



Global Renewable Energy Forum 2020

For increased Implementation and accelerated Action

September 24, 2020 (Thu), 14:00-17:00
Online Conference

SUMMARY REPORT



Botschaft der Republik Korea
Außenstelle Bonn
주독일 대한민국대사관 본분관

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PART 1

Global Renewable Energy Forum 2020



OVERVIEW OF GREF 2020

The 4th edition of the Global Renewable Energy Forum (GREF) was organized by the Embassy of the Republic of Korea, Bonn Office, Germany, in cooperation with the International Renewable Energy Agency (IRENA) and the UN Climate Change Secretariat (UNFCCC) on September 24, 2020. It was supported by the Korean-German Energy Partnership of the Ministry of Trade, Industry and Energy, Republic of Korea, and the Federal Ministry for Economic Affairs and Energy, Federal Republic of Germany.

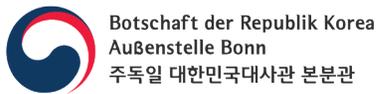
Despite an urgent need for reduction, global greenhouse gas emissions continued to rise in the pre-coronavirus period demonstrating that more ambition is required to achieve the 1.5°C target of the Paris Agreement. For that goal to remain in reach, the 2020s need to be a critical decade for climate action. Renewable energy plays a key role for that matter. While it has become a mainstream energy and outpaced fossil fuels seven years in a row, its deployment must speed up drastically to meet climate targets, and economic stimulus programs addressing the pandemic must focus on a green recovery. Likewise, green hydrogen is gaining more importance as the missing link of the energy transition and can play a crucial role in further shifting the world towards a future powered by renewables.

Against this backdrop, GREF 2020 dealt with green recovery programs, accelerating renewable energy action, and the future of green hydrogen. Two substantial sessions focused on the potentials to accelerate renewable energy expansion as well as on the key role of green hydrogen as an option for decarbonizing high-emitting industries in which a low share of renewables remains a challenge and for different forms of transport, including heavy mobility and shipping.

The partners of GREF 2020 were Eurosolar, ICLEI – Local Governments for Sustainability, the World Wind Energy Association (WWEA), Germanwatch, the hydrogen and fuel cell center (ZBT), the German Association for Gas and Water (DVGW), the International Geothermal Association (IGA), the EnergyAgency.NRW, and UNIDO ITPO Germany.

While the three previous conferences in 2016, 2017, and 2019 took place in Bonn, GREF 2020 was organized as an online conference¹. This also allowed the conference to have a global audience.

Co-organizers



Partners



¹ The video of the conference is available here: <https://www.youtube.com/watch?v=1e5PEzfT1yE>.

Key Findings of GREF 2020

Key findings of Session 1: Accelerating Renewable Energy Action

Key aspects for increasing the uptake of renewables were identified, namely: more investments in renewables, more renewable electrification and energy efficiency, expanded electric grids, more enabling policies and policy frameworks, increased flexibility, more social acceptance, a much more integrated approach, enhanced international cooperation, and more equity.

- » The post-COVID-19 recovery must be an agenda of resilience, development, and equality. Short-term recovery measures must be aligned with the long-term strategy to reinforce the energy transformation. Thus, public finance needs to be used strategically to recover from the pandemic with investments in renewable energy assets.
- » Increasing electrification with renewables and energy efficiency can provide more than 90% of the mitigation measures needed to reduce energy-related CO₂ emissions by 2050, but much more ambition is required to make it happen.
- » Increasing investments in clean energy five-fold to reach cumulative clean energy investments amounting to 49 trillion USD by 2030 is needed to reach climate targets.
- » The need to move from a power transition to an energy transition, as the shares of renewables remain low in transport, as well as heating and cooling, while the power sector is on track with a renewable energy share of 26.4% in 2019.
- » Socio-political acceptance, market acceptance, and community acceptance are key to building public support for renewables.
- » Electrification is the cornerstone in achieving full decarbonization (which must be achieved in Europe well ahead of 2050): accelerating decarbonization requires giving priority to electrification, which requires deploying more powerlines.
- » The energy transition needs flexibility as the future energy systems will have large shares of fluctuating renewable energy sources. Demand-side flexibility is one of the key factors for integrating renewable energy sources to support the grids and/or electricity markets.
- » There is much demand-side flexibility potential in electricity-intensive industries as well as from new technologies, like heat pumps, battery storage, and electric vehicles, particularly in low-voltage grids, which will substantially increase until 2050.
- » Involving and mobilizing citizens is paramount for the energy transition. Citizens must not only accept the transition but become supporters and drivers of it.
- » Community energy leads to a more democratically organized energy sector.
- » Ownership is a key element in renewable energy and the need to overcome the so-called 'equity/financial gap' to ensure that people have access to ownership, particularly in developing countries.
- » Supportive and inclusive frameworks and policies are needed for community energy: auctions are non-discriminatory, while feed-in tariffs tend to exclude small investors.

Key findings of Session 2: The Future of Green Hydrogen

- » Green hydrogen, and its derivative fuels, constitute a solution for end-use sectors that are hard to directly electrify, such as aviation, shipping, heavy-duty mobility, and industry, and which pose a challenge for the energy transition.
- » Green hydrogen will increase flexibility of power systems, particularly with regard to the so-called 'last mile' and for the so-called 'adequacy challenge' of the power sector in times of sustained unavailability of renewable energy that can last for days.
- » Green hydrogen is critical for reaching climate neutrality by 2050. To reach zero emissions by 2050, green hydrogen production must reach 19 exajoule (EJ), hydrogen production costs must drop to 0.9-2 USD per kilogram (currently 4-8 USD), and electrolyzer capacity for green hydrogen production needs to increase to 1,700 gigawatts (GW) (currently 0.2 GW). At least 7,500 Terawatt hours (TWh) of renewable electricity is needed for this amount of green hydrogen production.
- » As renewable electricity costs have substantially decreased, reducing electrolyzer costs remains a key challenge for producing competitive green hydrogen.
- » Scaling up the hydrogen value chain constitutes the main driver for cost reduction and enhancing the competitiveness of green hydrogen.
- » The scale-up in electrolyzer capacity is progressing with promising developments towards 100-megawatt (MW) electrolyzers and beyond. This rapid scale-up is needed to achieve ambitious hydrogen targets, i.e., in the European Union.
- » The world's largest proton exchange membrane (PEM)-electrolyzer (10 MW) is being constructed at the Shell Rheinland Refinery in Wesseling, Germany, by the REFHYNE project. It is paramount to use such projects to demonstrate the application case for green hydrogen in industry to develop a regulatory framework to attract investments for larger electrolyzers.
- » There are promising developments for the application of green hydrogen to decarbonize heavy industry (i.e., producing low-carbon steel) and heavy mobility (i.e., long-haul heavy-duty fuel cell trucks and hydrogen-powered zero-emission trucks).
- » The entire supply chain for hydrogen-powered ships is being developed in the Hydrogen Green Mobility Regulatory Free Zone in the Korean city of Ulsan.
- » Hydrogen must be produced sustainably and applied responsibly.

Program

14:00-14:05 **Welcome Address** by Dooyoung Lee, Consul General, Embassy of the Republic of Korea, Bonn Office

Keynote Speeches: The Green New Deal

14:05-14:10 Patricia Espinosa, Executive Secretary, United Nations Climate Change (UNFCCC)

14:10-14:15 Dr. Dolf Gielen, Director, Innovation and Technology Center, IRENA

14:15-14:20 Dr. Christine Falken-Grosser, Head of Division 'Bilateral Energy Cooperation', Federal Ministry for Economic Affairs and Energy

14:20-14:25 Paula Abreu Marques, Head of Unit "Renewables and CCS policy", DG Energy, European Commission

SESSION 1: Accelerating Renewable Energy Action

14:30-14:37 **"The Impacts of the Coronavirus Pandemic on Renewable Energy Expansion"**
Dr. Ricardo Gorini, Head of Renewable Energy Roadmaps, Innovation and Technology Center, IRENA

14:37-14:44 **"Overcoming Barriers to Renewable Energy Expansion"**
Rana Adib, Executive Director, REN21 - Renewable Energy Policy Network for the 21st Century

14:44-14:51 **"Achieving a 100% Renewable Electric Grid"** Antonella Battaglini, Chief Executive Officer, Renewable Grid Initiative

14:51-14:58 **"Unlocking the Full Potential of Demand-Side Flexibility for Renewables"**
Hannes Seidl, Head of Division, Energy Systems and Energy Services, German Energy Agency

14:58-15:05 **"Citizens-based Approaches to Accelerate Renewable Energy Deployment"**
Stefan Gsänger, Secretary General, World Wind Energy Association

15:05-15:45 **Panel Discussion and Q&A**
moderated by Dr. Frank-Michael Baumann, Managing Director, EnergyAgency.NRW

SESSION 2: The Future of Green Hydrogen

15:45-15:52 **"Prospects of Electrolysers for Green Hydrogen Production"**
Dr. Emanuele Taibi, Analyst, Power Sector Transformation Strategies, Innovation and Technology Center, IRENA

15:52-15:59 **"Hydrogen & Hard-to-Decarbonize Sectors: Heavy Mobility and Industry"**
Guillaume De Smedt, Director, Strategy Hydrogen Energy & Energy Transition, Air Liquide and Co-chair of the Study Task Force, Hydrogen Council

15:59-16:06 **"H2 Powered Ship" Regulation Free Zone and Development of H2 Small Boat to Megawatt"**
Chilhan Lee, Chief Executive Officer and President, Vinssen Co. Ltd.

16:06-16:13 **"A Glimpse at the Near Future: Hydrogen Production Plant in NRW"**
Dr. Frithjof Kublik, REFHYNE / Senior Consultant Business Development, Shell Rhineland Refinery

16:13-16:20 **"A Civil Society's Perspective on Green Hydrogen"**
Andrea Wiesholzer, Policy Advisor - Grids for the energy transition, Germanwatch

16:20-17:00 **Panel Discussion and Q&A**
moderated by Dr. Dolf Gielen, Director, Innovation and Technology Center, IRENA

17:00 **End of the conference**

PART 2

Report of GREF 2020

SUMMARY OF THE OPENING AND KEYNOTES SESSION





Dooyoung Lee

Consul General,

Embassy of the Republic of Korea, Bonn Office

OPENING REMARKS

While the conferences in 2016, 2017, and 2019 took place physically in Bonn, Germany, the 2020 edition of the Global Renewable Energy Forum (GREF) was convened as an on-line event due to the coronavirus pandemic. However, the online format also enabled reaching a broader audience. Although the COVID-19 pandemic has become a major concern in the short-term, Consul General Dooyoung Lee emphasized that the climate crisis remains the long-term concern. He referred to major wildfires in the Western United States, devastating floods in Africa, major typhoons in Asia, and heat waves in the Arctic as gloomy reminders of the ongoing climate change. Yet, despite an urgent need for reduction, global greenhouse gas (GHG) emissions continued to increase in the pre-coronavirus period. This demonstrates the need for more ambition to reduce GHG emissions in order to achieve the Paris Agreement. Renewable energy can play a key role in this respect. That is why the theme of GREF 2020 was ‘increased implementation and accelerated action’.

Mr. Lee also briefly outlined the Korean Green New Deal that was presented by President Moon Jae-in in July 2020. The aim is to transform the Republic of Korea into a zero-carbon society. For that matter, the Korean Government will invest approximately 60 billion USD over the next five years to accelerate the green energy transition, to boost climate-resilient infrastructure, and to foster green industry innovation. Furthermore, it aims to create 650,000 green jobs by 2025. It will turn public spaces into green, zero-emission spaces, increase the use of decentralized low-carbon energy, and establish an ecosystem, which supports the green industry innovation. In addition, 1.13 million e-vehicles and 200,000 hydrogen-powered vehicles will have entered the market by 2025.



Patricia Espinosa

Executive Secretary, United Nations Climate Change (UNFCCC)

KEYNOTE SPEECH

Ms. Patricia Espinosa reiterated that the climate crisis has not disappeared due to the coronavirus pandemic and “is like a hurricane slowly heading towards us”. She emphasized the need for a coordinated global recovery from the pandemic that should be guided by the Paris Agreement on Climate Change and the 2030 Agenda for Sustainable Development. Hence, the recovery must focus on building forward and developing cities and communities that are safe, healthy, green, and sustainable while minimizing the creation of carbon-intensive infrastructure. The investments made now will determine the emissions pathway of the next decades.

Both the public and private sectors must commit to an enhanced uptake of renewable energy and implement deep transformational changes to put the world on a climate-friendly trajectory. The transition towards renewables is a difficult task, but a necessary one, added Ms. Espinosa. In this respect, she referred to IRENA’s first ‘Global Renewables Outlook’ report, published in April 2020, and highlighted some key findings. The report demonstrates that CO₂ emissions must be reduced by 70% in 2050 compared to 2020 to achieve the Paris Agreement climate target. Furthermore, global renewable generation capacity increased by 176 gigawatts (GW) in 2019. Also, the report shows that annual capacity additions of renewables are regularly outpacing fossil fuels. As a result, renewables now account for one-third of global power capacity. Furthermore, transforming the energy system would boost the economy and create 42 million green jobs by 2050. As the report reveals, the economic recovery must focus on people’s health and safety and needs to be both resilient and sustainable.

In addition, Ms. Espinosa reiterated that States Parties to the Paris Agreement still have to submit their updated nationally determined contributions (NDCs) in 2020 and emphasized the necessity that they include clear measures towards the energy transition. Furthermore, the NDCs must show an increased level of ambition in order to be able to both recover from the coronavirus pandemic and to build a more sustainable future. Importantly, the energy transition must be a just transition that leaves no one behind.



Dr. Dolf Gielen

Director, Innovation and Technology Center, IRENA

KEYNOTE SPEECH

There have been many positive developments in the renewable energy sector as well as in the energy transition. Dr. Dolf Gielen named the European Green Deal as an example, which has a strong hydrogen component and a recently proposed new target of 55% of CO₂ emissions reduction by 2030. Furthermore, Europe emerged as the largest market for electric vehicles (EVs) in 2020. He also referred to recent developments in the Republic of Korea. In this regard, the Korean Green New Deal aims to add 30 gigawatts (GW) of solar photovoltaics (PV) and wind by 2025 and has ambitious targets for EVs and hydrogen-powered fuel cell electric vehicles. This is part of Korea's aim to reach zero emissions by 2050.

Furthermore, Dr. Gielen stressed that both Europe and Korea face significant challenges in the energy transition stemming from the high-energy intensity of their economies and their population density. Therefore, new solutions will be needed to address the transport and industry sectors. In this respect, Dr. Gielen referred to IRENA's 'Reaching Zero with Renewables' report, published in September 2020, which presents solutions for so-called hard-to-decarbonize sectors, including iron and steel, chemicals and petrochemicals, cement, aluminum, aviation, shipping, and road freight transport. Importantly, the report found that renewable energy can provide 50% of the needed solutions for these sectors. This can also provide opportunities of future cooperation, including between Europe and the Republic of Korea.



Dr. Christine Falken-Grosser
*Head of Division 'Bilateral Energy Cooperation',
Federal Ministry for Economic Affairs and Energy*

KEYNOTE SPEECH

The energy transition has become an important driver of Germany's economy. In this respect, the coronavirus pandemic has not affected Germany's commitments to fight climate change and to advance the energy transition. This understanding is also reflected in Germany's economic recovery package, which combines the fight against climate change with the measures needed for its post-COVID-19 recovery. The package includes measures across all sectors: electricity, heating and cooling, transport, and industry. Dr. Christine Falken-Grosser highlighted some of them, such as additional funding of two billion Euros for Germany's existing CO2 building renovation program, the revoking of the cap on solar power extension, and raising Germany's target for offshore wind generation from 15 to 20 gigawatts (GW) in 2030. A key element of the economic stimulus package constitutes the national hydrogen strategy that is combined with an investment package to promote green hydrogen technologies with seven billion Euros at the national and two billion Euros at the international level. This should increase electrolyzer capacity for green hydrogen production in Germany to 5 GW in 2030. Germany's top priority constitutes the market ramp-up of green hydrogen production globally.

Furthermore, Germany is committed to advancing the energy transition in cooperation with its partners that have the same interests. As the Republic of Korea constitutes one of Germany's key partners, Dr. Falken-Grosser was delighted that both countries had developed the Korean-German Energy Partnership in December 2019 to advance the energy transition in both countries. The partnership focuses on promoting green technologies, expanding renewable energy, system integration, energy efficiency, and nuclear decommissioning. It has great potential to contributing to the development of a secure, affordable, and climate-friendly energy system and provides huge opportunities for the Korean and German industries.



Paula Abreu Marques

*Head of Unit "Renewables and CCS policy",
DG Energy, European Commission*

KEYNOTE SPEECH

The European Green Deal, presented in December 2019, constitutes Europe's new green growth strategy towards climate neutrality. Mrs. Paula Abreu Marques referred to the September 2020 announcement of the President of the European Commission, Ursula von der Leyen, to significantly raise the EU climate target from 40% to 55% of greenhouse gas (GHG) emissions reduction by 2030. As this announcement was made amid the worst economic crisis since World War II, the European Union clearly demonstrates that recovery and prosperity can only be achieved through sustainability and clean energy.

Moreover, Europe can meet its ambitious climate targets, as it already reduced 25% of CO₂ emissions compared to 1990, while the economy grew by over 60% in the same period. Furthermore, Europe's power systems can cope with very high shares of renewables, as demonstrated during the pandemic. Yet, the EU must further accelerate its energy transition and must decarbonize sectors with low shares of renewables, namely transport as well as heating and cooling. In this regard, the EU is assessing its energy legislation to ensure it can attain its 55% greenhouse gas emissions reduction target by 2030.

Mrs. Abreu Marques also emphasized that the EU will have to increase the uptake of renewables in order to deliver on a 55% GHG emissions reduction by 2030 and current analysis points to a needed share of 38% to 40% of total final energy consumption by renewables in 2030. Energy efficiency also plays a key role in all actions taken by the EU, and energy efficiency measures must first be exhausted before applying other solutions, the so-called 'energy efficiency first principle'.

Importantly, the energy transformation must also result in benefits for society. Therefore, the EU will focus on a fair energy transformation that leaves no one behind and which leads to a more sustainable and resilient Europe. In this respect, the Green Deal and the EU's post-COVID-19 recovery efforts have the same goals. She referred to the unprecedented economic recovery package agreed by the EU in May 2020 with a clear focus on green energy and sustainability. The aim is to use the recovery to build forward and to move the EU towards achieving climate neutrality by 2050.

SUMMARY OF SESSION 1

ACCELERATING RENEWABLE ENERGY ACTION





Dr. Ricardo Gorini

Head of Renewable Energy Roadmaps, Innovation and Technology Center, IRENA

THE IMPACTS OF THE CORONAVIRUS PANDEMIC ON RENEWABLE ENERGY EXPANSION

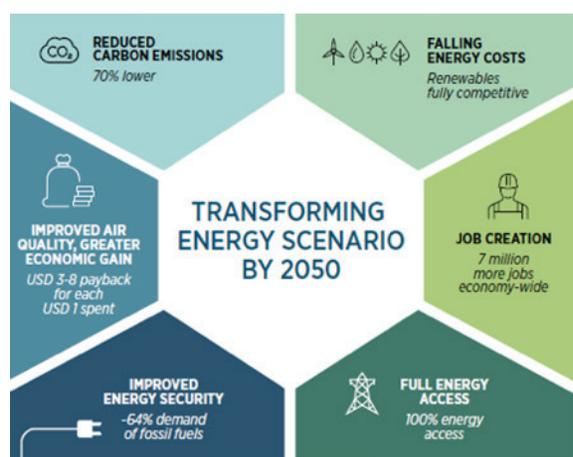
Dr. Ricardo Gorini's presentation focused on IRENA's position concerning the energy transformation and the COVID-19 impacts.

Prior to the coronavirus pandemic, there had been a clear trend in increasing penetration of renewables and significant cost reductions of renewable energy-related technologies, particularly wind and solar photovoltaics (PV) as well as increased competitiveness of renewable energy projects compared to fossil fuels. While the coronavirus pandemic resulted in negative impacts in all energy markets, it also put an interesting topic on the agenda, namely the awareness of sustainability. IRENA expects that the sustainability aspect will attract more interest in the energy transition.

A key message from IRENA's studies on the impacts of COVID-19 is the need to align the short-term recovery actions with the long-term strategy. This is a key imperative for reinforcing the energy transformation. The key drivers of this transformation, such as reduced carbon emissions, more green jobs, increased air quality, and energy security are being boosted by the policy discussions related to the post-pandemic economic recovery.

However, Dr. Gorini emphasized the importance of identifying criteria to analyze the economic recovery investments. In this regard, IRENA conducted quantitative and qualitative assessments of energy transformation investments to support countries to identify the best policy options for their economic recovery programs and put forward different criteria, such as the economic value of the stimulus, job creation, environmental benefits, and energy access.

Once criteria are determined, IRENA proposes a clear roadmap to take, namely focusing on increasing electrification with renewables and energy efficiency. It can be shown under IRENA's planned energy scenario (PES) that current country policies are heading towards the right direction and, for example, increase the renewable share in electricity generation from 26% in 2018 to 55% in 2050. To achieve the Paris Agreement climate target, however, this share must increase to 86% in 2050, according to IRENA's transforming energy scenario (TES). While energy efficiency is also improving under the planned en-



Source: IRENA (2020), *Global Renewables Outlook: Energy transformation 2050*, p. 57.

ergy scenario, more ambition is also needed in this respect. Therefore, it is imperative to enhance investments in the technologies that would achieve such high levels of electrification with renewables and energy efficiency.

Consequently, there is a clear need to increase investments in the energy transformation. While 825 billion USD were invested in 2019 in clean energy, this amount must increase fivefold to 4.5 trillion USD annually between 2019 and 2030 in order to reach cumulative clean energy investments amounting to 49 trillion USD by 2030 that are needed to reach climate targets. A key focus of these investments should be on end-use sectors (build-

ings, transport, and industry) and generation capacity. This means applying renewables and energy efficiency technologies in buildings, such as heat pumps and smart home systems. In the transport sector, energy efficiency measures could reduce nearly 50% of the needed energy, while extending the charging infrastructure for e-vehicles, and the increased application of bio-fuels could achieve the other 50%. Priorities for industry are energy efficiency measures and the direct use of renewables. In the power sector, the investments for the key renewable generation technologies solar PV and onshore wind must be increased to 318 billion USD and 273 billion USD, respectively, while the power grids, including smart meters, require annual investments of nearly 300 billion USD. Such investments must be reflected in Green New Deals.

Another key message from IRENA is that the post-COVID-19 recovery must be an agenda of resilience, development, and equality. Among the key opportunities to stimulate the economic recovery is using public finance strategically, which includes promoting investments in green energy assets (renewable energy and energy efficiency) as well as increasing national climate ambitions and raising renewable energy targets.

Further reading:

- » IRENA (2020), *The post-COVID recovery: An agenda for resilience, development and equality*, International Renewable Energy Agency, Abu Dhabi.
- » IRENA (2020), *Global Renewables Outlook: Energy transformation 2050* (Edition: 2020), International Renewable Energy Agency, Abu Dhabi.



Rana Adib

Executive Director, REN21 – Renewable Energy Policy Network for the 21st Century

OVERCOMING BARRIERS TO RENEWABLE ENERGY EXPANSION

While the renewable power developments have been very positive, with a record addition of 200 gigawatts (GW) in 2019, a key challenge remains the low level of investments in renewables, which merely increased from 280 billion USD in 2018 to 282 billion USD in 2019. While cost reductions of renewables could be a factor in this respect, investments in green energy must increase significantly to achieve the Paris Agreement.

Furthermore, while the renewable energy share continues to increase in the power sector (reaching 26.4% in 2019), the progress in transport, as well as heating and cooling, remains slow with renewable energy shares of 3.3% and 10.1%, respectively. This is particularly challenging as 83% of energy is used in heating and cooling and transport compared to just 17% in the power sector. In this regard, Ms. Rana Adib reiterated the need to move from a power transition to an energy transition.

Another key challenge constitutes the growth of renewables. While renewables are growing rapidly – 21.5% between 2013 and 2018, three times faster than fossil fuels –, they do not grow fast enough, and the rising energy demand keeps the share of renewables low compared to fossil fuels. As a result, renewables only accounted for 29% of energy demand growth between 2013 and 2018. Hence, there is a clear need for an exponential growth of renewable energy capacity. The post-COVID-19 economic recovery programs could be used for that matter. However, a study shows that only 2% of investments focus on energy, which plainly demonstrates a lack of acknowledgement of the important role renewable energy plays in driving the economy. Another issue is that the G20 will invest 151 billion USD in fossil fuels after the pandemic compared to only 89 billion USD in clean energy. Furthermore, many G20 countries are not using the economic recovery to make more green investments, as data shows that recovery packages of 16 of them have net negative environmental impacts. However, there are also positive examples, namely the Republic of Korea and the European Union.

Building public support for renewables is critical to overcoming barriers to renewable energy expansion. It requires socio-political acceptance, meaning renewable energy and energy efficiency become a priority in government policies and are supported by the

general public. It also requires market acceptance, implying the acceptance of renewable energy technologies by producers and consumers. Lastly, there is a need for community acceptance, meaning citizens' acceptance of specific renewable energy projects developed locally. While opinion polls show broad support for renewables, local resistance can be a key barrier for deploying and accelerating the expansion of renewables.

Dimensions of Social Acceptance of Renewable Energy



Source: REN21, *Renewables 2020 Global Status Report*, figure 61, p. 198.

Furthermore, government decision-makers must understand the drivers for renewable energy and the benefits they bring outside of the energy sector. At the local level, renewable energy improves air quality and leads to a healthy environment, while it contributes to the reduction of CO₂ emissions, relevant at the international level. Renewables also bring economic opportunities, create decent green jobs, provide affordable and inclusive energy, as well as energy security and sovereignty.

In addition, many structural challenges must be dealt with to accelerate renewables. In this regard, many existing solutions need to be applied urgently, but a much more integrated approach is required. Therefore, policies must be implemented to actively support renewables across all end-use sectors. Ms. Adib named e-mobility as an example, which is well reflected in the economic recovery packages. Making energy efficiency mandatory to decrease energy demand is another important aspect. Furthermore, there needs to be more ambition in phasing out fossil fuels. While removing fossil fuel subsidies is important, fossil fuels must also be banned altogether, particularly in the heating and transport sectors. In addition, public procurement should be used to create markets because there is a necessity to create also economic opportunities. Lastly, actively building citizen support is critical. Therefore, large-scale as well as local and decentralized solutions are needed to include all stakeholders in the energy transition.

The key message of her presentation is that there is a systemic problem that requires a systemic solution. In terms of renewable energy and the energy transition, this means including all stakeholders to create the right planning, policy, and regulatory frameworks.

Further reading:

» REN21 (2020), *Renewables 2020 Global Status Report* (Paris: REN21 Secretariat).

emphasized the challenges of such a fast decarbonization and the need for all actors to contribute to it in order to achieve the aims in an extremely short timeframe. While the PAC scenario is an important milestone, more work is necessary to fully understand the technical, political, and societal challenges of realizing such a scenario.

Regardless of the timeline for decarbonization, Mrs. Battaglini emphasized the essential steps and considerations that must guide decisions and policies. A key focus must be on optimizing all resources, including the availability of space and natural ecosystems. Energy infrastructure is generally planned to meet technical requirements, fulfill system needs, and economic constraints. From now on, energy planning must also include environmental and space constraints. By considering all impacts of energy infrastructure in the planning phase on an equal footing, it becomes possible to optimize all criteria assessed in the planning process. Another key focus should be ensuring that 'electrification comes first'. While electrification certainly cannot cover all energy needs of the economies, developing clear roadmaps for electrification is necessary to channel resources and develop supporting policies and frameworks. Moreover, an electricity roadmap would also clarify the needed infrastructure, establish clear pathways for those end-uses that cannot be electrified, and therefore provides clarity for the use of decarbonized/green gases – including green hydrogen.

Long-term, ambitious targets covering the next ten to thirty years are essential for planning the required energy infrastructure and ensuring timely deployment. Long-term targets also contribute to reducing risks, including financial ones. Mrs. Battaglini further emphasized the need to plan collaboratively and for the future, as plans too often focus excessively on yesterday's technologies, data, and experience. However, the future also has to be planned on what is possible. In this regard, it is essential to be aware of innovative technologies and the actual costs of technologies. In Europe, the economic recovery package could be an important instrument to stimulate innovation. However, the European Recovery Package lacks a key component necessary for a successful energy transition, namely a financial mechanism that targets communities and people. The energy transition cannot be achieved without people's support. Involving local communities is paramount as energy infrastructure – renewables and grids – as well as energy storage systems, are always deployed locally.

The most important innovation for accelerating renewables is flexibility. Flexibility in technology, flexibility in regulatory frameworks, flexibility in planning and deploying infrastructure, and flexibility in how potential pathways are imagined.

Finally, collaboration across sectors and regions is paramount to speed up decarbonization, to scale solutions, and to reduce risks and costs alike. The European electricity market is a positive example of how collaboration across countries can bring benefits to consumers. Now, these collaborative approaches also need to include people and nature. Only by breaking the silos, which are still very dominant in the energy sector, can solutions be developed, tested, proven to be effective, and deployed at scale. Cooperating across sectors and across borders with a variety of stakeholders is fundamental to truly re-invent the energy system that is fit for the future.



Hannes Seidl

*Head of Division, Energy Systems and Energy Services,
German Energy Agency (dena)*

UNLOCKING THE FULL POTENTIAL OF DEMAND-SIDE FLEXIBILITY FOR RENEWABLES

The future energy system will have a large share of renewable electricity, particularly from wind and solar photovoltaics (PV). For Germany, studies expect a 2.5-6 times higher installed capacity of renewables in 2050 compared to 2018. Therefore, the installed capacity will be three times the peak load in Germany. It means the German energy system must deal with feed-in peaks efficiently as well as with periods of low or no renewable energy supply. As a result, the energy markets of the future may be characterized by extremely low and extremely high prices. Accordingly, storage technologies are needed, international trade to equalize the fluctuations must be increased, a new understanding of the demand-side sector is required, as well as utilizing demand-side management.

There are many opportunities where demand-side flexibility can help to integrate renewable energy sources to support the grids and/or electricity markets. These can include services for grid congestion management or balancing power for the grids, as well as balancing group management or participating in the spot market. Here, new challenges result from the ever-increasing integration of fluctuating renewable energy sources in the electric power system.

THE ENERGY TRANSITION NEEDS FLEXIBILITY

Mr. Hannes Seidl's presentation also focused on the flexibility potential of the industrial sector, where 41% of total energy in Germany is consumed. According to two studies, the demand-side flexibility potential of the industry sector amounts to 5-15 gigawatts (GW). However, there are also challenges to unlock this theoretical flexibility potential, as learned by the German Energy Agency (dena) during pilot projects. It includes a lack of knowledge about the markets and potentials, lack of data availability, weak financial incentives, and contradicting network tariffs.

Besides flexibility potential in electricity-intensive industries, there are also many flexibility sources in the distribution grid, like heat pumps, battery storage, and electric vehicles (EVs), which will strongly increase until 2050. These new technologies increase the potential for flexibility, in particular in low-voltage grids. It is expected that in 2050, 15-

18 GW of battery storage, 12-30 million EVs, 7-17 million heat pumps, and 53-63 GW of power-to-X will be available as flexibility sources. With smart meters and devices, these flexibility sources can be used to provide flexibility to the grids and the markets.

Flexibility can also be economically beneficial and may reduce the need for grid expansion. Studies show that the application of flexibility can reduce the annual grid expansion costs by 42% by 2035, despite the additional costs for flexibility, compared to planning grids without flexibility.

A key precondition for unlocking demand-side flexibility is to provide information and consulting to industrial companies about the benefits of applying demand-side management. Furthermore, Mr. Seidl recommends as a first step unlocking the large potential of demand-side flexibility of electricity-intensive industries. Leveraging the potential of flexibility of applications for congestions management is more complex, but here, as well, barriers should be removed, and incentives put in place. A dena study on the issue, furthermore, put forward some recommendations on how to reduce the risk of gaming in flexibility markets.

Further reading:

- » Dena (2018), dena Study Integrated Energy Transition - Impulses to shape the energy system up to 2050, German Energy Agency, Berlin.



Stefan Gsänger

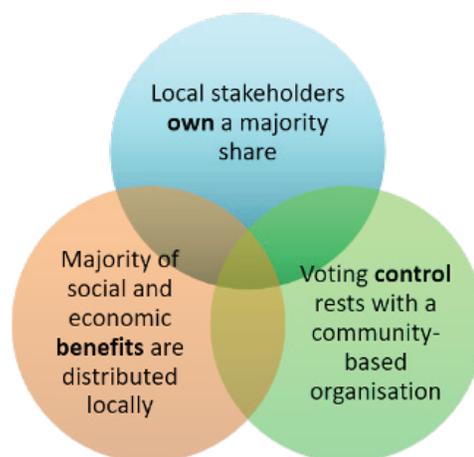
Secretary General, World Wind Energy Association (WWEA)

CITIZENS-BASED APPROACHES TO ACCELERATE RENEWABLE ENERGY DEPLOYMENT

A key emphasis of the energy transition should be on involving and mobilizing citizens and communities. They must be at the center of this transition. This needs to go beyond mere acceptance of the energy transition but becoming supporters and drivers of it. For that matter, citizens must be enabled and must directly profit from the benefits of using renewable energy, including local wealth. Hence, the structures must be in place to create a positive circle – as opposed to a vicious circle – in which citizens play an active role in driving the energy transition at the community level.

Community energy, in this regard, is referred to as local ownership, local profit-sharing – meaning that most of the social and economic benefits are distributed within the community –, and local control. It strengthens not only economic structures locally but also leads to a more democratically organized energy sector.

Ownership is a key element in renewable energy, and it becomes even more essential in developing countries where the focus is on providing basic energy services to the people. Here, ownership makes an even greater difference because the productive use of energy can launch a positive circle from energy supply over job creation to poverty alleviation with lasting positive impacts and economic development if the generated profits (i.e., from a mini-grid) remain in the community and are being reinvested. Furthermore, innovative concepts must be applied to close the so-called ‘equity gap’ to ensure that people can get ownership, particularly in developing countries.



Source: World Wind Energy Association.

It is also crucial to have the right frameworks in place. Switching from an energy system, which is highly centralized to a decentralized energy system with a much larger variety of investors, requires different frameworks and policies, which need to be supportive

**THE ENERGY
TRANSFORMATION IS FIRST AND
FOREMOST ABOUT PEOPLE,
CITIZENS, AND COMMUNITIES**

and inclusive. In this regard, quota systems and auctions constitute obstacles for community-based investors, small investors in particular, as they tend to exclude smaller investors. Feed-in tariffs (FITs), on the other hand, have demonstrated to be non-discriminatory.

In this respect, Mr. Stefan Gsänger presented the potential negative implications of switching from FITs to auctions by reference to Germany. Community energy has become mainstream in Germany, where around 50% of renewable energy investments have been made in community energy projects. However, when Germany decided to switch from feed-in tariffs to auctions in 2017, it has been undermining its previously very strong community energy sector. A study by WWEA found that the three goals set by the German government when introducing auctions in the power sector failed, including the aim to preserve the diversity of actors in renewable energy. In the case of wind power, the prices even increased in auctions compared to FITs, and communities have refrained from investing, as the accompanying risks of the awarded bids are too high.

In closing, he emphasized that in order to maximize social mobilization for the energy transition and to reach 100% renewable energy, all actors, including citizens, must be involved and mobilized. As there are some indications that women are underrepresented in community energy and renewable energy, in general, WWEA will conduct a study from 2020-2022 analyzing the role of women in community energy.

Further reading:

- » WWEA (2019), Community Wind under the Auctions Model: A Critical Appraisal, World Wind Energy Association, Bonn.



SUMMARY OF SESSION 2

THE FUTURE OF GREEN HYDROGEN





Dr. Emanuele Taibi

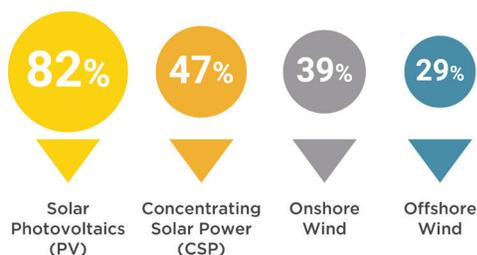
Analyst, Power Sector Transformation Strategies, Innovation and Technology Center, IRENA

PROSPECTS OF ELECTROLYZERS FOR GREEN HYDROGEN PRODUCTION

The presentation focused on electrolyzers as the key technology to produce competitive green hydrogen.

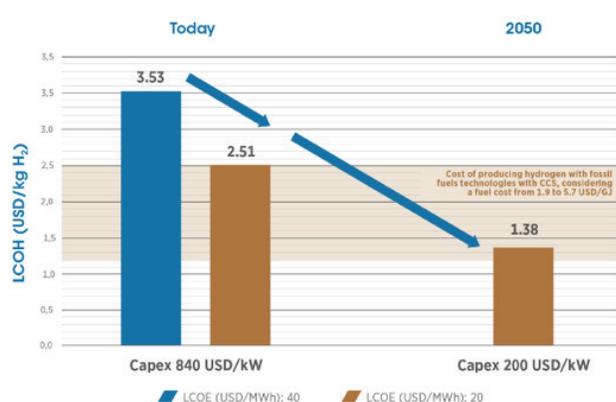
Green hydrogen will be a key part of future energy systems. It will be a solution for end-uses that are hard to directly electrify and will increase the flexibility of power systems. To reach zero emissions by 2050, IRENA identified three aspects as paramount regarding green hydrogen. Firstly, green hydrogen production must increase to at least 19 exajoule (EJ) by 2050. Secondly, hydrogen production costs must be significantly reduced from currently 4-8 USD per kilogram (kg) to 0.9-2 USD per kg to produce competitive green hydrogen. This requires cost reduction for both renewable electricity generation and for electrolyzers needed to transform green electricity into green hydrogen. Importantly, the production costs for renewable electricity in the best solar photovoltaics (PV) and onshore wind projects globally are already in-line with that objective, with a rapid decline of renewable energy costs between 2010-2019 (i.e., solar PV by 82%), according to IRENA's 'Renewable Power Generation Costs in 2019' report. Auctions for green electricity have dipped below 20 USD per Megawatt hour (MWh) in an increasing number of countries around the world in the last few years. Thirdly, electrolyzer capacity for green hydrogen production needs to increase from a current electrolyzer capacity of approx. 0.2 gigawatts (GW) in 2020 to 1,700 GW by 2050. The electricity demand to produce this amount of green hydrogen would be at least 7,500 Terawatt hours (TWh) of green electricity by 2050.

FALLING POWER GENERATION COSTS
Renewable energy costs declined rapidly over the last 10 years (2010-2019)



Source: IRENA, <https://www.irena.org/newsroom/articles/2020/Jun/How-Falling-Costs-Make-Renewables-a-Cost-effective-Investment>.

As renewable power generation costs have rapidly decreased over the last decade resulting in cost competitiveness of renewable power generation, it is important to reduce costs for the rest of the infrastructure needed to produce green hydrogen. A key focus in this regard is on electrolyzers, meaning the technology needed to use green electricity to split water molecules into green hydrogen and oxygen. That is why IRENA will publish a dedicated report focusing on electrolyzers in December 2020, specifically highlighting the potential for scale-up and cost reduction. Electrolyzers can also be an important source for providing demand-side flexibility, in particular with regard to the so-called 'last-mile' and for the so-called 'adequacy challenge' of the power sector in times of sustained unavailability of renewable energy that can last for days, as in the case of the "Dunkelflaute" in Germany.



Source: IRENA (2019), *Hydrogen: A renewable energy perspective*, p. 27.

With regard to hydrogen production costs, falling renewable energy costs allow for producing green hydrogen currently at 2.5-3.5 USD per kg in case of the best renewable resources. However, in order to be competitive, these prices must further decrease to the 1-2 USD per kg range. The decreasing renewable electricity prices are a step in the right direction. The key challenge is henceforth to significantly reduce the costs of electrolyzers to unleash the great potential of green hydrogen for decarbonizing the energy system, particularly with regard to so-called hard-to-decarbonize sectors.

Dr. Emanuele Taibi also referred to the Collaborative Framework on Green Hydrogen that IRENA established in June 2020 to promote dialogue between governments and the private sector on the topic. In this regard, IRENA members identified particular priority areas for knowledge-sharing. These include establishing a global knowledge database for green hydrogen and strengthening collaboration with existing hydrogen initiatives. Another key aspect is evaluating the nexus between hydrogen and renewables as well as the flexibility from coupling power and hydrogen. Also, an important point is scaling up infrastructure, be it a green hydrogen backbone with pipelines, as discussed in Europe, or shipping hydrogen. Coordinating standards and regulatory frameworks as well as the sharing of best practices on financial mechanisms are also regarded as priorities.

Further reading:

- » IRENA (2018), *Hydrogen from renewable power: Technology outlook for the energy transition*, International Renewable Energy Agency, Abu Dhabi.
- » IRENA (2019), *Hydrogen: A renewable energy perspective*, International Renewable Energy Agency, Abu Dhabi.
- » IRENA (2020), *Reaching zero with renewables: Eliminating CO₂ emissions from industry and transport in line with the 1.5°C climate goal*, International Renewable Energy Agency, Abu Dhabi.



Guillaume De Smedt

*Director, Strategy Hydrogen Energy & Energy Transition,
Air Liquide and Co-chair of the Study Task Force,
Hydrogen Council*

HYDROGEN & HARD-TO-DECARBONIZE SECTORS: HEAVY MOBILITY AND INDUSTRY

Air Liquide has been supplying hydrogen for over 50 years to its industrial customers. It currently produces approx. 14 billion cubic meters (m³) of hydrogen annually, which is mostly supplied to refineries, but also to small and medium-sized industry partners. Air Liquide also handles the hydrogen supply chain and delivers hydrogen using pipelines or trucks. It has 46 large hydrogen production plants from natural gas reforming, but it also operates around 40 electrolyzers worldwide. As of today, natural gas reforming for large-scale hydrogen production for industrial use is the most cost-competitive method and, thus, also the most common method used for that matter.

Air Liquide is focusing on new hydrogen applications globally, particularly with regard to decarbonizing heavy industry and mobility. In this respect, Air Liquide works with thyssenkrupp Steel at its Duisburg site, Germany, to use hydrogen instead of pulverized coal in all blast furnaces to produce low-carbon steel. This has the potential to reduce CO₂ emissions of steel production. Concerning mobility, Air Liquide has installed 120 hydrogen refueling stations in Asia, Europe, and North America. An example is the H2Haul project funded by the Fuel Cell and Hydrogen Joint Undertaking (FCH JU) that focuses on developing long-haul heavy-duty fuel cell trucks at four European locations. As part of the project, Air Liquide is installing the first high-pressure low-carbon hydrogen refueling station in Europe for long-haul trucks in Fos-sur-Mer, France. Furthermore, together with the Port of Rotterdam Authority, Air Liquide launched a project to deploy 1,000 hydrogen-powered zero-emission trucks (HyTrucks) on the roads between Germany, Belgium, and the Netherlands by 2025, with 500 of them to be operated in the Port of Rotterdam area. As part of the project, the needed infrastructure will also be provided. In this respect, 25 high capacity hydrogen refueling stations will be installed, and the needed electrolysis capacity will be built to produce low-carbon hydrogen for the project. Furthermore, Air Liquide is developing the largest PEM-electrolyzer in the world with a capacity of 20 megawatts (MW) in Bécancour, Québec, Canada. It is also constructing a 150-million USD liquid hydrogen plant in California, USA, to produce green hydrogen for the Californian mobility market.

**GOING TO SCALE REDUCES
PRODUCTION COSTS OF
GREEN HYDROGEN**

A key aspect in this regard is the need to go to scale to decrease the costs of hydrogen applications. The 'Path to hydrogen competitiveness' study of the Hydrogen Council³ of January 2020 demonstrates that scaling up the hydrogen value chain constitutes the main driver of cost reduction. It shows that going to scale can reduce hydrogen

production costs by 60%, distribution costs by 70%, and costs for end-use equipment by 45% until 2030. Furthermore, going to scale reduces the CAPEX costs of electrolyzers, which allows producing green hydrogen at a competitive price compared to so-called blue and gray hydrogen. Going to scale will also support reducing the hydrogen distribution costs, which is also very important for many hard-to-abate sectors, particularly heavy-duty mobility.

The scale-up in electrolyzer capacity is also progressing. Air Liquide currently has around 40 small size electrolyzers in operation worldwide. Since 2018, a 1.25-MW PEM-electrolyzer has been in operation as part of the HyBalance project in Denmark. Air Liquide is currently constructing the world's largest 20-MW membrane-based electrolyzer in Bécancour, Québec, Canada for green hydrogen production. At the same time, Air Liquide is leveraging its technological and engineering capacities to develop and execute 100 MW+ electrolyzer projects. This must be the logical next step, noted Mr. Guillaume De Smedt, in particular when considering the ambitious hydrogen targets of the European Union and its individual Member States. This scale-up will lead to cost reduction and will enhance the competitiveness of green hydrogen.

³ https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness_Full-Study-1.pdf.



Chil Han Lee

Chief Executive Officer and President, Vinssen Co. Ltd.

“H2 POWERED SHIP” REGULATION FREE ZONE AND DEVELOPMENT OF H2 SMALL BOAT TO MEGAWATT

Mr. Chilhan Lee’s presentation dealt with specific hydrogen developments in the shipping sector in the Republic of Korea. In this regard, the company Vinssen is developing electric-powered and hydrogen fuel cell-powered boats. It is developing a 10-meter-long leisure boat powered by a hydrogen fuel cell propulsion system, the first of its kind in Korea, scheduled to be launched in February 2021.



Source: Vinssen.

A key issue in this regard is the lack of regulation for hydrogen-powered boats in Korea. In this respect, the company was selected by the Korean Ministry of SMEs and Startups to test and develop the needed regulation. This is being done in the Hydrogen Green Mobility Regulatory Free Zone in the Korean city of Ulsan. Vinssen is also developing hydrogen charging stations for the boat. This poses another issue besides the lack of a proper regulation, name-

ly the absence of a reference case in the world for marine hydrogen charging infrastructure. Therefore, the entire supply chain will be developed in the regulatory free zone in the city of Ulsan.

The main challenge for Vinssen is establishing whether hydrogen fuel cells are workable in the maritime environment. That is why Vinssen started with a single hydrogen fuel cell stack application in its 10-meter-long leisure boat. This was increased to four hydrogen fuel cell stacks for its 14-meter-long leisure boat and eventually to 30-35 hydrogen



Source: Vinssen.

fuel cell stacks for its fuel cell electric-powered tugboat. The long-term aim is to use 20 times the number of hydrogen fuel cell stacks of the tugboat to operate container vessels. In its projects, Vinssen combines Korea's strengths in battery, hydrogen fuel cells, and shipbuilding technologies.

There are three key aspects needed for the hydrogen shipping industry to flourish: i) the maritime regulation must be finalized; ii) the required infrastructure need be in place, particularly the marine charging stations for hydrogen-powered as well as for battery-powered boats; and iii) cost reduction for hydrogen fuel cell stacks and hydrogen gas.



Dr. Frithjof Kublik

*REFHYNE / Senior Consultant Business Development,
Shell Rheinland Refinery*

A GLIMPSE AT THE NEAR FUTURE: HYDROGEN PRODUCTION PLANT IN NRW

Dr. Frithjof Kublik's presentation dealt with the practical challenges of laying the groundwork needed for scaling up the production of green hydrogen.

The Clean Refinery Hydrogen for Europe project REFHYNE is constructing the world's largest proton exchange membrane (PEM)-electrolyzer at the Shell Rheinland Refinery in Wesseling, the largest refinery in Germany. It is the largest PEM electrolyzer under construction and will also be the largest industrial-scale PEM electrolyzer when it starts operating in 2021. The project commenced in 2018 and is being realized by a consortium of different European partners, including Shell and ITM Power, that builds the electrolyzer. The total investment will be close to 20 million Euros, of which 10 million Euros is being contributed by the European Union's Fuel Cell and Hydrogen Joint Undertaking (FCH JU). The project would not have been possible without the FCH JU grant.

It is the first large-scale water electrolyzer integrated into a refinery. The 10-megawatt (MW) PEM-electrolyzer will have an annual production capacity of 1,300 tons of high-quality green hydrogen produced from renewable energy sources and will be fully integrated into refining processes. The production will only meet less than 1 percent of



the total hydrogen demand in the refinery, which is 180,000 tons per year, but it could, however, also be used for Germany's transport sector, i.e., to supply green hydrogen to the approximately 500 hydrogen fuel cell cars currently in operation. This could build a bridge between industry and transport.

Source: REFHYNE.

The 10-MW electrolyzer will be located in a custom-made, roughly 20 by 30-meter building in the center of the refinery close to the internal hydrogen network system of the refinery to which it will provide green hydrogen. The heart of the plant is a 10-MW PEM System by ITM Power that contains five 2-MW modules.

It is a lighthouse project that will be an important stepping stone towards constructing 100-MW and larger electrolyzer plants, which was also underscored during the visit of the European Commissioner for Energy, Kadri Simson, in July 2020. However, a key issue in this regard is securing the required investments, as grants like the one from the FCH JU are limited. For that matter, it is important to use the REFHYNE project to demonstrate the application case for green hydrogen in industry to develop a regulatory framework to attract investments for larger electrolyzers.

Moreover, the 10-MW PEM-electrolyzer constitutes a platform for new opportunities. It can be used for industrial purposes, such as in the Rheinland Refinery, where the green hydrogen is used for refining processes and to reduce CO₂ emissions in the refinery. For the power market, it can provide primary and secondary grid balancing. A key aim is also to use the produced green hydrogen for the transport sector and to deliver it to hydrogen refueling stations (HRSs). A further objective is to supply green hydrogen to a fleet of more than 50 hydrogen-powered fuel cell buses – one of the largest hydrogen bus fleets in Europe – of the RVK public transport company in the nearby city of Cologne, Germany, to be operated in 2021. It can also be a platform for synthetic e-fuels that are particularly of interest to the aviation sector, which is one of the hard-to-decarbonize sectors. Therefore, it is of key importance to further advance the electrolyzer technology along learning curves and to develop sound regulatory and business models for different hydrogen applications as a basis for constructing even larger industrial hydrogen production plants to meet the hydrogen ambitions in Europe and Germany for 2030 in the GW scale.



Andrea Wiesholzer
*Policy Advisor - Grids for the energy transition,
Germanwatch*

A CIVIL SOCIETY'S PERSPECTIVE ON GREEN HYDROGEN

Green hydrogen is critical for reaching climate neutrality by 2050 and provides many opportunities. It is a key option for decarbonizing so-called hard-to-abate sectors, which are difficult to electrify, such as aviation, shipping, and industry. Green electricity can also be converted into the gaseous energy carrier hydrogen using the power-to-gas technology. It allows green electricity to be stored and reused during times of low renewable energy supply and contributes to making the energy system more flexible and stabilizes power networks that are increasingly relying on solar photovoltaics (PV) and wind energy generation. Furthermore, hydrogen can be transported easier compared to electricity, and long-distance transportation of hydrogen creates the opportunity to build an international market for green hydrogen. It may also facilitate the development of new trade relations and international cooperation around green hydrogen, going beyond mere energy relations towards genuine climate partnerships that provide renewed impetus to the global energy transformation and towards reaching the Paris Agreement.

However, there are also challenges and risks regarding hydrogen production. Firstly, positive effects on greenhouse gas emissions reduction depend on the electricity mix being used. According to a study of the German research institute 'Öko-Institut', green hydrogen is only beneficial for climate protection if the electricity used to produce hydrogen is nearly 100% based on renewable energy. Also, as ever more electrolyzers are being deployed, satisfying the resulting increased demand in electricity with fossil fuels would be counterproductive for mitigating climate change. This paradox can only be solved by strongly accelerating renewable energy deployment. Furthermore, the accompanying energy loss of 30-40% when converting electricity into hydrogen is an issue, as well. Therefore, the production of green hydrogen can put substantial, additional stress on the expansion of renewable energy. Another concern is the resource-intensive and energy-intensive extraction of new metals, including conflict materials, needed for electrolyzers and fuel cells, which are often accompanied by human rights violations and environmental depletion. Other potential conflict areas relate to the substantial water use of electrolyzers, particularly in countries already confronted with water scarcity. A key takeaway from Ms. Andrea Wiesholzer's presentation is that hydrogen must be produced sustainably and applied responsibly.

Furthermore, the renewable energy expansion is key and a precondition for producing green hydrogen. Given the limitation of the production of sustainable, green hydrogen, there is a need for a responsible and targeted use of hydrogen instead of using a technology-neutral approach. While hard-to-abate sectors must be prioritized, a mere fuel switch is insufficient, and further demand reduction and efficiency measures need to be applied. Furthermore, to address the social and environmental risks associated with green hydrogen, ambitious sustainability criteria and a reliable certification system are needed that highlight the advantages of green hydrogen over hydrogen produced from fossil fuels. Lastly, new partnerships and cooperation for green hydrogen must be developed around the world, and common perspectives on green hydrogen need to be elaborated jointly with current and future energy exporters.

**HYDROGEN MUST BE
PRODUCED SUSTAINABLY
AND APPLIED RESPONSIBLY**

PICTURES OF GREF 2020

Keynote Speeches



Patricia Espinosa,
Executive Secretary, United Nations Climate Change
(UNFCCC)



Dr. Dolf Gielen,
Director, Innovation and Technology
Center, IRENA



Dr. Christine Falken-Grosser,
Head of Division 'Bilateral Energy Cooperation',
Federal Ministry for Economic Affairs and Energy

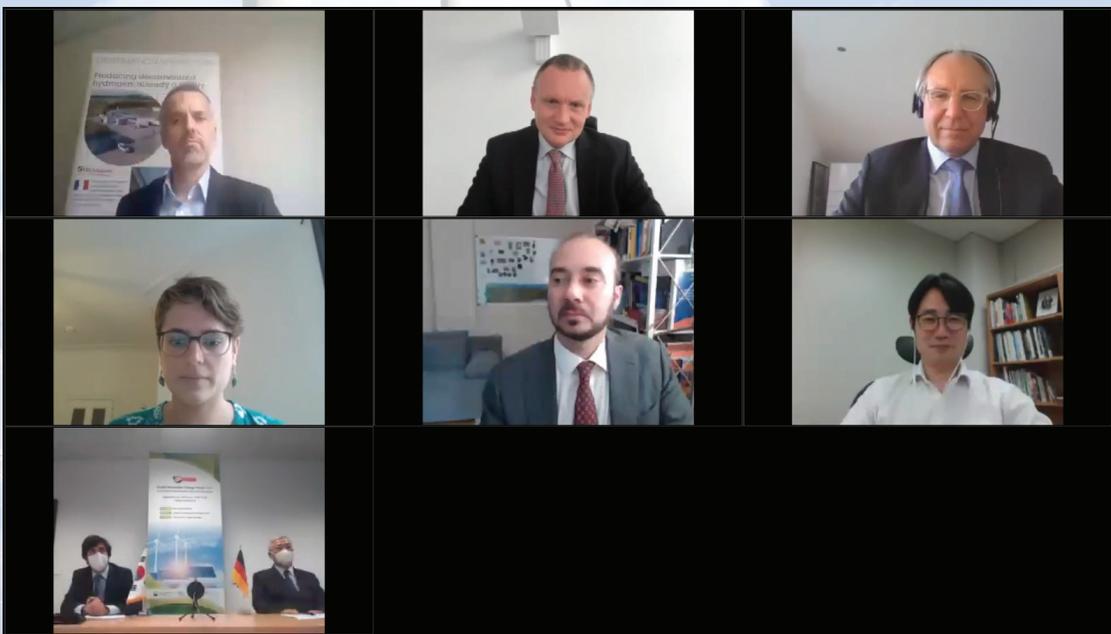


Paula Abreu Marques,
Head of Unit "Renewables and CCS poli-
cy", DG Energy, European Commission

Session 1



Session 2





Link to GREF 2020 video

<https://www.youtube.com/watch?v=1e5PEzfT1yE>

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