

Transforming industry towards a low-carbon future - a specific view on green hydrogen

Nordic-German roundtables

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Final report



Introduction

Between the 21st and 23rd of November 2021, the Konrad Adenauer Foundation's Nordic Countries project hosted a series of roundtable discussions in Luleå, Sweden, on the transformation of industry towards a low-carbon future, focusing on the role of green hydrogen. The roundtable discussion was part of the KAS Nordics project "Innovation for Sustainable Development in the Nordics".

Representatives from Germany, Norway, Finland, and Sweden working in politics, industry and academia were invited to the event. The goal of the roundtable discussions was to explore challenges and innovation potential for the sustainable development of a green hydrogen economy.

During the discussions the following topics were covered:

- › Policy challenges and Innovation in accelerating the transition towards a green hydrogen economy.
- › The economic viability of a green hydrogen economy and how to scale up the implementation of a green hydrogen economy in Europe.
- › Regional development aspects of the transition towards a green hydrogen economy.

We have summarized the results of the talks in this report to provide insight into the thoughts and ideas raised during the discussion series, as well as to stimulate future discussion on the topics covered. We have concentrated on the questions that were raised, the obstacles that were explored, and the innovative solutions that were proposed.

In summary, among the most significant obstacles repeatedly raised was a looming electrolyser production bottleneck, several limitations related to the current EU hydrogen strategy, challenges related to the rapid building up of renewable energy sources along the northeastern coast of Sweden, and the risk of national and EU regulation hindering necessary future hydrogen-related innovation.

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Summary

The roundtable discussion about the transition to a green hydrogen economy revealed that there is still a lot to be done on the European, but also the national and regional levels, in order to make the vision of a fossil-free industry a reality.

The European Union needs to regulate the functionality of and set targets for hydrogen

The general tenor of the roundtable was colored by participants' discontent with the integration of green hydrogen matters in the EU Fit for 55 package. The EU's good will was acknowledged, but the EU's integrated approaches for hydrogen and hydrogen-related matters such as electrolyser manufacturing facilities were seen as lacking by the roundtable attendees.

Thus, the enactment of functional European legislative frameworks and standards, as well as common definitions and safety regulations were considered the most pressing issues still needing to be resolved under the auspices of the EU. Nevertheless, it became clear that the regulation should not control the choice of technology or means of producing the low-carbon hydrogen, but should set emission targets and regulate the functionality that technological change aims to achieve in order to enable further innovation and development. Otherwise, improper regulation risks actually stifling innovation and technological developments. It should be noted that according to the IEA, carbon neutrality 2050 requires broad adoption of technologies that are still in development. By 2050, over half of CO₂ emission reductions will have to come from currently prototyped or proved technology (IEA, 2021).

Furthermore, European institutions' funding of innovation projects was discussed, including whether only large scale projects should be funded, or if also more comprehensive funding should be offered to smaller promising initiatives. As part of the first Innovation Fund call with a budget of a total of EUR 1.5 billion for large-scale decarbonization projects, only seven out of 311 applicant projects around Europe were chosen for funding (European Commission, 2021). Three of these seven projects are from the Nordic countries - two from Sweden and one from Finland.

The first call for small-scale projects with a total budget of EUR 100 million to develop ground-breaking technologies in renewable energy, energy-intensive industries, energy

storage, and carbon capture, use, and storage received 232 applications, with 32 successful applicants invited to begin the grant preparation process (European Commission, 2021a). The role of demonstration sites as part of the funding structure was discussed, as for example LKAB's, Vattenfall's and SSAB's joint HYBRIT demonstration plant was granted funding from the large-scale project fund.

The effectiveness of the EU's Hydrogen project funding was also discussed, as well as the viability and future prospects of numerous of the applicant initiatives which were not granted funding. It was concluded that investments are available, but that the sticking point lies in the coordination and balancing of initiatives that are supported. Sustainable public and private finance thus can make a difference. As an example, pension funds like the Pension Denmark fund were mentioned.

There was also agreement among the roundtable participants that Germany should be able to wield great influence on European-level policymaking. This was also taken as a risk - some German choices on the "Energiewende" are seen as "ecopopulist" in parts of the Nordic countries. On the other hand, with their influential projects on the European level, the Nordic countries are strong partners in sustainability projects. For this very reason, strengthened Nordic-German cooperation is crucial in order to better support promising initiatives and innovations on the road towards a low-carbon Europe.

The *principle of additionality* was also intensively discussed during the Luleå roundtables. In brief, the requirement of additionality means that renewable electricity used to produce green hydrogen is built in addition to existing renewable electricity production already going towards meeting renewable penetration targets as pertains to final electricity consumption. From the viewpoint of most present Nordic roundtable participants, an overly strict requirement of additionality was deemed extremely counterproductive from all participants' point of view, as the Swedish and Finnish energy grids are already very clean in comparison to the energy grids of countries such as Germany (Hydrogen Cluster Finland 2021 White Paper, p. 8).

Hydrogen is no silver bullet, but an important piece of the energy puzzle that must be scaled up despite remaining uncertainties

How accurately can we predict the future of technology in a fast changing world? This question was asked with regards to the future development of the green hydrogen market and the future economic viability of hydrogen. What has become clear is that there is no turning back on the road towards a low carbon future, as both politics and industry see a genuine low carbon transition as an absolute prerequisite for a livable

future on this planet. In fact, green hydrogen and green hydrogen demand are vital questions of national energy security for many countries, especially against the background of a great number of unknown scenarios.

Thus, while there is no definitive answer to the question of how to most efficiently scale up Europe's hydrogen economy, various recommendations and unanswered questions remain.

The participants agreed the European Union must be, and arguably already is, a forerunner on hydrogen in the EU. The European Clean Hydrogen Alliance is supporting over 750 projects alone (European Commission, 2021b). Again, the debate during the Luleå roundtables circled around whether to primarily encourage already established industry players, such as the joint HYBRIT venture of the three established actors Vattenfall, SSAB and LKAB, or comparably newer actors such as H2 Green Steel.

Throughout the roundtables, it was also repeatedly noted that resistance from (usually already established and carbon intensive) industry actors risked disadvantaging the zero carbon transition, leading to potential policy roadblocks that proactively need to be prepared for.

The role of national carbon price systems and the EU Emissions Trading System was also discussed, as was the rising EU carbon price, as well as the effect of the increasing carbon price on the economic viability of the emerging European hydrogen economy. The participants agreed that a higher-level carbon pricing system, potentially even a global one, would be necessary for a genuine green industrial transition. On the basis of the already noted actual carbon price increases since the introduction of the EU emission trading scheme, the participants overwhelmingly expected the carbon price to continue to sharply increase over the next few years, further cementing Europe's shift towards carbon-free technologies. In order to do so, the access to different sources of funding, greater cross-sectoral collaboration, and the stimulation of European hydrogen demand were considered crucial.

Geographical differences between and within countries reveal the importance of different strategies

Geographic differences in opinion as to how best to scale up the hydrogen economy were also noted. For Germany, for instance, hydrogen imports from other countries will be crucial for the successful scaling up of the German hydrogen economy. At the same time, many other countries have not yet developed their own hydrogen export strategies,

which currently makes it difficult to foster early agreements between Germany and potential German hydrogen partners. To complicate things further, in Germany the debate to scale up the hydrogen economy revolves around the question of so-called Carbon Contracts for Difference (CCfDs). Such carbon contracts can help reduce price volatility by putting a strike price above a carbon market price.¹

The situation in some of the Nordic countries in some aspects differs from the situation in Germany. In the cases of many other countries, such as Sweden, any large-scale export of hydrogen has not yet been officially planned for. In Finland, in contrast to Germany, would partially rely on nuclear power for its planned hydrogen transition, making so-called "pink hydrogen"² an important piece of the puzzle in the future Finnish hydrogen mix. Next to already existing nuclear plants, around 3 GW of new Finnish nuclear facilities are under construction or being planned (Clicinnovation, 2021).

At this point of the roundtable discussion, the issue of how to best define "clean" hydrogen and measure hydrogen's CO₂ footprint came up. A uniform lifecycle evaluation might be necessary to determine actual hydrogen-related CO₂ emissions in order to choose the most sustainable paths forward. In the end, the question about how to best prioritize between green, blue, turquoise, and pink hydrogen production remained unanswered, however.

Differences in attitudes and preferences can also be found within countries, however. Such differences for instance exist between northern and southern Sweden, leading to sometimes very different regional conversations and preferences concerning the best way forward for any future hydrogen economy. Southern Sweden has a high demand for electricity from the north, which raises the question of how to best balance Swedish domestic energy demand with the potential to export hydrogen produced with cheap renewable electricity produced in Sweden's north.

¹ Selling carbon reductions or surplus permits on the carbon market is a risk that investors in new low-carbon industrial technology must consider. This is owing to the legislative ambiguity around taxes and carbon markets (which promotes supply) as well as the unpredictable growth of low-carbon technology (which drives demand). A Carbon Contract is an agreement between a government or institution and an agent on a set carbon price over time. This agent can then sell any carbon emission reductions (or allowances) at the specified price during the contract period. Carbon Contracts for Differences (CCfDs) are created by putting a strike price above a carbon market price (a two-sided option) (2017). The agent gets the difference if the market price is lower than the striking price. If the market price is greater, the agent must reimburse the government (Gerres & Linares, 2020).

² Pink hydrogen is produced using nuclear energy-powered electrolysis. Nuclear-produced hydrogen can also be referred to as purple hydrogen or red hydrogen.

In this context, increasing energy prices were mentioned as a potential threat for the public support of new energy projects, as previously uncommon (or for many unheard of) new projects and technologies may be blamed for future energy price increases. The question of higher energy prices, however, will increasingly be a pan-European issue, which makes collaboration between countries even more crucial in order to avoid market instability, social unrest, and rising inequality.

Finally, the scaling up of the green hydrogen economy requires an even faster expansion of renewable energy production. In this context, the critical availability of rare raw earth elements and other necessary finite resources was seen as a potential future impediment to progress.

Partnerships: great potential for Germany and the Nordic countries as future hydrogen business partners

Germany's domestic hydrogen demand is approximately 55 TWh at present, and is expected to rise to between 90 and 110 TWh by 2030 (BMW, 2020). Nevertheless, according to Germany's National Hydrogen Strategy, only a part of this demand will be covered by German domestic hydrogen production. More precisely, Germany intends to build up to 5 GW of generation capacity, which will include both offshore and onshore facilities. This would equate to 14 TWh of green hydrogen generation, and will need the use of 20 TWh of renewable energy. Thus, Germany would need to import 70 to 80% of its hydrogen in the future in order to meet the energy needs. To fulfill part of this German hydrogen import demand, the Nordic countries with their abundance of renewable electricity production could be valuable geographically close, politically stable, and democratic partners.

Nevertheless, Germany is already signing hydrogen partnerships with Namibia, Australia and West African countries and is looking for partnerships with countries in the Middle East and Northern African region like Saudi-Arabia, where electricity currently costs around one EUR-cent per kWh (production price). So far, however, no official German partnership with any Nordic country has been planned. The question remains where the new German government will set the priorities. According to the coalition treaty of the new Scholtz-led Social Democrat/Liberal/Green German federal government, the "traffic light" coalition wants to drive technological innovation in the MENA region through climate partnerships with selected partners, and cooperate more with Russia on future issues like hydrogen and climate change (SPD, Bündnis 90/die Grünen & FDP, 2021).

Overall, the roundtable discussions concluded that hydrogen partnerships are indispensable and necessary in order to foster a functioning European hydrogen economy. As an example of new such potential partnerships, possible future cooperation between Finland and Germany were discussed. The BotHönia initiative (see example box 1 below), for instance, has highlighted a potential 115 GW of planned new wind energy capacity in Finland in September, with rising numbers (Clicinnovation, 2021). As noted by one of the roundtable participants (as of November 2021), circa 140 GW of new Finnish wind power, plus an additional 5-10 GW on the Åland islands, is currently in various stages of the electrical grid-connection permitting process (Fingrid, 2021).

Example box 1: The BotHönia initiative (Clicinnovation, 2021)

The BotHönia is an international initiative that aims at building a large-scale hydrogen economy cluster around the Gulf of Bothnia and the Baltic Sea. It acts as a unifying brand and platform for hydrogen-related activities. It will be utilized to facilitate communication across projects and to promote the area's hydrogen-related technologies and manufacturing.

Holistic thinking is key for policymaking that can keep pace with technological innovation

While technological innovation develops at a tremendous speed, policymaking processes tend to grind slowly. Therefore, in one roundtable session we asked how we best can design policymaking to most efficiently approach challenges that require fast and systemic solutions?

An allegory helps to summarize the shared perception of the necessity to think bigger and bold: Rather than focusing on the design of the construction components, imagine the final appearance of the cathedral. Envisioning what the future should and needs to look like may open the door for unforeseen innovation possibilities.

In practice, the cathedral construction allegory touches upon several challenges that policymakers must face when dealing with fast-paced technological innovation. First and foremost, "silo mentalities" can slow down permit and regulatory processes, making legislation obsolete quickly if not updated regularly. Secondly, the multifaceted and multidimensional nature of many policy challenges make it difficult to establish or adapt regulations, as regulatory aspects in many cases need to be implemented across several lines of work and many institutions. As a result, innovation in public institutions and

policy-making is required to provide a comprehensive approach that incorporates legal clarity and efficacy, cooperation and learning, as well as sustainability and ethics. A collaboration model for public agencies was presented as part of Jon Simonsson's presentation at the Luleå roundtable (see figure 1).

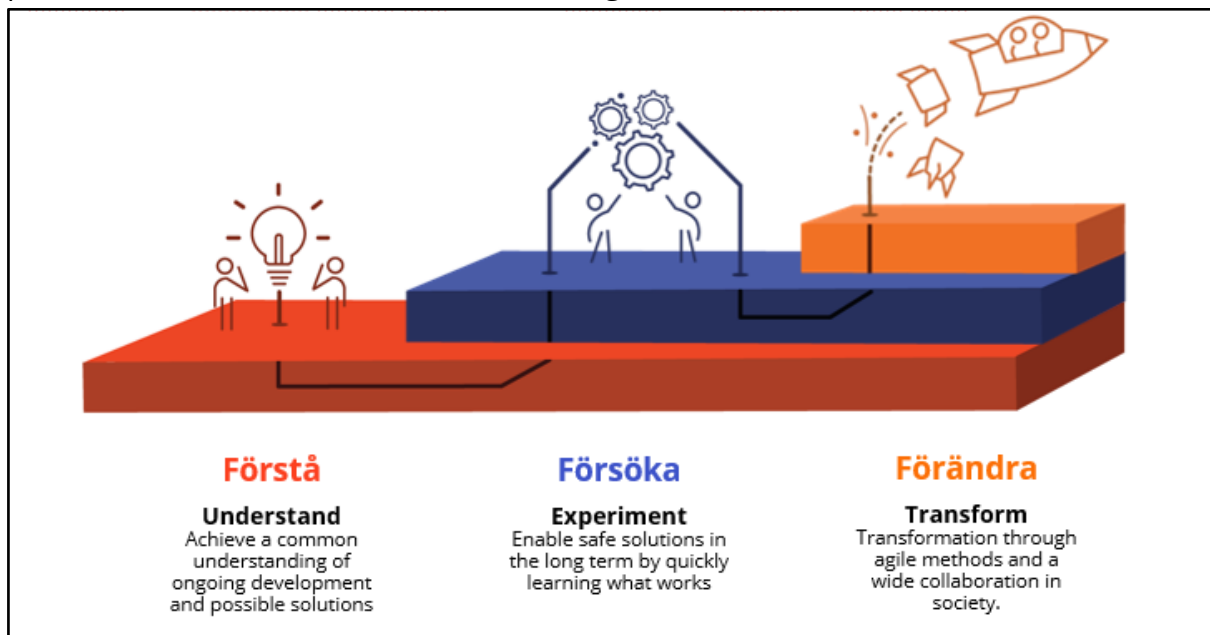


Figure 1: 3F- collaboration model (Source: Jon Simonsson)

In order to test new innovative processes in public institutions, courage is needed. For instance, the Swedish tax agency ("Skatteverket") was mentioned as an example of a "brave" innovative policymaking actor, as it has conducted beta tests with companies and citizens before rolling out the same reforms to larger audiences. In Germany, so-called regulatory sandboxes ("Reallabore") were raised as interesting examples of promising implementation strategies towards improved regulatory experimentation (see example box 2).

On a European level, the European Council approved a series of conclusions in November 2020 on the relevance of regulatory sandboxes and experimentation provisions in an innovation-friendly, future-proof, sustainable, and resilient EU regulatory framework (European Council, 2020).

The correct interpretation of already enacted regulations is also a recurring point of contention. Thus, so-called "one desk stops" can facilitate communication between regulators and their users. In Sweden, collaborative partnerships fostering bottom-up initiatives enable collaboration toward quick resolutions of many regulatory difficulties. That can refer to a particular agency, like for example KOMET (the Committee for Technological Innovation and Ethics) or Fossil Free Sweden which are examples of

successful collaborative partnerships between the government and the industry (see example box 3).

Example box 2: Regulatory sandboxes / “Reallabore” (BMWI, 2021)

Regulatory sandboxes enable the testing of novel technologies, goods, services, or methods that do not entirely comply with the existing legal and regulatory framework in a real-world setting. They function for a short period of time and in a restricted area within a sector or area. The objective of regulatory sandboxes is to gain knowledge about the potential and hazards associated with certain innovations and to establish the appropriate regulatory framework to accommodate them. Experimentation clauses are frequently used to establish the legal foundation for regulatory sandboxes.

Sandboxes are becoming increasingly crucial for Germany's attractiveness as an innovation hub. They are used by innovative businesses, public authorities, and academics to test concepts that were unthinkable just a few years ago, such as driverless cars, drones, or ships, as well as novel solutions for telemedicine and public administrations. Simultaneously, regulatory sandboxes contribute to regulatory advancement through regulatory learning.

Regulatory collaborative efforts can help to identify horizontal challenges across sectors, and foster a more coherent positive and constructive public narrative around the hydrogen transition, which in turn can enable more constructive future debates. Nevertheless, top-down and bottom-up approaches to policy making were discussed.

To summarize, it is critical to have a comprehensive, holistic view of energy challenges in order to visualize the overall "cathedral" that needs to be constructed by different actors on different levels. In the case of hydrogen, an example of a comprehensive strategy is Finland's new climate and energy policy, which suggests integrating hydrogen into a variety of sectors.

Example box 3: Komet and Fossil Free Sweden (Fossilfritt Sverige, n. d.; Komet, n.d.)

The Swedish Government formed the *Committee for Technological Innovation and Ethics* (Komet) on August 14, 2018. Its aim is to assist the government in identifying policy challenges, minimizing regulatory ambiguity, and expediting policy formulation related to fourth industrial revolution technology.

The Committee provides policy recommendations to the Government and, when appropriate, also conducts reviews about the need to adjust regulatory structures. The Committee is assisted by a reference group comprised of individuals from government agencies, business, and organizations with experience in policy creation.

Fossil Free Sweden is working to increase the pace of the climate transition. The goal is to build a strong industrial sector and to create more jobs and export opportunities by going fossil free. It was started at the initiative of the Swedish Government in 2015 ahead of the major UN climate conference in Paris and brings together actors in the form of companies, municipalities, regions and organisations that give their backing to the declaration that Sweden will be one of the first fossil free nations in the world.

The initiative is run by an office headed by a national coordinator. By working with companies, industries, municipalities and regions, Fossil Free Sweden is identifying obstacles and opportunities in order to accelerate developments. On that basis, Fossil Free Sweden produces political proposals that are presented to the Government and brings together actors to implement measures.

Fossil Free Sweden has a unique role between the business sector and politics, in the form of various ministries and Riksdag parties, in finding common ways ahead so as to speed up the transition to a fossil free welfare nation.

22 business sectors have produced roadmaps for fossil-free competitiveness within the frame work of Fossil Free Sweden. The roadmaps contain both commitments and political proposals. Fossil Free Sweden works to make the implementation of the roadmaps possible and are also developing strategies around different areas to speed up the transition.

Establishing hydrogen ecosystems on a regional level requires collaborative efforts and a systemic transition

The rapid growth of northern Sweden's Norrbotten region toward becoming a "New Green Ruhrgebiet" demonstrates how future formation of hydrogen ecosystems might progress and what opportunities and obstacles exist (see example box 4). Planning and infrastructure permit processes need to be adapted in order to accelerate the update and expansion of the power grid. The most significant result is that building such systems

needs a collaborative effort involving all stakeholders and having an impact on the entire system. Historical examples have demonstrated the difficult investments previously needed to transform northern Sweden, with lessons from history potentially acting as examples of best (and worst) practice.

Scaling up the hydrogen economy means that regions are forced to deal with big investment projects in relatively short timeframes. For example, current prognoses estimate that the Norrbotten region will need around 100,000 new inhabitants by 2040, a very significant increase of its current population of approximately 270,000. Luleå, Norrbotten's largest city, currently only has around 80,000 inhabitants. Apart from the rapid building up of industrial infrastructure, it is vital to develop and maintain an attractive working and living environment in order to be able to attract the necessary highly skilled staff and their families from traditionally more attractive and established regions such as Stockholm. Particular attention should be given to the employment needs of all adult family members in families that might consider relocating to Norrbotten.

To further complicate the labor challenges faced by northern regions such as Norrbotten, it is risky to confuse optimal policies towards attracting and retaining long-term labor influxes with policies designed to attract and only briefly retain short-term labor influxes. For instance, temporary labor influxes, which will be needed during the region's rapid expansion and build-up phase, might motivate policies that are not socially or economically sustainable in the long run. As an example of this, short term low quality housing, originally designed as temporary accommodation, risks being used in the long run as suboptimal housing for lower income families.

Example box 4: The Norrbotten region's economic development (DW, 2021; The Guardian, 2021; H2 Green Steel, n. d.; HYBRIT, n.d.; Monocle 2021)

Norrbotten, which is about the size of Austria and accounts for more than 20% of Sweden's geographical mass, is establishing itself as a leader in the rapidly growing renewable energy and high-tech industries. Thirty years ago, the region was characterized by significant unemployment and brain drain. Norrbotten now boasts Sweden's second-highest gross regional domestic product with an unemployment rate that hovered around 5% prior to the pandemic.

Hundreds of billions of Swedish kronor are planned to be invested over the next two decades in new projects along the Norrland coast's economic cluster. For example, this involves the development of Northvolt in Skellefteå, more investments in

Furthermore, labor immigration in historically comparably homogenous regions such as the Swedish and Finnish Arctic and Subarctic might also pose obstacles. Special attention should be drawn to the spillover effects of developments in hydrogen-strong regions on

other more energy dependent regions, which might become dependent on energy supplies from energy exporting regions. As an example of this regional dependency dynamic, northern and southern Sweden as well as northern and southern Germany were mentioned, as the energy production in both states would happen in the north, while the south remains dependent on the energy supply.

Higher energy prices and looming energy shortages could also be of major consequence for the establishment of new energy policies. In Germany, hydrogen clusters are currently the most developed in the Ruhr region, northern Germany, and parts of eastern Germany.

Nevertheless, all of the so far mentioned challenges also provide many opportunities for the development of more modern, diverse, vital, and competent future regions. Furthermore, the role of Small and medium sized Enterprises (SMEs) and academia in hydrogen ecosystems was discussed, as while SMEs may very well consider integrating hydrogen in their systems, they will not necessarily make hydrogen into their primary business. The role of academia and research institutions was deemed critical in educating the future workforce in necessary skills, while at the same time stimulating social acceptance of hydrogen projects via better education and sharing of knowledge.

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