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POLICY BRIEF

ADAPTIVE POLICY TO LEVERAGE HYDROGEN IN THE ENERGY TRANSITION

Task Force 10

SUSTAINABLE ENERGY, WATER, AND FOOD SYSTEMS

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موجز السياسة

سياسة تكيّفية للاستفادة من الهيدروجين في الانتقال الطاقي

فريق العمل العاشر
نُظم الطاقة المستدامة والمياه والغذاء

المؤلفون
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ABSTRACT

Hydrogen is a key enabling vector of the energy transition. Multiple studies have demonstrated the potential of hydrogen to reduce carbon emissions and serve as a new energy medium in industries where electricity cannot be easily used. Along with continued research and development efforts, currently, the challenge is to upscale hydrogen production and deployment, thereby triggering further dramatic cost reduction. An adaptive energy policy instrument is essential to support necessary investments, while considering the regional diversity of energy and industrial policies.

Certificates are a versatile and preferred energy policy instrument for leveraging hydrogen production and deployment. They can facilitate the scaling up of both green hydrogen produced via electrolysis using renewable or nuclear energy, and blue hydrogen produced from fossil fuels with carbon capture and storage. Transportation (including aviation) and the existing industrial usage are easy avenues for upscaling hydrogen deployment and reducing cost. Thus, hydrogen certificates are a key mechanism to ensure a decarbonized world enabled by burden sharing among the Group of Twenty (G20) countries.

The transition from gray to blue and green hydrogen offers an adaptive path for hydrogen production and deployment in both energy resource-rich and consuming countries. An exchange platform and working group unifying industry practitioners, policy makers, and academics from the G20 countries, especially from hydrocarbon producing countries, will foster a better understanding of environmental certificates and carbon credit-based hydrogen policies. This will accelerate hydrogen deployment in the G20 countries by integrating positive and negative economic externalities in international trade mechanisms, and by clarifying the financial treatment of policies supporting large investments in hydrogen.

يصنـف الهيدروجيـن كعامـل تمكيـن فعـال فـي تحـولات الطاقـة. أظهـرت العديـد مـن الدراسـات قـدرة الهيدروجيـن علـى خفـض الانبعاثـات، والقيـام بـدور وسـيط طاقـة جديـد فـي الصناعـات التي لا يسـهل فيهـا اسـتخدام الكهربـاء. بالاضافـة إلـى جهـود البحـث والتطويـر المسـتمرة، يمثـل الارتقـاء بإنتـاج الهيدروجيـن وتعميمـه تحديًـا كبيـرًا، ممـا يترتـب عليـه تحقيـق المزيـد مـن الانخفـاض الجـذري فـي التكلفـة. تُعـد سياسـة الطاقـة التكيّفيـة عامـلاً جوهريًّا لدعـم الاسـتثمارات الضروريـة، مـع مراعـاة التنـوع الإقليمـي لسياسـات الطاقـة وفـي قطـاع الصناعـة.

تصنـف "الشـهادات" الاعتماديـة كأحـد السـبل المعتمـدة والتفضيليـة فـي الاسـتفادة مـن إنتـاج الهيدروجيـن وتعميمـه. تسـاهم هـذه الشـهادات فـي تسـهيل زيـادة كلٍّ مـن الهيدروجيـن الأخضـر الـذي يتـم إنتاجـه عبـر التحليـل الكهربـي باسـتخدام الطاقـة المتجـددة أو النوويـة، والهيدروجيـن الأزرق الـذي يتـم إنتاجـه مـن الوقـود الأحفـوري عبـر تجميـع الكربـون وتخزينـه. يُعـد النقـل (بمـا فـي ذلـك الملاحـة الجويـة) والاسـتخدام الصناعـي الحالـي طُرقًـا سـهلة لزيـادة تعميـم الهيدروجيـن وخفـض التكلفـة. بالاضافـة إلـى مـا سـبق، تعـد الشـهادات الاعتماديـة للهيدروجيـن آليـة رئيسـية فـي ضمـان عالـم منخفـض الكربـون مـن خـلال مشـاركة العـبء بيـن دول مجموعـة العشـرين.

يوفـر الانتقـال مـن الهيدروجيـن الرمـادي إلـى الأزرق والأخضـر مسـارًا تكيُّفيًّـا لإنتـاج الهيدروجيـن وتعميمـه فـي البلـدان الغنيـة بمـوارد الطاقـة والمسـتهلكة للطاقـة علـى حـدٍّ سـواء. ستسـاهم منصـة التبـادل والعمـل الجماعـي، التـي توحـد ممارسـي الصناعـة وصُنـاع القـرار والأكاديمييـن مـن دول مجموعـة العشـرين، وبالأخـص مـن البلـدان المنتجـة للهيدروكربـون، إلـى تعزيـز فهـمٍ أفضـل للاعتمـادات البيئيـة وسياسـات الهيدروجيـن القائمـة علـى ائتمـان الكربـون. تسـاهم هـذه المنصـة فـي تسـريع تعميـم الهيدروجيـن فـي دول مجموعـة العشـرين مـن خـلال دمـج العوامـل الاقتصاديـة الخارجيـة الإيجابيـة والسـلبية فـي آليـات التجـارة الدوليـة، ومـن خـلال توضيـح العـلاج المالـي للسياسـات التـي تدعـم الاسـتثمارات الكبيـرة فـي الهيدروجيـن.

CHALLENGE

The Paris agreement and the subsequent COP22 (Conference of Parties) to COP24 have implored nations worldwide to reduce emissions drastically, towards net-zero. The renewable energy directive 2018/2001/EU has been effected in December 2018, as part of the "Clean energy for all Europeans" package. This directive covers various uses of hydrogen, including transport and the heating/cooling sector. However, it neglects the use of hydrogen in other important sectors, such as ammonia production and steel making, and does not cover non-renewable low carbon hydrogen. Quotas, feed-in tariffs, subsidized investments, and tax breaks have been used to support early investment in hydrogen demonstration projects. Therefore, further mechanisms are necessary to scale up deployment of this particularly powerful energy vector, hydrogen.

Production technologies for large volumes of hydrogen already exist. According to a study by the Hydrogen Council (2020), gray hydrogen produced by reforming natural gas costs USD 1–2/kg, blue hydrogen produced through added carbon capture and sequestration to address carbon dioxide (CO_2) emissions costs USD 3/kg, while green hydrogen generated from renewable resources costs USD 5/kg. To decrease costs, economies of scale need to be created (Hydrogen Council 2020). The world faces a chicken-and-egg dilemma regarding a hydrogen-based economy. Development of markets for hydrogen must keep pace with the development of hydrogen production technologies.

Few of the many hydrogen projects deployed worldwide operate on a commercial scale. While hydrogen technologies exist for both supply and demand, their commercialization has been slow. For hydrogen to gain prominence in supporting CO_2 emission reduction, economies of scale must be achieved faster. Moreover, a USD 70 billion investment may be needed to reach the scale required (Hydrogen Council 2020), compared to the USD 500 billion per annum investment for maintaining the fossil fuel oil and gas supply (IEA 2019a). Industry players need to "derisk" hydrogen deployment projects to secure investment. One critical issue is the creation of an effective mechanism for selecting the appropriate technological trajectories over a long period, and complying with political goals.

Currently, almost all hydrogen production occurs for industrial applications, and takes place on site or close to where it is used. Its transportation and storage pose many challenges. Generating blue hydrogen by reforming natural gas with carbon capture and storage (CCS), or green hydrogen via electrolysis using renewable energy, nuclear energy, or biogas, are expensive ways to achieve and accelerate hydrogen production.

As production costs fall, hydrogen transportation costs gain importance in the value equation. Both energy importing and energy exporting countries should gainfully time the global transition towards a hydrogen-based economy, within the various technological trajectories possible in a market-based decision-making framework. A strong policy commitment from all G20 countries is needed to drive this evolution of the energy system.

Relevant and timely incentives to invest in a hydrogen-based economy are needed. The implementation of a carbon emission trading system, and market pricing for carbon emission rights and other negative externalities (e.g., pollution) or common goods (e.g., underground storage) provides a meaningful and robust mechanism to facilitate decision making to choose from the different technological trajectories and versatility of hydrogen. Establishing exchanges and regulatory bodies that can issue certificates and enable trade, provides a pathway to facilitate the "derisking" and regulation of hydrogen technology development at scale. A hydrogen certificate is a transferable record or guarantee, with regard to two dimensions: the energy consumption reduction associated with the usage of hydrogen and the carbon emission reduction associated with hydrogen usage. This hydrogen certificate represents the value of the economic externalities of the usage of hydrogen as energy in various industries.

PROPOSALS

Leveraging hydrogen allows fossil fuel producing countries to participate in the global goal of reducing CO_2 emissions, and to valorize their resources and storage capacity. It enables them to diversify their economies, to export, or use a clean energy vector domestically, partially addressing the issue of potentially stranded assets.

Recently, considerable work has been undertaken to quantify the economic opportunities associated with hydrogen (Hydrogen Council 2020). For instance, the National Hydrogen Roadmap (CSIRO 2018) indicates how these opportunities can be realized in Australia, a country endowed with large gas reserves and high solar energy potential. In fact, most of the G20 countries already have a roadmap for hydrogen. In developed countries, hydrogen use has wide-ranging potential in, for example, transport, residential and industrial heating, and power generation. This analysis was advocated at the 2nd Hydrogen Energy Ministerial Meeting (METI 2019). Meaningful political and financial support has already been directed towards research and development (R&D) and early demonstration projects.

The proposed adaptive policy framework is based on three pillars to establish hydrogen as one of the foundations of a net-zero emissions world. These include: i) Establishing a mechanism to guide the pace of hydrogen deployment using certificates, that is, a transferable record or guarantee, representing the value of the economic externalities of the usage of hydrogen in various industries, ii) derisking hydrogen production and deployment at scale in the short, medium, and long term, and iii) supporting and enabling further R&D in the hydrogen and fuel cells field.

Establish certificates as the preferred mechanism to incentivize hydrogen investments

Leverage hydrogen in industry using certificates associated with carbon dioxide emission pricing

Certificates are a well-established and versatile energy policy mechanism to internalize positive and negative economic externalities. “Carbon credits” have been used and advocated in many instances such as CO_2 equivalents, and Certified Emission Reductions issued by Clean Development Mechanisms under the Kyoto Protocol and subsequent COP agreements. More recently, renewables certificates in Europe, Asia (including China and Korea), and the US guarantee the origin of electricity generation. Additionally, similar to energy performance certificates, energy efficiency certificates enable companies to launch large technology implementation programs for reducing energy consumption. Such tools with proven efficiency enable countries to achieve policy objectives, while permitting industry players to choose the best technologies. Thus, they accelerate technological adoption and facilitate the creation of economies of scale without preempting technological trajectories or market structure.

Political agreement on climate burden-sharing mechanisms and global welfare creation and loss mitigation is needed for implementing the hydrogen certification scheme. For example, a formal agreement on how to implement Article 6, COP21 requires the correct governance involving carbon emissions, and the correct trading and market mechanisms to finance the development of a disruptive energy vector like hydrogen as a clean energy medium.

Decoupling the green attribute from the physical flow of the product, and independence from its production sites, power this system. Linked to each hydrogen molecule, a certificate is issued to represent the monetary value of the carbon emissions avoided in hydrogen production or by using hydrogen instead of another fuel. This hydrogen certificate is delivered to producers by an internationally recognized hydrogen certification institute. Every G20 country has to establish such an institute certifying the economic externalities of hydrogen. Issued with each usage of hydrogen, the certificate's value depends on physical attributes and on government policy. For implementation, the hydrogen certification scheme must include the hydrogen certification governance, eligibility and registration of hydrogen generation plants, the certificate information content (including issuance, transferability, and cancellation), a registry system, and a trading platform (CertifHY 2019). To develop an effective international exchange system, the hydrogen certificate must be supported by a verification body (e.g., a centralized certification authority or decentralized blockchain solution) ensuring uniqueness, and avoiding double counting of certificates. The adaptiveness of the certificate policy is maintained through international exchanges, and by setting goals varying across regions and industries, and evolving over the years.

Proposals:

- Certificates and further incentives should be provided to transition fossil fuel producing countries to cleaner fuels, and progressively diversify their resource-based industry and export revenues.

- A joint working group of hydrocarbon-rich G20 countries should be established to institute a certification body for each region or country, including an international exchange platform.

- The existing momentum around the certification mechanism in Europe may be used to pilot the hydrogen certification system for production and supply to industry. Blockchain technologies can support this certification system efficiently, and handle international exchanges.

- Hydrogen certificates must work transversely across different energy carriers (electricity, gas, biofuels, and others) and energy performance, to enable certification and track energy attributes throughout the energy supply chain.

Implement the certification system to boost green hydrogen production

Green hydrogen can be produced in two ways: i) via electrolysis, using renewable power, and ii) via steam methane reforming (SMR), using biogas. The former, frequently termed "Power-to-Gas" (PtG) technology, can convert excess, curtailed, constrained, or dedicated renewable electrical power (e.g., wind or solar) to hydrogen at approximately 75% efficiency with very low carbon emissions. Currently, green hydrogen generated via PtG is estimated to constitute below 1% of total world hydrogen production. An overview of over 250 PtG projects worldwide (Fargère et al. 2018) reveals that most of them have been developed under a demonstration or proof of concept framework, mainly in developed Organization for Economic Cooperation and Development countries with mature electricity and gas networks. Additionally, the report indicates progressive growth in the average installation size, from several kilowatt installations some years ago, to between one and ten megawatt projects today, to the forthcoming hundred-megawatt projects announced recently.

An increase in the average installation size and more affordable renewable electricity contribute to lowering the production cost of green hydrogen that fluctuates around USD 5/kg currently. Further policy support is necessary to compensate for this premium price of green hydrogen as compared to USD 1–3/kg for hydrogen from fossil fuels. Moreover, this support is essential to ensure complete decarbonization of hydrogen production in the mid-term, with hydrogen progressively changing from gray to blue to green. This green premium can be addressed in two ways: i) via a technology push through capex subsidies on electrolyzers and tax exemptions on renewable electricity usage, thereby decreasing green hydrogen production costs, and ii) via market pull by encouraging demand for green hydrogen to replace fossil fuels and gray hydrogen. The latter can be promoted through the certification system, thereby recognizing the carbon footprint reduction and attributes, and the market value premium of green hydrogen.

Specialized certificates and first institutes certifying the origin of hydrogen generation have been established. The pilot phase covers the production of green and blue hydrogen with 76,000 certificates (CertifHY 2019). This label of origin informs customers about the source of their hydrogen, and serves as a tracking system to ensure the quality of hydrogen. Similar to the certification of the origin of electricity, this system can be extended across the entire hydrogen value chain.

When implemented and recognized at scale, green hydrogen certificates will generate an additional revenue stream for early hydrogen projects, making them competitive with carbon-based alternatives. Increased competitiveness of early commercial hydrogen projects will accelerate scaling up. Thus, they would contribute to further reduction of green hydrogen costs via economies of scale and learning-by-doing effects.

Proposals:

- Encourage green hydrogen production through certification mechanisms that recognize reduced carbon footprint at its fair value, thereby creating an additional revenue stream for early commercial hydrogen projects and encouraging scaling up.

- Providing incentives, grants, and financial assistance to first industry movers has proven to be an enabling mechanism for early adopters, and should be continued.

- Enable a G20 hydrogen platform to exchange industry best practices for reducing the production costs of green hydrogen.

- Scale up and derisk large (in the order of tens-to-hundreds megawatts) green hydrogen production projects worldwide, guarantee priority access to inexpensive renewable electricity for optimizing the cost structure, and supply to early hydrogen markets in a sustainable and commercial way.

- Emphasize offtake securization and encourage green hydrogen markets (through measures such as renewable energy storage in remote areas, clean transportation, hard-to-electrify industries, and natural gas grid decarbonization).

Implement the certification system to promote blue hydrogen: Hydrocarbon reforming with carbon capture and storage

Almost 96% of deliberate hydrogen production occurs using fossil fuels, causing approximately 2.2% of global CO_2 emissions (IEA 2019). Retrofitting current and future fossil-based hydrogen production with CCS is a key mitigation technology to decarbonize this entire sector. Existing large gray hydrogen facilities and new projects need to be decarbonized simultaneously, to promote scalability and decrease costs.

CCS almost doubles the cost of hydrogen production, making it a difficult investment proposition without policy support (BloombergNEF 2019, IFPEN-SINTEF 2019). Existing carbon policies in several G20 countries are currently insufficient for making CCS feasible. However, appropriate carbon emission pricing and green certificate exchanges can help circumvent the cost issue. Resource-rich countries among the G20 members fall at the lower end of the blue hydrogen cost curve, and can adopt policy tools to scale up CCS, potentially lowering its cost. Existing policies must be complemented by technology-specific incentive mechanisms to ensure blue hydrogen deployment.

Proposals:

- CCS must be developed and scaled to limit the global average temperature increase to below 2 °C (Celsius), and certainly not exceeding 1.5 °C.

- A dedicated G20 hydrogen working group and platform must be enabled for hydrocarbon-rich member countries to support CCS and blue hydrogen production.

- Carbon sequestration certificates representing carbon storage units presented in Heidug and Zakkour (2019) should be implemented to provide a strong value proposition to producers and consumers of blue hydrogen.

- Best practices on how hydrocarbon rich economies can leverage blue hydrogen to create a net-zero emissions world must be documented and shared.

Resolve the chicken-and-egg dilemma by derisking large hydrogen projects

Role of certificates in incentivizing and decarbonizing the existing and future industrial hydrogen feedstocks

Hydrogen is already a valued and widely used commodity in several sectors, including in the oil and gas industry for crude oil refining, ammonia industry, and fertilizer industry. Traditionally, industrial hydrogen has been derived from natural gas through the industrial process of SMR, generating 7kg of CO_2 per kg of hydrogen. The steel industry's reliance on hydrogen for iron ore reduction is expected to increase by 2030 (Hydrogen Council 2020). As per estimates, the steel industry contributes approximately 6% of total global CO_2 emissions. Certificates regarding clean hydrogen generation valorize CO_2 emission reduction. Meanwhile certificates regarding improvements in energy efficiency, using hydrogen as a primary fuel, valorize the value added by improved energy performance. Therefore, certificates provide financial incentives to implement hydrogen in industrial heating processes.

The cost poses a major challenge in replacing hydrogen produced from methane via SMR with its green counterpart produced via electrolysis. SMR is a well-established process performed on an industrial scale. Therefore, gray hydrogen produced from natural gas or coal costs approximately USD 1–3/kg, depending largely on local feedstock prices. Currently, green hydrogen costs significantly more, and cannot compete with gray hydrogen. CCS for the production of blue hydrogen via SMR adds to the overall price. Other factors affecting the cost increase include the scale and geology of the storage system. Many industries view blue hydrogen as a competitive solution for the long term, until cost parity with green hydrogen can be achieved. Moreover, blue hydrogen supports the use of existing production infrastructure at scale, while decreasing the carbon footprint of hydrogen produced.

Green certificates and other financial mechanisms such as carbon taxation can play an integral role in incentivizing and enabling the transition from gray to green hydrogen feedstocks. Implemented by many developed countries already, carbon taxation enables cost parity by penalizing CO_2 emitters. Resource rich countries among the G20 members are well-positioned to initiate this energy transition to cleaner fuels.

Proposals:

- A G20 hydrogen working group of industry practitioners, academics, and policy makers should be established to assess hydrogen policies on incentives and taxes in hydrogen producing and consuming countries.

- Large-scale hydrogen projects are significantly more cost-competitive than small-scale ones. Consequently, industrial demand for clean hydrogen should be encouraged to incentivize other hydrogen applications, through economies of scale and technology cost reduction.

- Industrial sectors currently using hydrogen feedstocks rank among the major greenhouse gas contributors globally. Decarbonizing their value chains can lead to significant, long-term greenhouse gas reduction. These reductions must be registered through carbon credits and certificates that can be exchanged in a market, thereby creating an additional revenue stream for clean industries.

Certificates to build an adaptive hydrogen deployment system in the transportation industry

Governments' pivotal role in setting national targets for hydrogen mobility is evident in the 18 hydrogen roadmaps developed worldwide to meet the G20 Summit goal of "10 million hydrogen fuel cell vehicles, 10 thousand hydrogen refueling stations (HRS) in 10 years" (Hydrogen Council 2020). The roadmaps include the following: Hydrogen Roadmap Europe aims to achieve 3,700 HRS, 3,700,000 fuel cell passenger vehicles, 500,000 fuel cell light commercial vehicles, 45,000 fuel cell trucks (FCTs) and buses on road by 2030; the US aims to achieve 1,000,000 fuel cell electric vehicles (FCEVs) by 2030; Japan aims to achieve 800,000 FCEVs by 2030; and China has already implemented subsidies for an FCEV rollout and is implementing additional policies to support commercial hydrogen vehicles, such as FCTs for the medium- and heavy-duty segments.

However, to achieve these ambitious goals, the hydrogen economy needs support for scaling up and acceleration. Government support initiatives for hydrogen infrastructure, and for passenger and commercial hydrogen vehicles worldwide, need to be implemented aggressively. Coordination between the ramp up of infrastructure and vehicle deployment is vital. Policy measures can overcome this chicken-and-egg dilemma. Moreover, governments must establish regulations for hydrogen mobility, standardization, and safety. They must simultaneously balance the optimization of hydrogen fueling infrastructure, scrapping of old vehicles, and the encouragement of auto leasing/auto finance, and remove purchase restrictions and upgrade rural consumption.

Consumer acceptance of hydrogen mobility is needed. As education is the key to successful hydrogen mobility, a comprehensive public education and outreach program needs to be developed. To increase nationwide awareness and acceptance of hydrogen, public and private organizations can adopt varied approaches. These include coalition building, public relations and media campaigns, and long-term commitment of resources to the country's education system.

Promoted through a certification system that recognizes its carbon footprint reduction and additional market value, hydrogen can become cost-competitive against other fuels at the refueling station. This can be enabled either at production through capex subsidies on electrolyzers and on CCS, or at refueling stations through tax exemptions on renewable electricity usage. Coordination between the ramp up of infrastructure and vehicle deployment can be facilitated using market pull, encouraging demand for green hydrogen to replace gray hydrogen. The environmental value that certificates attach to each molecule of hydrogen used in mobility, is determined by the market and by governmental policies. This can scale up hydrogen demand in the transportation industry faster, in the appropriate vehicle segments.

Proposals:

- Hydrogen is an appropriate zero-emission fuel for large, heavy-duty vehicles that require fast fill for long, continuous operation; hence, buses, trucks (medium- and heavy-duty segments), trains, and ships should be prioritized.

- A G20 working group should be enabled to target the apparent hydrogen uses including in road, rail, and shipping logistics, and international transportation, among the G20 countries.

- A policy framework should be developed to ensure fuel price parity for hydrogen at the refueling station.

- A green certificate of origin will ensure hydrogen fuel production at scale without CO_2 emissions, simultaneously providing the vehicle user a carbon credit certificate valorizing clean mobility, thus incentivizing investment in fuel cell vehicles.

Piloting hydrogen and methane blending using certificates

The second-largest source of fuel globally, natural gas is used to produce electricity, heat for homes and businesses, and chemicals. Natural gas pipelines transmit 37PWh of energy annually, worldwide. However, natural gas has generated over 18Gt of CO_2 in 2018, and 40Mt of leaked methane, comprising over 40% of global CO_2 emissions (IEA 2019).

Natural gas is an important global energy source with low global prices. Countries and industries are gradually moving away from coal and peat investment to natural gas. Natural gas infrastructure assets, including pipes, interconnectors, and gas turbines are valued at over USD 1 trillion. Transferring to a new technology or fuel can take decades. Along with no apparent economic benefit or incentive, industries have limited alternatives to decarbonize their natural gas supply.

With regard to the large-scale penetration of renewables in the global electricity system, sector coupling is gaining significance. Renewables variability creates considerable excess electricity that should be captured and used. This is achieved by converting the excess electrical energy into an energy carrier, hydrogen being the simplest, and directing that towards existing infrastructure, that is, the natural gas grid that itself must be decarbonized in the coming years.

A major feedstock for chemical production, hydrogen can replace natural gas for producing electricity directly, using gas turbines or fuel cells, or by combustion in boilers, to heat homes and businesses. Additionally, hydrogen acts as an energy storage vector when used in transport, and allows the sector coupling of electricity and heating systems. Current specifications for integrating hydrogen into natural gas pipelines vary widely in Europe and worldwide, necessitating the determination of an internationally accepted range. Hydrogen is widely known to blend with natural gas up to 20% with minimal modification of modern gas infrastructure, including pipes, interconnectors, and specialized gas turbines (Hydrogen Europe 2019; Northern Gas Networks 2016). Higher percentages of up to 100% in the gas pipes are certainly achievable by upgrading the pipe infrastructure, turbines, and boilers, as is expected in the next decade, provided that investment gains political support.

Proposals:

- Hydrogen blending to the gas grid, R&D, technology, pilots, and at scale demonstration projects must be globally supported and stimulated.

- A working group should be established to support early R&D, pilots and experiments through the sharing of best practices among the G20 countries.

- Global certification and regulations for introducing hydrogen into the natural gas infrastructure must be developed, supported by carbon taxation and guarantees of origin.

Derisking aviation with hydrogen-based electrofuels

The aviation industry generated 918 million Mt of CO_2 in 2018, comprising approximately 2.4% of global CO_2 emissions (Graver, Zhang, and Rutherford 2018). This major and rapidly growing source of emissions must be addressed in pursuing a zero carbon emissions economy (Murphy 2018).

While ushering in an era of large-scale renewables deployment, excess energy should be captured and used. As their costs reduce and the scale increases, many electrofuels, such as ammonia, kerosene, and formic acid, can serve as viable energy carriers for multiple industries. As industrial raw materials, as a progression from fossil diesel, and as energy carriers, electrofuels are certainly significant in energy transition.

As an application that possesses the technology, the aviation sector has a corporate social responsibility to promote green fuels, communicating a positive message to the industry and citizens. Retrofitting the existing fleet or introducing a new fleet of airplanes can take decades, rendering the existing aviation sector difficult to decarbonize. Developing battery electric and hydrogen fuel cell electric airplanes is a step towards reducing emissions. However, liquid fuels for aviation can be decarbonized using the existing infrastructure and supply chain by introducing electrofuels. These carbon-containing fuels replace existing fossil fuels with a carbon-neutral synthetic fuel, manufactured using sustainable biological sources and renewable green hydrogen.

Proposals:

- Global carbon-neutral electrofuel production at scale, R&D, technology pilots, and demonstrations should be supported and stimulated, while implementing a carbon tax on fossil-based aviation fuel.

- A G20 financial fund dedicated to support R&D hydrogen pilots implemented by two or more G20 countries, especially enabling the sharing of best R&D practices, should be created.

- Sustainable biofuel routes and renewable green hydrogen must be encouraged to achieve a sustainable carbon fuel supply chain.

- Certification and regulations must be developed to boost the production of carbon-neutral electrofuels and their use in aviation and other industries.

Adaptive policy to leverage hydrogen in the energy transition—Policy brief conclusion and core proposals

- Hydrogen implementation should be derisked and enabled at scale in an adaptive way, thus allowing the market to choose appropriate energy solutions for a net-zero emissions future.

- Certificates are an appropriate mechanism to match the diverse hydrogen industrial consumption with regional disparities, while enabling clean hydrogen production using multiple resources.

- The hydrogen certificate design must integrate a clear value differentiation between fossil fuel-based blue hydrogen produced with CCS, gray hydrogen produced without CCS, and renewable green hydrogen, to support market growth and level competition.

- The transition from gray to blue and green hydrogen offers an adaptive path for hydrogen production and deployment in both energy resource-rich and consuming countries.

- Each G20 country must institute a body to certify hydrogen production and deployment.

- An international trading platform for hydrogen certificates must be established.

- A G20 working group dedicated to improving understanding and accelerating implementation of environmental and efficiency certificates should be enabled. A carbon credit-based policy should be implemented to integrate positive and negative economic externalities in the hydrogen deployment plans and international trade mechanisms among the G20 countries.

- An exchange platform unifying industry practitioners, policy makers, and academics from hydrocarbon producing countries, for sharing hydrogen best policy practices and insights from certification projects is needed to accelerate implementation and R&D of hydrogen-related aspects.

Disclaimer

This policy brief was developed and written by the authors and has undergone a peer review process. The views and opinions expressed in this policy brief are those of the authors and do not necessarily reflect the official policy or position of the authors' organizations or the T20 Secretariat.

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