

The European Union Hydrogen Strategy as a significant step towards a circular economy

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Abstract: *The paper is structured in three parts: the first contains some reflections on the essence of the circular economy concept; the second reviews the European Union positions vis-à-vis the circular economy and the large scale utilization of hydrogen, with reference in particular to the most recent strategic documents (European Green Deal, EU New Industrial Strategy for Europe, EU Strategy for Energy System Integration, EU Hydrogen Strategy, European Clean Hydrogen Alliance); the third part evaluates the feasibility and implications of the transition to a hydrogen based economy and the relation of this transition to the circular economy. The conclusions state that the adoption by the European Union of a hydrogen strategy represents a significant step towards a true circular economy.*

Keywords: *circular economy, hydrogen economy, transition to a hydrogen economy, European Green Deal, EU hydrogen strategy*

JEL classification: O13, O14, P18, P48, Q42

Circular economy: a mature concept waiting for its time

As a concept, circular economy is at least decades old and the raising awareness on the subject is related by many authors to Kenneth Boulding who spoke in 1966 about “open” and “closed” economies (Boulding, K., 1966), **contrasting**, in this way, **two historical periods and two perceptions about planet Earth** (for a synthesis of this comparison see Table 1).

Table 1. Open and closed economies – two historical periods and two perceptions about planet Earth

Historical period/ Perception about planet Earth	Open economy system	Closed economy system
From the beginning of humankind until the end of the first half of the 20th century	Perception of a virtually limitless world: humankind aimed at exploring and conquering the environment. Natural resources, air, water and environmental sustainability were perceived as either being limitless or taken as a free given input without constraints.	-

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<p>From the second half of the 20th century until present times.</p>	<p>-</p>	<p>The world/planet Earth has started to be perceived as being very large but anyway finite. More and more people started to become aware that natural resources, air, water and environmental sustainability are limited and those limits started to be quantified.</p>
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Source: Table designed by author based on bibliography.

Kenneth Boulding used some powerful metaphors, naming the open economy of the early stages of human civilization as a **“cowboy economy”** (meaning that reality was perceived by the majority of people as having open and limitless spaces and resources that were out there waiting to be discovered and exploited) and the more recent historical periods, starting with the second half of the 20th century, as **“spacesman economy”** (meaning that planet Earth started to be perceived by more and more people as having finite available space and resources as well as a finite environmental sustainability capacity). The understanding of the limits of planet Earth perceived as a spaceship led Boulding to the concept of a “cyclical ecological system” as a possible solution for the sustainability of humankind. Although in his paper *“The Economics of the Coming Spaceship Earth”* Boulding did not use explicitly the concept of “circular economy”, he mentioned anyway a “cyclical ecological system” which in fact implies circularity.

Further research on the origin of the representations of the limited space and resources provided by planet Earth reveal other metaphors, adequate to the historical periods when they were created: in the 19th century, the American economist and journalist Henry George (whose writings influenced Kenneth Boulding) compared planet Earth with a **ship sailing the seas**; during the early 20th century, the English writer George Orwell had a similar vision.

In the second half of the 20th century, the metaphor for planet Earth evolved **from “ship” to “spaceship”**: in 1965, the American politician and diplomat, Adlai Stevenson, compared planet Earth to “a little spaceship” (note the adjective “little” which underlies the infinitesimal dimensions of planet Earth in comparison with the Universe); in 1966 the British economist and writer Barbara Ward published the novel “Planet Earth”, while in 1969 the American architect, inventor and futurist Buckminster Fuller published “The Operating Manual for Spaceship Earth”.

Comparing the two metaphors, planet Earth as a ship sailing the seas and planet Earth as a spaceship travelling through the Universe, we can note a difference: while in the first case the ship sailing the seas had some finite resources of food and water on board that could be supplemented in a limited way by catching sea food, in the second case, that of a spaceship travelling through the Universe, the food, water, air and life supporting environment conditions are entirely confined to the interior of the spaceship. The first metaphor represents a partial circular economy, while the second represents a true circular economy.

After the mid-1960s the concept of circularity in economy emerged under different names and approaches, not all of them being explicit but all of them being based

on the ideas of finite resources and the need of environmental sustainability, the need for sustainable development and co-existence with the natural environment instead of domination and exploitation of the natural environment. Some of these approaches were focused on the limited character of the resources available on planet Earth, like the first Report to the Club of Rome, Limits to Growth (Meadows, D.H., Meadows, D.L., Randers, J., Behrens III, W., 1972). Others were oriented towards building a more sustainable economy and society, even at a global scale, like Our Common Future, also known as the Brundtland Report (World Commission on Environment and Development, 1987).

The idea of circularity in economy and society has been explored from various angles and under different names. The literature on circularity and closed loops is so rich that it may represent a domain of research in itself, which is not the purpose of this paper. Some concepts that were proposed as result of these studies were those of a closing circle (Commoner, B., 1971), looped economy and performance economy (concepts developed to a large extent by Walter Stahel, one of the founding fathers of circular economy and co-author of the first report presented in 1976 to the Commission of the European Communities about an economy in loops/circles), cradle to cradle, regenerative design or blue economy. A synthetic analysis of the main schools of thought related to circular economy can be found with Ellen MacArthur Foundation which is a reputed promoter and source of well-structured information on circular economy (The Ellen MacArthur Foundation, 2020).

A notable mention in this context may refer to the works of the American mathematician, statistician and economist of Romanian origin, Nicholas Georgescu-Roegen, that coined the concept of “bio-economy” as an alternative type of economy based on biological rules instead of the traditional approach to economics which was based more on Newtonian physics (Mayumi, K., 2001). Bio-economy is largely a circular economy because biological processes are circular in their nature.

Based on the review of literature, we attempt to synthesize some aspects which represent in our understanding the essence of the circular economy concept:

- Economy and society not only interact with nature (which has a finite dimension), but are parts of it;
- As economy and society are forms of manifestation of human life, they are based, influenced and shaped by the biological nature of life/nature, which is intrinsically circular;
- Circular economy both as a concept and as a way of organizing economy and society starts with the understanding of the available resources which are limited at any given time due to available technologies and scale of economic and social activities;
- Circular economy means/implies a different understanding of human needs (separating essential from non-essential needs) and a different design of things/processes (with a focus on sustainability and not on profit);
- Circular economy does not mean to carry on the same activities in the economy and society, while recycling more, but to think differently, to design products and processes differently so that waste is eliminated or vastly reduced, the products are much more durable and they can be repaired or their parts can be reused and recycled. According to this approach, waste still exist, but it is orders of magnitude smaller than in the linear economy.

The aspects mentioned above are in no way intended to be absolute, definitive and final. They represent a level of understanding specific for this moment but, in our opinion, they can help in focusing the discussions about circular economy on the true nature of this concept.

As many other concepts, the understanding of the circular economy may be enriched with new meanings in relation to new knowledge or new circumstances. The climate changes and the urgency to address its consequences gave a strong support to the circular economy approaches, while the Covid-19 crisis as well as the availability of new technologies have accelerated some already manifested trends (digitalization, remote working, automatization including the use of artificial intelligence and robots).

The European Union's positions vis-à-vis the circular economy: a work in progress

We can trace the interest of the European Union of today in exploring circular economy quite early, to the year 1976, when a report named “The Potential for Substitution Manpower for Energy” was presented to the DG V Labour and Social Affairs of the Commission of the European Communities (Stahel, W.R., Reday, G., 1976). Anyway, some decades passed until European Union has adopted an official and explicit position related to circular economy, in December 2012, by means of the document “Manifesto for a Resource Efficient Europe”. In this document, the European Union stated from the first paragraph that “In a world with growing pressures on resources and the environment, **the EU has no choice but to go for the transition to a resource-efficient and ultimately regenerative circular economy**” (European Commission, 2012).

Two milestones in the formulation of a clear and operational position of the European Union vis-à-vis the circular economy were: **July, 2014** when the European Commission presented the document “*Towards a circular economy: A zero waste programme for Europe*” (European Commission, 2014) and **December, 2015** when the European Commission presented its first action plan “*Closing the loop - An EU action plan for the Circular Economy*” (European Commission, 2015). The main purpose of the Circular Economy Action Plan has been the achievement of a carbon neutral, resource efficient, competitive economy and provided for 54 actions. A Report presented by the European Commission in March, 2019 highlighted the fact that all actions have been successfully implemented or were well underway towards completion (European Commission, 2019).

In our view, the first Circular Economy Action Plan of the European Union presented some **the positive aspects**, among which:

1. for the first time, this Action Plan provided for a systemic approach of the economic circuits **starting with the design of products and services** and continuing with the extraction of resources, production, use and repair, re-use and recycling. **This systemic approach included product design, production processes and consumption;**
2. after the adoption of the Action Plan the circular economy principles have been implemented in a significant number of areas, such as plastic production and consumption, water management, food systems and the management of specific waste;
3. the establishment of a monitoring framework for a circular economy at

the level of the European Commission based on the request by the Council of the European Union in 2016 (Council of the EU, 2016). A first report on the monitoring framework was presented by the EU Commission in January, 2018 (European Commission, 2019).

4. the establishment starting with 2017 of an annual **Circular Economy Stakeholder Conference** organized by the European Commission and the European Economic and Social Committee and the launch of **the European Circular Economy Stakeholder Platform** that allows an open exchange of views of all parties interested (authorities, business community, civil society) and provides for permanent monitoring and improvement (European Commission, 2017).

At the same time, we can mention as a **weakness** of the first Circular Economy Action Plan the fact that, from the point of view of content and communication, the circular economy appeared to be mostly related to recycling and reusing, job creation, business opportunities. In this context, the majority of official documents, press releases and fact sheets on circular economy referred only to a very limited extent to the need for changing the design of the products and services according to a new philosophy aiming at eliminating or maximizing waste (European Parliament, 2016).

The main potential negative effect of this interpretation (that creates the perception that circular economy refers mainly to recycling and reusing) **is that it implies the production and consumption continue as usual, while people are just more careful with recycling and reusing of materials.**

Such a misinterpretation may void the circular economy concept of its main characteristic that is to keep materials as much as possible in the economic loop by **different technological designs** (with a focus on more durable products and less materials and energy intensive production processes), **different productions technologies** (aiming at becoming carbon neutral), **different consumer behaviours** (less fashion products that are obsolete by design) and **different citizen behaviours** (more environment cautious, more inclined to sharing, more inclined to adopting eco-friendly habits). Without any doubt, the recycling and reuse of materials is beneficial for the environment, making the economic processes less energy intensive and less polluting, but these activities represent just one part (and not the essential one) of the circular economy.

European Union - Some strategic documents adopted in 2020 and their implication for the transition to a circular economy and the large scale use of hydrogen (European Green Deal, EU New Industrial Strategy for Europe, European Clean Hydrogen Alliance, EU Strategy for Energy System Integration, EU Hydrogen Strategy)

The year 2020 has been a milestone in the change and significant improvement of the position of European Union institutions regarding environment protection, transition to a circular economy and supporting the achievement of the objectives of the United Nations Strategy for Sustainable Development 2030. A number of strategies and action plans have been adopted as a fulfilment of activities and discussions that have been carried out in the previous years.

A number of circumstances required the European Union to think ahead for the decade until 2030 and to adopt new and bold strategies. Among them we can

mention:

- The pressures determined by obvious effects of climate change;
- The serious implications of the Covid-19 crisis and the need to restart the economies of the European Union member states;
- Some geopolitical changes that required a rethinking of the position of European Union at least vis-à-vis the United States and China;
- The beginning of a new multi-annual programming period (2021–2027);
- The implications of Brexit.

In response to the above circumstances and trends European Union adopted a number of strategies that aim at achieving simultaneously several goals in a mutually reinforcing manner. These strategies are:

- **The European Green Deal** that is the most ambitious programme ever adopted by the European Union that aims to transform the economies of the member states into low carbon economies (with zero net carbon emissions in 2050) by achieving economic growth without an increase of consumption of resources and environment pollution, without reducing prosperity and increasing the competitiveness. A budget of about 1 trillion Euros have been envisaged and the participation of the private sector is encouraged and already very active. In essence, the roadmap for the European Green Deal has in view “the efficient use of resources by moving to a clean, circular economy” (European Commission, 2020a).

- **EU Strategy for Energy System Integration** is a very comprehensive document that proposes a holistic approach to the energy system at the level of the whole European Union. It is built on 3 elements: a circular energy system based on eliminating energy waste and maximizing energy efficiency; the transition to the production of cleaner energy from renewable sources; promotion of renewable and low carbon fuels, such as hydrogen, inclusively in sectors that are usually hard to decarbonize (such as metallurgy, chemical industry, heavy transport, constructions). The strategy provides also for the protection and information of consumers (European Commission, 2020b).

- **The EU New Industrial Strategy for Europe** is a comprehensive framework for the successful transition of the European Union economy towards the new realities of the global economy of the 2050s (European Commission, 2020c). The 3 main priorities have in view to secure the competitiveness of European industry, while achieving carbon neutrality by 2050 and digital leadership. One component of the strategy refers to the establishment of a **Clean Hydrogen Alliance** which is important because brings together the supply and demand of clean hydrogen, as well as the hydrogen transmission and distribution (European Commission, 2020c).

- **A new Circular Economy Action Plan - For a cleaner and more competitive Europe.** This is the second action plan of the European Union regarding the circular economy (the first one was adopted in 2015) and it is an integral part of the new EU Industrial Strategy. The action plan aims to double the circular use of materials in the economy until 2030 while providing high quality, efficient and affordable products and services for the European citizens. The action plan is very comprehensive including, besides the measures related to the internal market, measures related to international cooperation in

support of the circular economy and even “measuring well-being beyond the GDP” (European Commission, 2020d). This action plan stresses for the first time the importance of including circularity from the design stage of products and services which will be addressed through a sustainable product policy legislative initiative. In this way, the weakness of the first Circular Economy Action Plan we mentioned above has been corrected.

– **EU Hydrogen Strategy - A hydrogen strategy for a climate-neutral Europe.** According to this strategy, the European Union considers hydrogen as essential for the achievement of the zero emissions target for 2050 as well as for the targets of the Paris Agreement on climate change. The strategy recognizes the multitude of utilizations that are made possible by clean hydrogen (as a fuel, for energy storage, heating, industrial processes, transport, etc.). Hydrogen has also the advantage of making use of some existing infrastructures available in the oil and gas industries and can capitalize on the growing sector of renewable energies (wind, ocean waves, solar, biomass). In fact, hydrogen is very well positioned for a true circular use of energy resources (for instance, electricity obtained from solar or wind sources can be used for production of hydrogen through electrolysis and further on, hydrogen can be stored and used in fuel cells to produce electricity. This is a true circular process). The transition to a hydrogen based economy is perceived at the level of the European Union as a strategic decision and almost all member states are as of July 2020 members of the “Hydrogen Initiative” (European Commission, 2020e).

These documents briefly mentioned above represent the most comprehensive package ever adopted by the European Union which represents the roadmap to its future. The documents are mutually reinforcing each other and their implementation will require a lot of secondary and tertiary regulations as well as, in many cases, reaching consensus among the member states. The whole transition of the European Union to a zero emissions economy, clean energy and digital technologies will be incredibly complex. But the proposal of these documents in 2020 provides a significant chance for success.

The hydrogen based economy: a secret hidden in plain view

The concept of a “hydrogen economy” or, more accurate a “hydrogen based economy” is at least several decades old, some authors placing the first public uses in late 1960s or early 1970s. But in the last decade and, particularly, in the last few years, the concept entered the main stream so that in July 2020 a Google search of it returns no less than 65.7 million mentions.

Anyway, some observations are necessary:

- First, the use of hydrogen represents for the moment a tiny fraction of the global energy use and most of hydrogen is used for production of fertilizers (like ammonia), in oil processing industries, treating metals or food processing industries. Hydrogen has been used as a rocket fuel since 1950s and, in recent times, it is more and more used for fuel cells in various transport applications. Hydrogen is used also for electricity generation in remote areas that are not connected to the electrical grid or as a back-up electricity source instead of Diesel generators (US Energy Information Administration, 2020).
- Second, by “hydrogen economy” or hydrogen based economy” we

understand a type of economy wherein a growing part/proportion of energy and of other economic inputs (like in the production of fertilizers or processing food products like margarine) are based on hydrogen. The key aspect is the “growing part/proportion” and therefore one cannot expect very soon an economy wherein the majority of energy is based on hydrogen.

– From this statement comes the third observation, that the transition to a hydrogen based economy may take several decades, with 2050 as a vantage point from which a much clearer view will be possible. Both political decisions in favour of a hydrogen economy and technological advances that are already occurring at a faster and faster pace may substantially help in reducing the time of transition to a hydrogen based economy and also significantly improving the quality of environment and reducing of environment degradation.

From these details it may seem that the use of hydrogen in economy is a rather remote possibility, more like a laboratory experiment. And yet, the hydrogen economy is already present, growing at a very fast rate at a scale we are not aware of and this is why it is secret hidden in plain view. In the following we are going to provide some examples that will substantiate this statement.

Uses of hydrogen in different industries as of mid-2020 and immediate prospects for the coming years:

– In the US in 2019 there were around 25000 **fuel cells powered trucks**, while in Europe only 500 (FuelcellWorks, 2019a). Anyway, in June 2020 Hyundai delivered the first 10 units of the XCIENT mass produced **heavy truck based on fuel cells** to Switzerland and will continue to deliver 50 trucks per year until 2025, up to a total of 1600 units (Fuelcellworks, 2020b).

– In Germany, operations of **fuel cell trains** started on an experimental basis in 2018 and were completed in February 2020. Following the successful tests, a fleet of 14 Coradia iLint units has been ordered to Alstom (Railway Gazette International, 2020). Great Britain and the USA are also experimenting with fuel cell trains to be used on non-electrified areas of the railway networks;

– Since early 1990s several hundreds of **hydrogen buses** are operated in Europe, North America and Asia. The EU funded since 2001 more than 47 hydrogen buses that were operated in 20 cities, starting with Amsterdam, Barcelona, Hamburg, London, Luxembourg, Madrid, Porto, Stockholm, Stuttgart (Hydrogen Europe, 2020);

– The expansion of **hydrogen refuelling stations** is very illustrative for the interest manifested at a global scale for this non-polluting form of energy. In 2019 there were 432 hydrogen refuelling stations, a number 5 times higher than in 2015. The global distribution was the following: Europe 177 stations (of which 87 in Germany, 26 in France, 4 in Switzerland), 178 in Asia (of which 114 in Japan and 33 in South Korea and 27 in China), 74 in North America (of which 48 in California). Malaysia and Saudi Arabia also opened hydrogen refuelling stations while Australia will join by mid-2020. The stations under construction in 2020 are also numerous, namely about 226, as a sign of a continuing trend: 34 in France, 21 in the Netherlands, 6 in Switzerland, 40 in South Korea, 21 in the USA (Ludwig-Bölkow-Systemtechnik GmbH, 2020). In its turn, Great Britain has in view to build 100 hydrogen refuelling stations until 2025 (Collins, L, 2020a)

- The undergoing plans for **fuel cells production and related vehicles** of Hyundai has in view to sell by 2025 about 670000 electric vehicles a year, out of which 110000 based on fuel cells. According to Hyundai “Fuel Cell Vision 2030” strategy for a hydrogen based society, by 2030 the company will produce 700000 fuel cells per year for vehicles (cars and trucks), ships, railways, drones and electricity generation. In the same area of activity, in April 2020 Volvo Group signed an agreement with Daimler Truck AG for establishing a joint venture for the production of fuel cells and heavy trucks based on fuel cells (Volvo Group, 2020);
- In December, 2019 Japan launched the first **liquefied hydrogen carrier** for the transport of hydrogen from South East Australia to Japan. Regarding the use of hydrogen for maritime transport, a study published in March, 2020 by the International Council on Clean Transportation (ICCT) showed that all container ships crossing the Pacific can be powered by hydrogen (Collins, L., 2020b).
- **Regarding air transport**, Airbus announced in July 2020 that the company has in view to launch by early 2030 a **commercial plane using clean hydrogen** as an energy source (Hill, J.S., 2020). In its turn, Boeing made a first flight with a plane powered by hydrogen in 2008 and considers that this fuel as a possibility for reducing pollution. In August 2020 the Commonwealth Scientific and Industrial Research Organization (CSIRO) and Boeing Australia presented a report that states the possibility to generate energy for almost all ground based aviation operations until 2025, while by 2035 hydrogen can be used to supplement fuels for aviation, while in 2050 hydrogen may be used as the main/only fuel for aviation (Bruce, S., et al, 2020).
- Fuel cells based on hydrogen are used as **back-up energy source for cloud, computer farms and data centres**. In July 2020, Microsoft demonstrated that data centres can be provided with energy from fuel cell for days, thus replacing Diesel based generators. Microsoft experiment is part of its strategy to become carbon neutral by 2030 and can be easily replicated by other IT companies like Amazon, Google, Facebook (Delbert, C., 2020).

The examples presented above may be considered only as a tiny fraction of the hydrogen based industrial processes that have been started or are already decided and they can be complemented to huge investments in the production of clean hydrogen. The transition to a hydrogen based economy has reached a critical mass and there is a fast growing interest for it in a variety of industries and involving a lot of really big players.

Conclusions

In our view, the **transition to a hydrogen based economy is feasible** because the key factor, hydrogen, is the most common element in the Universe, while the technologies for its production and use are largely available and diverse, in train of increasing their efficiency and most importantly, hydrogen can be used as a source of energy for industries otherwise difficult to decarbonize (heavy truck transport, railways, sea transport, aviation, constructions, chemical industry, metallurgy). Hydrogen can also be used for the storage of energy when there is an excess output of electricity, as well as for back-up generators in sectors that need continuous access to electricity (data

farms and cloud facilities, different industrial processes, hospitals, research facilities).

The large scale use of hydrogen in economy is still faced with **some serious challenges** related to production costs, transport and storage (Jouault, F., 2020), areas in which technologies are available, but costs are still high or conversion efficiency from one phase to another is still relatively low. A significant challenge is also to increase the proportion of the production of clean hydrogen (hydrogen produced from renewable sources) and here solar and wind produced electricity may provide the right answer.

In this context of high pressure for decarbonizing the economy, preventing further climate change and implement a more circular approach in economy, **European Union is well positioned to take a leading place** in this transition to a hydrogen based economy, having both the vision (with intermediate targets for 2024, 2030 and 2050), the technological capabilities and the financial means.

As in the case of large scale adoption of electric vehicles, in the initial stages there is a sort of **vicious circle** (the cost of operation cannot decrease until a large scale deployment and use of the technology takes place, while a large scale deployment and use is prevented in the initial stages because of the high prices) that can be overcome and even transformed into a **virtuous circle** by large scale administrative/programs like those proposed by the European Union. In case of electric vehicles, battery prices have fallen almost 85 % between 2010 and 2019, from about 1100 US\$ to 156 US\$ per kilowatt/hour (Henze, V., 2019), among the main reasons being: a) different government regulations that simultaneously asked for the reduction of emissions and provided rather generous subsidies for buyers of electric vehicles (that determined an increase of battery production and sales, an increase of electric cars sales) and b) technological improvements.

The importance of the adoption of the EU hydrogen strategy for a climate-neutral Europe consists in a number of its characteristics:

- it provides the necessary economic stimulus for the transition to large scale production and use (because the strategy provides both for supply and demand);
- it provides guidance and support for all economic stages, namely production, transport, distribution, utilization;
- it is correlated to strict regulations regarding the decarbonization of economy and to the achievement of the goal of a climate-neutral Europe;
- it includes a significant cooperation with the central and local governments, private sector, civil society, experts through the European Hydrogen Alliance;
- it contains clearly defined targets for 2024, 2030 and 2050 which will allow the focusing of innovation and research, deployment, production and use on concrete targets. Among these targets we can quote the participation of 500 companies in the Hydrogen Alliance in 2020, of 1000 companies in 2024 and of 2000 companies by 2050; the decrease of carbon dioxide emissions by minimum 9 million tons per year in 2024 and by 90 million tons in 2030; the production of 6 GW of clean hydrogen in 2024 and of 40+40 GW of clean hydrogen in 2050 of which 40 GW to be produced in EU member states and 40 GW in non-EU, partner states that will export to the EU (European Commission, 2020).

The documents adopted by the European Union in the first half of 2020 (European Green Deal, EU New Industrial Strategy for Europe, European Clean

Hydrogen Alliance, EU Strategy for Energy System Integration, EU Hydrogen Strategy) provide a complete roadmap for this decade and for the period until 2050 that make possible a transition to a carbon neutral economy and society in Europe, by means of adopting the principles of a circular economy and by using hydrogen on a large scale as a fuel, as a means for the storage of energy, as an input for various industries.

Because the European Union is focused in its strategies on the use of clean hydrogen (obtained from renewable sources) this will allow the implementation of a true circular economy mechanism wherein the inputs are coming from nature (water, solar and wind energy, biomass) and hydrogen is obtained without polluting the environment. Further on, hydrogen will be used in different industrial processes as a fuel or for generating electricity and the only by-products of these processes will be heat and water.

The European Union as an organization and its member states have access to all the necessary technologies and, very important, funds are available to secure further research, implementation and providing stimulus for the private sector to invest in its turn. It is significant that the largest economy in the European Union, Germany, is particularly interested in supporting the fast transition to a hydrogen based economy by adopting in June 2020 an ambitious hydrogen strategy and by starting already the implementation of numerous practical projects, like the Westkuste 100 project started on August 1, 2020 in Schleswig-Holstein land which aims at creating the first regional hydrogen economy and what is called a “real world laboratory” (Westkuste100, 2020).

The European Union has always been a promoter of environment protection, of protection against climate changes and also a promoter of circular economy as a means for achieving sustainable development. In our opinion, at present there are favourable circumstances for a successful transition to a zero carbon economy in Europe because the vision, the technologies, the research capabilities and the funds are simultaneously available.

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