/Status of Knowledge:

- H2NZ seems to be the most advanced initiative in the VCM
- Can probably serve as a basis for Solar NH<sub>3</sub>-Pool Chile to generate carbon credits on the VCM in the future (> 2024)
- No details about content of the methodologies so far
- FC inquired about details of H2NZ in Dec 22, no answer

### Expected timeline:



Source: H2NZ webinar (June 2022)



# *Opportunities through Compliance Mechanisms*

# Article 6.2 of the Paris Agreement (PA): Background

## What is Article 6.2? Mechanism for emissions trading for Parties to the PA

- Cooperative approaches that involve the use of internationally transferred mitigation outcomes towards NDCs
- Partner countries collaborate under bilateral agreements to achieve their NDCs
- ITMOs (Internationally Transferred Mitigation Outcomes) = CO<sub>2</sub> metric for mitigation outcome
- Corresponding Adjustments required to avoid double counting (regardless of whether ITMO is in or outside the NDC)
- Case-by-case approval, Parties agree on own methodology, monitoring of mitigation outcomes (how ITMOs are produced and contracted)
- Scope: emission reductions and removals (REDD+ units not explicitly excluded but subject to full guidance)
- International registry and reporting platform planned
- Share of Proceeds (SoP) strongly encouraged to contribute to adaptation finance, Overall Mitigation in Global Emissions (OMGE) also strongly encouraged through cancellation of ITMOs
- Reporting on human rights /rights of indigenous people, and on avoiding negative impacts
- As an example, KliK (for the Swiss government) pays a cost-covering price per ton of CO<sub>2</sub>. Their willingness to pay is generally higher than on the VCM. The average price of ITMOs purchased by KliK is CHF 21 (USD 23.50).





# Chile and Article 6.2

## Current state of Chile's engagement under Article 6.2:

- Joint Declaration between Chile and Switzerland on Article 6.2 Cooperation
  - Possibility to hand in Mitigation Activity Idea Note at the KliK Foundation to develop an Article 6 activity in Chile
  - Validation through FOEN (Swiss Federal Office for the Environment) → need of a methodology!
- Chile exploring other potential Article 6 partnerships with South Korea, New Zealand and the World Bank
- Chile partnering with Japan under JCM (Joint Crediting Mechanism)

### Take-aways:

- No methodology for green hydrogen certification → too early-stage for Swiss-Chilean cooperation under Article 6
- Other potential cooperations of Chile under Article 6 have not yet concretized
- No methodology for green hydrogen certification under JCM

# EU ETS: Background

- EU ETS covers largest point source emitters in the EU, including indirectly the fertilizer industry (production of hydrogen, production of ammonia, production of nitric acid)
- EU ETS covers only emissions generated *in the production process* within the installations' reporting boundaries; relevant product benchmarks:
  - $8.85 \text{ tCO}_2/\text{tH}_2$
  - $1.619 \text{ tCO}_2/\text{tNH}_3$
  - $0.302 \text{ tCO}_2/\text{tHNO}_3$
- Installations covered by the EU ETS receive a certain number of allowances (one allowance = one tonne of  $\text{CO}_2$ ) for free each year
- At the end of a reporting year, installations must surrender allowances covering all relevant emissions in the reporting year; if the freely allocated allowances are not sufficient, the balance is to be purchased on the open market.
- Changes in production capacity (increase or decrease) lead to a recalculation of the free allocation
- Price of allowances have soared to approx. 100 EUR/t $\text{CO}_2$  in early 2023

## Take aways:

- Purchases of low-carbon raw materials (e.g. green ammonia as input for nitric acid production) have no influence on allocation of allowances for EU ETS installations
- As a result, no direct monetization options for green ammonia foreseen via the EU ETS



Source: <https://tradingeconomics.com/commodity/carbon>

# Carbon Border Adjustment Mechanism (CBAM)

- CBAM intends to place a carbon price on emissions-intensive goods entering the EU in order to level the playing field against similar goods produced in the EU and subject to the EU ETS
- CBAM will enter into application in its transitional phase on 1 October 2023 and will initially apply to imports of certain goods and selected precursors whose production is at most significant risk of carbon leakage: **cement, iron and steel, aluminium, fertilisers, electricity and hydrogen.**
- During this period, importers of goods in the scope of the new rules will only have to report greenhouse gas emissions (GHG) embedded in their imports (direct and indirect emissions), without making any financial payments or adjustments.
- Once fully in place as of 2026, EU importers of goods covered by the CBAM will need to buy so-called “CBAM certificates”. CBAM certificates are not tradeable nor bankable to ensure they constantly reflect the evolution of the ETS price, they can only be surrendered to the competent authority.
- The price of the certificates will be calculated depending on the weekly average auction price of EU ETS allowances expressed in € / tonne of CO<sub>2</sub> emitted.

## Take aways:

- Starting in 2026, importers into the EU of hydrogen and fertilizer (nitric acid, ammonia) production will have to pay for the emissions caused by the products outside of the EU (direct and indirect emissions)
- No direct monetization option apparent as CBAM certificates not tradeable, only indirect incentive to import products with lower CO<sub>2</sub> footprint (e.g. green hydrogen and green ammonia)

Source: [Carbon Border Adjustment Mechanism \(europa.eu\)](https://europa.eu/eu-observatory/energy-environment/cbam/) & [A brief explanation of the Carbon Border Adjustment Mechanism \(CBAM\) - Carbon Market Watch](https://www.carbonmarketwatch.com/)

# *Emission reductions in the application of fertilizers in Switzerland*

- Other carbon projects/programs monetizing the climate benefits of fertilizers exist, for instance the ENTEC26 program registered as domestic compensation in Switzerland's carbon market:
  - ENTEC26: a program that reduces nitrous oxide emissions in Swiss agriculture. → Fertilizer additives reduce the nitrification of nitrogen in the soil and the emission of nitrous oxide is reduced.
- **Background Information:** Nitrous oxide emissions from nitrogen conversion in the soil are the second most important source of greenhouse gases in Swiss agriculture after methane emissions from ruminants. The nitrous oxide is produced after fertilization as a by-product of the bacterial conversion of conversion of nitrogen from its ammonium to its nitrate form (nitrification), as well as in the opposite process of denitrification. Around two thirds of the emissions escape directly from agricultural soils. The remainder results indirectly from nitrogen, which is lost as ammonia and nitrate.

## **Take-away:**

- Approach taken in ENTEC26 monetizes the emission reductions during application of the fertilizer, which is not an applicable model for Solar NH<sub>3</sub>-Pool Chile as the emission reductions occur in the production of the hydrogen.

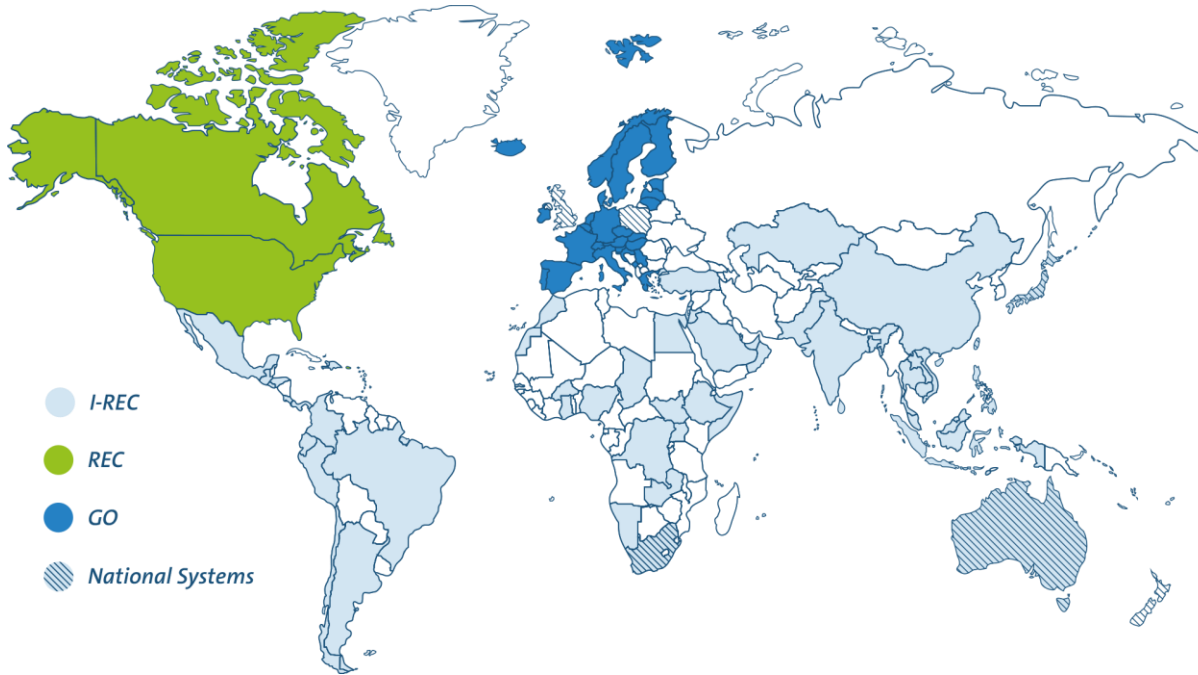
Source: [ENTE26 KliK Factsheet.pdf \(agrocleantech.ch\)](#)



# *Opportunities through Green Hydrogen & Ammonia Certification*

# Energy Attribute Certificates: Background

Energy Attribute Certificates (EACs) Worldwide



- Production, trade/distribution and consumption of renewable electricity can be electronically **documented and tracked** with Energy Attribute Certificates (EACs);
- Companies can claim the environmental benefit of renewable electricity for their own electricity consumption;
- EACs are usually **unbundled from the physical electricity deliver** (contractual instrument in form of a certificate per MWh);
- Contractual instruments to convey information about
  - Type of power plant
  - Name of plant & location
  - Actual amount of renewable electricity purchased (in MWh)
- Depending on factors such as geography / vintage / system, prices generally range more or less from 0.50 to 5.00 USD/MWh
- Various types of EACs exist:





# Landscape of hydrogen certification schemes

VOLUNTARY MARKET		MANDATORY MARKET
<b>Aichi Prefecture</b> ■ Low Carbon Hydrogen Certification	<b>China Hydrogen Alliance</b> ■ Standard and Assessment for Low Carbon Hydrogen, Clean Hydrogen, and Renewable Hydrogen Energy	<b>California Air Resources Board</b> ■ Low Carbon Fuel Standard
<b>Australian Clean Energy Regulator*</b> ■ Hydrogen Guarantee of Origin	<b>Green Hydrogen Organisation</b> ■ Green Hydrogen Standard	<b>European Commission*</b> ■ Renewable Energy Directive (RED II)
<b>CertifHy</b> ■ ■ Green and Low-Carbon Hydrogen Certification	<b>Smart Energy Council</b> ■ Zero Carbon Certification Scheme	<b>UK Department for Business, Energy &amp; Industrial Strategy</b> ■ Low Carbon Hydrogen Standard
<b>CEN-CENELEC*</b> ■ Joint Technical Committee 6	<b>TÜV SÜD</b> ■ CMS 70	<b>UK Department for Transport</b> ■ Renewable Transport Fuel Obligation
		<b>US Department of Energy**</b> ■ Clean Hydrogen Production Standard

\*in development.

\*\*in development for specific program eligibility.

Source: [Creating a global hydrogen market: Certification to enable trade \(irena.org\)](https://www.irena.org/publications/2021/04/Creating-a-global-hydrogen-market-Certification-to-enable-trade)

Important to differentiate between:

- **Tracking systems** that generate tradable credits/certificates which can be traded (direct monetization opportunity)
- **Labeling standards** that certify green hydrogen according to certain criteria allowing to sell green hydrogen at a premium cost (indirect monetization opportunity). Criteria vary highly across initiatives. → regulatory gap

■ Standard with criteria for «green» hydrogen

■ Tracking / trading system for green hydrogen

■ Unclear

# Map of organisations working on hydrogen certification



Notes: \* in development. BEIS = Department for Business, Energy and Industrial Strategy; CEN = European Committee for Standardization; CENELEC = European Committee for Electrotechnical Standardization; JTC = Joint Technical Committee; RED II = Renewable Energy Directive II.

Source: [Creating a global hydrogen market: Certification to enable trade \(irena.org\)](https://www.irena.org/publications/2019/04/creating-a-global-hydrogen-market-certification-to-enable-trade)

# CertifHy: Tracking System for Hydrogen (Europe)

- First European certification scheme for renewable and low-carbon hydrogen as a solution to track hydrogen's origin
- Electronic certificates prove that hydrogen is produced with a specific feedstock and method of production (including information about where and when it is produced)
  - Green label: hydrogen produced from renewable energies with 60% GHG reduction
  - Low carbon label: hydrogen produced from non-renewable energies using carbon capture and storage with 60% GHG reduction
- After third-party auditing, the certificates are issued in a central registry and can be transferred to consumers, traders or brokers
- Enable EU-wide consumption of non-renewable and renewable hydrogen regardless of the location in EU; by using a CertifHy certificate, the corresponding quantity of hydrogen consumed acquires the properties of the hydrogen covered by the CertifHy certificates → Hydrogen guarantees of origin (GOs)
- Geographic scope: CertifHy covers the European Economic Area (incl. EU) plus Switzerland. **Issuing of CertifHy Certificates for production of hydrogen outside this geographical scope is not possible. Cancellation of CertifHy Certificates for Hydrogen uses outside this geographical scope is not possible.** → BUT CertifHy is looking to expand to outside of Europe (no timeline available so far)
- Technologies: The CertifHy scheme is technology-neutral as long as the requirement to comply with the definitions is met. Any hydrogen production technology that can provide evidence that the defined requirements for the amount of Hydrogen produced are met are included in the scope of the CertifHy scheme.
- Application: The CertifHy Scheme shall be open to all kinds of applications of the hydrogen including energy, mobility, **chemical conversion**
- Certificate content: each Certificate shall have a value of 1 MWh based on the lower heating value.

Source: Microsoft Word - CertifHy Scheme-Document V2.0 2022-04-28 endorsed CLEAN

# CertifHy: Current Status

## Pilot phase:

- The CertifHy GO scheme was tested successfully during a pilot phase carried out in collaboration with four hydrogen production plants: Air Liquide's Steam Methane Reformer in France, Nobian's Chlor Alkali plant in the Netherlands, Colruyt's Water Electrolysis in Belgium and Uniper's Windgas project in Germany
- In total, 85'000 CertifHy GOs of green and low carbon hydrogen have been issued in Europe by the scheme participants during this pilot project and afterwards. (Status: Jan 2022)
- Price: no public information available

## Next steps:

- Extension of the CertifHy GOs' scope outside of Europe (no timeline given)
- Development of an EU Voluntary Scheme for the certification of hydrogen as RFNBO (Renewable Fuel of Non-Biological Origin) compliant with REDII (Revised Renewable Energy Directive ) and REDII Delegated Acts. By showing compliance with the EU criteria through specific certification schemes such as CertifHy, economic operators will be able to capture the premium value of the renewable hydrogen they produce and supply.
  - This scheme is pending recognition by the European Commission as EU Voluntary Scheme for RFNBO (renewable hydrogen and derivatives used as fuel for the transport sector).
  - The final RFNBO regulation is expected by the end of July 2023. Currently, Hinicio & TÜV Süd provide pre-certification assessment (audit hydrogen facilities and give an opinion on whether it will be CertifHy-eligible in the near future)

Source: [220111 CertifHy New Website Official Press Release](#)

# *I-REC for Hydrogen Code (International Tracking System)*

- The I-REC Standard Foundation (I-REC Standard) and Avance Labs (“an independent global hydrogen accelerator that leverages data science and carbon finance to accelerate the integration of hydrogen and its derivatives into the global energy transition”) have signed a memorandum of understanding (MOU) for the development and eventual Accreditation of a Product Code for renewable and low-carbon hydrogen (the “Hydrogen Product Code” or “I-REC(H) Product Code”)
- Goal: “develop a tracking methodology that is a fact-based, ex-post, and technology agnostic, which would form the basis for a certificate instrument for produced hydrogen. This mechanism will support claims for hydrogen usage including that of low or zero-carbon products.”
- Status: in development (MoU signed in January 2022)
- No details available so far (including about applicability)
- Scope: expected to be international

Source: [I-REC for Hydrogen Code | I-REC Standard \(irecstandard.org\)](https://irecstandard.org)

# Green Hydrogen Certification Scheme in Chile: Current Status

- Chile has outlined a strategy that indicates that green hydrogen will help to reduce the country's greenhouse gas (GHG) emissions by 21%, and identifies the potential for hydrogen production and the possible markets and sectors that would use it.
- A study financed by the World Bank for the Government of Chile identifies the available schemes and analyzes which ones could be used in the country.
- It recommends the adoption of a method that is designed based on the internationally accepted guarantee of origin standards (for example, the European CertifHy or California's Low Carbon Fuel Standard), which serves the dual purpose of verifying the reduction targets that the country has proposed and trading in hydrogen internationally.

Sources: [estrategia nacional de hidrogeno verde - chile.pdf \(energia.gob.cl\)](#) & [Inicio green hydrogen certification report Chile WB.pdf](#)



# ***Certification of Green Ammonia: Ammonia Energy Association***

- The Ammonia Energy Association (AEA) is a global non-profit industry association that promotes the responsible use of ammonia in a sustainable energy economy. AEA is seeking to facilitate the establishment of a globally harmonised Certification Scheme for the carbon intensity of ammonia.
- According to their website, “the AEA is seeking to facilitate the establishment of a globally harmonised Certification Scheme for Low-Carbon Ammonia (the Certification Scheme) to support the development of a market for low- and zero-carbon ammonia. The Certification Scheme will quantify the absolute greenhouse gas (GHG) emissions associated with ammonia production and enable prospective producers and consumers to trade ammonia on the basis of certified, transparent, and verifiable emission reductions.” → tradable certificates for green ammonia
- AEA membership currently includes 165 corporations around the world
- Initial consultations held in 2021

Source: [AEA-Low-Carbon-Ammonia-Certification-Discussion-Paper.pdf \(ammoniaenergy.org\)](#)

## *Take-aways for green hydrogen and ammonia certification*

- Many initiatives are being launched relating to “certification” of renewable energy carriers
- Most mechanisms are designed for a specific country or region (e.g. CertifHy). Some are suitable for international trade, however most of them are still under development and not yet concrete.
- Majority of initiatives relate to hydrogen and not ammonia directly
- Whereas most of the certification systems offer a label that certifies the hydrogen or its derivative as “green”, “zero-carbon” or “low-carbon”, etc. and therefore do not offer a direct monetization opportunity, systems like I-REC or CertifHy (seek to) offer a tracking system for green hydrogen and its derivatives issuing tradable certificates. The differentiation between the intended purpose (label vs tradable certificates) of the schemes being developed is oftentimes still unclear.
- Regulation regarding what can be considered as green hydrogen is still evolving. The revised Renewable Energy Directive of the EU soon to be finalized offers a definition of so-called RFNBOs (renewable fuels of non-biological origin) → only applicable to RFNBOs used for transportation purposes so far.
- Most promising initiatives to follow:
  - **CertifHy**: Most mature system with planned extension of the schemes to hydrogen production outside of Europe, but only applies to hydrogen (not green ammonia)
  - **I-REC for Hydrogen**: Global scheme in development, but only applies to hydrogen (not green ammonia)
  - **Ammonia Energy Association**: No clear scheme however the association plans to support the development of a dedicated tracking scheme for green ammonia

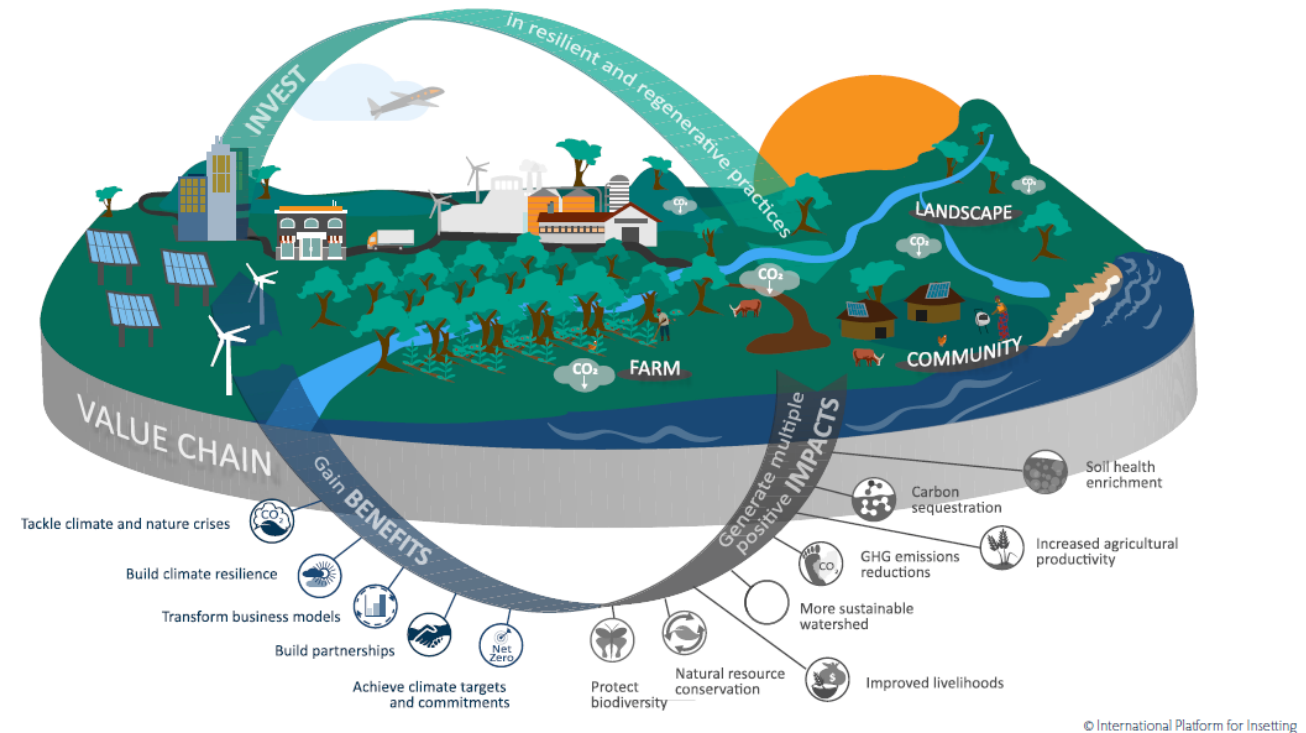


# *Opportunities through Insetting*

# Definition of Insetting

- The concept of insetting is not formally defined, in contrast to offsetting. Different stakeholders in the market have different understandings of insetting and many different definitions can be found.
- Guidelines are also currently in development, which leads to significant unclarity into how insetting should be handled in practice.
- Among these different definitions, The “International Platform for Insetting” (IPI) defines insetting as follows:

*Interventions by a company in or along their value chain that are designed to generate GHG emissions reductions or carbon removals, and at the same time create positive impacts for communities, landscapes and ecosystems.*



© International Platform for Insetting

Source: [A Practical Guide to Insetting, IPI 2022](#)

## Differences Insetting vs Offsetting

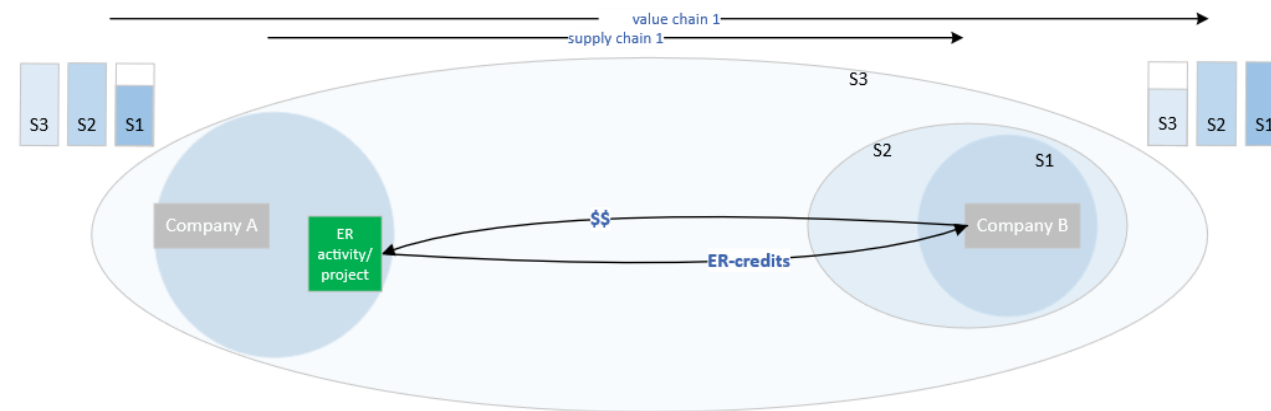
	Offsetting	Insetting	Explanations
<b>Boundary</b>	global	value chain, Scope 3 (and surrounding)	Surrounding in the sense of community level, landscape level; the boundary must be in line with accounting standard
<b>Involvement</b>	short-term	medium to long-term	
<b>Commitment</b>	low	high	
<b>Third-party certification</b>	yes	yes/no	Certification not necessarily required for insetting
<b>Transfer in form of credits</b>	yes	possible	Transfer of inset credits only within the value chain
<b>Focus on specific emission source</b>	no	yes	

### Take aways:

- Contrary to offsetting projects, there is no need for insetting projects to be registered under a standard for the benefits (i.e. emission reductions in a company's value chain) to be accounted. However, without registration and generation of carbon credits, there is also no monetary transaction possible.
- The main intention of an insetting project is to ensure accountability of the emission reductions within a company's value chain, rather than generating financial revenues for a project
- When developing an insetting project for carbon credit generation, the same carbon standards and rules apply as for offsetting

## Example Insetting Use Case: Credit generation and transfer within the value chain

- As part of Company B's value chain (scope 3, S3) emission mitigation activities, the company invests in a emission reduction (ER) project located in scope 1 (S1) of their supplier company A.
- After certification of the project, Company B receives ER-credits („inset credits“), which are retired in the registry of the Carbon Standard. At the same time, Company B accounts for the ER to their carbon footprint using an inventory accounting approach.



### Take aways:

- The set-up of an insetting projects is highly dependent on how the company (Company B in the example above) wishes to account for the emission reductions generated: if the intention is to account the emission reduction towards a Science-Based Target, crediting is in fact not recommended
- Assuming an insetting project is set-up as in the example above, the same challenges apply as those discussed in the section on “Opportunities on the Voluntary Carbon Market (VCM)”, namely current lack of methodologies for green hydrogen production
- Seeking to monetize the low-carbon benefits of green ammonia via insetting would apply having to follow strict guidelines in order to allocate the emission reductions to different off-takers





# *Results of Indicative Economic Assessment & Recommendations*

# *Indicative economic assessment of monetization options via VCM*

- Monetization options via carbon markets appear to be the primary foreseeable mid-term pathway for Solar NH<sub>3</sub>-Pool
- Indicative economic assessment was performed for two scenarios assuming the emission reductions can be credited under a VCM methodology:
  - **Scenario A:** What production cost premium of green ammonia can be covered if emission reductions are monetized at average VCM carbon price forecast for 2030?
  - **Scenario B:** What VCM carbon price would be needed to cover differential in production costs for grey and green ammonia?

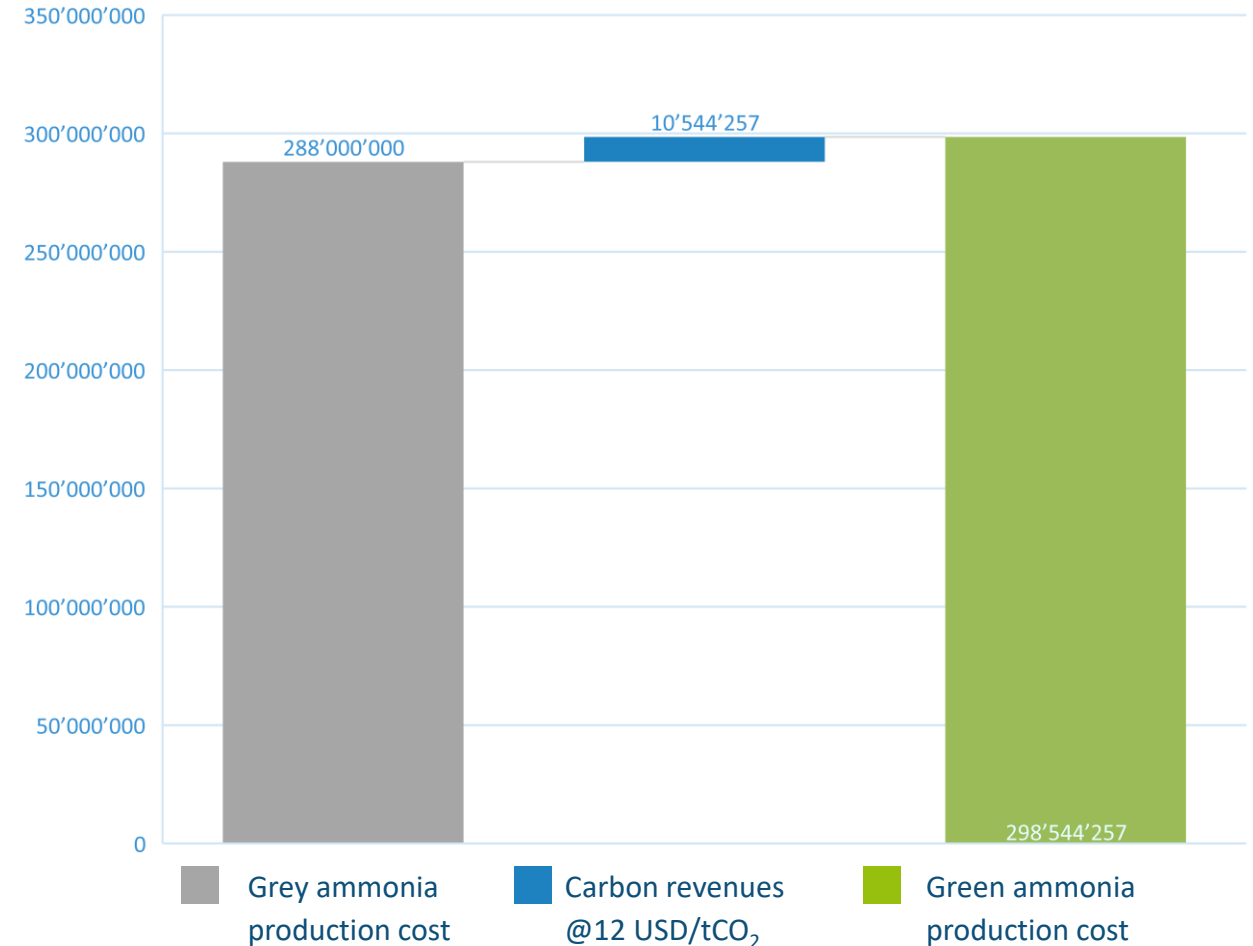
# Carbon Credits on the VCM: Scenario A

- The production of **480'000 tonnes of green ammonia** per year translates to emission reductions of approx. **879'000 tonnes of CO<sub>2</sub>e** per year (according to emission reduction estimations from WP1 & WP2 and green ammonia footprint of 0.44 tCO<sub>2</sub>e/tNH<sub>3</sub>, i.e. 81% reduction compared to grey ammonia)
- At a price of 12 USD/tCO<sub>2</sub> (projected 2030 average VCM carbon price\*), this would generate a **carbon revenue of 10.5 million USD** per year.
- Based on production costs of grey ammonia of 600 USD/tNH<sub>3</sub>\*, the aforementioned revenue would cover the production cost premium of green ammonia if premium would not exceed 22 USD/tNH<sub>3</sub> (i.e. **production cost of green ammonia of 622 USD/tNH<sub>3</sub>**).

## Notes:

- Only production costs are factored in (transport costs of green ammonia to Europe are not include in this indicative assessment)
- For sources marked with \*, please refer to attached Excel file

Scenario A: carbon credit price is known



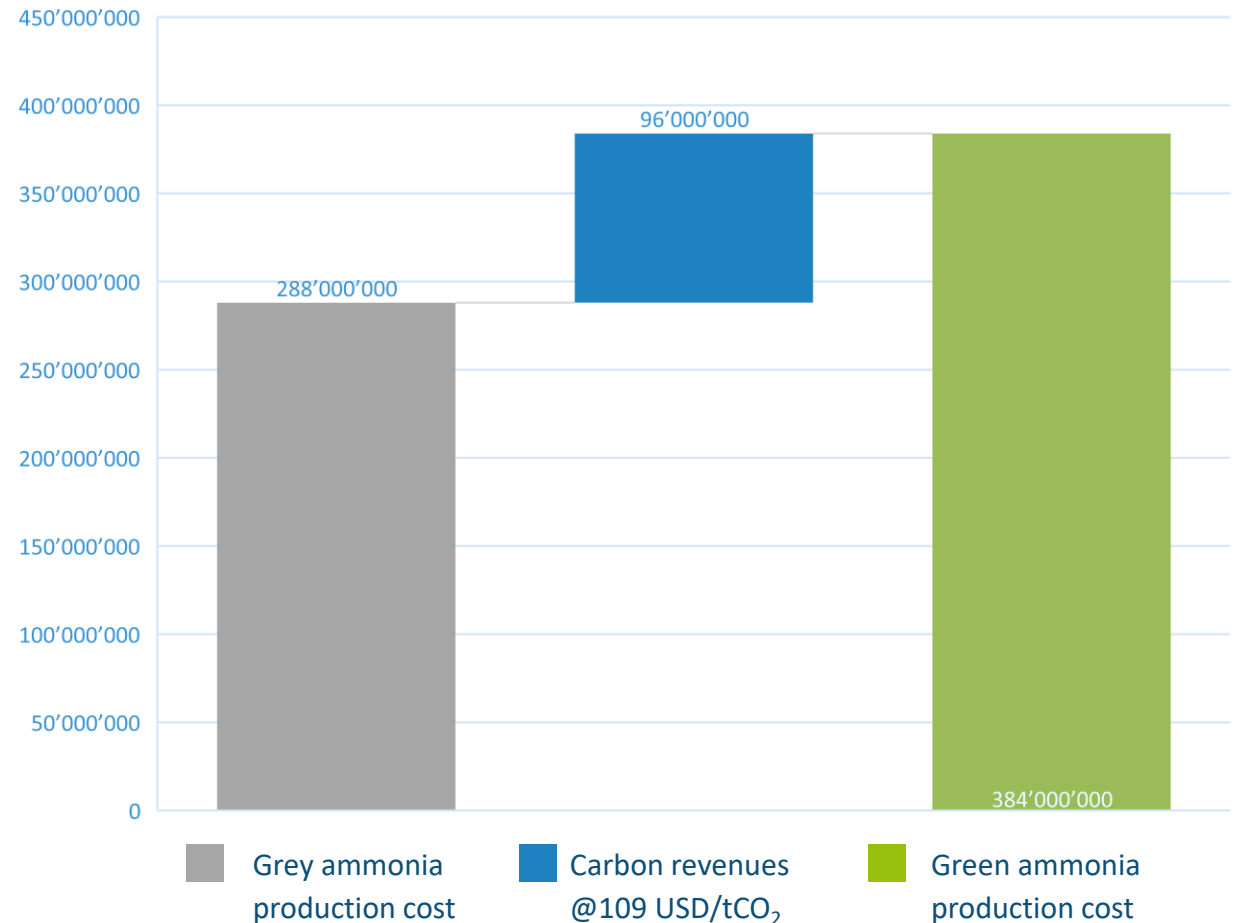
## Carbon Credits on the VCM: Scenario B

- Assuming **production costs of green ammonia in Chile are 800 USD/tNH<sub>3</sub>\***, the production of 480'000 tonnes of green ammonia costs **approx. USD 384 million per year**.
- Assuming that this volume results in **emission reductions of approx. 879'000 tonnes of CO<sub>2</sub>e per year**, a carbon credit price of approx. **USD 109 per tonne of CO<sub>2</sub>e** would be required to cover the cost difference between the production of grey ammonia and the production of green ammonia.

### Notes:

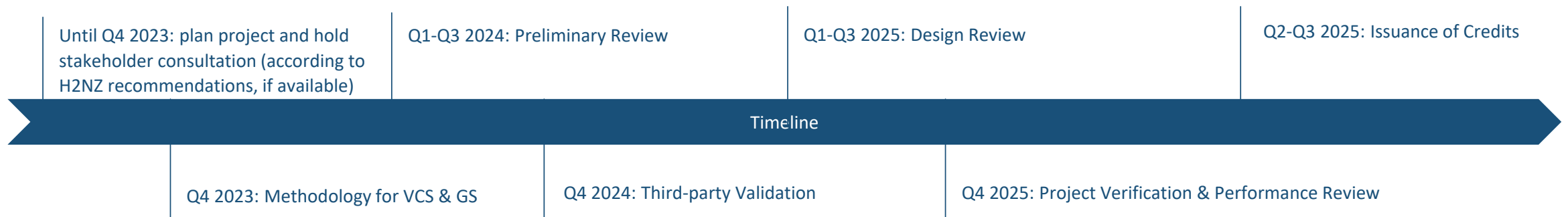
- Only production costs are factored in (transport costs of green ammonia to Europe are not include in this indicative assessment)
- For sources marked with \*, please refer to attached Excel file

Scenario B: production cost of green ammonia is known



# Indicative timeline for carbon credit generation

- As soon as a methodology is available at Gold Standard (as an example), the project proponent (Solar NH<sub>3</sub>-Pool Chile) has to follow certain steps for the registration of the project under this methodology:
  - Plan project and hold stakeholder consultation
  - Preliminary review by SustainCERT
  - Preliminary design approval
  - Third-party validation
  - Project design review by SustainCERT
  - Performance review by Design certification
  - Project monitoring
  - Third-party verification
  - SustainCERT
  - Performance certification



# Conclusions & Recommendations

- **Conclusions on monetization options:**
  - The landscape of direct monetization options for emission reductions along the green ammonia value chain is evolving quickly, but at the moment options satisfying the framework of the Solar NH<sub>3</sub>-Pool Chile project are limited
  - The **H2NZ initiative** is the most advanced initiative for the monetization of the carbon benefits of green hydrogen on the voluntary carbon market. Methodologies are still under development. Solar NH<sub>3</sub>-Pool Chile could become an early-mover by applying the H2NZ methodology as soon as it is available (projected in Q4 of 2023).
  - **CertifHy** is the main framework for the monetization of green hydrogen via energy attribute certificates, currently operating in Europe and seeking to expand internationally. This mechanism, however, certifies hydrogen, not ammonia and is therefore not a suitable option for Solar NH<sub>3</sub>-Pool Chile as currently designed
  - **Ammonia Energy Association** is the main initiative for green ammonia certification. Efforts of the association to develop tracking system for green ammonia could potentially provide basis for a monetization opportunity in the future.
  - CBAM mechanism will potentially level the playing field for low-carbon products imported into the EU (e.g. green ammonia) in comparison to carbon-intensive one produced under the EU ETS
  - Importantly, no double counting between monetization options should occur (i.e. issuing of both carbon credits and energy attribute certificates is not allowed)
- **Key recommendation for Solar NH<sub>3</sub>-Pool Chile :**
  - **Engage with H2NZ** with the aim of potentially becoming an early-mover and pilot for application of the methodologies under development, as the availability of such methodologies is critical for monetization via VCM (and also Article 6 or insetting, although potentially less attractive options)
  - **Engage with Ammonia Energy Association** with a similar aim of signaling interest in piloting a green ammonia certification scheme
  - Due to unclear direct monetization pathways available at the moment, **indirect monetization options could be considered** (e.g. certification of the green ammonia under a “low-carbon” label to be able to sell at a premium in Europe)



# *Appendix*



# *Regulations relevant for green hydrogen production*

# ***EU Hydrogen Strategy***

The hydrogen strategy for a climate-neutral Europe was adopted in July 2020. By the first quarter 2022, all of its 20 action points were implemented and delivered.

Support measures include, but are not limited to:

- Proposal for the Renewable Energy Directive includes sub-targets for renewable hydrogen in industry and transport.
- Proposal for the Renewable Energy Directive & proposed directive on the internal market in hydrogen include certification schemes for renewable and low-carbon hydrogen.
- Proposed revision of the EU ETS includes the option to introduce carbon contracts for difference.

## *EU Renewable Energy Directive*

- The renewable energy directive is the legal framework for the development of renewable energy across all sectors of the EU economy, supporting clean energy cooperation across EU countries.
- On 30 March 2023, a provisional agreement was reached, for a binding target for 2030 of at least 42.5%, but aiming for 45%. Once this process is completed, the new legislation will be formally adopted and enter into force.
- As a key energy-consuming sector, industry is included for the first time in the Renewable Energy Directive. The agreement establishes indicative targets (1.6% of annual increase in renewable energy use) as well as a binding target to reach 42% of renewable hydrogen in total hydrogen consumption in industry by 2030. The agreement also reinforces the regulatory framework for renewable energy use in transport (14.5% greenhouse gas intensity reduction or 29% share of renewable energy in final energy consumption), including a combined sub-target of 5.5% for advanced biofuels and renewable fuels of non-biological origin, including a minimum level of 1% for renewable fuels of non-biological origin. These targets support the EU's ambitions on renewable hydrogen roll-out.

Source: Accelerate the rollout of renewable energy (europa.eu)

# EU Renewable Energy Directive: RFNBOs

- With the adoption of two Delegated Acts, the EU Commission proposed detailed rules to define what constitutes renewable hydrogen in the EU:
  - First DA defines under which conditions hydrogen, hydrogen-based fuels or other energy carriers can be considered as an RFNBO (Renewable Fuel of Non-Biological Origin).
    - *Additionality: Electrolysers to produce hydrogen will have to be connected to new renewable electricity production.*
    - *The requirements for the production of renewable hydrogen will apply to both domestic producers as well as producers from third countries that want to export renewable hydrogen to the EU to count towards the EU renewables targets. **A certification scheme relying on voluntary schemes will ensure that producers, whether in the EU or in third countries, can demonstrate in a simple and easy way their compliance with the EU framework and trade renewable hydrogen within the Single Market.***
  - Second DA provides a methodology for calculating life-cycle greenhouse gas emissions for RFNBOs. The methodology takes into account greenhouse gas emissions across the full lifecycle of the fuels, including upstream emissions, emissions associated with taking electricity from the grid, from processing, and those associated with transporting these fuels to the end-consumer. The methodology also clarifies how to calculate the greenhouse gas emissions of renewable hydrogen or its derivatives in case it is co-produced in a facility that produces fossil-based fuels.
- To date, only RFNBO used as transport fuels can be counted towards the EU's renewable energy targets. However, the Commission proposed in its July 2021 amendment to the Renewable Energy Directive that RFNBOs should be counted towards Europe's renewable energy targets regardless of the end-use sector in which they are consumed.
- Status: submitted to the European Parliament and the Council for approval (March 2023). They both have 2 months to accept or object the Commission's proposal. Their scrutiny period can be extended, at their request, by two further months. They do not have the possibility to amend the Commission's proposals.

# ***CMS 70 GreenHydrogen certification (TÜV SÜD)***

- Defines requirements for the production (generation) and marketing of hydrogen using renewable energies
  - Can be applied worldwide
  - Certified hydrogen may be used for mobility applications, for material use (e.g. steel production, hydrogenation of oils, production of artificial fertilisers) or as a storage medium for energy use.
  - The system boundary for fulfilling the basic requirements is the production plant, including ancillary units such as water treatment, on-site energy supply, hydrogen purification, up to the filling/weighing point or injection into a gas network or transfer point at the pipeline.
- In addition to providing its own certification, TÜV SÜD is also a third-party auditor for CertifHy and ISCC.

Source: [TÜV SÜD Standard CMS 70 Grund- und Zusatzanforderungen 2021.11 final \(tuvsud.com\)](https://tuvsud.com)



The background of the slide is a dark blue aerial photograph of a dense forest. A winding river or stream, appearing in shades of light blue and green, meanders through the center of the forest canopy. The trees are tightly packed, creating a textured green surface.

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# ***First Climate***

***GREEN BY  
CHOICE***

**First Climate Markets AG**

Industriestr. 10

61118 Bad Vilbel / Germany

**First Climate (Switzerland) AG**

Brandschenkestrasse 51

8002 Zurich / Switzerland

