POLICY BRIEF

Policies for a sustainable hydrogen economy in Europe

Executive Summary and Policy Guidelines

While green hydrogen will play a vital role in decarbonising our economy, it is not the primary solution for emissions reduction. Instead, energy efficiency and savings, renewable electricity expansion, and direct electrification are the top three approaches for reducing emissions. However, green hydrogen becomes essential in certain applications such as steelmaking and other industrial processes, as well as for long-distance aviation and shipping, and it can be beneficial in seasonal energy storage.

This policy brief spells out principles that should guide the development of a regulatory framework to advance a green hydrogen economy in Europe that complements and is well interlinked with Member States' national hydrogen strategies and other decarbonisation methods. The key principles underpinning this framework entail a strong emphasis on green hydrogen production and imports, sectoral prioritisation of hydrogen use, and the integration of sustainability criteria in international hydrogen markets. Furthermore, the European hydrogen strategy needs to support inclusive social and economic development in any hydrogen-exporting country inside and outside the EU, and also act as a unifying agent for the EU Member States.

To this end, these **Policy Guidelines** should be considered for Europe's green hydrogen economy:

1. **Prioritise Financial Support for Green Hydrogen:** Direct investment aid should exclusively support green hydrogen projects and focus on priority sectors on the application side.
2. **Prioritise Green Hydrogen in Carbon Contracts for Difference:** Implement strict criteria to ensure that Carbon Contracts for Difference (CCfDs) for emission-intensive industries prioritise green over blue hydrogen as soon as it is available.
3. **Promote Sustainable Hydrogen through the European Hydrogen Bank:** Use the European Hydrogen Bank (EHB) to support green hydrogen production, ensuring adherence to high sustainability standards and prioritising hard-to-abate application sectors in the auction schemes.
4. **Coordinate Infrastructure Development:** Develop hydrogen infrastructure while adhering to sectoral prioritisation, incorporating strict hydrogen readiness criteria as well as close interlinkage with power grid planning, and encouraging local production and consumption, instead of excessively relying on long-distance hydrogen transport.
5. **Set Quotas for Green Hydrogen Usage:** Establish binding quotas for green hydrogen use in priority sectors, coupled with certification schemes to drive its adoption.

instrat GERMANWATCH zero.

1 Introduction

Today, there is no debate about a climate-neutral energy system and economy without the mention of hydrogen. And while hydrogen will indeed play an important role in the decarbonised future, major net-zero scenarios[1] see it only second (or strictly speaking fourth) in terms of the effectiveness of emissions reduction approaches. This is because only green hydrogen, produced via electrolysis with renewable electricity, is a true zero-emission energy carrier and can substantially contribute to achieving climate protection targets. Production, processing, and transport of green hydrogen, however, involve energy losses and require huge amounts of additional renewable electricity as a prerequisite. Therefore, the top three emissions reduction approaches remain:

(1) energy savings and energy efficiency measures,

(2) expansion of renewable electricity production,

(3) direct electrification in sectors including industry, transportation, and heating.

Nevertheless, for some processes, hydrogen or its derivatives are the only viable decarbonisation approach. These are, for example, processes that require hydrogen as a feedstock or reaction agent, such as steelmaking or where the weight or energy density of batteries hinder direct electrification, such as in long-distance aviation and shipping. In addition, seasonal energy storage and balancing of a renewables-dominated electricity system will, in the mid- to long-term, make room for hydrogen to complement short-term energy system balancing via battery-based technologies. The net-zero scenarios mentioned above project hydrogen to account for 10-25 per cent of the global final energy consumption in 2050.

This policy brief should therefore guide the development of a regulatory framework for a green hydrogen economy in Europe and in the three focus countries – Portugal, Poland, and Germany – to guarantee that hydrogen is well integrated into the broader energy system. This means that hydrogen complements direct electrification, renewable electricity expansion, and efficiency gains, and concurrently contributes to the fast and efficient decarbonisation of the overall system. For this reason, a spotlight is put on the production of green hydrogen, prioritisation of hydrogen use in hard-to-abate sectors, and sustainability criteria and mechanisms to comply with these criteria for both domestically produced and – in particular – imported hydrogen. The proposed guidelines and policy measures aim at shaping the policy landscape until around 2030.

[1] (A) International Energy Agency (2022): Global Hydrogen Review 2022, https://iea.blob.core.windows.net/assets/c5bc75b1-9e4d-460d-9056-6e8e626a11c4/GlobalHydrogenReview2022.pdf [Last retrieved: 2023-10-12].
(B) Agora Energiewende, Agora Industry (2021): 12 Insights on Hydrogen, https://static.agora-energiewende.de/fileadmin/Projekte/2021/2021_11_H2_Insights/A-EW_245_H2_Insights_WEB.pdf [Last retrieved: 2023-10-12].
(C) International Renewable Energy Agency (2023): World Energy Transitions Outlook 2023, 1.5°C Pathway, https://www.irena.org/Publications/2023/Jun/World-Energy-Transitions-Outlook-2023 [Last retrieved: 2023-10-12].

2 Principles to foster sustainability of the EU hydrogen economy

The vision of a hydrogen economy that contributes to a fast and efficient decarbonisation of the energy system and industry, and at the same time is a driver for the fossil fuel phase-out – in particular for natural gas – has to obey the following key principles.

A strong focus on green hydrogen

Only green hydrogen produced via electrolysis of water with electricity derived from renewable sources has a long-term sustainability, scalability, and viability prospect, and should become an essential part of the European energy system. Fossil-based grey hydrogen (the bulk of current production) is no better than natural gas in terms of cost, international dependencies, and environmental impact. While carbon capture may lower CO_2 emissions from fossil-based hydrogen production (termed blue hydrogen in that case) to a certain extent, this technology comes with limitations in effectiveness, costs, and scalability,[2] such as limited capture rates (roughly 60 per cent currently[3]), additional energy consumption for the capture process, high upfront investment costs, as well as significant operating costs or a so far non-existent transmission and storage infrastructure for CO_2. Furthermore, it neither resolves the issue of gas mining environmental impact and supply chain methane leakage, nor does it curb European dependence on natural gas imports. Moreover, it entails a high risk of fossil lock-ins or stranded assets, as the production facilities for this so-called blue hydrogen require large capital-intensive investments which take too long to amortise for them to be in line with climate objectives. Blue hydrogen should thus play a politically clearly constrained role, if any at all, and serve exclusively as a fuel in pilot-stage innovative projects in industry, where early low-carbon hydrogen availability is essential, e.g. for technological learning.

Similarly, hydrogen produced with electricity sourced from the current carbon-intensive European power grids can result in an overall emissions increase and should not be supported during implementation of hydrogen solutions. As hydrogen production with electrolysers is energy-intensive, powering this process with fossil fuels is neither viable nor sustainable. The EU delegated acts have rightly set the bar very high for classifying grid-powered hydrogen as renewable. However, exceptions in the regulations for ‘low-carbon’ electricity grids create privileges for nuclear power-focused national energy policies. It is thereby of particular importance to ensure that no new nuclear power plants are justified by the hydrogen business case.

---

[2] M. Riemer, V. Duscha, Carbon Capture in Hydrogen Production – Review of Modelling Assumptions, Energy Proceedings, Vol. 27, 2022, https://www.energy-proceedings.org/carbon-capture-in-hydrogen-production-review-of-modelling-assumptions/ [Last retrieved: 2023-10-12].

[3] Even though there is a technical possibility to achieve much higher capture rates (90% or above), they have not been demonstrated at large scale*. Today, around 50-60%** of CO_2 from both the production process and the flue gases (resulting from burning natural gas to provide heat for the process) is captured in commercially available plants, which utilise hydrogen in a co-production of ammonia and urea.

*See: International Energy Agency (2022): Global Hydrogen Review 2022, p. 228 (see footnote 1).

**See: Bauer et al., On the climate impacts of blue hydrogen production, Sustainable Energy Fuels, 2022, Vol. 6, pp. 66-75, https://pubs.rsc.org/en/content/articlehtml/2022/se/d1se01508g [Last retrieved: 2023-10-12].

In a nutshell, only green hydrogen ought to play a long-term role in the future climate-neutral energy systems of the EU Member States and should, hence, be prioritised and fostered accordingly. Any support mechanisms should reflect this principle by implementing measures and criteria to assure that green hydrogen – as soon as it is sufficiently available – becomes the preferred option in terms of price for the final consumer.

Sectoral prioritisation of hydrogen use

While hydrogen is a versatile energy carrier that theoretically can be used for a multitude of processes based on fossil fuels today, its production, transportation, and use include considerable energy losses. This makes direct electrification preferable to the use of green hydrogen in terms of energy efficiency. Therefore, in the near- to mid-term, hydrogen use is reasonable only for a selected number of applications.

Clear, no-regret green hydrogen applications are industrial processes where grey hydrogen is already used today, such as in the chemical industry, or where electrification is not readily feasible, such as in steelmaking where hydrogen can replace coal as a reducing agent. Hydrogen could also serve as a long-term energy storage carrier to seasonally balance a renewables-based power system with variable production profiles. The introduction of hydrogen-derived synthetic fuels is expected to play a prominent role in the decarbonisation of long-distance shipping and aviation, as high weight as well as limited range render battery-electric solutions unsuitable for these applications. In heavy-duty long-distance road transport, the competitiveness of hydrogen in comparison with electric vehicles and overhead lines will depend on further technological advances, renewable energy costs, and the availability of key resources for both technologies. However, research and development is currently moving in a direction less favourable for hydrogen in that case.

Adoption of hydrogen in light-duty vehicles, decentralised residential heating, as well as low- to mid-temperature industrial processes should be discouraged since more efficient and economically viable solutions are already available.[4] Blending hydrogen into the natural gas grid will yield only incremental reductions for the emissions balance of the gas system[5] while it perpetuates the use of fossil gas. In urban public transport, hydrogen vehicles have some potential if hydrogen is produced locally at low costs. Battery electric vehicles will generally be cheaper, more energy-efficient, and have better scalability once the charging infrastructure is laid out as planned.

[4] For decentralised heating see: J. Rosenow, Is heating homes with hydrogen all but a pipe dream? An evidence review, Joule, Vol. 6, Issue 10, https://www.sciencedirect.com/science/article/abs/pii/S2542435122004160 [Last retrieved: 2023-10-12].

[5] International Renewable Energy Agency (2022): Global hydrogen trade to meet the 1.5°C climate goal: Part II – Technology review of hydrogen carriers, p. 104, https://www.irena.org/publications/2022/Apr/Global-hydrogen-trade-Part-II [Last retrieved: 2023-10-12].

Overall, the prioritisation and limitation of sectors for hydrogen application will bring hydrogen demand down[6, 7] to numbers which can more realistically and readily be supplied with green hydrogen and will have a two-fold beneficial effect on the overall emissions balance of our economy. Firstly, it will accelerate the phase-out of fossil fuels, in particular in those sectors where hydrogen is not seen as an option for decarbonisation, since alternative options such as direct electrification will be pushed forward there. As a result, green hydrogen will be available sooner and in larger quantities for the prioritised sectors, and the decarbonisation of these hard-to-abate sectors will be accelerated.

Furthermore, sectoral prioritisation of hydrogen use will result in the set-up of geographic clusters with considerable hydrogen demand, for example from industrial users, which are already clustered due to other location factors. This can have a simplifying effect on the required infrastructure to deliver and handle hydrogen and lead to a reduction of financial and material resources to build the corresponding hydrogen grid.

Ambitious sustainability criteria for an international hydrogen market

Although a strong focus should be on domestic decentralised hydrogen production in proximity to its end use, European strategies rightly envision a substantial international (intra- and extra-European) trade in renewable hydrogen and its derivatives by both pipelines and ships. The rationale behind this is that European countries could overcome the technical and economic limitations of their domestic energy markets by buying energy stored in the form of hydrogen and its derivatives from markets generating renewable electricity at lower costs – both in Europe and externally (e.g. North Africa). Such exchange could facilitate the decarbonisation of the European economy, notably its industry, accelerate the global clean energy transition, and provide hydrogen-exporting countries with additional streams of income.

However, the true environmental and socio-political sustainability of a global hydrogen market is by no means guaranteed, and considerable risks exist, such as preserving the unequal global division of labour (with poorer countries exporting hydrogen, a simple commodity, instead of developing their own economies) or the capture of hydrogen income streams mostly by elites (as often happens with oil and gas wealth). EU countries therefore should aim to harmonise their domestic industrial ambitions, considering the global efficiency of hydrogen value chains, with social and economic goals, as set out in the UN Sustainable Development Goals. This includes advocating for sustainability criteria with the highest ambitions across environmental, social, and economic dimensions, such as affordable and clean energy, decent work, economic growth, and reduced inequalities, not only in Europe but also in the countries that are exporting hydrogen outside the EU. Also, the EU and Member States should enter into bilateral partnerships at eye level with export countries where appropriate to support inclusive social and economic development in these countries.

---

[6] As outlined in the study* commissioned by the Greening H2 project consortium and performed by Bruegel, the modelled hydrogen consumptions in the REPowerEU communication of the European Commission are a significant outlier, above both the ambition contained in national strategies and a sensible trajectory as evaluated in the study.
*B. McWilliams & G. Zachmann (2023): Renewable Hydrogen in Germany, Poland, and Portugal, https://www.euki.de/euki-publications/greening-h2-policy-brief/ [Last retrieved: 2023-10-12].

[7] As outlined by Agora Energiewende* a strong focus on electrification along with energy efficiency could reduce the hydrogen demand to one fifth of that foreseen in the REPowerEU plan.
*Agora Energiewende (2023): Breaking free from fossil gas. A new path to a climate-neutral Europe, https://static.agora-energiewende.de/fileadmin/Projekte/2021/2021_07_EU_GEXIT/A-EW_292_Breaking_free_WEB.pdf [Last retrieved: 2023-10-12].

3 Policy levers to ensure these principles

Financial support schemes need to focus on green production and sectoral prioritisation

Following the principles laid out in Section 2, production and use of hydrogen should be considered only when it is part of a significant emissions reduction strategy, and when direct electrification is not feasible. Therefore, direct investment aids, such as under the framework of the *Important Projects of Common European Interest* (IPCEI) or *Projects of Common Interest* (PCI) should be provided only for green hydrogen-related projects in priority sectors where hydrogen is the most promising or only decarbonisation approach: hard-to-abate industries, long-distance aviation and shipping, and ,in the long run, seasonal energy storage.

The concept of carbon contracts for difference (CCfDs), offering financial compensation from the state to emission-intensive industries for increased investment or operating expenditures stemming from low- or zero-emission technologies, can be a powerful tool to incentivise and enable investment decisions into low-carbon industry production. Germany is the first European country to introduce a CCfD framework[8] for its heavy industry, while adoption of a corresponding mechanism at EU level would be important and has been proposed.[9] As many of the low- or zero-emission technologies that would be covered by a CCfD framework involve the use of hydrogen, only the use of green hydrogen should be eligible for compensation in such a framework. However, the German CCfD framework also includes the possibility of state subsidies for blue hydrogen. This is highly problematic because it means public money is spent on a technology that entails great risks for fossil lock-in effects, the expansion of fossil natural gas production, and ultimately rising overall emissions, and it sends a wrong and difficult international signal. Even though the German CCfD framework gives financial priority to green hydrogen over blue, this alone is not enough to counter the danger of fossil lock-ins. Instead, any state subsidies for blue hydrogen should tie its use to strict criteria and rules. On the production side, this includes very ambitious environmental and climate standards, including any upstream emissions in the overall emissions balance. On the application side, projects must continuously check whether the use of blue hydrogen is really necessary. This should be linked to individual project-by-project permits that include a fixed roadmap for the transition to green hydrogen, and which must be reviewed and regranted on a regular basis.

As a de-risking scheme for investments into sustainable hydrogen production, as well as a tool to facilitate renewable hydrogen imports to the EU, the European Commission introduced the so-called European Hydrogen Bank (EHB) in early 2023, which should be operational by the end of 2023. The EHB supports

---

[8] For details see: https://www.bmwk.de/Redaktion/DE/Artikel/Klimaschutz/klimaschutzvertraege.html [Last retrieved: 2023-10-12].
[9] T. Gerres, P. Linares (2022): Carbon Contracts for Differences (CCfDs) in a European context, https://henrike-hahn.eu/files/upload/aktuelles/dateien/Study_CCfD_Henrike-Hahn_6.2022.pdf [Last retrieved: 2023-10-12].

producers of renewable hydrogen through an auctioned fixed price payment per kg of hydrogen produced.[10] This, in turn, enables offering a price to hydrogen consumers that is competitive with current prices for emission-intensive fuels. The EHB idea closely follows and will be interlinked with the German initiative H2Global, which includes a two-sided auction scheme with auctions on the producer and consumer side. With this, the gap between the lowest producer bid and the highest consumer bid should be bridged by state funding. For both mechanisms to ensure the highest possible emissions reductions, and positive environmental, social, and economic effects from hydrogen production projects, strong, ideally internationally valid, sustainability criteria have to be applied for projects to be admitted to the auctions. This should include making environmental and socio-economic sustainability and positive value creation in the producing countries an integral part of the admission criteria. On the consumer side of the auctions, as well as for the off-take agreements included as a prerequisite in the EHB scheme, the design of the mechanism must make sure that the subsidies provided do not tip the balance towards hydrogen use in sectors where other and more efficient decarbonisation options exist.

Regulation of infrastructure development needs to integrate hydrogen into the energy system in a coordinated way and solve the chicken-and-egg problem

Large-scale production, transportation, storage, and use of renewable hydrogen or its derivatives require substantial infrastructure investments and proactive regulatory initiatives in a relatively short time period. The development of additional and large-scale electrolyser capacity presents a serious technical and resource-related (regarding primarily materials and workforce) challenge that necessitates active public intervention (e.g. skills pacts, trade negotiations), private and public cooperation, as well as the intensification of research in order to build a robust electrolyser value chain.

On the transportation side of the hydrogen value chain, the plans for national and trans-European hydrogen pipeline grids need to reflect the principle of sectoral prioritisation. The concept of hydrogen valleys with a focus on demand clusters combined with local and regional production allows for de-risking investments by anchoring early infrastructure around no-regret hydrogen demand, and with this solving the chicken-and-egg problem. To support this concept, proactive regulatory initiatives that include state involvement in planning processes are required. Furthermore, in parts of the hydrogen value chain, there is potential to adjust existing natural gas infrastructure to the needs of hydrogen or derivative fuels. However, from a climate perspective such repurposing will only make sense for parts of the natural gas infrastructure and a significant fraction of the existing grid will have to be decommissioned.[11] This might create social challenges that need to be addressed and solved in a coordinated grid development strategy.

Furthermore, through electrolysers, as well as to some extent through hydrogen-based electricity grid balancing, electricity and hydrogen infrastructures may become closely interlinked. Therefore, an inte-

[10] DRAFT economic Terms and Conditions (T&C) of the 2023 Innovation Fund Pilot Auction for renewable hydrogen production: https://climate.ec.europa.eu/system/files/2023-03/policy_funding_innovation_draft_term_conditions_pilot_auction_en.pdf [Last retrieved: 2023-10-12].

[11] Agora Energiewende (2023): Breaking free from fossil gas. A new path to a climate-neutral Europe. See footnote no. 7.

grated planning process for the entire energy system becomes of central importance. Such interlinked planning processes for hydrogen, natural gas, electricity, and ultimately also district heating as well as CO_2 grids, will need to be introduced from the transnational down to the regional and local level, always considering energy efficiency and the phase-out of natural gas within the next three decades. In this context, particularly for regions with large renewable energy potential that can act as energy exporters (such as Portugal and Spain), the question of whether to focus, and to what extent, on electricity or hydrogen transport infrastructure needs to be addressed and the suitability of existing oil and gas infrastructure for the future energy system need to be evaluated.

When it comes to the installation of new or repurposed gas pipelines, as well as power plants and other components of infrastructure (e.g. storage, industry assets), it is of central importance to apply strict criteria in terms of full hydrogen readiness. This means the transition to using green hydrogen in these installations must be possible without major retrofitting, which avoids high investment costs or stranded assets. However, in any case, eventual hydrogen adoption cannot serve as a rationale for exacerbating European gas dependence, especially in easy-to-electrify sectors such as household heating or cooking.

Ambitious and progressive quotas for green hydrogen use in no-regret sectors need to be introduced

A key demand-side support mechanism that can foster the uptake of green hydrogen and de-risk investments into production facilities is binding quotas for the use of green hydrogen or derived fuels in specific application sectors. Such quotas already exist in the aviation sector, where the ReFuelEU aviation regulation sets mandatory minimum shares for sustainable aviation fuels, with a specific sub-quota for green hydrogen-based fuels starting in 2025. However, the ambition level with a quota of only 1.2 per cent green hydrogen-based fuels in 2030, 5 per cent in 2035, and progressively reaching 35 per cent in 2050,[12] needs to be increased if the EU wants to meet its climate targets. The general approach, however, is to be endorsed and should be expanded to other transport sectors, such as long-haul shipping, as well as to industries (e.g. the chemical industry), where grey hydrogen is used today. In addition, quotas in sectors such as the steel industry, where green hydrogen will be key to new zero-emission production technologies, can boost the hydrogen uptake and at the same time accelerate the transformation of production facilities in these sectors. These quotas must then be combined with internationally recognised certification schemes for green and fair hydrogen, derived fuels and hydrogen-based primary materials such as green steel. In this way, additional upstream quotas in the value chain, such as for the use of green steel in the automotive sector, can be introduced. This can further enhance the uptake of green hydrogen, as well as materials and final products based on it. At the same time, it is essential that any quota regulation is limited to hard-to-abate sectors and hence respects the principle of sectoral prioritisation.

[12] For details see: https://www.europarl.europa.eu/news/en/press-room/20230424IPR82023/fit-for-55-parliament-and-council-reach-deal- on-greener-aviation-fuels [Last retrieved: 2023-10-12].

About us

Instrat

Instrat is a Warsaw-based think tank with a mission of supercharging policies and public opinion with open data and research for a fair, green and digital economy.

Zero

ZERO – Association for the Sustainability of the Earth System is a Portuguese environmental NGO with the main goal of promoting sustainability as the cornerstone of public policies, not only in Portugal but also throughout Europe. At ZERO, we firmly believe that striking a balance between the environment, society, and economy is essential to construct a more socially and economically cohesive world while fully respecting the planet's natural limits. ZERO engages in several significant activities, including monitoring public policies, promoting and encouraging public participation through awareness and educational campaigns, disseminating scientific knowledge, collaborating on research projects, and developing sustainability-related initiatives. These efforts are aimed at boosting social participation, whether through our independent initiatives or in cooperation with other partners.

Germanwatch

Following the motto of Observing. Analysing. Acting. Germanwatch has been actively promoting global equity and livelihood preservation since 1991. We focus on the politics and economics of the Global North and their world-wide consequences. The situation of marginalised people in the Global South is the starting point for our work. Together with our members and supporters, and with other actors in civil society, we strive to serve as a strong lobbying force for sustainable development. We aim at our goals by advocating for prevention of dangerous climate change and its negative impacts, for guaranteeing food security, and for corporate compliance with human rights standards. Germanwatch is funded by membership fees, donations, programme funding from Stiftung Zukunftsfaehigkeit (Foundation for Sustainability), and grants from public and private donors.

About the project

The “Green(ing) H2 Project” aims to empower civil society – such as NGOs, think tanks and associations, to engage actively in the hydrogen debate and to support the policy processes on EU level as well as in Poland, Germany, and Portugal as countries that hold key roles in advancing the hydrogen economy in Europe. The first step on this way was to build a cross-European network of organised civil society actors who are interested or involved in green(ing) hydrogen at the European and national levels as well as encouraging and facilitating exchange of knowledge and perspectives. This network constitutes the basis for the second step, which was to develop the here presented guidelines for policy makers. These guidelines spell out principles that should guide the development of a regulatory framework to advance a green hydrogen economy in Europe. The project members will disseminate these guidelines among civil society organisations and government ministries to support the policy processes that pave the way for the further advancement of a truly net-carbon free hydrogen economy.

Authors: Dr. Simon Schreck (Germanwatch), Michał Smoleń, Wojciech Żelisko (both Instrat), Dr. Rita Prates (ZERO)

Edited by: Anna Brown (Black & White)

You can download this paper here: https://www.euki.de/en/euki-publications/greening-h2-policy-brief/

October 2023

Publisher:

Germanwatch e.V.
Stresemannstr. 72
D-10963 Berlin
info@germanwatch.org

ZERO - Associação Sistema Terrestre Sustentável
Av. de Berna 31, 2º D (S6)
1050-038 Lisboa, Portugal
zero@zero.ong

Instrat Foundation
ul. Hoża 51
00-681 Warsaw, Poland
info@instrat.pl

Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag

European Climate Initiative EUKI

This policy brief has been prepared by the Greening H2 consortium funded by the European Climate Initiative (EUKI), a project financing instrument by the German Federal Ministry for Economic Affairs and Climate Action.

instrat GERMANWATCH zero.