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Clean hydrogen in Europe: The only way forward is together

Clean hydrogen is a central piece of Europe's Green Deal goal of reaching climate neutrality. Beyond the ambitious goals announced by the EU last year, the question now is how to build a common pathway at the Member State level. The German and French strategies illustrate the challenges of aligning the tools needed for successful progress regarding the ramp-up of a European hydrogen economy.

Beyond the hype, a major tool for reaching climate goals

European Union institutions are progressively converging on the twin goals of reaching so-called "climate neutrality" by 2050 and, as a first milestone, reducing greenhouse gas (GHG) emissions by at least 55% by 2030. Such ambitious objectives will undeniably require very significant and long-term efforts in all sectors, from energy production to industry and transportation.

In that context, though **clean hydrogen is not a new solution, it is once again taking centre stage worldwide**. The reason is two-fold:

– First, there is a **need to decarbonize the current production of hydrogen, which accounts for about 3% of CO2 emissions in the EU**.[1] Indeed, although hydrogen use does not generate emissions, its production is to date almost entirely dependent on fossil fuels.

– Second, **clean hydrogen is needed in several GHG-intensive industrial sectors that today use natural gas and coal** (notably, for chemicals, cement and steel) **as well as in transportation**, where decarbonization is currently difficult to achieve.

For its supporters, **plentiful, relatively cheap clean hydrogen is a major, if not indispensable, ingredient needed to reach climate neutrality by 2050**. Bill Gates, author of a recent book on solutions to avoid climate disaster, mentions this tool as having the

1. Approximatively, 100 million tons out of total EU GHG emissions of 4000 million tons.

This article is part of a series launched by Institut Montaigne and the Genshagen Foundation, Green Deal Reloaded - Perspectives for a Sustainable and Just Transformation of Europe, which reflects on the economic, social and political issues related to the Green Deal, in the context of the Covid-19 crisis and recovery in Europe.

long-term potential to help reduce world GHG emissions by up to 30%. The world currently produces 100 million tons of hydrogen annually: Bloomberg NEF estimates indicate that in a 1.5° warming scenario, production needs to increase to 700 million tons by 2050 (a sevenfold increase) and be emission-free.[2] Not surprisingly, many regions across the globe aim at becoming clean hydrogen leaders.

The technical, economic and legal hurdles to achieving this transformation cannot be underestimated. On the technical and economic side, the biggest hurdle is the availability of sufficient amounts of low-carbon, and cheap, electricity needed to produce clean hydrogen from water electrolysis (splitting water to extract dihydrogen molecules).[3] **But the regulatory challenges are equally complex**.

In the past year alone, more than 30 new projects have been announced by large European companies (utilities, industry, and transportation operators) as well as start-ups.[4] However, most projects will need an adequate legal and regulatory framework in order to reach completion. Such a **regulatory framework is a precondition for the mobilization of tens of billions of euros in public and private capital**. In that regard, Europe's experience in the development of renewable electricity production shows that being able to raise money from banks and capital markets requires a well-designed set of rules.

Brussels, Berlin and Paris: The issue of coordination

Against that background, it is no surprise that both the EU (July 2020) and many Member States, including France (September 2020) and Germany (June 2020), launched strategies to increase the production of clean hydrogen rapidly. For the purpose of this analysis, we will focus on France and Germany, two major European states with high ambitions in the hydrogen sector.

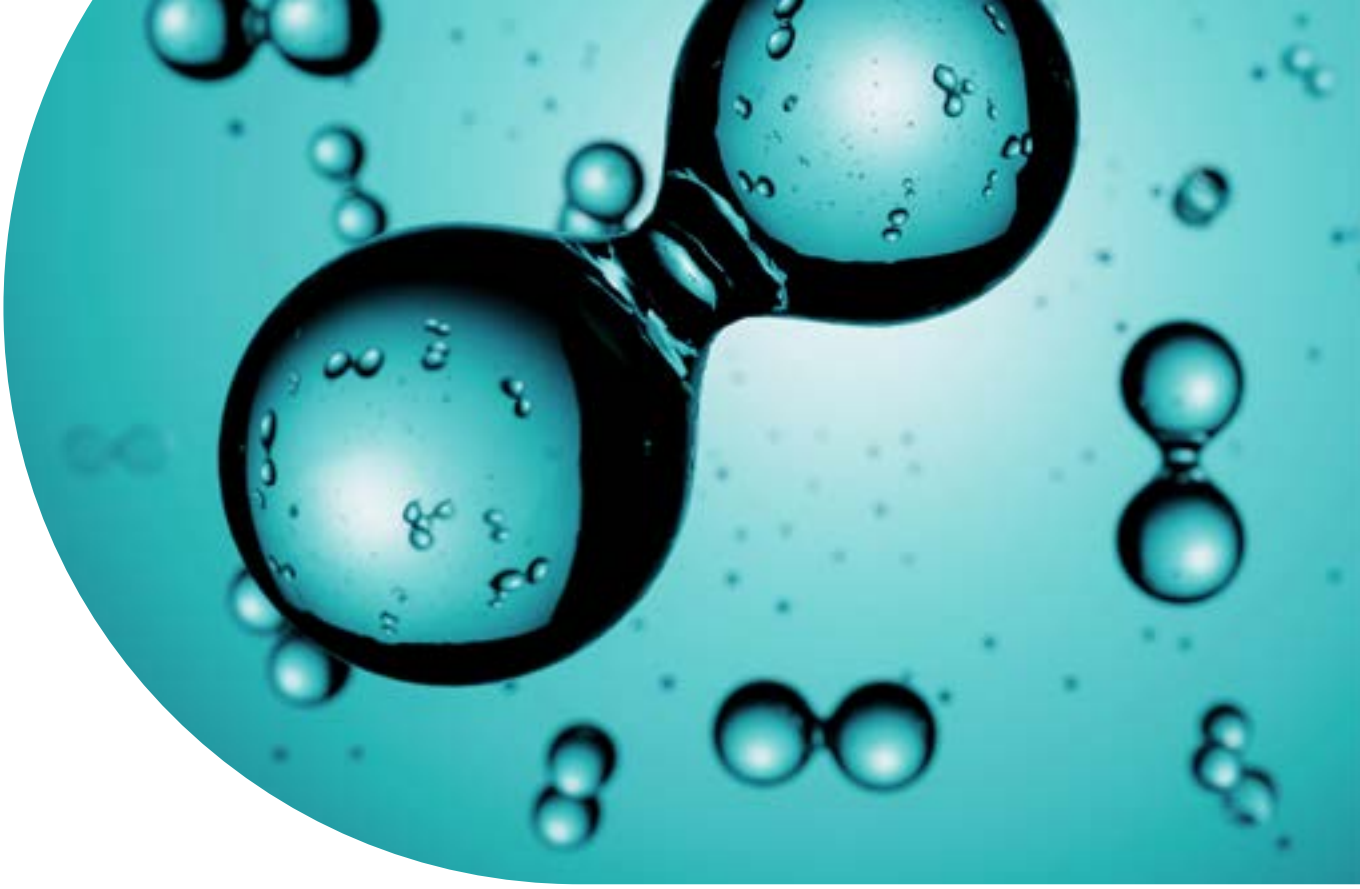
One year after these strategy announcements, the legislative machines in **Brussels, Paris and Berlin have started issuing texts and proposals, allowing for an initial assessment** of the direction that each one is taking. While France focuses on national clean hydrogen projects, using renewable and nuclear electricity, Germany intends to focus mainly on hydrogen from renewable electricity produced nationally or imported using long-distance transportation.

As is the case in other policy areas and as further explained below, **there is a risk of insufficient coordination**. This could lead to added complexity, with significantly different rules for deciding which projects are labelled as "clean hydrogen," which ones may obtain public support from the state, etc. Even though initial projects are designed to serve local hydrogen production and consumption, such fragmentation is likely to slow the ability of stakeholders (including project developers and investors) to scale up their hydrogen efforts across Europe.

Compared to the support of renewable electricity, a higher level of coordination will be needed to bring more than 10 gigawatts of clean hydrogen production capabilities online (starting almost from scratch), over the next 10 years, in the two countries and beyond.

To outline the key elements of a successful framework, as well as the risks of excessive divergence, we can go into more detail by diving into three key aspects of clean hydrogen strategies.

2. "Hydrogen Economy Outlook Key messages", March 30, 2020 (Click here)
3. Other techniques can be used to produce emissions-free hydrogen, eg those mentioned in context of the German hydrogen definitions of blue hydrogen and turquoise hydrogen.
4. "The story in numbers: The infra funds winning the green hydrogen race" Inframation News, 14 May 2021.



1. Fifty Shades of Hydrogen

There is a wide variety of hydrogen definitions, many of which include a form of "colour coding." The spectrum starts with "*green hydrogen*" and reaches all the way from "*blue*" and "*turquoise hydrogen*", to "*grey*" and even "*pink hydrogen*". In particular, the German Hydrogen Strategy includes such a colour-coding concept. The EU Hydrogen Strategy and the French Hydrogen Strategy, on the other hand, do not. They rely on terminology that is more descriptive, eg, "*Fossil-based Hydrogen*."

Why does this matter? Even though the strategies themselves are not legally binding, the definitions used in them are likely to be referenced by legislators, for instance when issuing subsidies or permits. It is therefore important to look at the context of the respective hydrogen definition and what it does in the respective regulatory framework.

The European Union has not yet adopted an EU-wide set of legally binding definitions.

This has not prevented **France** from moving forward with its own definitions under the **Ordinance of February 17, 2021**,[5] the first attempt in Europe at building a unified set of regulations for clean hydrogen (including a support scheme and a traceability system).

More specifically, it defines three categories of hydrogen: (i) **Renewable Hydrogen**, produced by using electricity generated exclusively from renewable energy sources and without emitting a certain threshold of CO2/kg, which shall be set by ministerial order, (ii) **Low-carbon Hydrogen**, which has to meet the same CO2 emission threshold as renewable hydrogen but is not required to be produced using renewable energy sources and (iii) **Carbonaceous Hydrogen**, which refers to hydrogen that is neither renewable nor low carbon.

The most relevant difference between the French categories of hydrogen is that Renewable Hydrogen and Low-Carbon Hydrogen can use the French traceability system (cf. Section 2 below) and can benefit from French support payments (cf. Section 3 below). However, a ministerial order still needs to set the CO2 threshold for Renewable and Low Carbon Hydrogen.

The **German** Hydrogen strategy introduced a variety of hydrogen colours: (i) "*green hydrogen*" is derived from water electrolysis and using electricity from renewable sources, (ii) "*blue hydrogen*" is produced using carbon capture and storage technologies[6], (iii) "*turquoise hydrogen*" is produced via methane pyrolysis and (iv)

5. Ordinance No. 2021-167 of 17 February 2021 on hydrogen (Click here)

6. Carbon capture and storage technologies are still a politically complicated topic in Germany, since in particular the long-term underground storage triggered protests and following a Federal law passed in 2012, some Federal States with important storage capacities have factually stopped underground storage projects of being developed.

"*grey hydrogen*" is based on the use of fossil hydrocarbons. However, so far, only "*green hydrogen*" found its way into German law. Due to an amendment in December 2020, the German Renewable Energy Act exempts Green Hydrogen production from certain surcharges (cf. Section 3 below). However, the law delegates the difficult task of precisely defining the criteria for Green Hydrogen back to the government.
An **ordinance**[7] **published on May 19, 2021** sets out rather strict criteria. In essence, green hydrogen needs to be produced from renewable energy sources that are mostly located in Germany and that do not receive any subsidies. Furthermore, the electricity used for hydrogen production needs to be delivered via the same utility as the guarantees of origin for the renewable energy or, in case of delivery via a direct line, be consumed in the same 15-minute interval in which the renewable energy source produced the electricity. However, the German ordinance stresses that this is merely an interim solution, which is to be immediately aligned with requirements that might soon be set by the European Union. Furthermore, this strict and interim definition of "*green hydrogen*" so far only applies in the context of the German surcharge exemption (cf. Section 3 below), ie, only in the context of one of possibly several German support schemes for hydrogen.

The German government already announced that it intends to use the time to coordinate its efforts with the EU and align the interim solutions that are already put in place. Both Governments may already take into account the CO2 thresholds for sustainable hydrogen recently published in the context of the so-called "EU taxonomy" regulation. This major EU initiative established a list of "environmentally sustainable" economic activities. It aims to provide appropriate definitions to investors, companies and policymakers on economic activities that can be considered environmentally sustainable.

In addition, a revision is ongoing in Brussels of the directive setting objectives and tools for renewable energy (so-called "RED II" directive). It will be key to determine what "renewable electricity" means for hydrogen producers. For instance, the latest proposals would require renewable (eg wind and solar) plants to meet strict conditions: They should be recent (less than 12 months old) and they may not benefit from State support. Many stakeholders are concerned the proposed definition will result in insufficient amounts of renewable electricity available for the development of clean hydrogen.

Therefore, **there is currently a window for France and Germany to each decide on the technologies they want to support**. It would be unrealistic to expect France and Germany to suddenly align their national energy strategies. That said, it should be possible to work towards common hydrogen terminologies so that France, Germany and the EU can use the same standardized wording. Aligning the definitions could facilitate a rapid ramp-up of sustainable hydrogen production. That way, companies on the ground and financial markets providing the necessary capital can easily understand what projects may be eligible for support payments and labelled as sustainable investments. For cross-border projects, such alignment may even be necessary.

In any case, definitions should remain consistent with the overall clean hydrogen production objectives, which are very ambitious. Being too strict may end up being counterproductive by excluding many projects and technologies. Realism and willingness to compromise will thus be needed.

2. Tracing the origins

The traceability of hydrogen will be key to future hydrogen markets. This is because the physical characteristics of hydrogen as a chemical element are always the same and do not change if it is produced via the electrolysis of water instead of processing fossil hydrocarbons. A future market with different categories of hydrogen would therefore need to rely on a robust certification system that allows suppliers and customers to confirm the delivery of the correct type of hydrogen.

As soon as hydrogen is injected into pipelines that carry more than one category of hydrogen, the need for a traceability system becomes obvious. Otherwise, it would probably be close to impossible to tell just from its physical characteristics where and how the delivered hydrogen was produced. Today we have such systems, for example, for the EU's renewable electricity market: national registers issue guarantees of origin for each megawatt-hour of renewable electricity produced and allow

7. The necessary approval by the German parliament is still pending and (minor) changes to the ordinance are therefore still possible.

the guarantees of origin to be freely tradable. This way, renewable electricity suppliers and customers can trade renewable electricity that has been injected in the public grid, even though it is impossible to physically trace back a molecule consumed at a specific connection point to the installations by which it was produced.

The French Ordinance introduced the concept of such a register for Renewable Hydrogen and Low-Carbon Hydrogen produced in France. This French register shall allow for two types of guarantees to be registered: (i) **Guarantees of origin** (GOs), which are issued if the hydrogen is either likely to be mixed with another type of hydrogen or another gas (eg, natural gas) or if the GO is likely to be transferred independently of the hydrogen produced and (ii) **Guarantees of traceability** (GTs), which are issued when the physical traceability of hydrogen is technically possible (eg, the hydrogen is not mixed with any other type of hydrogen or gas). The guarantee is issued at the same time as the hydrogen is produced. As a result, a GT cannot be transferred independently of the related quantity of hydrogen. If the related hydrogen is sold to a third party, the GT may be either annulled or transformed into a GO.

Germany has yet to publish its proposal for a hydrogen traceability system. This was to be expected, since the German National Hydrogen Strategy stresses a multilateral approach in this regard by not proposing national legislation, but stating that quality standards and guarantees of origin for green hydrogen and its downstream products shall be developed on the European level. However, a national German traceability system can be expected. This is because the renewable energy directive (EU) 2018/2001 (RED II) requires Guarantees of Origin to be set up not only for renewable electricity but also for gas (including hydrogen), as well as heating and cooling.

Germany's multilateral approach is open to reflect the large legislative package currently prepared under the European Green Deal that aims to increase the EU climate target to a 55% net reduction of greenhouse gas emissions by 2030 (Fit for 55 Package). The Fit for 55 Package includes a review of RED II and the introduction of a gas package for decarbonized gas markets.

In particular, via the European Council, both France and Germany are involved in the context of the Fit for 55 Package and the comprehensive review of the European regulatory framework under the European Green Deal. The challenge is not only to agree on new legislation on the European level. Due to the very short timeframe until 2030 and the vast amount of technology to be built at a large scale, the European institutions, as well as Member States such as France and Germany, need to trigger significant private investment even before the regulatory framework is fully developed. This accelerated process will only be successful, if private investors have sufficient comfort along the way. Clear grandfathering provisions will be essential to avoid unnecessary disruptions of investor confidence. Furthermore, interactive processes between public authorities and private investors regarding the projects under development can be very helpful.

For traceability systems, such interactive exchange between stakeholders is channelled through **Project CertifHy**. The project is run by the Fuel Cell and Hydrogen Joint Undertaking (FCH JU), a public-private partnership led by the European Commission and aims to develop a guarantee of origin scheme for hydrogen across Europe in order to facilitate harmonized implementation and future cross-border activity. The currently running phase III of Project CertifHy includes first trades via a platform organised by GREXEL (part of EEX Group). Even though many European companies already joined in the past years, Project CertifHy remains open for new stakeholders to join the conversation.

Overall, the national traceability systems will need to ensure sufficient coordination to allow for cross-border transactions and projects to take shape. A unified system, similar to the one used for GHG emissions allowances (EU Emissions Trading Scheme, EU-ETS) could be implemented in the medium to long term.

3. Following the Money

Europe's strategy for the development of decarbonized hydrogen also involves the emergence of a European-based electrolysis industry.[8] Both the French and German governments prioritize this hydrogen manufacturing process, which appears to be the most promising and has a high industrial potential. This contrasts with other countries such as the UK, which also has a focus on decarbonizing the current grey hydrogen production by capturing and storing carbon (CCS).

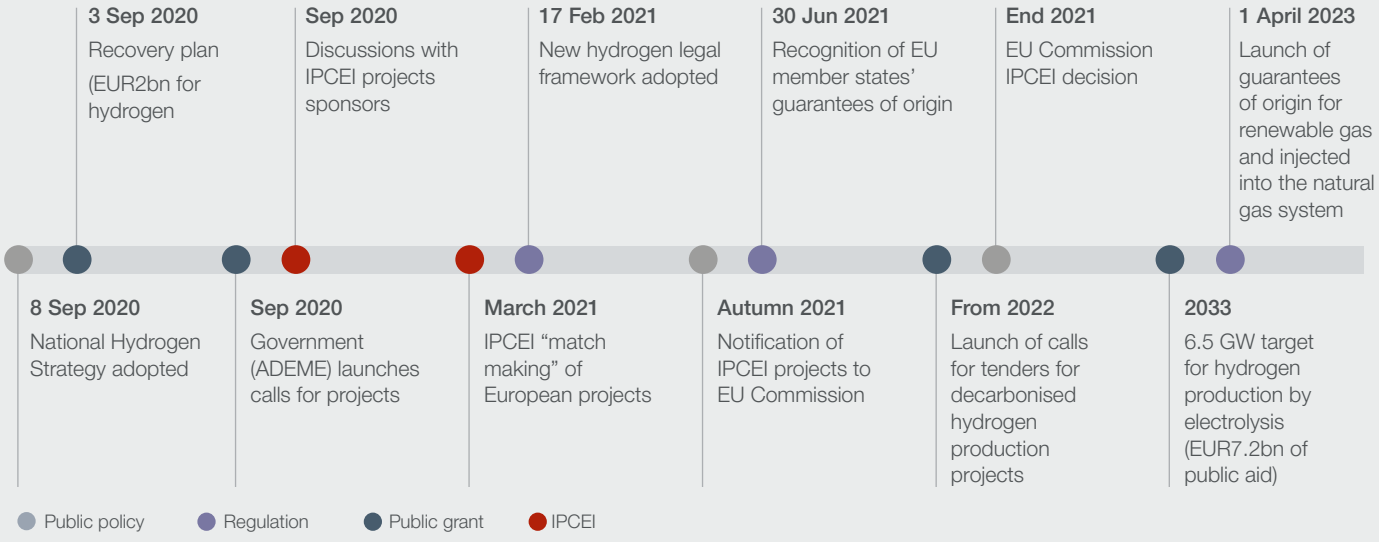
However, hydrogen produced by water electrolysis is currently around three times more expensive than fossil-based hydrogen. That said, in light of a possible rapid market ramp-up, hydrogen production costs are projected to be reduced significantly through economies of scale, as they did for renewables.[9]

At the EU level, a key tool for supporting private initiatives is called the "Important Project of Common European Interest" (**IPCEI**). This is a system to allow and foster subsidies to be paid by the Member States, by encouraging strategic alliances across Member States and providing exemptions from State aid rules. This tool is already used for ramping up battery and semiconductor production in Europe, and other strategic sectors. In the hydrogen field, the "European Clean Hydrogen Alliance", supported by the European Commission, aims to foster a similar collective effort. By building common know-how and experience for developing projects, it brings together industry, national and local public authorities, civil society and other stakeholders in order to define a pipeline of concrete, major hydrogen projects in Europe.

However, at the French and German level, it is not clear whether the support schemes will be sufficiently coordinated.

In France, the Government has reserved **EUR 1.5 billion** in potential subsidies as part of the hydrogen IPCEI. It also intends to implement a national support scheme, inspired by existing schemes for renewables.

French hydrogen timeline



Through a tender procedure and by contract, two types of support are granted: An additional remuneration ("**operating aid**") to compensate for the higher costs of clean hydrogen. For some projects, in addition to the operating aid, an **investment aid** is possible to cover high initial costs (eg for the electrolyser). This support mechanism will target production units of renewable hydrogen and low-carbon hydrogen (as defined by law) produced by

8. The electric current decomposes the water molecule into ions of hydroxide (OH) and H+ protons. The protons accept electrons in an oxidation reaction thus forming hydrogen gas.
9. Hydrogen Council, "Hydrogen Insights: A perspective on hydrogen investment, market development and cost competitiveness", February 2021. (Click here)

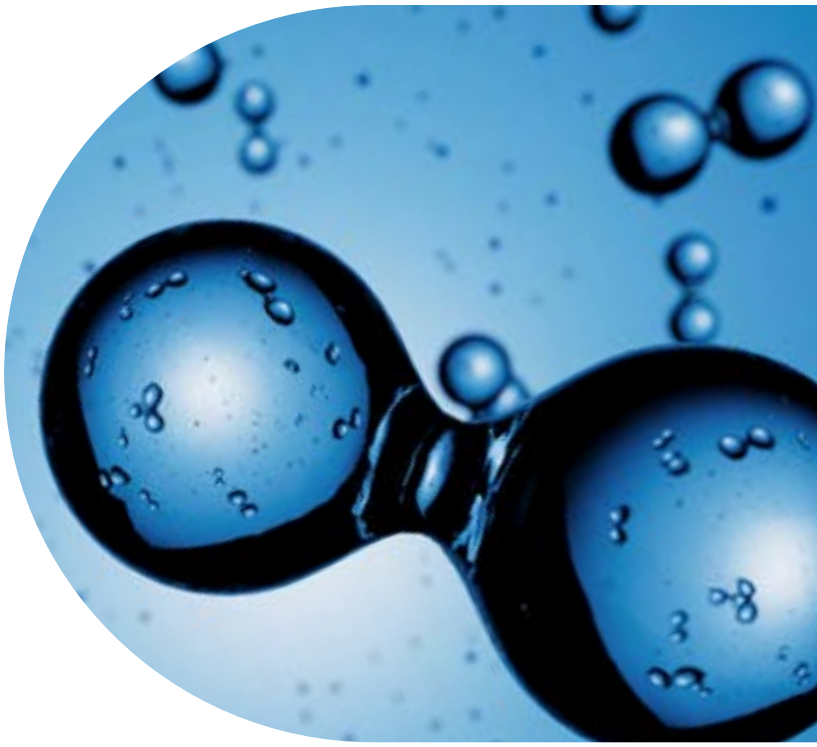
electrolysis of water and located on the French territory exclusively.[10] The contract will include the beneficiary's economic and environmental commitments over the duration of the contract, up to 20 years (more likely, 12 to 15 years). The procedure for granting the contract will be subject to the public procurement principles of transparency and equal treatment.

The government has been careful not to repeat past mistakes. The scheme fundamentally differs from power purchase agreements used for wind and solar support[11], where the French State found that some projects had secured what was perceived as excessive profitability. The French Ordinance sets out strong checks to the amount of aid granted to the beneficiary.[12] The support contract may provide that the project holder shall give up such subsidies and tax breaks so that the capital invested may not exceed a "reasonable" income level. The launch date of the first calls for projects will depend on the European Commission's State aid approval.[13]

In Germany, the support scheme consists of several elements, most of which still require clarification and/or additional laws/ordinances to be drafted and adopted. However, it is already clear that Germany will spend billions of EUR on hydrogen technologies being rolled out starting in 2021 and 2022 (cf. timeline below). The German support scheme will most likely not be combined in one central legal act. Instead, there will probably be numerous amendments to important energy sector laws, such as the German Renewable Energy Act (*Erneuerbare Energien Gesetz – EEG*) and the German Energy Industry Act (*Energiewirtschaftsgesetz – EnWG*), which would typically be followed by ordinances specifying the details.

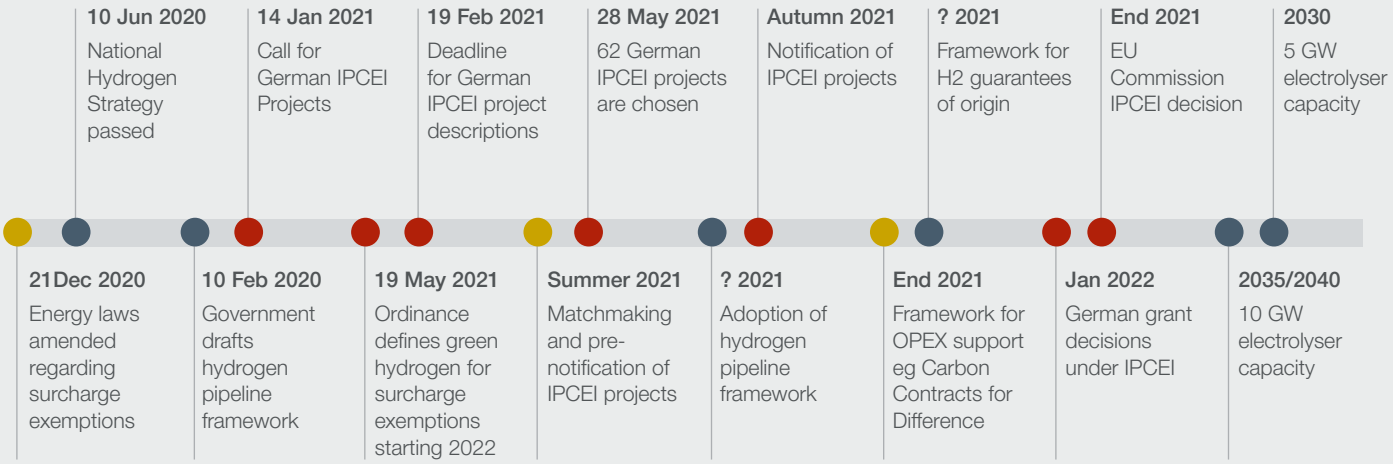
Just like in France, Germany's scheme is expected to cover operating and investment costs. **Operating costs** will take the form of an exemption of clean hydrogen from the so-called "surcharges" paid by electricity consumers in Germany. These surcharges finance the public support offered to renewable plants and are the cause for the high price of electricity in Germany. In addition, projects will benefit from public subsidies to cover the **investment costs**, as part of the German application to the EU clean hydrogen IPCEI initiative. A total of 230 projects applied under a call for projects in February 2021. On 28 May 2021, the German government announced that 62 projects were chosen, including transportation, pipelines, green chemicals and green steel applications, as well as about **2 GW of electrolyser capacity**. A total of **EUR8 billion** is earmarked for the German IPCEI projects alone. They will be coming from the German Federal State and the German Local States, and aim to trigger total investments of about EUR 33 billion (incl. **EUR20bn** from private investors). The German government aims to send out grant decisions as early as the beginning of 2022.

In light of a recent decision by the German Federal Constitutional Court, Germany's path of decarbonisation has to be accelerated. Current draft legislations foresees raising the bar from 55% to 65% GHG reduction by 2030, followed by 88% by 2040 and the plan for Germany to reach carbon neutrality by 2045. Such acceleration of Germany's decarbonisation will most likely also impact the timeline for the German hydrogen efforts. Details are expected to follow the Federal election, in September 2021.



10. Article L. 812-2 of the Energy Code.
11. Recently France passed legislative provisions aimed at the renegotiation of solar power purchase agreements concluded between 2006 and 2010.
12. Article L. 812-5 of the Energy Code.
13. The revision of the State aid framework, including the State aid guidelines for energy and environmental protection, is expected in 2021. The European Commission has already approved, under EU State aid rules, a EUR30 billion Dutch scheme to support projects to reduce greenhouse gas emissions, including hydrogen production (European Commission, Press release, 14 December 2020) (Click here).

German hydrogen timeline



In addition to IPCEI, Germany is contemplating an innovative contractual system under which a subsidy paid to the hydrogen consumer (eg a steel plant) would be linked to the price of a ton of CO2 under the EU-ETS. This so-called "Carbon Contract for Difference" (**CCfD**) regime would target the support of the GHG emissions avoided by the consumer, in addition to the hydrogen itself. This system is more advanced, but also more complex, than current support schemes used to support wind or solar plants. In its July 2020 hydrogen strategy, the European Commission also proposed to develop a CCfD regime as part of a pilot program.

As shown above, there are significant differences between the support schemes in France and Germany. This is quite similar to the current situation in the field of support to renewables, and also reflects structural differences in financing mechanisms for the energy transition. It would be useful to aim for more alignment, at least at least regarding the key principles. There is room for additional convergence.

To live up to the expectations and the potential of clean hydrogen to accelerate the road to climate neutrality, European stakeholders will need to clear several hurdles. The need for a well-designed legal framework is one of them. Looking at the example of France and Germany, there is room for improvement. Further, beyond the issue of internal coordination, Europe should not forget it will be facing stiff competition from the rest of the world. Therefore, clean hydrogen offers a chance to design holistic, multi-level support and regulatory systems – a precedent that could be useful for future initiatives launched as part of the Green Deal.

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