Mobilizing consumer demand for green hydrogen-based products

Potential role of demand-side policies to stimulate decarbonisation of European heavy industry

February 2025

INVEST-NL

ENERGIE NEDERLAND

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Introduction

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The European Union has committed to decarbonizing heavy industry as part of its goal to become a global leader in the energy transition. **At Deloitte, we see the shift to low-carbon hydrogen, and specifically to green hydrogen as a great opportunity to drive this transformation, boosting Europe's competitiveness on the global stage.**

However, recent years have seen a troubling decline in green hydrogen projects, with many delayed or cancelled due to high costs, weak demand, and competition from imports. Meanwhile, European companies are grappling with competition from regions with lower energy prices and environmental standards.

To decarbonize European heavy industry, urgent intervention is needed. The Draghi report and the EU Competitiveness Compass highlight the need for coordinated policies and targeted investments to restore EU competitiveness and ensure its future prosperity in a lower carbon environment. This study explores how policies aimed at mobilizing consumer demand could be a step in that direction.

We would like to thank all stakeholders involved for sharing their knowledge and opinions in interviews and workshops.

Tarek Helmi

Global Low-Carbon Solutions Lead, Deloitte Netherlands

INVEST.NL

Invest-NL is committed to collaborate with industry, policymakers and investors to shape the financial preconditions for industrial decarbonization in Europe, including production and use of green hydrogen.

This research highlights the potential of a green hydrogen-based product demand obligation to stimulate its market development. It leverages examples from current and potential industrial hydrogen users, such as the steel and fertilizer industries, to illustrate pathways for demand creation. By understanding their dynamics, Invest-NL aims to identify policy instruments which can accelerate investments in green hydrogen projects.

Ultimately, this demand-side approach can be extended to the decarbonization of the broader industry, and beyond hydrogen to encompass other decarbonization technologies. Hence, we trust this report forms a starting point for the broader dialogue on demand creation to drive investments and foster the decarbonization of Europe's industry.

Jeroen van der Wal

Sr. Business Development Manager Hydrogen, Invest-NL

Stephan Falcão Ferreira

Business Developer Energy Transition, Invest-NL

ENERGIE NEDERLAND

Energie-Nederland understands that **industry faces a lack in demand for sustainable products**, resulting in delays in final investment decisions on new installations providing such products. As there is an uneven playing field between European industry and non-EU industry at present we initiated this study into a demand-side approach.

The outcome of this study offers perspectives for energy producers, industry and consumers wanting to become more sustainable.

Energie-Nederland is the association for all parties that produce, generate, supply and trade electricity, gas, hydrogen and heat in the Netherlands. We represent virtually the entire energy market in the Netherlands. Our 80 members – including many newcomers – are active in renewable energy and non-renewable energy. Members are active in the development and exploitation of (new) wind farms and electrolysers. **Demand creation is a prerequisite for making further progress in scaling up these innovative installations.**

IJmert Muilwijk

Program Manager Natural Gas and Hydrogen, Energie-Nederland

Report objectives

Explore the role of demand-side obligations in stimulating decarbonization of heavy industry

Report objective is underpinned by the following questions:

- **What are the key barriers to decarbonization** of the heavy industry, especially through use of green hydrogen in the steel and fertilizers sectors?
- **How could a demand-side obligation** aimed at the users of steel and fertilizer-based products **help address the barriers?**
- **What could be the impact on the price of** (selected) **end-products** if such an obligation were to be introduced?
- **What would be required** to make such an obligation work, especially in terms of certification?

Provide a starting point in a broader dialogue about strengthening European industry

This report explores **a specific potential policy instrument** – a demand-side obligation aimed at steel and fertilizer sectors. Such a potential obligation would necessarily form **part of a broader regulatory landscape and** will need to be considered in the context of other instruments. This consideration falls outside the scope of this report.

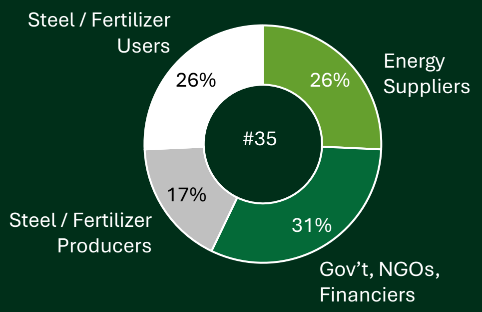
This report **does not include specific policy design recommendations**. Rather, it reflects the views of **stakeholders** from across the energy system, as well as results of **quantitative and qualitative analysis.**

While providing insights and answers, the report will likely raise more questions. The authors' ambition is that it is a **starting point for a broader dialogue** on strategies and policies required to **strengthen European industry during the decarbonization journey.**

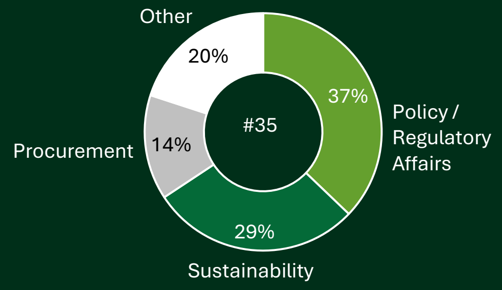
This report is the outcome of a six-week part of a broader study on the role and design of demand-side obligations.
Subsequent phases may provide further depth and breadth of analysis.

01. Stakeholders involved in the research

Types of organisations



Stakeholder roles



Stakeholders were involved in the study as an expert panel and through in-depth interviews. All engagements with stakeholders were conducted in a manner that respects competition law boundaries.

Executive summary

Energy transition in the heavy industry remains challenging. Direct electrification is often not an option due to the need for very high temperatures and the use of molecules as feedstock. As a result, **in comparison with other parts of the energy system, the Dutch heavy industry has seen limited reduction in CO_2 emissions** over the last two decades**.** What's more, much of the emission reduction that was realized has been a result of lower production volumes rather than actual decarbonization measures.

Although green hydrogen offers a technically-feasible solution, its adoption is hindered by several economic and policy barriers. EU's Renewable Energy Directive (RED III) mandates use of green hydrogen for current grey hydrogen users. However, industry stakeholders indicate that with the current policy formulation, **green hydrogen use and even further existence of heavy industry in the Netherlands and the EU more broadly are at risk. Main barriers are high cost of green hydrogen-based products, lack of demand for those products, and policies which make import more attractive than local production.** These barriers have led to a declining pipeline of green hydrogen projects in Europe, with many delays and cancellations.

A potential solution to this issue is the implementation of a **demand-side obligation that would require use of green hydrogen in end-products** made with steel and fertilizers. Requiring a certain percentage of products to be made using green hydrogen could provide the **demand certainty for steel and fertilizer producers, and in turn stimulate emergence of a market for green hydrogen**, enabling investments in the necessary infrastructure and reducing costs over time. This could be complemented by other policy measures, such as subsidies and improved border adjustment mechanisms (for example importers paying for the difference between grey and green H_2-based steel and fertilizers), to ensure a level playing field between EU and non-EU producers.

Effective design of a demand obligation requires careful consideration of **geographical scope, obligated parties, which end-markets to target, as well as how to certify and track green hydrogen-based products through the value chain.** Research suggests an **EU-wide obligation would be more effective than one at a national level**, as most steel and fertilizers produced in the Netherlands are exported to other EU countries, and most steel used is imported. An EU-level obligation would encourage decarbonization across the region, benefiting also the Netherlands by creating consistent demand for green hydrogen-based steel and fertilizers while minimizing competitive disadvantages and reducing reliance on imports. Most stakeholders also agree that the obligation should be placed **as close to the consumers as possible** to maximize its impact, focusing on the markets with high **concentration** and **captive** nature of operations. A tailored approach is needed for each end-market.

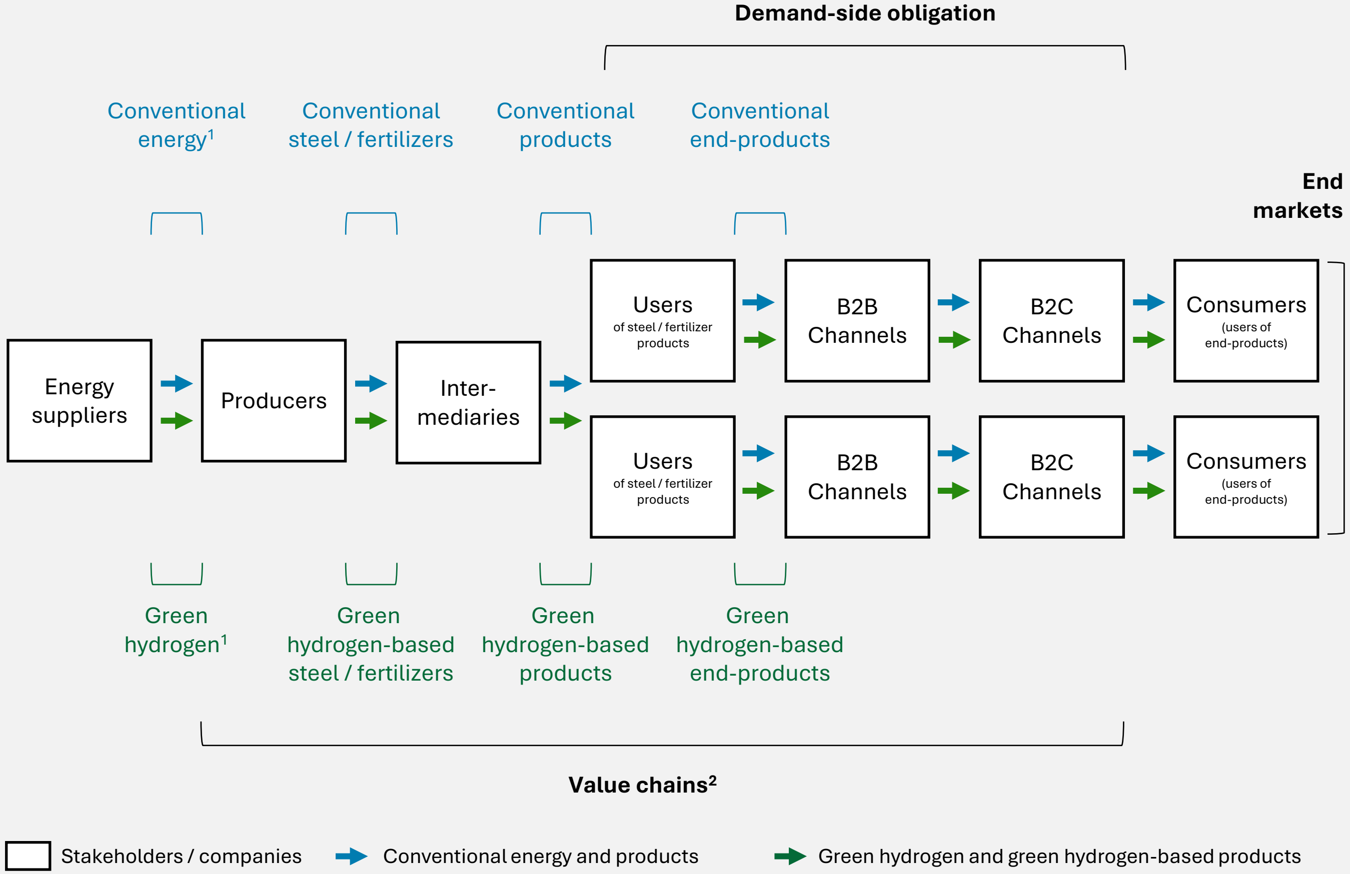
Preliminary analysis shows that the **increase in cost of many end-products resulting from a well-placed obligation would be limited** – often less than 1% even if all conventional steel or fertilizers were replaced with green hydrogen-based alternatives. Conversely, **emissions reduction could be disproportionally high**, because for many products steel and fertilizers are the main sources of production emissions. A gradual implementation of the obligation could foster a **positive cycle of rising demand and falling costs.**

Administering the obligation would require **standardized certification** that is simple and does not create excessive additional effort. Initial research identified two possible models of certification that could be used, a mass-balance method, where the green hydrogen certificate "travels" with the steel and fertilizer products through the value chain, and a book-and-claim method, where producers offer green hydrogen-based steel or fertilizer certificates on a trading platform, where obligated parties buy them to meet the obligation.

This report serves as a starting point for broader dialogue about the role a well-designed demand-side obligation could play in addressing the barriers to heavy industry decarbonization. It reflects stakeholder views and sector analysis, but **further work is needed to fully assess the scope and impact of such policies within the regulatory context of the Netherlands and the EU.**

Definitions

02. Definitions



Notes: 1) For this study, conventional energy also includes fossil carriers with CCS; Other inputs are also used in steel / fertilizer production, e.g., iron ore and nitrogen. These are not central for this project and are not called out explicitly; 2) Value chain depiction significantly simplified
Source: Deloitte synthesis of various value chain taxonomies and stakeholder input

The following terms are used in this report, simplified for brevity:

Energy suppliers are companies that supply conventional energy (e.g., coal, hydrogen) or green hydrogen to steel and fertilizer producers.

Steel Producers convert energy and iron ore into long and flat steel. **Fertilizer Producers** convert energy and nitrogen into fertilizers. In this document, **only nitrous-based fertilizers** (made with ammonia) are considered.

Intermediaries purchase raw steel and fertilizers, often process them, and sell them. They might operate sequentially (e.g., steel trader-packaging producer, farmer-trader).

Users buy processed products and combine them with other inputs to create end-products (e.g., construction company building a house, packaged food producers processing vegetables into cans). Some users may also function as intermediaries.

B2B Channels sell end-products in bulk to B2C Channels, often as part of the same company as Users (e.g., automotive OEM's production unit is a User, local sales company is a B2B Channel, car dealer is a B2C Channel).

B2C Channels sell end-products to consumers. They include retail companies and other entities (e.g., government commissioning infrastructure projects). Channels and consumers are grouped into **end-markets** (e.g., automotive, packaged food).

Demand-side obligation would be a legal requirement for companies "close to consumers" to use specific amounts of green hydrogen-based steel / fertilizer products.

Conventional energy includes coal, gas and other fossil carriers, used in production of conventional steel and fertilizers, which are then processed into conventional products and into end-products.

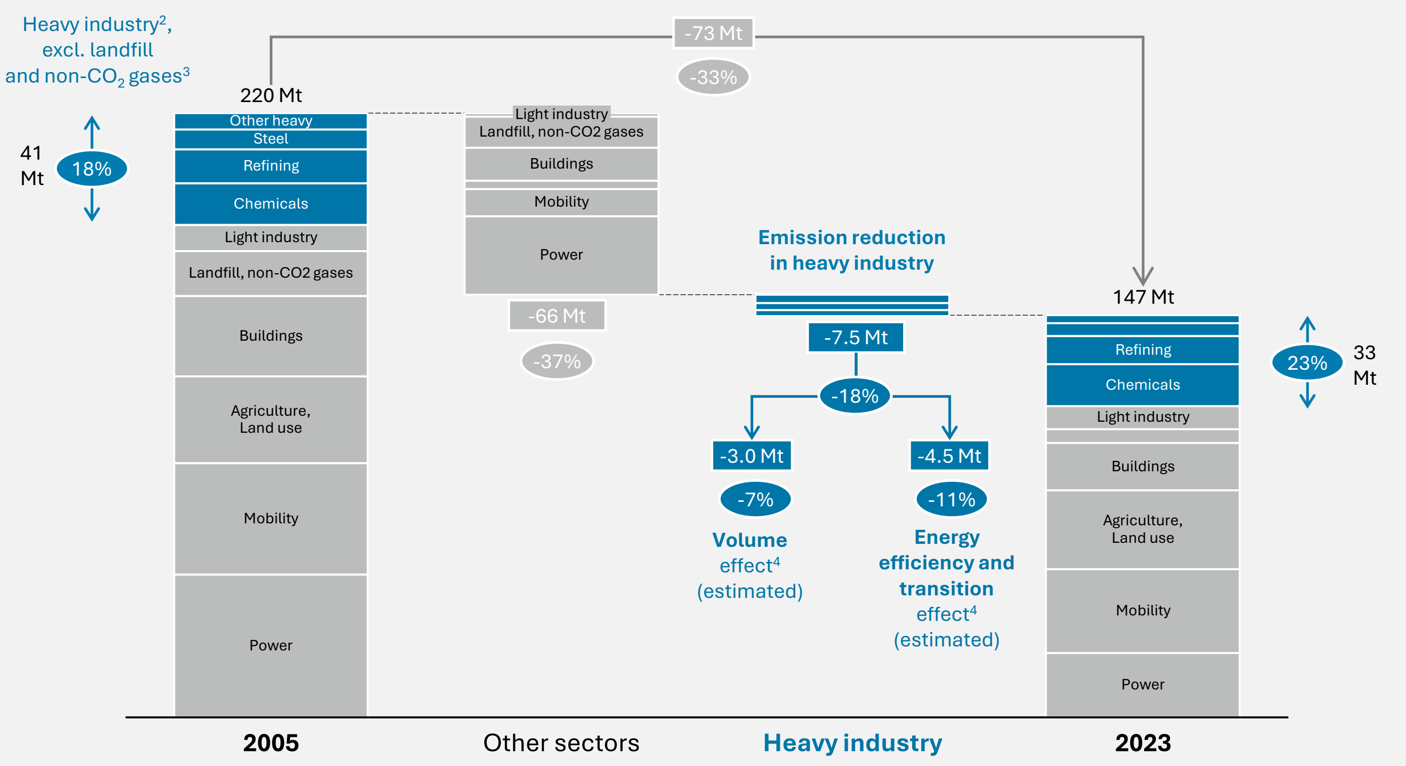
Green hydrogen in this report is hydrogen that is compliant with RED III's definition of renewable fuels of non-biological origin (RFNBO). Green hydrogen is used in production of green hydrogen-based steel and fertilizers, which later become green hydrogen-based products and end-products.

Contents

What are the key barriers to decarbonization?

In comparison with other parts of the energy system, the heavy industry in the Netherlands has seen limited reduction in CO_2 emissions

03. Netherlands GHG emissions to air[1] reduction (CO_2eq, 2005-2023)



Since 2005, total greenhouse gas (GHG) emissions in the Netherlands declined by 33% or 73 Mt CO_2eq. **Most of that decline** (66 Mt) **came from outside the heavy industry sector:** because of a shift to renewable power generation, energy efficiency and electrification in mobility and buildings, and stricter rules on landfill and non-CO_2 gases.

Reduction in the heavy industry in this period was ca. 18% (7.5Mt), meaning that its share of the total emissions increased from 18% in 2005 to 23% in 2023.

Part of the emission reduction in heavy industry can be explained through lower production volume. For example, production volume in oil and gas declined in the 2005 – 2023 period by 83%, in steel by 9%, in building materials (e.g., cement, glass, ceramics) by 7%, and in basic chemicals by 5%. Overall, we estimate that of the total 7.5 Mt emission reduction in heavy industry in this period, at least 3.0 Mt was due to the volume effect.

This means, that the **emission reduction resulting from energy efficiency and transition in heavy industry was no more than 4.5 Mt, or 11% over the 18-year-period**, although in some sectors (e.g., fertilizers) this reduction was likely higher.

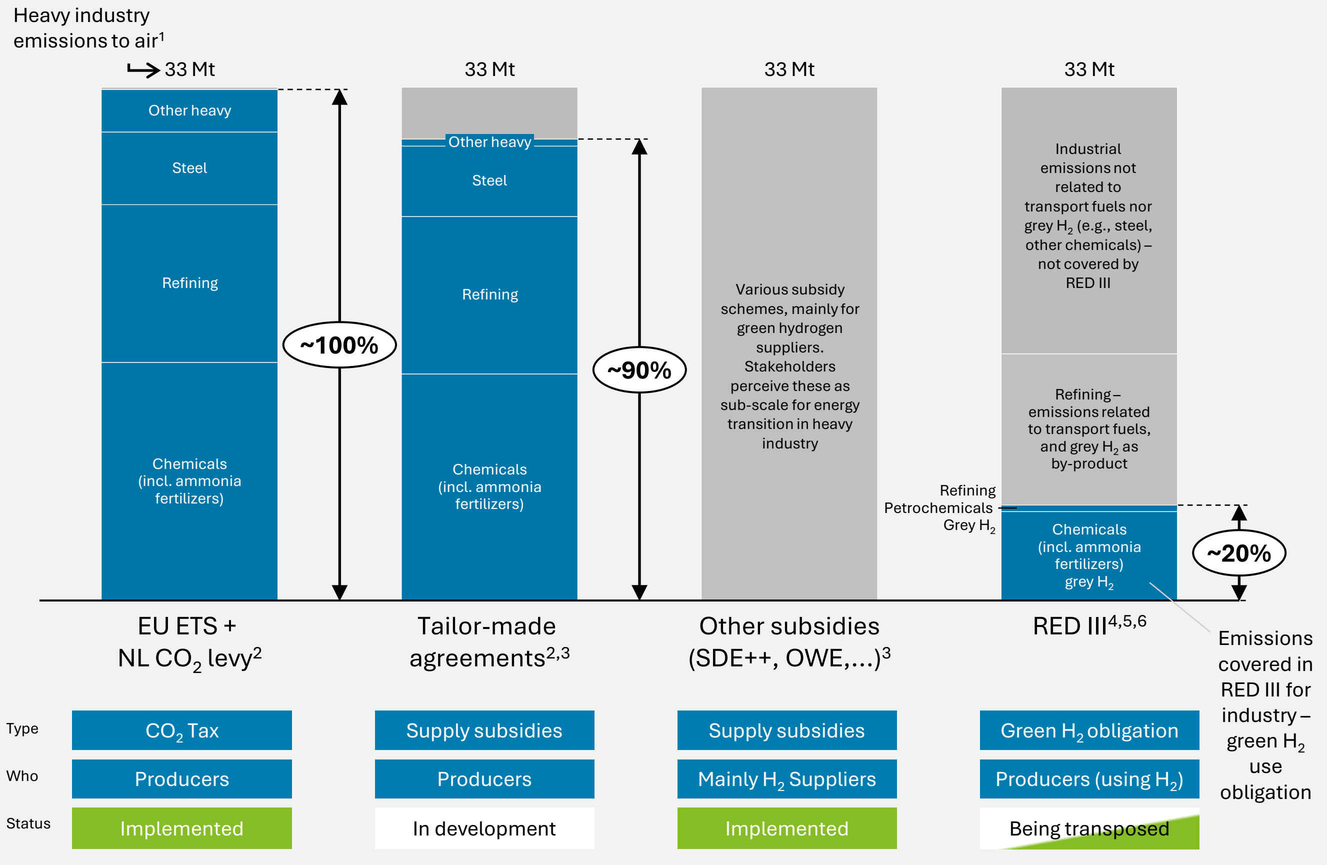
Energy transition in heavy industry is structurally more difficult than in other sectors. This difficulty results from the need to generate very high temperatures (which are difficult to achieve through electrification), as well as from the use of molecules in non-energy applications, such as feedstock and reduction agents.

Although green hydrogen offers one of the main technically-feasible solutions to decarbonization of heavy industry[5], its adoption is hindered by several barriers, most notably high cost of green hydrogen-based products, lack of demand for those products, and policies which make import more attractive than local production. These barriers are explored further in this report.

Notes: 1) Emissions according to the United Nation's Intergovernmental Panel on Climate Change (IPCC). In some sectors, IPCC numbers differ slightly from other methodologies, such as those used in the EU ETS. For example, in the Fertilizer sector, CO_2 which is captured and embedded in Urea is not counted as emitted by IPCC, while it is by ETS method. These differences do not change the overall findings; 2) Heavy industry, excl. landfill and other gases includes the following sectors: Chemicals = Basischemie, Refining = Aardolie-industrie, Steel = Basismetaalindustrie and Cokesfabrieken, Other heavy = Winning van aardolie en aardgas, Bouwmaterialenindustrie and Papierindustrie; 3) Landfill, other gases includes CH_4, N_2O and F-gases, mainly in Basischemie and Waterbedrijven en afvalbeheer; 4) Volume effect estimated as equal in percentage terms to the change in the manufacturing volume index ('Kalendergecorrigeerde productieindex') in the same period. Energy efficiency and transition effect calculated as total emission reduction minus the volume effect.; 5) Full replacement of ammonia production with green H_2, is not a solution for urea, which requires CO_2, that currently comes from conventional ammonia production
Source: CBS "Emissies van broeikasgassen berekend volgens IPCC-voorschriften"; CBS "Nijverheid; productie en omzet"; Deloitte analysis

Policy support for heavy industry decarbonisation is still being shaped, with a current focus on the supply-side: industrial producers and green hydrogen suppliers

04. Main policy instruments aimed at reducing GHG emissions in heavy industry in NL (CO_2eq, 2023)[1]



To reduce the cost difference between conventional and low-emission solutions, policy-makers use **taxes, subsidies and obligations, mostly on the supply-side**, targeting producers and (potential) hydrogen suppliers.

Emissions Trading Scheme (ETS) and NL CO_2 levy are CO_2 taxes, increasing the cost to **producers** of using conventional technologies, therefore reducing the relative cost of switching to technologies that are less carbon-intensive. Almost all heavy industry producers in the Netherlands fall under a CO_2 taxation scheme.

The Dutch Climate Agreement sets out high-level principles and measures to achieve decarbonization targets. One of the measures are **'tailor-made agreements'** between the Government and the largest industrial emitters. These agreements would involve **subsidies** for producers, conditional on specific timelines and investments. However, as of late 2024, **only one binding agreement has been signed**, focused on electrification (a solution less applicable to steel and fertilizers)**.**

Other subsidy schemes, such as SDE++, OWE and EU Hydrogen Bank are also available. However, stakeholders indicate that these subsidies are **significantly lower than what is required to decarbonise heavy industry**. For example, the 2024 OWE subsidy was € 0.25B for projects with a total capacity of 0.1 GW. In comparison, estimated capital cost alone (excluding all operational costs) to achieve the Dutch electrolysis target of 4GW capacity by 2030, is € 12B, or ca. 50 times the OWE subsidy[7].

Stakeholders assess that a policy with the **greatest impact on heavy industry is EU's Renewable Energy Directive (III),** which stipulates that renewable fuels of non-biological origin (RFNBO) – primarily green hydrogen – should be used to reduce emissions. RED III requires member states to ensure that **42% of hydrogen used in industry in 2030 should be green**. RED III is now being transposed into law by member states. **The Netherlands intends to cascade part of the member state obligation to individual companies.**

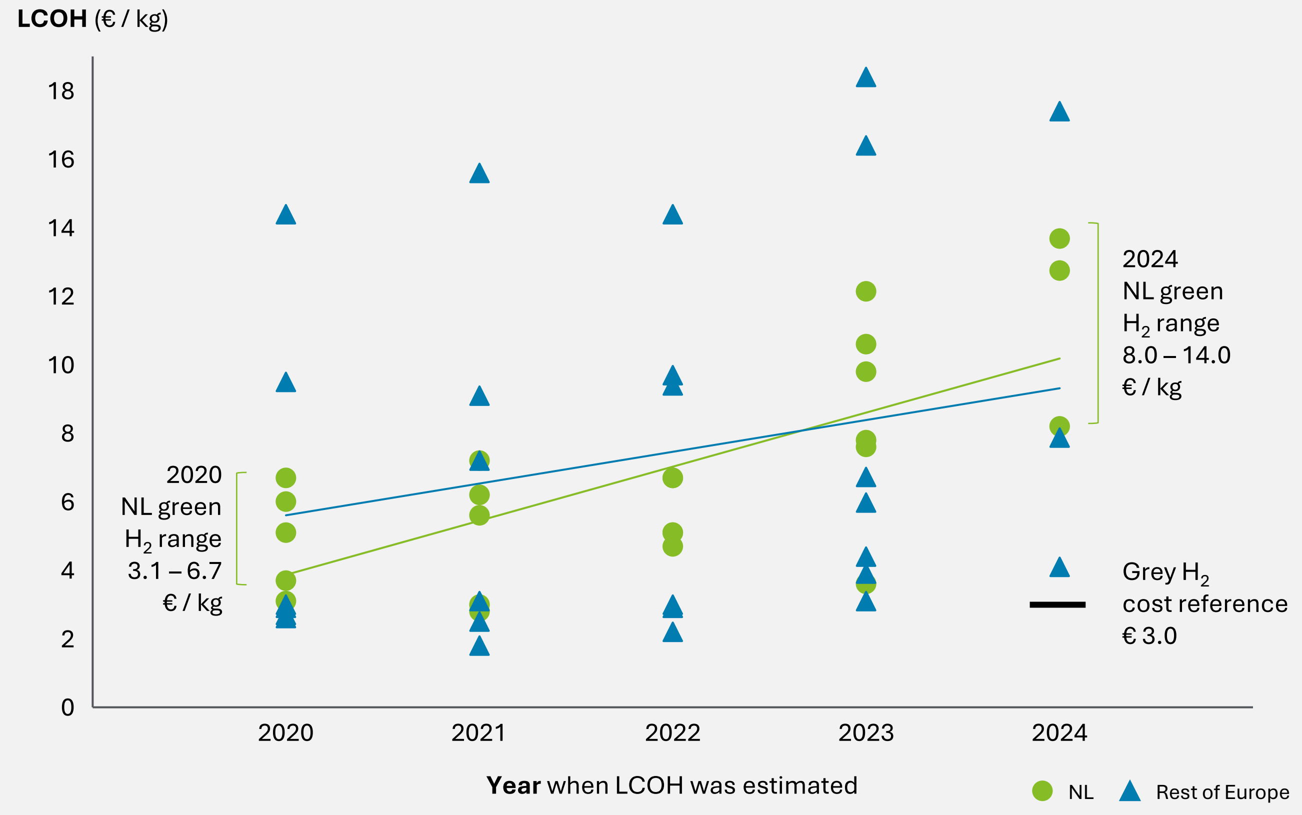
However, stakeholders indicate serious concerns **whether RED III alone will achieve the intended objectives, while maintaining industry competitiveness** (see next pages).

Notes: 1) Emissions under IPCC method. See note earlier in the report; 2) ETS, NL CO_2 levy and Tailor-Made Agreements also cover companies outside heavy industry, mainly in power (not shown); 3) Tailor-made agreements and "Other subsidies" are not fully exclusive, as within the tailor-made approach use of other subsidies is considered; 4) Split of H_2 volumes between applications (transport vs. industry) and between production routes (SMR vs. by-product) based on previous research and aligned with CE Delft-TNO. Share of emissions covered by RED III for industry based on 9 tonne CO_2 per 1 tonne of grey H_2. Volumes shown later in the report; 5) Apart from the obligation, RED III also includes subsidies for production and import, and is planned to include subsidies for demand; 6) Through so called 'Ammonia Recital' RED III allows exclusion of some ammonia plants from the targets; 7) TNO estimate of € 3,050 / kW scaled up to 4 GW

Source: Nederlandse Emissieautoriteit "Rapportages en cijfers EU ETS"; CBS; CE Delft-TNO "Afnameverplichting groene Waterstof"; European Commission; Rijksoverheid "Voortgang maatwerkafspraken verduurzaming industrie"; TNO; Deloitte analysis

However, adoption of green hydrogen in heavy industry is limited by high cost

05. Estimated levelized cost of green hydrogen (LCOH) in NL and Rest of Europe in various sources[1]



Over the last five years, the **estimated levelized cost of green hydrogen production (LCOH) in the Netherlands has increased by more than 100%.** Most estimates for The Netherlands made in 2020 suggested LCOH between € 3.1 / kg and € 6.7 / kg, while latest estimates put this figure in the € 8.0 / kg to 14.0 / kg range.

The main reasons for an upward trend in LCOH are:

- increases in **equipment and services cost across the renewable electricity and electrolysis value chains.** While cost inflation impacted all parts of the economy, it has been especially high in offshore wind, which is expected to be the main source of renewables for hydrogen production in the Netherlands;
- **increases in electricity grid tariffs**, resulting from investments aimed at expanding grid capacity.

Stakeholders also point out that the strict rules on what constitutes green hydrogen, as articulated in the EU delegated acts (e.g., rules on additionality and temporal correlation) limit hydrogen producers' ability to reduce LCOH, for example by trading with the grid.

Resulting **LCOH levels are considered by most stakeholders to be prohibitive to green hydrogen adoption in heavy industry**, as they are several times higher than the cost of grey hydrogen (ca. € 3.0 / kg) and translate into steel and fertilizer cost which would be several times higher than the cost of conventional alternatives (see next page).

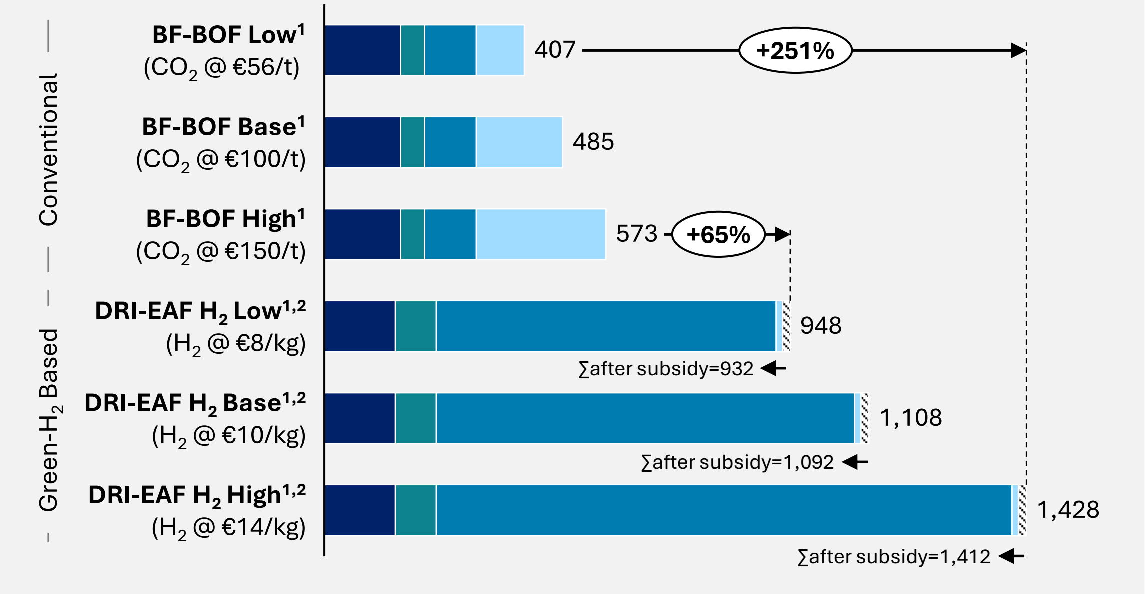
> Our business case was already challenging when we were getting the quotes around € 3 per kg of hydrogen. **At around € 10, there is no business case**
>
> Heavy industry producer

> As projects reach more advanced stages, and **more detailed designs are made, cost estimates become more robust.** Unfortunately**, more robust almost always means higher**
>
> Potential hydrogen supplier

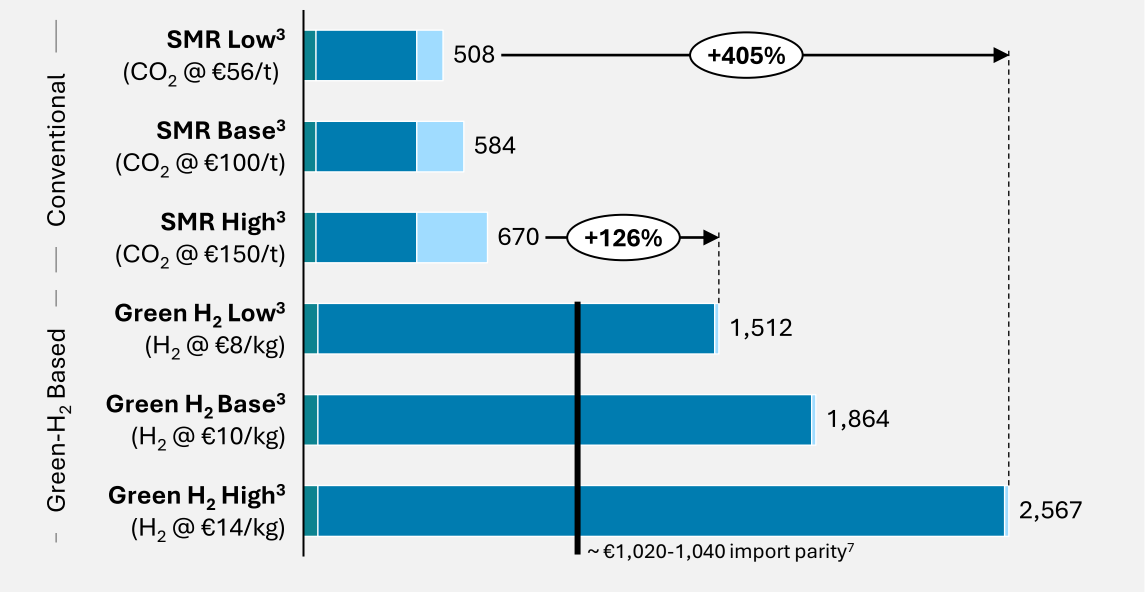
Notes: 1) Outlier of € 21.2 / kg in 2023 excluded from the chart
Source: Hydrogen Europe; TNO; Deloitte EU Hydrogen Observatory; Wood Mackenzie; Umlaut & Agora Industry; Berenschot & TNO; Expert interviews; Deloitte analysis

Resulting cost of green hydrogen-based products made in NL would be several times higher than of conventional alternatives and imports, even considering CO_2 cost and subsidies

06. Green hydrogen-based vs. conventional steel cost (€/t of steel)



07. Green hydrogen-based vs. conventional fertilizer cost (€/t of ammonia equivalent)



Green hydrogen is more expensive than the current energy sources used in steel (coal) and fertilizer (gas) production. As a result, the **cost of green hydrogen-based steel is projected to be over 60% higher than conventional alternatives, and potentially as much as 250%. For ammonia-based fertilizers, the cost difference could range from ca. 125% to over 400%**, driven by hydrogen's central role in ammonia production. Use of green hydrogen in steel and fertilizers also requires capital investments at the production plants, though the hydrogen cost itself remains the dominant factor.

Stakeholders indicate that these cost levels exceed the cost of products made using other lower-carbon solutions (e.g., CCS/DRI-natural gas – not explored in this report) and of importing the green hydrogen-based products from outside Europe, which is particularly relevant for ammonia, where global trade routes are well established.

Stakeholders point out that **absorbing this value gap by the producers or through subsidy alone is highly unlikely as the total additional cost for steel and ammonia production in the Netherlands could be €4.4 B to €11.3 B annually,** incl. €2.3–6.2 B annually for 6.1 Mt of steel and €2.1–5.1 B annually for 2.5 Mt of ammonia. This is an equivalent of 18–45 times the full OWE subsidy for 2024.

Raw material | CAPEX / OPEX | Energy[4] | ETS (CO_2)[5] | Subsidy[6]

Notes: 1) BF-BOF CAPEX €537/t steel capacity, DRI-EAF H_2 CAPEX €800/t steel capacity, 20 years depreciation, OPEX 4.1% of CAPEX for BF-BOF and 4.8% for DRI-EAF H_2, emissions 1.76t CO_2e/t steel BF-BOF and 0.13t/t steel DRI-EAF H_2; 2) Lower raw material volume for DRI-EAF H_2 due to process characteristics, as per TSN plans; 3) SMR CAPEX € 750 / t NH_3 capacity, Green H_2 CAPEX € 878 / t NH_3 capacity, 25 years depreciation, OPEX 2.0% of CAPEX SMR, 1.9% Green-H_2, emissions 1.72t CO_2e / t NH_3 for SMR and 0.15t CO_2e/t for green H_2 (emission as a result of balance of plant requirements), N_2 cost not included for SMR (generated as by-product), included for Green-H_2 but not visible; 4) Gas € 38 / MWh (avg. NL TTF '23-'24), Coal € 117 / t (avg. Rotterdam futures '23-'24); 5) Low ETS is lowest value '23-'24, high is IEA Stated policy 2040 value and midpoint is middle; 6) Assuming €2.0B subsidy for steel spread over 20 years of production and 6.1Mt/p.a.; 7) Import H_2 at € 5/kg and 6-8% transport cost. Source: Capital IQ; CBS; Ember; XE; IEA; Deloitte analysis

Stakeholders see minimal demand for products at this cost, which given the competition from imports makes it impossible to commit to green hydrogen and threatens industry existence

08. Stakeholder perspectives on barriers to industrial decarbonisation – illustrative and summarised examples

Given cost, **demand for green hydrogen-based products is minimal…**	… stakeholders indicate that the current policy results in an **uneven playing field…**	…makes it **impossible to commit** to green hydrogen…	…and **threatens** further existence of **industry** in Europe
Demand is only getting lower, and the projects are being shelved – hockey stick effect is not happening Energy supplier	RED III leaves a **back door for import of grey ammonia and fertilizers** so how come European producers are expected to use green hydrogen? Industrial producer	Waiting for policy choices makes it **difficult for producers and customers to find each other**. Business cases cannot be approved without a customer Financier	If RED III is implemented in the current shape, **there won't be a European heavy industry** as we know it today Industrial producer
If our customers pay the price of green hydrogen today, they will go out of business, because they **cannot pass on the cost to end-consumers** Energy supplier	Under CBAM as it stands, **if someone gets taxed for importing grey steel, they will just switch to importing grey end-products** Industrial producer	We do not need more alliances and targets - **we need to remove uncertainty and make the projects bankable** Financier	Main concern is the existence of steel industry in Europe. **No one will be using green hydrogen in Europe if no one produces industrial products here** Steel/fertilizer customer
Demand for some other products, like advanced biofuels, **is somehow mandated** in Europe, so **why can't we do it for steel and fertilizer** Industrial producer	Why do we **allow imports from countries with energy based on coal** while local companies are struggling to stay in business Steel/fertilizer customer	Some companies have no choice but to **delay the transition** – if they want to survive Steel/fertilizer customer	It is important to generate value in Europe – **EVs and batteries are examples where this did not work** Financier

In all likely scenarios, steel and fertilizers made with green hydrogen will be several times more expensive than conventional alternatives and imports.

Virtually all **stakeholders agree that voluntary demand for green hydrogen-based products at these prices is minimal and will remain so without intervention.**

The threat of imports is significant, as many consider the current RED III framework—where **EU producers face a green hydrogen obligation, but importers do not—**as creating an **uneven playing field**, particularly before technology matures and economies of scale are achieved.

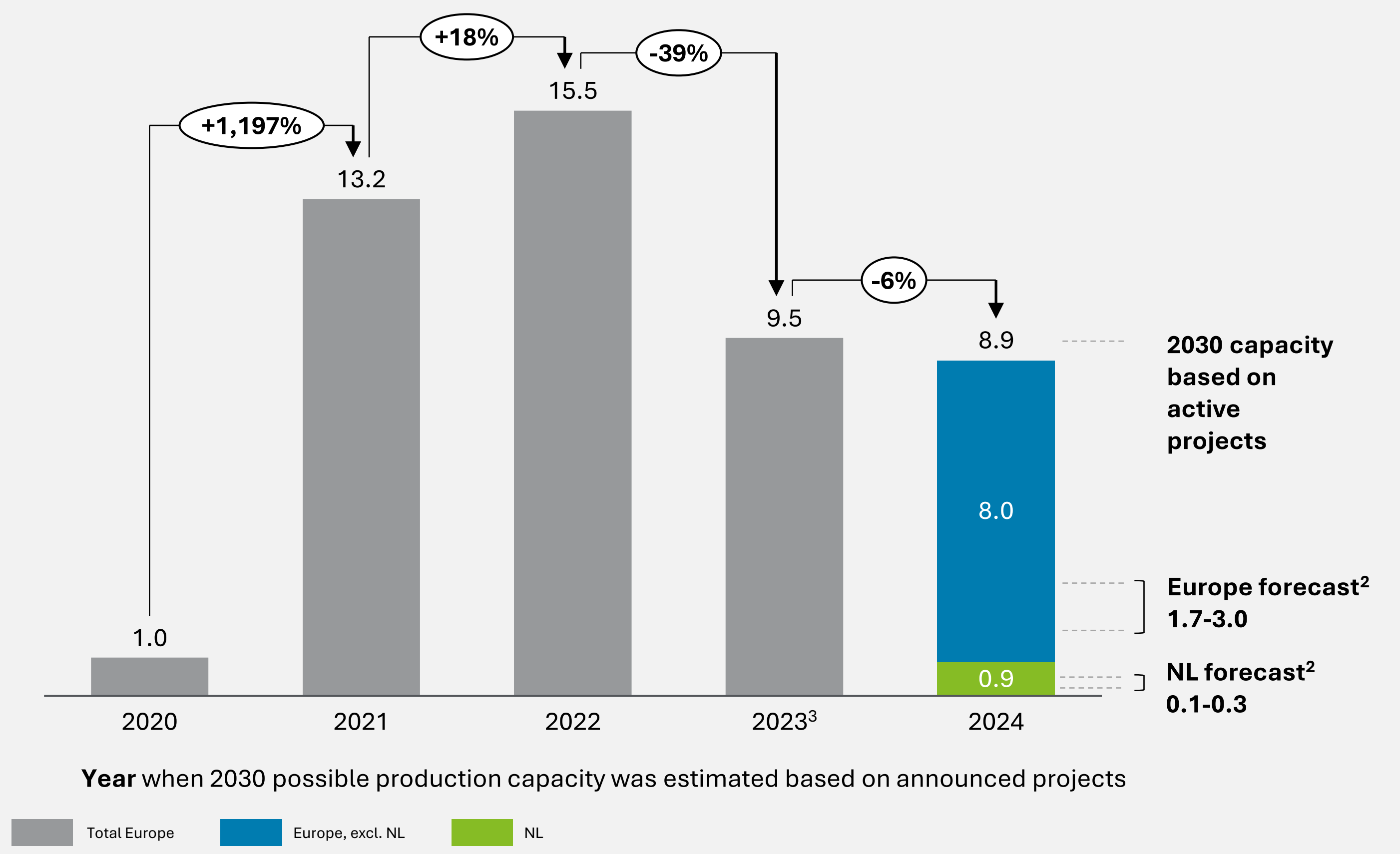
This creates a **vicious cycle: steel and fertilizer producers are unable to invest and commit to buying hydrogen** (as they cannot pass the additional cost through the value chain), while potential **hydrogen producers cannot take investment decisions to supply it at an acceptable price.**

However, stakeholders believe this **cycle can be broken with the right demand-side policy instruments** (explored further in this report).

Source: Expert interviews

Because heavy industry producers cannot commit to green hydrogen use, the pipeline of green hydrogen production projects has been declining

09. Green hydrogen 2030 cumulative possible production capacity in Europe and Netherlands (Mt of H_2 p.a.)[1]



Between 2020 and 2022, numerous green hydrogen projects were announced across Europe, with a possible production capacity of over 15 Mt p.a. by 2030.

However, **facing limited demand from potential customers, competition from imports, policy uncertainty and other barriers, many of these projects have been delayed, scaled down or cancelled**.

As a result, the total possible **2030 capacity has declined to just over half of the peak estimate**, now standing at approximately 8.9 Mt p.a.[3]

In the Netherlands, only one industrial-scale[4] green hydrogen project is under construction - Holland Hydrogen 1, **with a 2030 planned capacity of ca. 0.03 Mt p.a.** Green hydrogen from this project is intended primarily to be used for the so called 'refinery route' which, while contributing to the heavy industry decarbonisation, will be counted towards the transport sector RED III targets. Around 20 additional projects are at the feasibility stage, which could bring the Netherlands' possible 2030 production capacity to 0.9 Mt p.a.

Given project development timelines, and likelihood of further cancellations and delays, it is almost certain that **actual 2030 capacity will be significantly lower** than the possible maximum based on announced projects. For Europe, the latest estimate suggests total green hydrogen production capacity in 2030 will be between 1.7 and 3.0 Mt p.a., **well below EU target of 10 Mt p.a. If the same ratio applies to the Netherlands, its production capacity would likely be 0.1-0.3 Mt p.a.**

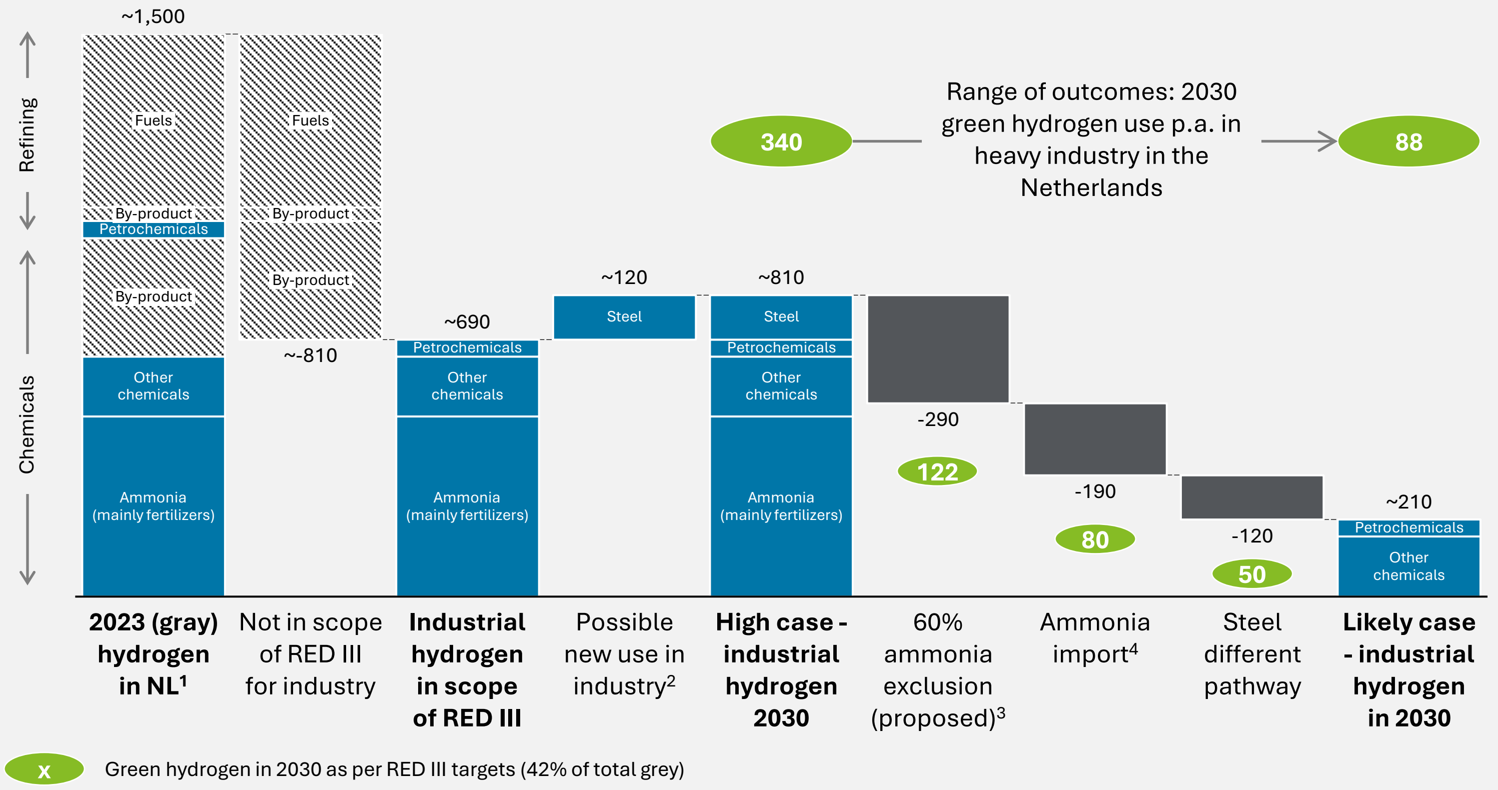
> People often don't understand that **it takes many years to build large-scale electrolysis facilities**
>
> Energy company

> Pipeline of projects is getting **smaller, but it is also becoming more robust, closer to reality**
>
> Potential hydrogen supplier

1) For Europe, 2030 capacity based on Hydrogen Europe. For the Netherlands, based on 2024 IEA Hydrogen Project Database. Includes NL projects in Feasibility study, FID/Construction and Operational status, excluding one multi-GW project for which wind plot will not be available in time for 2030 production; 2) Europe forecast as per Hydrogen Europe, NL forecast applying Europe ratios to NL planned capacity. NL historical capacity plans not available; 3) The decline between 2022 and 23 results mainly from a cancellation of a single large project in Spain; 4) For the purpose of this study, industrial scale considered above 10 kt p.a.
Source: Hydrogen Europe "Clean Hydrogen Monitor"; IEA; Expert interviews; Deloitte analysis

Without an intervention, green hydrogen use in heavy industry is highly uncertain

10. Current and possible hydrogen use in Dutch industry, based on expected transposition of RED III (kt p.a.)



1) Split of H_2 volumes between applications (transport vs. industry) and between production routes (SMR vs. by-product) based on previous research and aligned with CE Delft-TNO estimates; 2) 'HeraCless 1 H_2' plan: 3 Mt of 7 Mt Tata Steel NL capacity; 3) Ammonia exclusion percentage is preliminary; 4) Ammonia import or full replacement with green H_2, is not a solution for urea, which requires CO_2, that currently comes from grey ammonia production

Source: CE Delft-TNO "Afnameverplichting groene Waterstof"; European Hydrogen Observatory; TNO/CBS "The Dutch hydrogen balance, and the current and future representation of H_2 in energy statistics"; CE Delft "Analyze toekomstplannen Tata Steel"; Ministerie van Economische Zaken en Klimaat "Routekaart Waterstof"; Hydrogen Europe "Clean Ammonia In The Future Energy System"; Deloitte analysis

In the Netherlands, companies produce and use ca. 1,500 kt of grey hydrogen p.a. Of this, ca. **690 kt is industrial hydrogen, which, under RED III targets, should be gradually replaced by green hydrogen: 42% by 2030**, and 60% by 2035**.**

Conversion of primary steel production to DRI-EAF H_2 could add ca. 120 kt of hydrogen demand, bringing total industrial use to around 810 kt p.a.. This would result in an estimated **theoretical demand for green hydrogen in 2030 of ca. 340 kt p.a. under the 42% RED III target.**

However, under currently planned policies, **this high-case scenario seems unlikely, particularly in the ammonia and steel sectors.**

Ammonia producers are currently the largest industrial users of grey hydrogen in the Netherlands (ca. 480 kt p.a.), with most use related to **fertilizers**. However, since only hydrogen consumed within the EU triggers an obligation under RED III, **importing green hydrogen-based ammonia and fertilizers from regions with lower hydrogen costs is a more attractive option.** Stakeholders indicate that **even grey ammonia or fertilizer imports is less expensive** than EU production, also when the CO_2 taxes imposed on importers through CBAM are considered.

To partially counter the threat of imports, the Dutch government has proposed exempting 60% of ammonia production from offtake obligation. For the remaining 40%, imports will still be a viable alternative. This means that **under currently planned policies, demand for green hydrogen in ammonia production is likely to remain limited.**

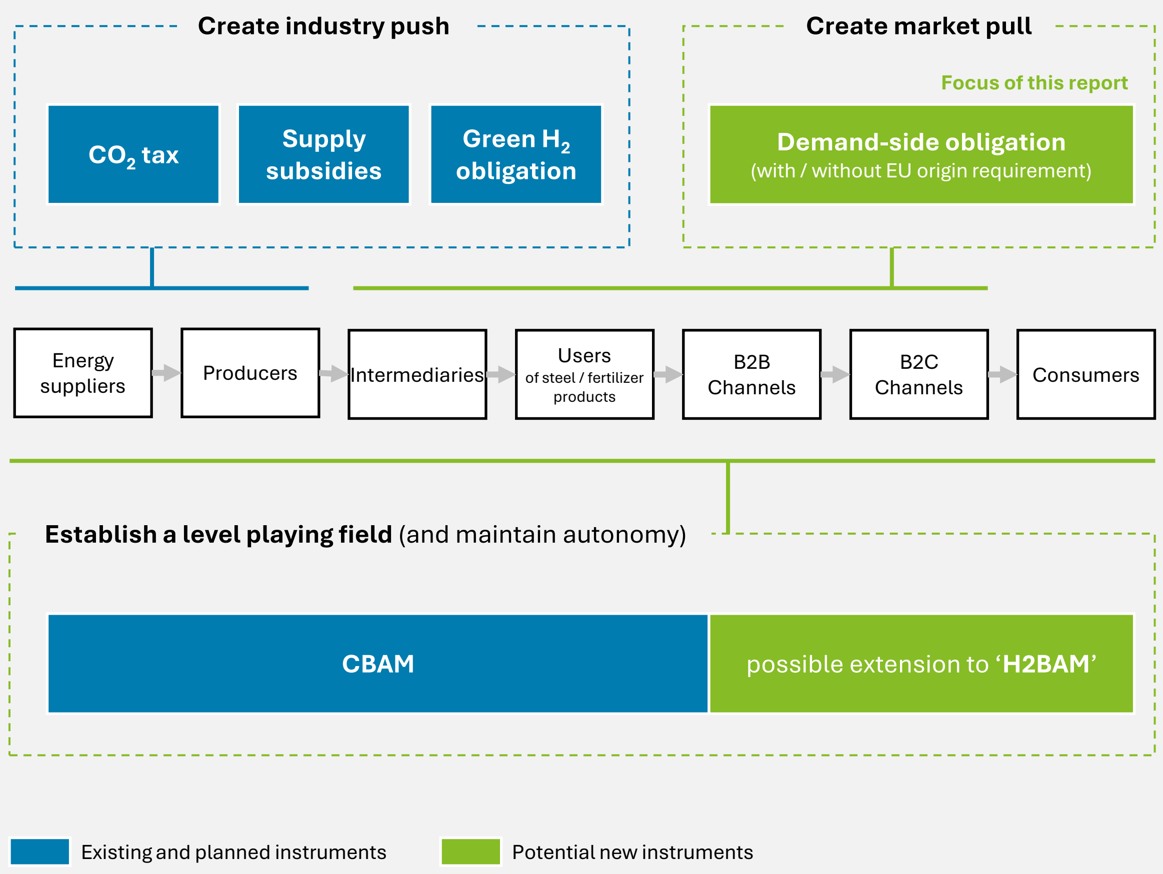
In the steel sector, the use of hydrogen is also uncertain. Alternative pathways, such as CCS, DRI with natural gas, or importing semi-finished products, might be more cost-effective, and would not involve a green hydrogen obligation.

Given these uncertainties, assuming other industrial hydrogen users remain in the Netherlands, **likely 2030 green hydrogen demand would total ca. 88 kt p.a.**, 252 kt. below the high-case estimate of ca. 340 kt.

How could a demand-side obligation help address the barriers?

Combining current supply-side policies with new demand-side interventions could address the barriers, and support adoption of green hydrogen in heavy industry

11. Potential policy instruments to stimulate green hydrogen use in heavy industry



Source: Stakeholder interviews; Deloitte analysis

Stakeholders agree that while current supply-side policy instruments are needed for transitioning European heavy industry to green hydrogen, they will not be enough on their own.

The **CO_2 tax (ETS) and supply subsidies** are intended to incentivize initial investments by narrowing the cost gap between green hydrogen and conventional energy carriers. While these subsidies are needed to jumpstart production, relying on them to close the entire value gap would require massive public spending (as estimated earlier), which is unlikely to be economically or socially acceptable.

The primary benefit of the **green hydrogen obligation** (RED III) is to reduce technological uncertainty by signalling a preferred energy carrier. However, as stated earlier, without strong import protections, this obligation puts European producers at a significant disadvantage compared to global competitors who face no similar requirements.

One possible solution mentioned by stakeholders is extending the Carbon Border Adjustment Mechanism (**CBAM**) so that importers compensate for the cost of green hydrogen used by European producers. While such a 'Hydrogen Border Adjustment Mechanism (**H2BAM**)' would reduce the cost difference between European producers and importers, it would likely not lead to emission reductions and would not address the potential impact of state subsidies provided outside Europe. It could also have unintended consequences, such as shifting imports from steel or ammonia to intermediate or end-products (e.g., crops, steel products), potentially further eroding Europe's industrial base.

To overcome these key barriers, stakeholders argue that policy support should extend beyond supply-side and border adjustment measures to include demand-side instruments.

Specifically, they advocate for a **demand-side obligation—requiring a certain (increasing) share of steel and fertilizers in key markets to be produced using green hydrogen.** This would provide demand certainty, enabling investment decisions, economies of scale, and the emergence of a liquid market. The obligation could be further supported by an EU origin requirement or demand-side subsidies, such as the Dutch government's plan to purchase part of hydrogen certificates for products supplied to the market.

Stakeholders emphasize that, if well-designed, **a green hydrogen-based product obligation would likely strike the optimal balance between sustainability, affordability, security, and European strategic autonomy** (see next pages).

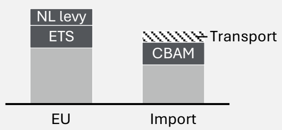
A demand-side obligation could reverse the shift from EU-made products to conventional / grey imports, which stakeholders expect under the current policy framework

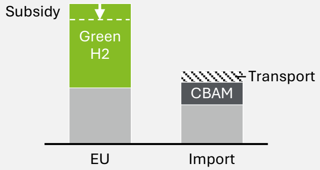
12. Impact of potential policy instruments on EU industry[1] – ILLUSTRATIVE

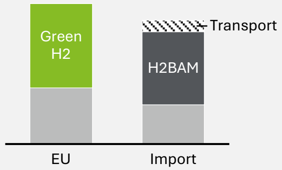
Focus of this report

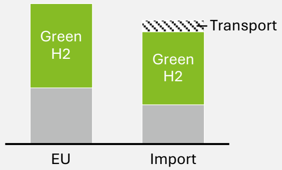
Existing and planned instruments: CO_2 Tax + CBAM; Green H_2 obligation

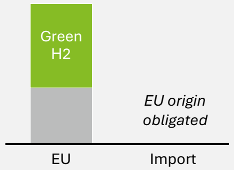
Potential new instruments: Extended CBAM; Demand-side obligation; Demand-side obligation with EU origin











	CO_2 Tax (ETS, NL CO_2 levy) **+ CBAM**	**Green H_2 obligation** (+ supply subsidies)	**Extended CBAM ('H2BAM')**	**Demand-side obligation**	**Demand-side obligation with EU origin[2]**
Producers[1] of **steel** and **fertilizers**	+- EU producers pay CO_2 tax. Importers pay an equivalent of CO_2 tax for emissions outside EU. Does not compensate for NL CO_2 levy, nor for the difference in energy cost, but transport cost offsets large part of the cost gap.	-- Green H_2 increases cost of EU production well above CBAM. Even after subsidies, cost gap to imports is prohibitive. EU production of steel, fertilizers becomes uncompetitive. Industry declining in EU.	+- Importers pay for the difference between grey and green H_2-based steel and fertilizers (e.g., EU LCOH x obligation %). EU steel, fertilizers producers recover some of the competitiveness.	+- Products sold in EU have the same green H_2 content, regardless of origin (importers required to use green H_2 in line with EU obligation). However, green H_2 production less expensive outside EU.	++ Steel, fertilizers and end-products sold in EU must be partially made in EU using EU-produced green H_2.
Producers of **end-products** (e.g., steel components, food)	-+ Most end-products are not covered by CBAM. Where cost gap is significant, production in EU could be replaced by grey imports.	+- End-products made in EU increasingly using imported steel and fertilizers.	-- Most end-products are not covered by H2BAM (assuming CBAM-like design). Import of end-products is significantly more attractive than production in EU.	+- More EU end-products are competitive with imports, except for those where green H_2-based steel and fertilizers are a significant share of the total cost.	++ End-products are covered by the obligation produced in EU.

Beyond obvious economic reasons (e.g., jobs, R&D), maintaining heavy industry in the EU contributes to the region's strategic autonomy (e.g., steel is used in infrastructure and defense)

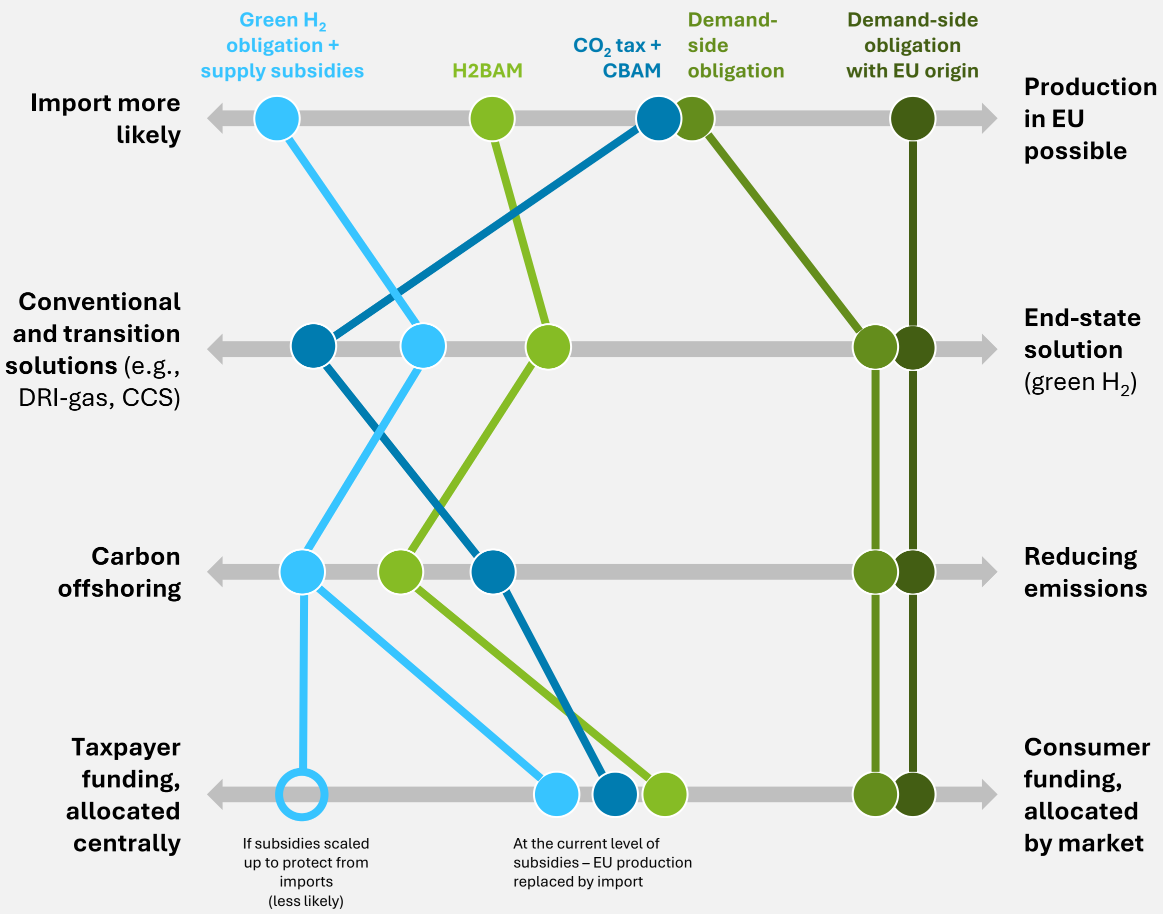
-- / +- / ++ - negative / mixed / positive relative impact on producers

1) Impact shown for producers or steel, fertilizers and end-products sold in EU. For exporters, impact of most listed policy instruments is likely negative, unless export exemptions are implemented. This has not been shown for simplicity but needs to be considered in the next phases; 2) EU origin obligation can be implemented in various ways, e.g., green H_2 from EU or green H_2-based steel / fertilizers from EU. These would have different impact on EU industry and EU H_2 producers and should be explored in the next phases

Source: Stakeholder interviews; Deloitte analysis

The obligation could also help move faster to the end-state solution, avoid carbon offshoring and more effectively allocate funding

13. Effect on key levers for potential policy instruments – ILLUSTRATIVE



Because of higher conventional energy and green H_2 costs, EU producers are structurally disadvantaged versus import in most policy scenarios that require them to pay CO_2 taxes or use green H_2.

Details on previous page

CO_2 taxes incentivize technology with lowest abatement cost today, which is often not the “end-state” solution, such as green H_2. Without a demand-side obligation, most imports – even with CBAM / H2BAM will likely be based on conventional / grey energy.

Without a demand-side obligation, imports of products using conventional / grey energy will likely increase, especially if EU producers face the green H_2 obligation while importers do not. For many products, offshoring the production and paying for emissions under CBAM (also if extended to H2BAM) will likely remain more attractive than investing in decarbonisation.

Substantially increasing subsidies to meet green hydrogen obligations would likely impose a significant taxpayer burden, primarily benefiting existing producers. In contrast, a demand obligation could foster the emergence of new producers, potentially in more advantageous locations within the EU. This approach would also tie the cost burden more directly to product usage, potentially influencing consumer choices.

Source: Stakeholder interviews; Deloitte analysis

Existing demand-side obligations suggest that it can be an effective instrument to build scale, especially if balanced with the right incentives

14. Existing demand-side obligations – case studies

Ethanol blending in petrol in EU

Context: Since 2003, EU has been promoting use of biofuels, like ethanol, in transport, further stimulated by a 2009 RED II target of 10% renewable fuels in transport. RED III further increases the targets and sets rules on types of biofuels that should be used.
Impact: Member states have been mandating and/or incentivizing use of ethanol in fuel, largely through tax incentives. Currently most petrol in Europe has at least 5% ethanol blend (E5), in at least 14 countries E10 is a standard, and in some E85 is used.

Key takeaways:

- **obligation combined with demand-side incentives help kick-start the transition;**
- **barriers to adoption decline as scale grows.**

ReFuelEU: EU-wide Sustainable Aviation Fuel (SAF) blend obligation

Context: A regulation mandating that aviation fuel at EU airports contains a minimum of 2% SAF in 2025, increasing to 70% by 2050. The obligation is placed on fuel suppliers, with cost passed on to consumers.
Impact: Obligation increased SAF demand certainty, which combined with inclusion of international aviation in ETS have triggered several production FIDs around Europe (e.g., Rotterdam biofuels). Some airlines have announced SAF surchargers, to compensate for part of green premium.

Key takeaways:

- **obligations strengthen supply business case and steer investments to favourable locations;**
- **value chains find a way to spread the additional cost / green premium.**

15. Stakeholder perspectives on existing demand-side obligations

Some stakeholders see **clear benefits of a demand obligation…**

SAF is an example where a **simple law with a long-term perspective increases predictability for investors**
Financier

Customer pull created by the obligation would **increase scale and drive down unit cost**
Industrial producer

…while others stipulate a **more balanced stick-and-carrot approach**

You need to be careful **not to create inflation and a societal backlash**
Steel user

I would **start with incentives**, then shift to obligations
Industrial producer

You need **value-chain-specific solutions**
Fertilizer user

Specific **design choices** will be key to success

Not sure **where in the value chain** you put the obligation
Industrial producer

Question is **if we should obligate carbon intensity or specific technology**
Financier

Key issue is **protection from unfair import**
Steel user

Source: Company information; Stakeholder interviews; Deloitte analysis

Additionally, voluntary demand-side initiatives show that an initial small scale ‘pull’ effect for low-carbon products can be successful in contained pockets of the market

16. Existing voluntary demand-side initiatives – case studies

Integrated green H_2–based steel value chain for premium products

Context: Greenfield mill in Sweden, set to start green H_2-based steel production in 2027, scaling up to 5 Mt by 2030 (4% of EU production today). Integrated steel and hydrogen production within the same site.
Impact: Established in 2021, Stegra claims to have secured 1.5 Mt+ of steel offtake in long-term contracts, supported by €6.5 B in funding. This initiative aims to solve the ‘vicious cycle’ problem by creating demand certainty for the steel producer, while providing early mover advantage for customers (which include car manufacturers and large furniture company).

Key takeaways:

- **some premium customers are willing and able to pay green premium;**
- **greenfield plants benefit from proximity to low-cost green hydrogen.**

Low-carbon wheat flour

Context: Collaboration between one of largest German agricultural traders, a Dutch fertilizer manufacturer, a large milling company and supplier of raw materials for bakeries.
Impact: Fertilizer with lower carbon content (existing product with relatively small green premium) which has an expected 50% lower cradle-to-gate CO_2 emissions is used in wheat growing, and subsequently in production of bread and other staples. CO_2 reduction is certified and tracked through the value chain using ISCC PLUS (fertilizer) and REDCert (wheat).

Key takeaways:

- **green premiums can be absorbed in commodities if impact is small;**
- **to claim CO_2 reduction, end-to-end certification mechanisms are required.**

17. Stakeholder perspectives on existing voluntary demand-side initiatives

Stakeholders see the value of **small scale, integrated voluntary demand** schemes....

These projects take a disruptor’s perspective – an **integrated approach that leads to a bankable business case**

Financier

We are **happy to pay a green premium** because for us steel is **not a major cost component**

Consumer goods company, steel user

In some **small market segments**, there is **marketing value in being a first mover** on sustainable products

Industrial producer

...however, they are **sceptical** about the ability to build **scale sufficiently fast**

Voluntary demand fluctuates a lot – **when companies struggle for survival** like they do now, it **drops off the cliff**

Steel user

We would need something **faster, that creates a big shift**

Fertilizer user

These new projects work best when they are greenfield, in advantaged locations. It is **difficult to use this approach with existing producers**

Financier

Source: Company information; Stakeholder interviews; Deloitte analysis

Designing an obligation will require choices around geographical scope, place in the value chain and end-markets, as well as how to certify and track

18. Key design choices for a demand-side obligation and identified principles

Who to obligate

Geographical scope (Netherlands or EU)

Most stakeholders indicate that an **EU-level obligation should be the goal**, as it would have a greater impact on the volume of green hydrogen-based products and on the producers, than one limited to the Netherlands. However, it would require more time to implement.

The impact of a Netherlands-only obligation will depend on the proportion of steel and fertilizers sold in the country that are locally produced. If most are sourced domestically, the obligation will (all other things being equal) benefit local producers; otherwise, it will support producers in the rest of the European union or in other regions.

Obligated parties (place in the value chain)

While **each end-market requires a tailored approach**, the research has identified some common principles:

- An obligation should be placed **as closely to end consumers as possible** to avoid ‘shifting’ the cost burden to another company, and to enable increased cost to be spread across products & consumers.
- To minimize administrative effort, the obligation should **target markets with high concentration**, where few companies have a big share of sales.
- Ideally, the obligation should **apply to “captive” companies** – those bound to a specific location – providing better protection from unfair imports.

What to obligate

End-markets and products (where to start)

To maximize impact, focus should be on end-markets that require the **highest volume of** steel or fertilizers, where steel or fertilizers represent a **high share of production emissions**, and at the same time a relatively **small share of the cost** (e.g., because other materials, labour, marketing are also used).

To minimize administrative effort, focus should be on end-markets **that are concentrated, captive and with limited options for substitution** (analogous to value chain choices).

Note 1: How to define a product will be a key decision (e.g., using national or international product codes).
Note 2: Obligation should be avoided in sectors where a significant portion of production is exported outside the EU (not analysed in this report).

How to obligate – initial considerations in next section

Certifications and tracking

Stakeholders point out the importance of **robust yet pragmatic approach to administering a demand-side obligation.** Initial research identified two possible models of certification that could be used.

Mass-balance method, where the **green hydrogen certificate “travels” with the steel and fertilizer products** through the value chain, with the obligated party using it to meet their compliance target.

Book-and-claim method, where **producers offer** green hydrogen-based steel or fertilizer **certificates on a trading platform**, with no tracing of interim products. Obligated parties at the end of the value chain **buy certificates to meet their obligations.**

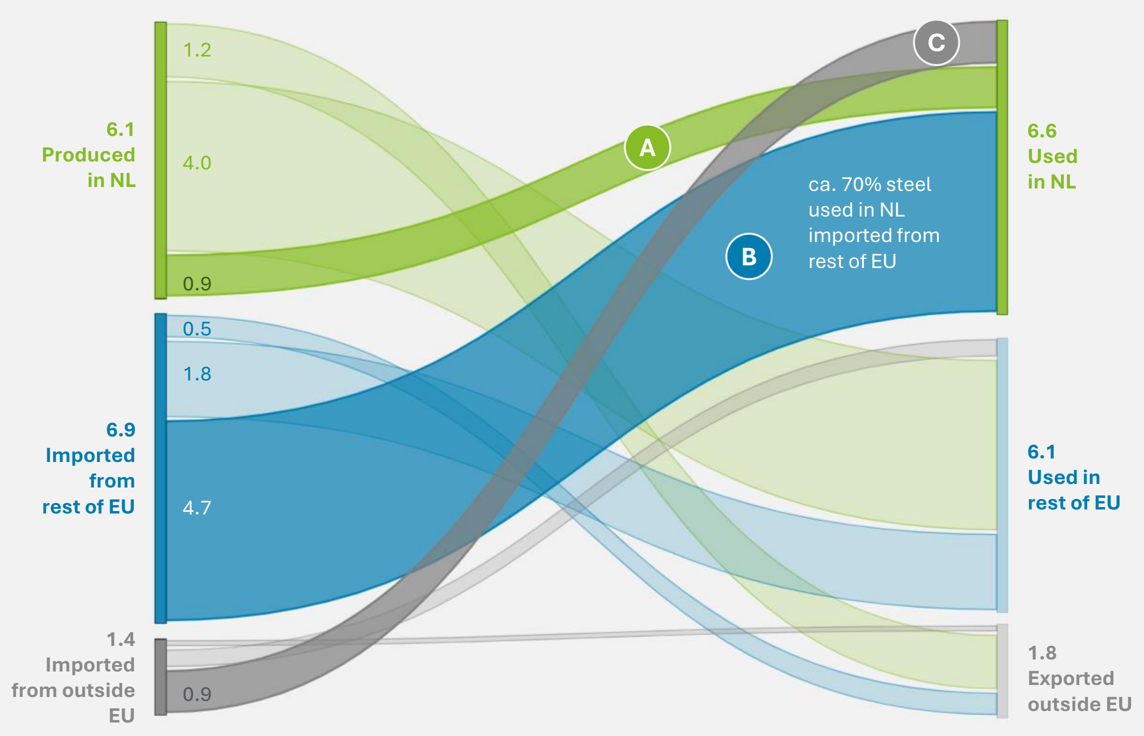
These design choices were the most frequently mentioned during the research, but they are not exhaustive. Other factors, such as whether to mandate EU origin or support obligated parties with demand-side subsidies, will also need consideration. These aspects will require further detail, evaluation, and iteration in next phases.

Design choices are mutually dependent. Especially which parties to obligate will differ depending on which end-markets are chosen.

Source: Stakeholder interviews; Deloitte analysis

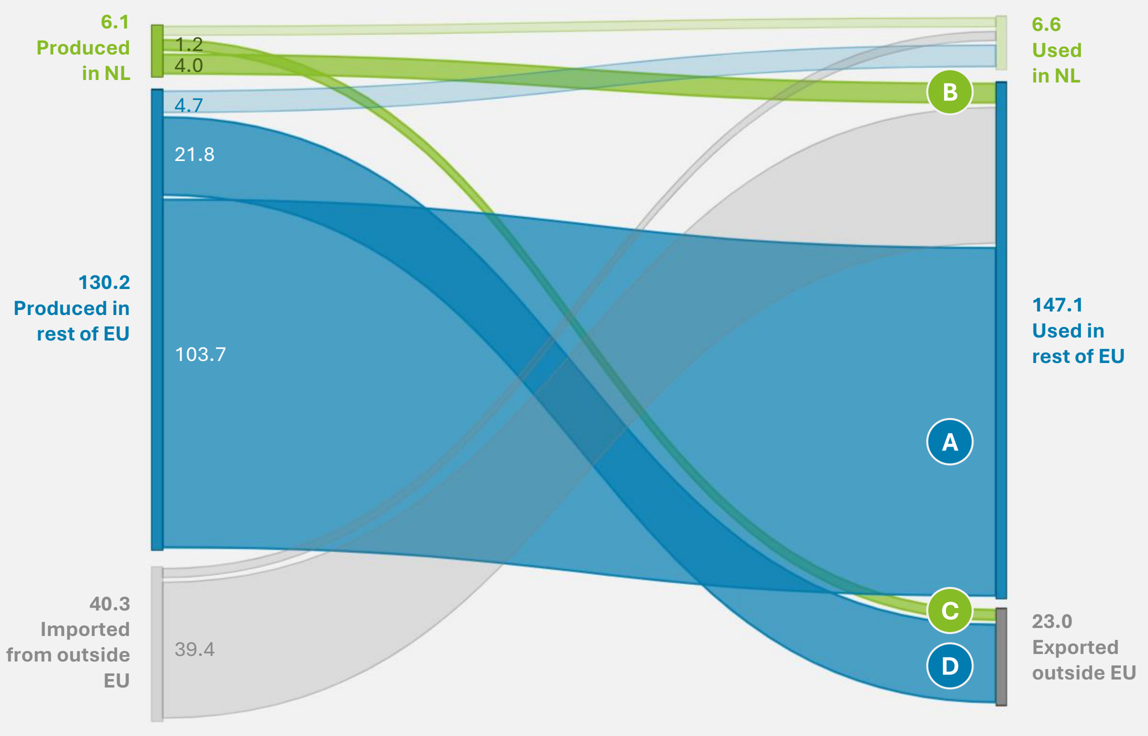
In **steel**, an EU-level obligation could stimulate green H_2-based production across the common block, while an obligation placed in NL would likely be fulfilled by imports from EU countries

19. Netherlands steel production, use and import-export (2022, Mt p.a.) – INDICATIVE



Currently, under 15% A of steel used in the Netherlands comes from local production. The remainder is imported, from other EU countries B and to a smaller degree C from outside the EU (mainly China). Therefore, if a potential green hydrogen-based steel obligation is placed on the end-use in the Netherlands, it might have a relatively small effect on decarbonisation of steel production – and therefore use of green hydrogen for steel – in the Netherlands.

20. EU steel production, use and import-export (2022, Mt p.a.) – INDICATIVE

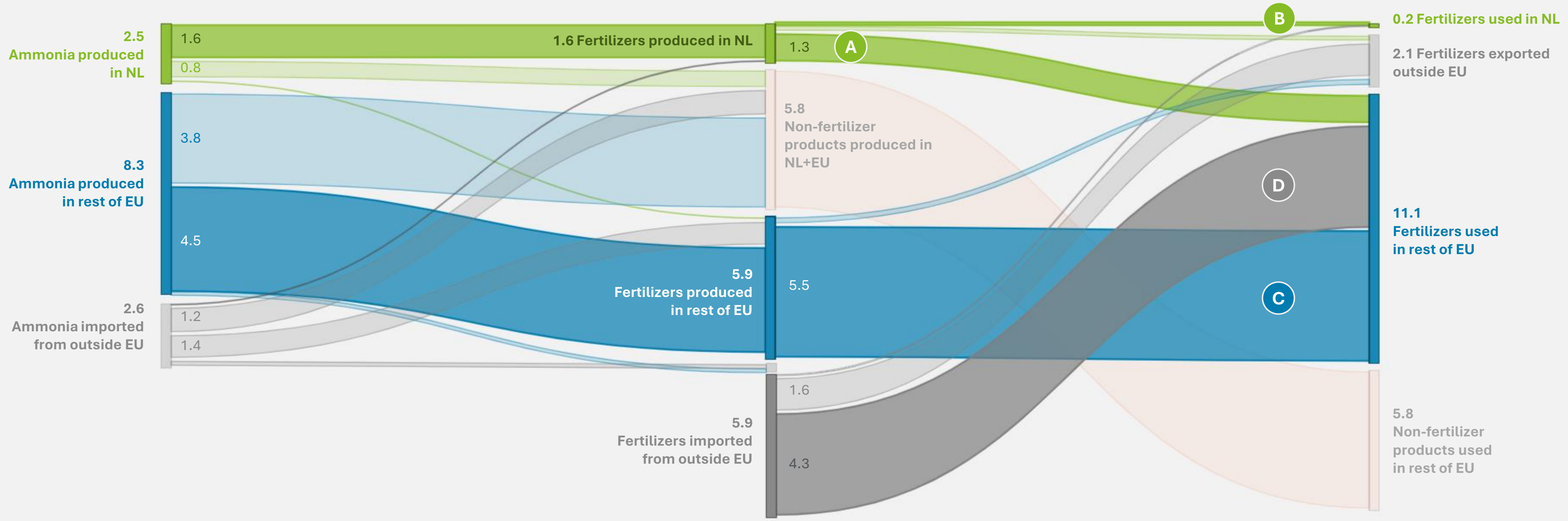


Over 70% A of steel used in the rest of EU (outside NL) is produced there. An EU-level demand obligation may therefore have a positive impact on decarbonisation across the common block. This would include the Netherlands which exports most B of its steel to other EU countries for processing into end-products, such as cars. These benefits need to be weighed against a potentially negative impact on competitiveness of export of EU steel to non-EU countries, which represents ca. 20% C of production in the Netherlands and ca. 15% D in the rest of EU.

Source: World Bank; Eurofer; Stakeholder interviews; Deloitte analysis

Similarly in **fertilizers**, an EU-level obligation could stimulate green H_2-based production in NL, while an NL-only obligation would likely be largely fulfilled by imports

21. Netherlands and EU ammonia and ammonia-products (incl. fertilizers) production, use and import-export (2022, NH_3 eq. Mt p.a.) – INDICATIVE



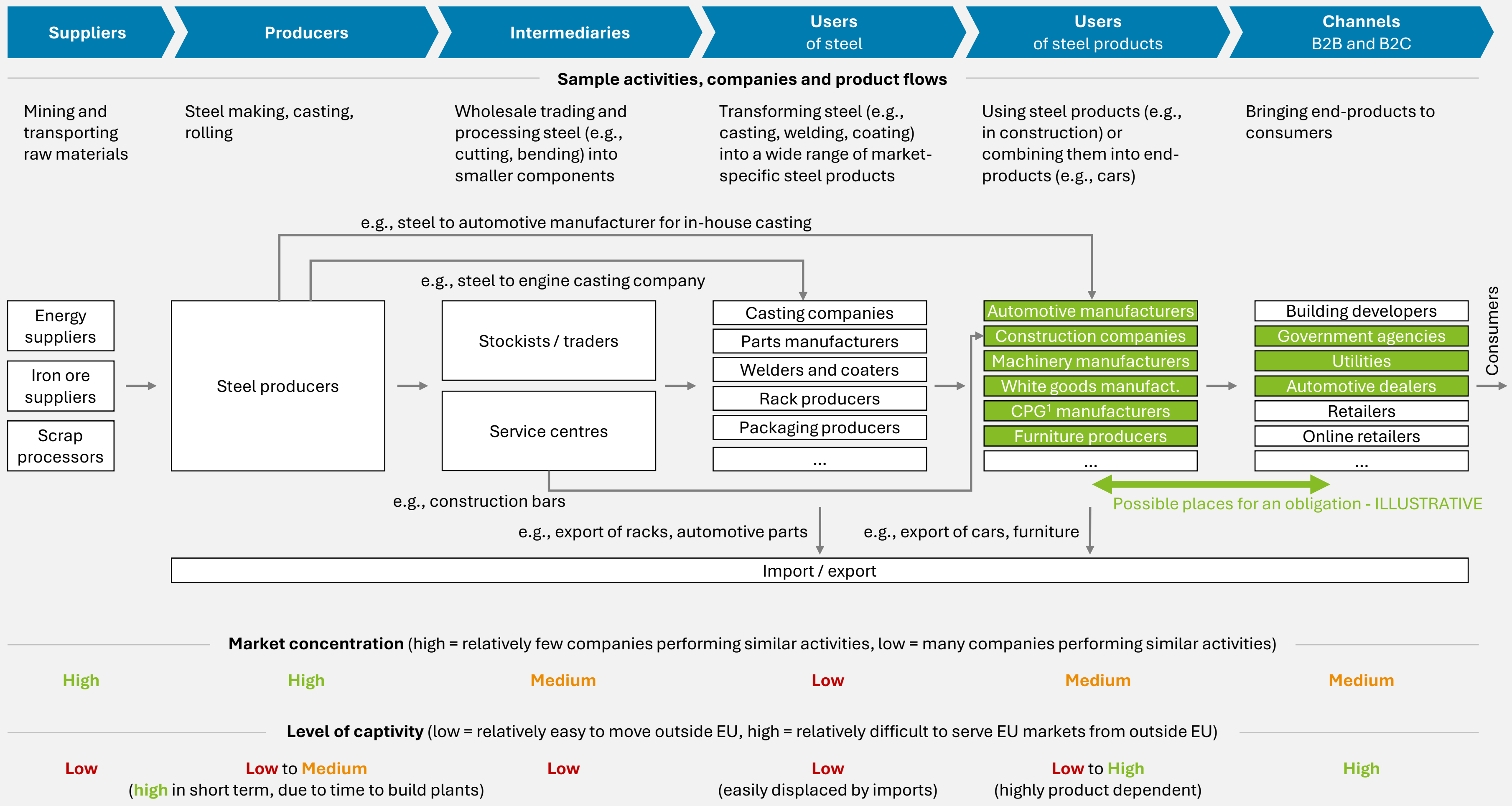
Most ammonia produced in the Netherlands is used locally to make fertilizers which are then exported to other EU countries A. Fertilizer use in the Netherlands represents only a small fraction (<5%) B of local production. Therefore, if a potential green hydrogen-based fertilizer obligation is placed on the end-use in the Netherlands, it would have a relatively small effect on decarbonisation of Dutch production.

Most fertilizers used in other EU countries are produced from EU-made ammonia, including a significant amount made in the Netherlands A C. An EU-level demand obligation would therefore have a likely positive impact on production decarbonisation across the common block, including in The Netherlands. However, given green hydrogen-based ammonia and fertilizer production in other regions is often less expensive than in EU, and that import routes are already well established D, achieving these benefits will likely need some form of an EU origin requirement within the obligation, (to limit imports replacing EU production).

Source: World Bank; Fertilizers Europe; International Fertilizer Association; Stakeholder interviews; Deloitte analysis

In **steel**, placing an obligation on users of steel products, and selectively on B2B/B2C channels could strike a balance between impact and ability to enforce

22. Simplified **steel value chain** and factors influencing potential fit with a demand obligation – **ILLUSTRATIVE**



1) CPG = Consumer Packaged Goods
Source: Industry information; Stakeholder interviews; Deloitte analysis

The steel value chain comprises a **wide range of products, processed and manufactured by a wide range of companies for multiple end uses.**

Many of these companies are part of global markets, especially in the middle of the value chain, and as such could relatively easily move outside the EU if an obligation makes them disadvantaged.

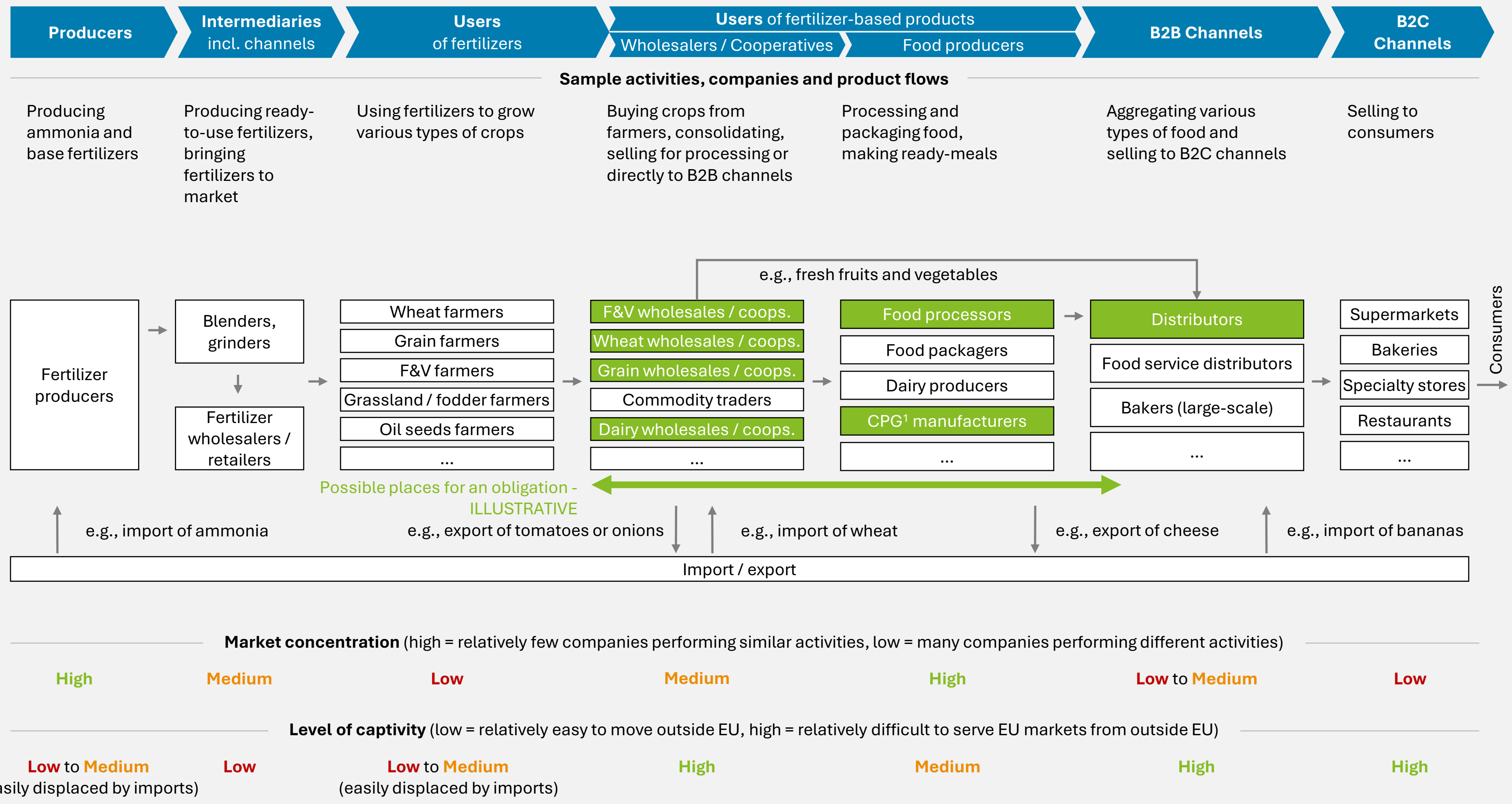
Entities at the end of the value chain - B2B/B2C channels (e.g., retailers) aggregate a wide range of products and bring them to more homogenous end-markets. They are also relatively ‘captive’, meaning it would be difficult for them to serve NL/EU markets from outside the EU.

In many end-markets, however, entities in the Channels category might be **too small and fragmented** to efficiently enforce. In such cases, **placing it one step earlier** in the value chain (e.g., on white goods manufacturers), could be more practical.

Government agencies are slightly different but very important entities at the end of the value chain that are both captive and highly concentrated. As such they could play an **important role in kick-starting the obligation**, e.g., by making green hydrogen-based steel obligatory in infrastructure works, or in offshore wind tenders

For **fertilizers**, there are multiple places in the value chain where a demand obligation might be effective, depending on end-market, incl. wholesalers, food producers and B2B Channels

23. Simplified **fertilizer value chain** and factors influencing potential fit with a demand obligation – **ILLUSTRATIVE**



1) CPG = Consumer Packaged Goods
Source: Industry information; Stakeholder interviews; Deloitte analysis

While the range of fertilizer applications is relatively limited (compared to steel products, the number of crop types is small), **different food types follow different routes to markets with at times many processing steps and companies involved along the way.**

Wholesalers / cooperatives – in countries where they hold a large market share, like the Netherlands – are a large, concentrated and relatively captive group, and as such **may represent the logical step in the value chain for a demand obligation**. Many cooperatives wield significant direct influence over upstream activities (e.g., how the crops are grown by farmers), and as such could be instrumental in enforcement.

In countries where the role of wholesalers / cooperatives is less prominent or in case a threat from crop imports is high, the **obligation could be placed further down the value chain, on food producers or B2B channels.**

In both steel and fertilizers, there are certain characteristics of end-markets and products that could make them attractive for a demand-side obligation

24. What makes an end-market (and product) fit for a demand obligation

Maximize impact[1]			Minimize administrative and enforcement effort		
High **total** (potential) steel / fertilizers **volume**	High **share of** total production **emissions**	Low **share of** total end-product **cost**	**Concentrated market** with few companies	**Captivity** – Limited options for companies to avoid the obligation	Limited **options for substitution**
The more steel / fertilizers are used in the end-market or product in absolute terms, the greater the impact of an obligation on the energy (e.g., hydrogen) that shifts to a low-carbon alternative.	The greater the impact of steel / fertilizers on the production emissions, the greater the incentive to transition to green H_2-based products. Typically, includes end-markets where there are few raw material inputs.	The smaller the share of steel / fertilizers in product cost, the less expensive it is to transition to green H_2-based products. Typically includes end-markets with large components of value-added activities (e.g., R&D, labour) and marketing.	The fewer companies operate in the end-market (especially at the end of the value chain), the easier to implement the obligation and manage the certification scheme.	The higher the cost of transport relative to cost of end-product, the more difficult it is to move production facilities to places without an obligation. Note: If a market is not by nature captive it can become captive due to an EU-origin requirement.	The fewer possibilities to substitute steel / fertilizers with other inputs, the more likely the end-market will comply with the obligation, instead of using substitutes. In steel, substitution typically comes from materials like plastics and aluminium. In fertilizers, substitution options (other than import) are limited.

When obligating, **enforcement is typically easier for homogeneous** products (with fewer variants), as opposed to heterogenous ones. However, given the nature of **steel and fertilizer value chains** (where products are homogenous at the start of the value chain and very heterogenous at the end of the value chain) this criterion is **not considered at this stage.**

Notes: 1) Impact evaluated as maximum amount of green hydrogen-based product sold in the market resulting in a lower-carbon footprint
Source: Expert interviews; Deloitte analysis

Construction, automotive, domestic appliances and selected processed crops provide a potential starting point for an obligation design

25. Relative end-market fit for a demand obligation – ILLUSTRATIVE and PRELIMINARY

		Maximize impact			Minimize admin. &enforcement effort		
Steel	**Use in EU (2023)**	High total volume[1]	High share of emissions	Low share of cost	Concentrated market	Captivity	Limited options for substitution
Construction	36%	+++	++	+++	+	+++	++
Automotive	19%	+++	+++	+++	+++	++	++
Mechanical engineering	15%	++	++	++	++	++	+
Metalware	14%	++	+++	+	+	+	++
Tubes	9%	+	+++	+	+	++	++
Domestic appliances	2%	+	++	+++	+++	++	++
Others	5%	++	+	+	+	+	+
Fertilizer							
Wheat	26%	+++	+++	+	++	+++	+++
Coarse grains	26%	+++	+++	++	++	+++	+++
Fruits and vegetables[2]	17%	+++	++	+	++	++	+++
Grassland	12%	++	++	+	+	+++	+++
Oilseeds[3]	12%	++	++	++	+	++	+++
Fodder crops	7%	+	++	+	+	++	+++

Steel and fertilizers are global commodities with thin margins.

However, **in some end-markets, this policy could be easier to implement with greater impact on hydrogen use and lower effort.**

In steel end-markets, **construction** is largely captive, with steel use closely tied to location, making enforcement easier. Though steel accounts for large emission share in construction, its cost impact is relatively low. Cost impact is even smaller in **automotive** and **domestic appliances**, though captivity is also lower.

Fertilizers are the biggest source of emissions in crop production, but cost impact varies. It is generally the lowest when crops are **processed**, which is typically the case with **wheat** (flour, bread, pastries), but also some **coarse grains** (barley for beer), and **vegetables** (canned tomatoes, potatoes for fries). As such, to be practical, demand obligation for fertilizers will need to target specific products, rather than crop types.

More analysis is needed to identify the right end-markets for a demand obligation, but these could provide a useful starting point.

+++ ++ + Low / medium / high relative score on the criteria

Potential starting point for obligation design

Notes: 1) Volume estimated based on current use of steel and fertilizers; 2) Permanent crops, sugar, potatoes and others crops; 3) Including 1% maize for biogas
Source: Eurofer; Fertilisers Europe; Deloitte analysis

What could be the impact on the price of end-products?

For many end-products, cost increase from using green hydrogen-based steel and fertilizers would likely be relatively small and have a disproportional effect on emission reduction

26. Potential price increase and CO_2 decrease of selected green hydrogen-based end-products for – ILLUSTRATIVE EXAMPLES

End-markets	End-products	Cost[1] increase 100% green H_2-based product	Production CO_2 abated[2]	% production CO_2 reduction from 1% cost increase[3]
Steel				
Construction	House	0.6%	26%	37
	Wind turbine (offshore)	1.1%	36%	33
Automotive	Car (ICE)	1.0%	25%	25
	Car (BEV)	1.0%	16%	16
	Truck	3.0%	42%	14
Metalware	Tomatoes (can only)	7.6%	17%	2
Domestic applian.	White goods	1.0%	23%	23
Others	Container ship	10.0%	73%	7
Fertilizers				
Wheat	Bread	0.6%	20.2%	34
Fruits and vegetables	Tomatoes (excl. can)	<0.1%	2.0%	35
	Fries	0.5%	<0.1%	<1

Product deep-dive next page

Steel and fertilizer producers face significant cost increases (60%-400%) when using green H_2 compared to conventional options (as shown earlier). However, **when passed on to end-products, the cost increase would likely be much smaller, because steel and fertilizers account for a fraction of the total costs** (assuming no additional margin is added by the intermediaries).

For example, within the total cost of building a house, labour, interior finishing, permits, land and non-steel components have much greater share than steel. In automotive, the same logic applies – while a car engine is often made from steel, its cost is not just a result of the amount of steel used, but rather of the value-added activities related to how it was designed and manufactured.

Similarly, the cost of most food products is largely a result of labour (e.g., farming, processing, distribution), marketing, transport, land cost etc., and not of the fertilizers used in the production of raw inputs.

Gradual implementation of the obligation **would dilute the cost impact further** (e.g., starting with 10% green H_2 content would have <0.1% cost effect), could be synchronized with the positive cycle of declining unit costs and increasing volume.

In those end-markets where labour, design, marketing and other non-physical components have a high share of the production cost, **policymakers could consider selectively expanding an obligation to other materials** (e.g., glass, plastics, cement).

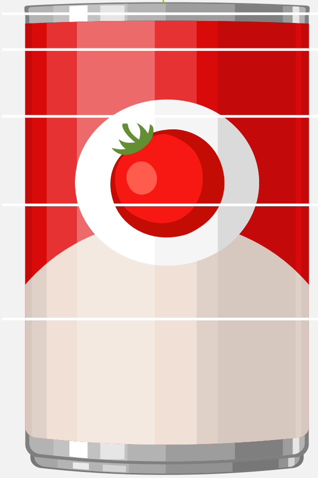
Notes: 1) For products with a deep-dive in this report (house, canned tomatoes, fries), the base cost scenario shown earlier in this document was used (BF-BOF steel € 485 / t vs. DRI-EAF H_2 € 1,092, SMR ammonia € 584 / t vs. Green H2 € 1,864). For other products, cost increase used in the sources is shown. This can be based on different TCO assumptions than for deep-dive products, but is not expected to change directional findings; 2) Emissions up to production of end-product. For fertilizer only production of ammonia, not on land-use; 3) CO_2 abated divided over cost increase
Source: Agora; Bloomberg; ING; ETC Mission Possible; IEA; Sustainability by numbers; Rentel; Ethical Consumer; JEMA; Transition Asia; The Liquid Grid; Mintie; Forbes; RMI; TEI; Articles from: Journal of the Air & Waste Management Association; International Journal of Environmental Science and Development; Technical University of Denmark; Energy Policy; Scania; Agronomy for Sustainable Development; Deloitte analysis

Green H_2 premium is relatively low because fertilizers and steel are typically a smaller share of the total cost of end-products than processing and other material inputs

27. Cost components of typical house in NL[1]

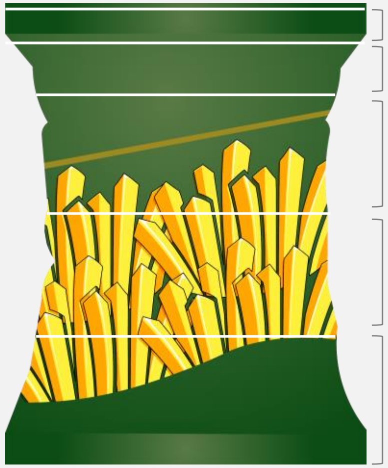
Average 124m[2] new build in Utrecht, sales price ca. €490k

28. Cost components of a can of tomatoes[1]



400g can peeled tomato white label, retail sales price ca. €0.69

29. Cost components of potato fries[1]



1 kg potato fries – white label, retail sales price ca. €1.86

It is estimated that a typical house **requires ca. 3.8 t of steel,** mainly used in foundation and floors. Initial analysis suggests that using 100% green H_2-based steel would result in **ca. 0.6% (< € 3,000) increase in the average house price.**

Assuming the Netherlands reaches its ambition of building 100k houses p.a. and using 100% green H_2-based steel it would result in **29kt p.a. green H_2 demand** (at 80kg H_2 / t steel).

Canned tomatoes use **steel (ca. 73 g)** and **fertilizer (ca. 0.3 g)** in production. While cost **impact of steel is relatively high** (ca. 7.6% if 100% green H_2-based steel was used), **impact of fertilizers is much smaller** (ca. 0.1%). Total cost increase could be ca. 7.7% or € 0.06. With ca. 79M cans sold in the Netherlands annually, using both green H_2-based steel and fertilizers in their production would result in **0.75kt p.a. of green H_2 demand.**

The estimated cost impact of using green H_2-based fertilizer for potato fries is **limited** (ca. 0.5% or < € 0.02 price increase, resulting from 6.5g of ammonia per 1kg potatoes).

A 100% green H_2-based fertilizer obligation on all fries sold in the Netherlands (ca. 390 M) would result in an estimated green **H_2 demand of 0.4kt p.a. in NL.**

Notes: 1) Numbers might not add to 100% due to rounding; 2) Including additional VAT
Source: CBS; CasaData.nl; Kadaster; BouwendNederland; RIVM; homedeal.nl; bouwtotal.nl; Tomato news; Onion Potatoes.com; Euromonitor; Deloitte analysis

What would be required to make it work?

Administering the obligation would require standardized certification that is simple and does not create excessive additional effort

30. Demand obligation requirements – stakeholder perspectives

Stakeholders indicate that an obligation would require **robust certification…**

Let's start by **defining what "green" means**. Does scrap qualify, or is it just about primary steel?

Steel user

We would need a **simple but robust certification and tracking** tool

Producer

Steel and fertilizers are made by a few large companies – they can **easily track how much green H_2-based products they make**

Financier

…but the main principle should be **simplicity and minimum administrative effort…**

We shouldn't get bogged down trying to build detailed and exhaustive product specs - CBAM shows how difficult that is. **Let's focus on the big items**

Producer

If we add new reporting requirements, let's also **remove some of the existing ones**

Fertilizer user

…learning from solutions that are already in place

ETS shows that a **relatively simple, central data and trading platform works,** without terrible admin

Producer

There are IT tools we **already use for product tracking**. Let's check if we can just extend them

Producer

Things like **food packaging are already well regulated** – let's leverage that

Consumer goods company

31. Example efforts certification schemes

Lower Emission Steel Standard (LESS): Climate-friendly steel label

Established in 2024 by the German steel association and the Ministry of Economic Affairs.

It is a voluntary labelling system for emission and scrap content in steel aimed at accelerating the transition to climate neutrality through market instruments.

The tiered labelling system (comparable to energy consumption labels of electronics) is built on a proposal of the IEA and is currently voluntary for participating companies.

It combines scrap quota and production carbon footprint of the virgin steel process. And as such, provides steel users with the information required to evaluate the performance of the steel in an easy to digest manner.

In parallel, the Chinese steel association is currently developing a comparable labelling.

ISCC PLUS: certification of renewable, bio-based, and circular raw materials

ISCC PLUS is a global voluntary certification system, a spin-off from the ISSC EU scheme which certifies biofuels under RED II(I) and other EU regulation (e.g., RefuelEU or EU ETS).

ISSC Plus verifies the use of renewable, bio-based, and circular raw materials by certifying production locations along the value chain, providing those locations with the opportunity to generate and pass on the related certificates for their respective products.

Applied to fertilizers, this system is used to certify low-carbon ammonia and sustainable production processes, ensuring fertilizer production is traceable on environmental (carbon) impact in the value chain.

This system is used in the earlier mentioned low-carbon wheat flour case study.

Source: Stakeholder interviews; Agora "Creating markets for climate-friendly basic materials"; Deloitte analysis

Initial research identified two possible models of certification

32. Demand obligation and certification methods

Mass-Balance	Book-and-Claim
Description	
In both methods, steel and fertilizer producers generate certificates equivalent to the amount of green hydrogen-based production or import.	
Certificate "travels" with the steel or fertilizer as it undergoes conversions in the value chain. The process is enabled by a tracking platform (e.g., blockchain based). Share of green hydrogen in products can be reported. **The obligated party obtains certificates when they buy the product** and uses it to prove the minimum green hydrogen-based content to meet their compliance target.	**Steel and fertilizer producers offer the certificates for sale into the market**, where they can be traded on a dedicated platform. There is no tracing of green hydrogen content in the products. **The obligated parties** at the end of the value chain **purchase certificates** equal to their obligation.
Characteristics	
+ Tracking green hydrogen along value chain, allows more informed decisions on trade-offs + Forms a direct link between production and demand (actual use of green H_2-based products) - Green premium needs to “work” it’s way back along value chain and gets potentially diluted - Elaborate and potentially costly system of standards and certification (end-to-end value chain)	+ Avoids tracking along the value chain, limiting due diligence and reporting effort + Directly channels funds raised by the mechanism to steel and fertilizer producers - Potentially vulnerable to misuse if non-EU producers can generate certificates
What is required	
Standards: Define how to calculate carbon intensity and/or green hydrogen content within steel and fertilizers, as well as how to calculate it when these are processed into (end-) products and would provide a foundation for an obligation. Many value chain standards already exist (e.g., CSRD, proof of sustainability for fuels, ISO). Stakeholders suggest that these could form basis for defining what constitutes green hydrogen-based steel and fertilizers (pending assessment)	
Certification: Required to trace production and use of green hydrogen-based steel and fertilizers in the value chain. Stakeholders suggest that the demand obligations could build on existing or emerging labels, such as Digital Product Passports, Environmental Product Declarations (pending assessment) or ammonia certification by Ammonia Europe	

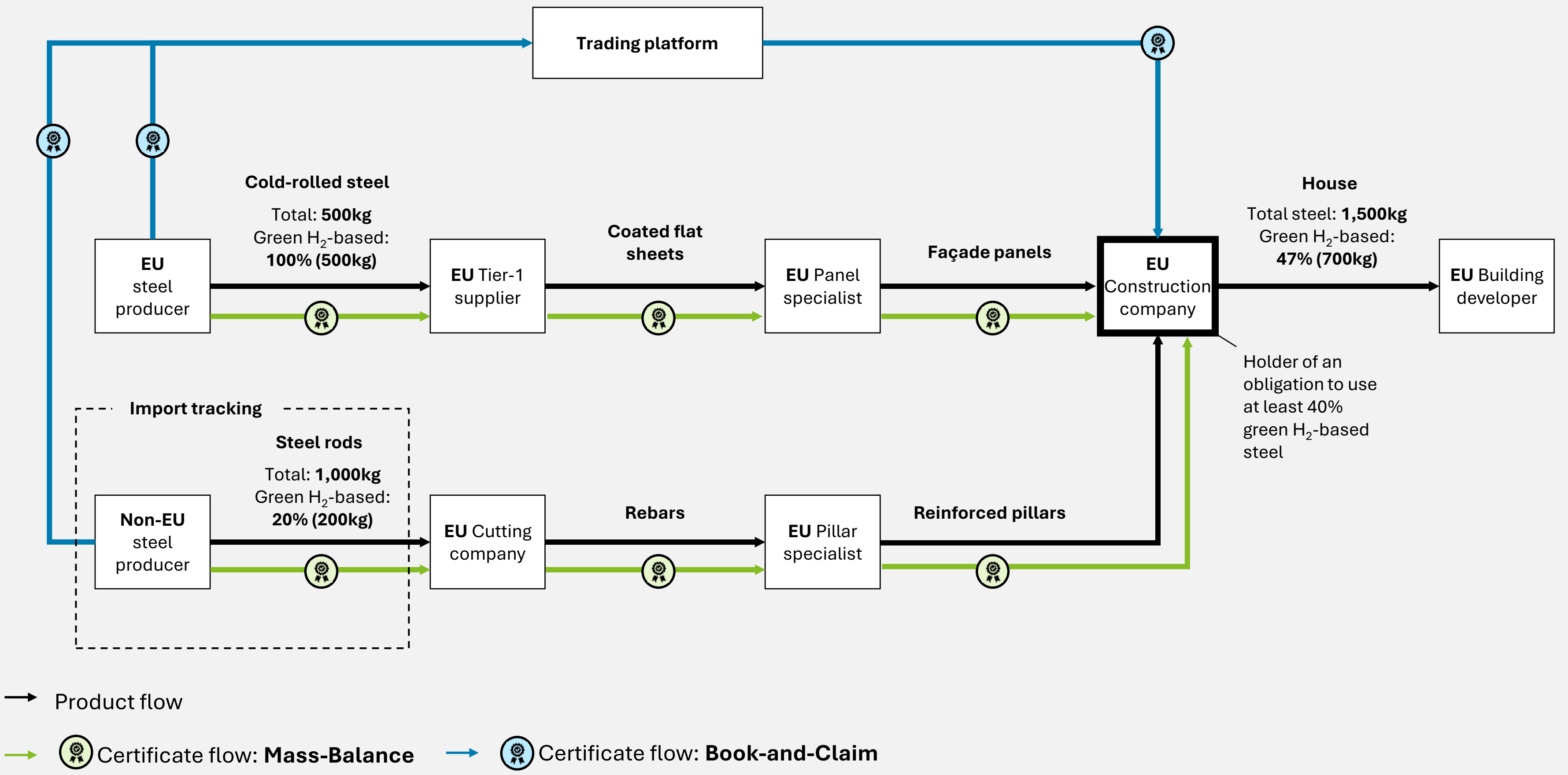
Given the nature of the products and value chains, this report does not consider **physically segregating conventional and green H2-based products**, as it would require dedicated supply chains and extensive effort.

+ Positive characteristics of a method - Negative characteristics of a method

Source: United Nations A guide to traceability

For example, if a book-and-claim model was implemented in construction, certificates generated by steel producers might be bought on a trading platform by construction companies

33. How a demand **obligation for steel** could work in construction – SIMPLIFIED AND ILLUSTRATIVE[1]



Certificates are generated by an EU steel producer or an importer (when steel first enters the EU).

The two certification models in a steel value chain could work as follows:

- **Mass-Balance:** Each party processing steel into intermediary and end-products reports on how much steel was based on green hydrogen and certifies it to their customers. Cost of steel at each step is higher by the amount of additional cost of using green hydrogen.

  Construction company which holds the obligation to use certain % of green H_2, aggregates the certificates and retires them to fulfil the obligation.

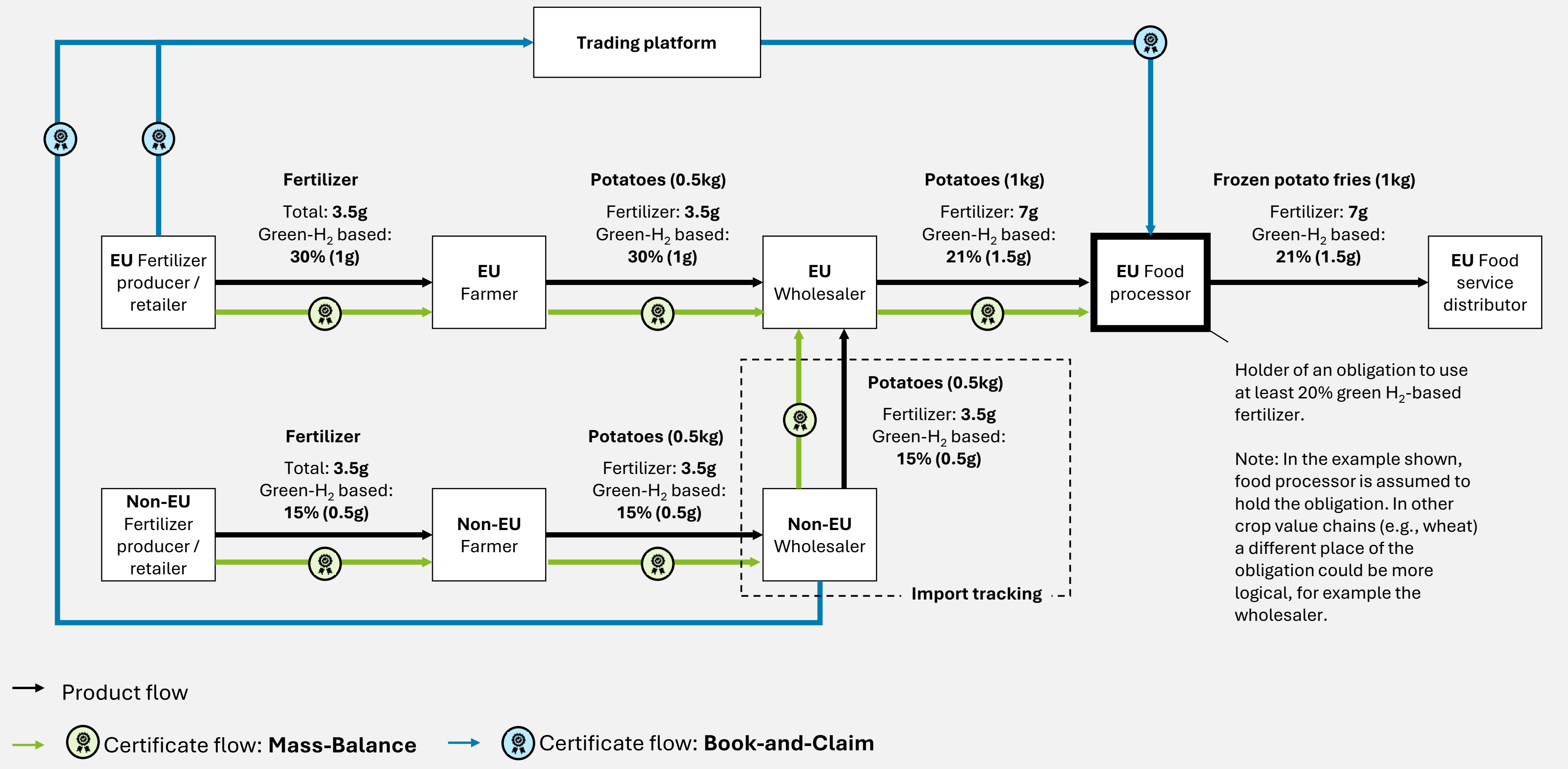
- **Book-and-Claim:** Steel producer offers certificates for sale on a trading platform. The cost of steel passing through the value chain remains the same. The holder of the obligation (e.g., construction company), buys certificates corresponding to the amount of green hydrogen-based steel they are obligated to use (% of total steel used).

Regardless of the method the construction company can "balance" their obligation within a portfolio of construction projects.

Notes: 1) Illustrative pending design choices (e.g., how to treat scrap and substitution by other materials)

The two certification models would work similarly in fertilizers, while an additional consideration is allowing for different levels of fertilizer usage by different types of farmers

34. How a demand **obligation for fertilizer** could work for potato fries – SIMPLIFIED AND ILLUSTRATIVE[1]



Certificate is generated either by EU fertilizer producer or by the importer.

Like in the steel example, the two certification models in a fertilizer value chain could work as follows:

- **Mass-Balance:** The certification is tied to the crop and follows the value chain. Also, when the product transforms from the crop (potatoes) to fries, the certificate remains attached to the specific batch.
- **Book-and-Claim:** Certificate trading is conducted centrally, without tying specific fertilizers and crop batches to specific end-products.

Additional consideration, which contrasts fertilizer value chain with steel is that **different types of farmers use different amounts of fertilizer.** One solution to address this might be a **use of tiering system (e.g., conventional, organic, biodynamic) to determine the amount of fertilizer used and therefore the obligation.**

Notes: 1) Illustrative pending design choices (e.g., how to report on the amount of fertilizer used)

Next steps

This report provided initial answers to key research questions, and identified a research agenda for next phases

35. Summary of answers from this report and research agenda for next phases

Key questions	Summary of answers from this report	Selected open questions (research agenda) for next phases
What are the key barriers to decarbonization?	Currently planned green H_2 obligation (if cascaded from member states to individual companies), would make locally produced steel and fertilizers several times more expensive than conventional or imported alternatives, even with CO_2 pricing and subsidies. Demand for such costly products is minimal, and competition from imports threatens the EU industry.	▪ Can the green H_2 production in EU be scaled up on time to meet RED III targets, even with an obligation? ▪ Can an obligation cover sufficient product volumes to maintain EU industry? ▪ How fast can an obligation be adopted and what can be done in the meantime to maintain EU industry? ▪ …
How could a demand-side obligation help address the barriers?	Combining supply-side policies with a demand-side obligation could support adoption of green H_2 in industry. It might help reduce the shift from EU production to conventional / grey imports, while helping to move faster to the end-state technology, avoid carbon offshoring and more effectively allocate funding. Initial views point to a preference for an EU-level obligation placed close to consumers, although each end-market will require a tailored design.	▪ Is it feasible to design the obligation directly at EU-level, or should it be first 'tested' in the Netherlands? ▪ In which end-market should the obligation be first implemented (after a more granular analysis)? ▪ For the selected end-markets, who should be the obligated parties? ▪ How many companies and products would fall under obligation in the selected end-markets? ▪ How much of green H_2 demand would result from different design decisions? ▪ Are there existing regulations (e.g., food packaging) that could serve as a base for the obligation? ▪ …
What could be the impact on the price of end-products?	For many end-products, cost increase from using green H_2-based steel and fertilizers would be minimal (ca. 1%), while having a disproportional emission reduction effect.	▪ How to minimize additional margins emerging throughout the value chain on the obligated cost? ▪ Is there a need for demand subsidies or other consumer-side instruments to minimize the cost burden? ▪ …
What would be required?	The obligation would require a certification that is simple, robust, and minimizes administrative burden. Mass-balance and book-and-claim are potential models.	▪ Which of the two certification models (or another) should be explored further? ▪ What would be required in terms of infrastructure and reporting processes to enable the certification? ▪ Are there solutions that could dramatically reduce the enforcement burden (e.g., blockchain)? ▪ …

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List of acronyms

€ M, € B	million euro, billion euro
B2B	Business to business
B2C	Business to consumer
BEV	Battery electric vehicle
BF-BOF	Blast furnace - basic oxygen furnace
CAPEX	Capital expenditure
CBAM	Carbon Border Adjustment Mechanism
CCS	Carbon capture and storage
CH_4	Methane
CO_2eq	Carbon dioxide equivalent
CPG	Consumer packaged goods
CSRD	Corporate Sustainability Reporting Directive
DRI-EAF	Directly reduced iron - electric arc furnace
E5, E10, E85	Fuel with 5, 10, 85 percent of ethanol blend
ETS	Emissions Trading Scheme
EU	European Union
F&V	Fruits and vegetables
F-gases	Fluorinated greenhouse gases
FID	Final investment decision
g, kg	gram, kilogram
GHG	Greenhouse gas
H_2	Hydrogen
H2BAM	Hydrogen Border Adjustment Mechanism (concept)
ICE	Internal combustion engine
IPCC	Intergovernmental Panel on Climate Change
ISCC	International Sustainability and Carbon Certification
kt	Kiloton (thousand tonnes)
kW, GW	Kilowatt, gigawatt
LCOH	Levelized cost of hydrogen
LESS	Low-Emission Steel Standard
Mt	Megaton (million tonnes)
N_2O	Nitrous oxide
NH_3	Ammonia
NL	The Netherlands
OEM	Original equipment manufacturer
OPEX	Operational expenditure
OWE	Subsidy for hydrogen production by electrolysis
p.a.	Per annum
REDII(I)	Renewable Energy Directive two (three)
RFNBO	Renewable fuels of non-biological origin
SAF	Sustainable aviation fuel
SDE++	Stimulation of sustainable energy production and climate subsidy
SMR	Steam methane reforming