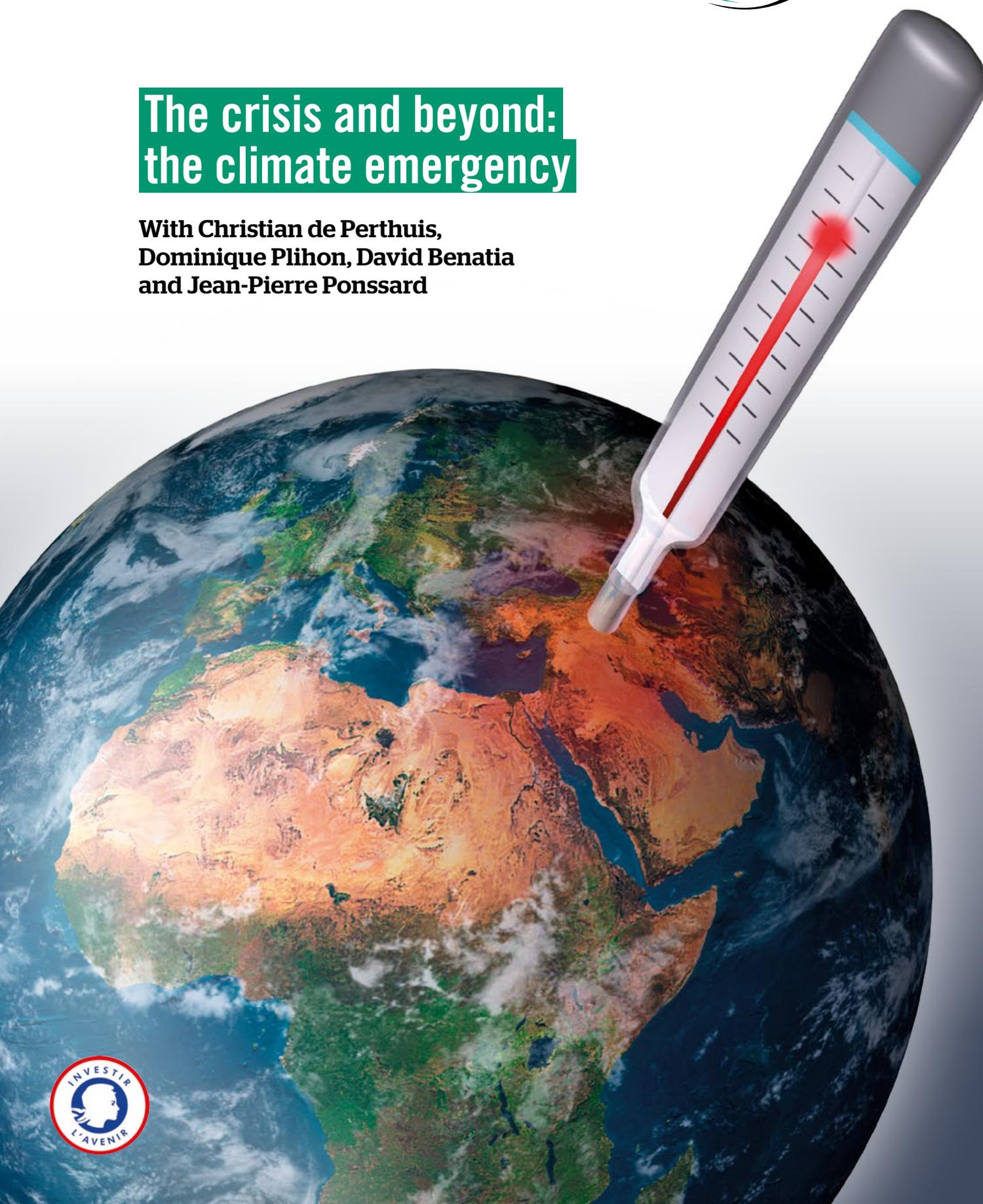


# LOUIS BACHELIER

Economic and financial news seen through research

## The crisis and beyond: the climate emergency

With Christian de Perthuis,  
Dominique Plihon, David Benatia  
and Jean-Pierre Ponsard



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nprecedented, sudden and global are just some of the adjectives that come to mind to describe the Covid-19 crisis. And to deal with it, many countries have introduced restrictive, sometimes draconian, measures, while pouring public money into different economic sectors to keep them afloat. If the responses to the pandemic have not been perfect – hindsight will eventually allow us to draw the right conclusions – and have been subject to much trial and error, they at least have the merit of having been introduced quickly. It is, in fact, easier to act when the threat is immediate and palpable, with the risks of several hundred thousand deaths and of health systems being overwhelmed.

Global warming, on the other hand, arguably the greatest challenge facing us in the 21<sup>st</sup> century, seems to be a victim of its long time frame. In fact, five years after the conclusion of the Paris Agreement, international climate negotiations are faltering, if not at a standstill, despite the climate emergency, which is manifested by increasing natural disasters and higher temperatures (the warmest November was recorded in 2020). While waiting for possible political negotiations on climate change on the part of the world's leaders, national and local initiatives are now taking over – in the form variously of green stimulus plans, ambitious municipal policies and the development of innovative start-ups.

At the Institut Louis Bachelier, our ambition is to contribute through excellent academic research to sustainable development in Economics and Finance. In addition to being mentioned in our statutes, this objective is reflected in the

mobilisation of numerous researchers in various research programmes such as Green and Sustainable Finance, the Finance and Sustainable Development Chair and the Sustainable Finance and Responsible Investment Chair; the organisation of academic conferences such as the 5<sup>th</sup> edition of Green Finance Research Advances, in partnership with the Banque de France, which was held recently; and the publication of reports such as The Alignment Cookbook, which examines methods for aligning investment portfolios with the Paris Agreement, and this latest issue of Cahiers Louis Bachelier.

In this issue, you will find an interview with Christian de Perthuis, founder of the Climate Economics Chair, on the occasion of the publication of his latest book; an article on the role of central banks in the management of climate change, based on a study by Dominique Plihon of the Energy and Prosperity Chair; an article on wholesale electricity markets, based on an econometric analysis by David Benatia of the Energy Market Finance Laboratory; and lastly, an interview with Jean-Pierre Ponsard, Scientific Director of the Energy and Prosperity Chair, who presents his views on hydrogen and sustainable mobility.

Enjoy your reading!



**Jean-Michel Beacco,**  
delegate general  
of the Institut Louis Bachelier

# “WE ARE LOSING PRECIOUS TIME IN THE CLIMATE NEGOTIATIONS”

The welcome slowdown in greenhouse gas emissions in the first half of 2020, following the lockdown measures taken to combat the Covid-19 pandemic, gave a glimmer of hope in the fight against climate change, which has been dragging on for too many years. During this unprecedented period in recent history, Christian de Perthuis (see biography) spent his time reflecting on the parallel between the fight against the virus and the struggle on behalf of the climate. The results of his analysis can be found in his latest book, *Covid-19 et réchauffement climatique* (Covid-19 and global warming) (see Box). In this issue of the Institut Louis Bachelier's Cahiers, he looks back on a year that from every standpoint has been exceptional and makes recommendations for speeding up the transition to a low-carbon economy. Interview.

**ILB:** After holding steady in 2019, CO<sub>2</sub> emissions seem likely to decline in 2020 due to the pandemic. What are your thoughts on the situation?

**Christian de Perthuis:** The latest forecasts predict a 7% reduction in CO<sub>2</sub> emissions in 2020. This is historically unprecedented. When other greenhouse gases are taken into account, such as methane and nitrous oxide, most of which come from agriculture, the drop in emissions is likely to be slightly less. Looking more closely at the figures by sector, transport emissions have fallen the most and will not return to their former levels. On the other hand, after falling in the first half of the year, industrial emissions have increased sharply, especially in China, where economic recovery came earlier than in the rest of the world. But although emissions fell in 2020, the important point is that they further increased the accumulating stock of CO<sub>2</sub> in the atmosphere. It is the increase in this stock that is causing global warming. The decrease in one year's emissions is hardly noticeable in the overall amount, which continues to increase due to its very high inertia: the annual flow of emissions represents barely 1% of the global stock. Stabilising the stock will require several decades of emission reductions. Since we are not going to lock down the population for the next 30 years, the question is therefore: Will there be a return to the previous trend in emissions or will there be structural

changes favourable to speeding up the low-carbon transition? My analysis leads me to believe that the second possibility is more likely, that is, an acceleration of structural changes conducive to the low-carbon transition.

**But is there not a risk that the world will return to business as usual once the pandemic is over?**

**CdP:** There is indeed a risk of reversion to business as usual, as I point out in the conclusion to *Covid-19 et réchauffement climatique*. And because of the very long temporality characteristic of climate, the risk is high. The time lag between the introduction of measures taken to curb the epidemic and the first effects of these measures is only two weeks. For climate change, it is several decades! But the pandemic will have a lasting impact on household behaviour, particularly in terms of food. The vulnerability of the population to the virus is greatly exacerbated by poor nutrition, particularly the over-consumption of animal products and sugar. The risk of transmission of the virus to humans is increased by the destruction of wild ecosystems and the practice of certain forms of livestock farming. The search for greater resilience to the pandemic simultaneously reinforces the response to climate change, which also involves rethinking our food consumption patterns and the agricultural systems that underpin them.



**Christian de Perthuis** is Professor of Economics at the University Paris Dauphine - PSL and founder of the Climate Economics Chair, a research platform on the economics of climate change. His expertise on the European CO<sub>2</sub> allowances market and environmental pricing is internationally recognised. He is the author of numerous articles and books, including *Le Tic-Tac de l'horloge climatique*, published in 2019 by De Boeck Supérieur.

**Might not the rise of digital technology as a result of the pandemic cancel out efforts made in other sectors such as energy production?**

**CdP:** The growth of digital technology has been very important in the organisation of production, particularly with teleworking. This shift amounts to substituting the transport of information for the transport of people. Even though digital technology is not carbon neutral, this shift saves a lot of CO<sub>2</sub>. I would add that the transport sector is more difficult to decarbonise than the digital sector. This is because digital technology is powered solely by electricity and therefore does not depend on combustion engines, which will take a long time to convert. Another consequence of the switch to digital concerns the replacement of traditional retail businesses by online commerce. Hence the need to regulate the system, which currently overwhelmingly favours the major digital companies. More generally, the Covid-19 crisis brings out the need for more state regulation to control this shift towards digital capitalism. Admittedly, digital capitalism is not tied to fossil fuels in the same way as thermo-industrial capitalism, but it is still based on consumerism, whereas the low-carbon transition calls for greater restraint in terms of both food and energy consumption.

**Can we now hope for international coordination in the fight against climate change, with the announced return of the United States to the Paris Agreement?**

**CdP:** On 4 November 2020, the day the United States formally left the Paris Agreement, Joe Biden said that one of his first decisions as president would be to re-join it. But the question arises as to the credibility of this announced return. Let us not forget that the United States defected on two previous occasions prior to the Donald Trump episode: when it pulled out of the Kyoto Protocol in 2001, and in the aftermath of the Copenhagen summit in 2009 when President Obama failed to obtain the support of Congress, thereby undermining

**The search for greater resilience to the pandemic simultaneously reinforces the response to climate change.**

the commitments tabled by the United States. Restoration of its credibility requires first of all that the USA should table a national contribution that has been considerably reassessed compared to the one tabled under Obama in 2015. Over the same period, the European Union has, for example, increased its greenhouse gas emissions reduction target from 40% to 55% by 2030. American credibility will also depend on President Biden's ability to speed up the low-carbon transition by reducing US dependence on fossil fuels (oil and gas). The problem will be to get such measures through

the Senate, where the Democrats do not have a majority.

**Five years after it ended, what provisional assessment can be made of the Paris Climate Agreement?**

**CdP:** It feels like we are reliving a version of the early 1990s, which marked the beginning of international climate negotiations. These got off to a good start before descending into a kind of slow race with the election of Donald Trump as President of the United States. Successive COPs have clearly shown this. →

**Covid-19 et réchauffement climatique: a key work for understanding climate issues**

Drafted during the first lockdown, completed during the summer and published on 14 October by De Boeck Supérieur, Christian de Perthuis's latest book *Covid-19 et réchauffement climatique* is a powerful plea for an economy of resilience, as the cover shows.

In this work, the author compares the two “destroyers of the commons” – the virus and climate change –, discusses their impact on the economy and the planet and argues for a low-carbon recovery and the preservation of the natural environment. At the same time, he maintains a degree of optimism, much to the dismay of the collapsologists. Affordably priced, enjoyable to read and packed with anecdotes and references, it provides an insight into the main issues at stake in the huge challenge facing the 21st century of combatting global warming. Read it now!





**An ambitious multilateral agreement must necessarily be based on a common measurement, reporting and verification system (MRV), which is not currently the case.**



The only concrete result was the adoption of a Rulebook at COP 24 in Katowice, Poland, at the end of 2018 to implement the Paris Agreement. However, this is incomplete, as it does not include economic instruments to combat emissions and the loss and damage resulting from global warming. We need therefore to rapidly speed things up, as we are losing precious time in the climate negotiations, particularly in terms of MRV (Measurement, Reporting and Verification). However, an ambitious multilateral agreement must necessarily be based on a common MRV system, which is not currently the case. There is also the need to reassess and deepen the emissions reduction targets, as pretty much only the European Union and the United Kingdom have made commitments in this regard. There is still some time left, since the next COP, in Glasgow, has been postponed until November 2021. This conference will be the real test of the willingness of countries to increase their efforts. They have the opportunity to do so, with the fall in the price of renewable energy and of electricity storage, as well as the consequences of the pandemic, which means that governments need to take greater account of the social and resilience aspirations of populations.

**But one of the priorities of governments has been to get their economies going again...**

**CdP:** I think that today we can no longer sustain an opposition between the economy and ecology. The one cannot succeed without the

other. Reviving the economic machine now goes hand in hand with more green investment.

**By way of conclusion, France has launched a recovery plan with a massive 30 billion euro share earmarked for the ecological transition. What is your analysis of this?**

**CdP:** Is 30 billion “massive”? It’s only a third of the total. Let’s take a closer look. A very important aspect of this recovery plan concerns investment in research and development to speed up the emergence of new solutions. For example, this is the case for green hydrogen. As the French recovery plan is in part linked to the European Union, this is also a guarantee of credibility, especially from a financial standpoint. On the other hand, even though the amounts have been revised upwards, the component on the thermal renovation of buildings looks very similar to previous measures. In this regard, it is not enough simply to come up with a figure of billions of euros; it is essential also to act on supply and behaviour. Another weakness of the French recovery plan concerns the public funding of the conversion of industrial sites and human capital dependent on fossil fuels. Speeding up the low-carbon transition requires large-scale, rapid conversion. At the European level, there is a dedicated programme – the Just Transition Fund –, but it is mainly focused on Eastern European countries that use a lot of coal. Our national recovery plan does not make provision for the cost to the community of these restructurings for the low carbon transition. In my opinion, this is its main weakness. ●



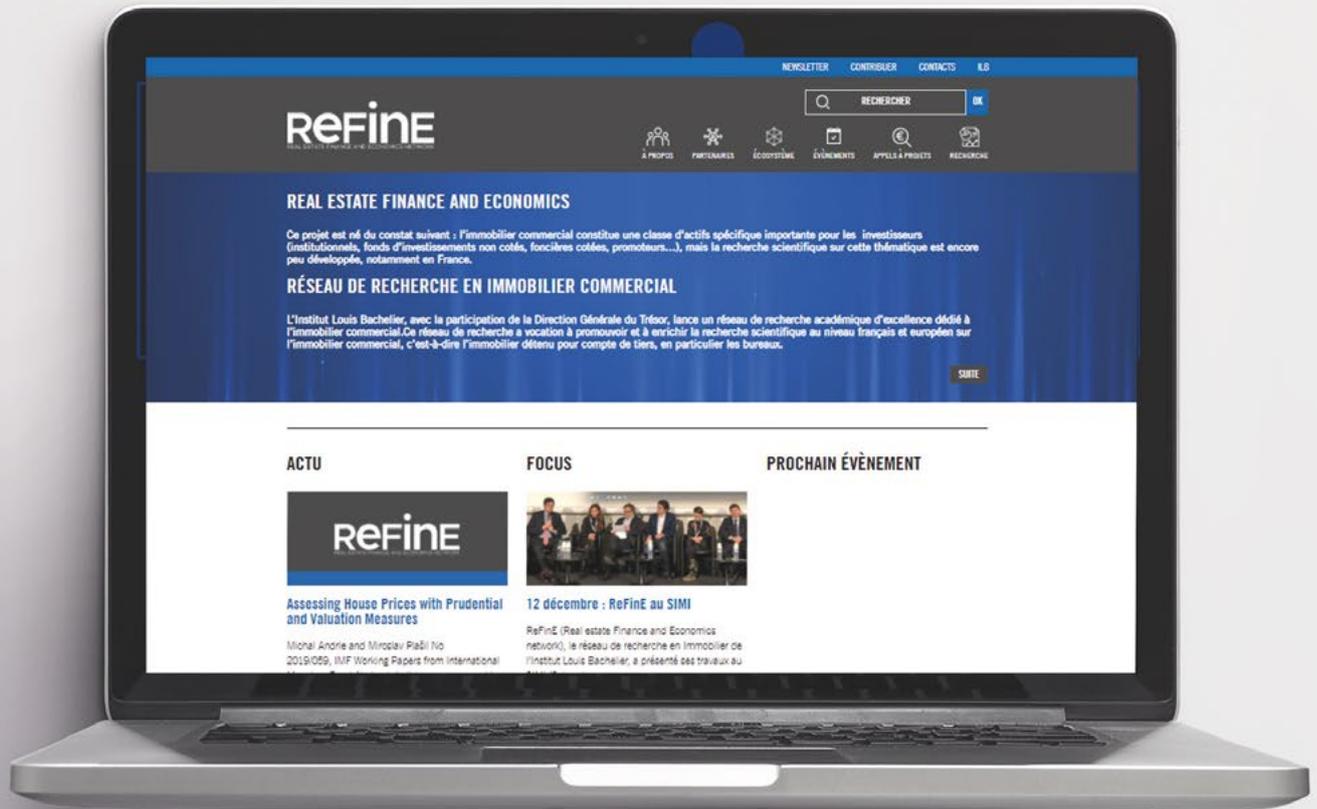
The video interview with Christian de Perthuis can be viewed on:  
[www.louisbachelier.org/  
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# SHOULD CENTRAL BANKS HAVE ECOLOGICAL GOALS?

With regard to meeting the financial challenges of the ecological transition, there has been extensive discussion and debate around expanding the role of central banks, the importance of which has increased since the 2007 crisis and even more so since the start of the Covid-19 pandemic. Researchers have analysed this question by studying the different doctrines of central banks throughout history.

**T**he ecological transition is one of the major challenges of the 21st century, in the context of limiting global warming to two degrees Celsius by the end of the century. In addition to the necessary changes in production and consumption patterns, the ecological transition also gives rise to financial problems. For example, the Federal Reserve recently admitted, for the first time, that global warming poses a risk to financial stability. For its part, the ECB (European Central Bank), through its President Christine Lagarde, has undertaken to “green” its actions still further. While these positions seem to be heading in the right direction in response to the climate emergency, they do not necessarily meet with unanimous approval among supporters of neo-liberalism, who are in favour of market self-regulation and central bank interventionism focused solely on monetary stability. “Global warming poses risks to financial stability since it can affect many actors in the system such as banks and insurers. In addition, the ecological transition requires massive investments and financial resources. Central banks are the main actors in the monetary and financial system and their role has become much more important since the 2007 crisis,” Dominique Plihon says. “To shed light on the subject, we felt it necessary to study the subject of central banking within a historical, theoretical and institutional perspective.”

## CENTRAL BANKS HAVE EVOLVED OVER TIME

Since their creation in the 17th century, first in Sweden and then in England – the Banque de France was only created in 1800 – central

banks have pursued four major objectives, the ranking of which has changed over time: monetary stability, stability of the financial system, economic development, and state financing. Historians have identified four distinct major periods in the evolution of central bank doctrine and policies: the “Victorian” period (1840-1914), the Keynesian period following the Great Depression of 1929 (1930-1970), the monetarist and neo-liberal period (1970-2007) and the current period, beginning after the global financial crisis of 2007. In their work, the researchers have taken this chronology and enriched it by adding the different phases of capitalism, the associated monetary regimes, and the dominant energy sources of each era. “The first observation is that central banks have always evolved over time and have always adapted themselves to different situations. For example, during the Keynesian/Fordist era, central banks financed state debt and supported major works policies after the 1939-1945 War, with economic and social stability as their main objective,” Dominique Plihon points out.

## MONETARISM AND NEO-LIBERALISM PROVED TO BE A FAILURE...

From the 1970s, central banking changed significantly, with the main objective being monetary stability. At the time, inflation was very high, particularly following the oil shocks, while economic growth was low, thus calling into question the effectiveness of existing economic policies. To remedy this situation, monetary policies became tighter, with high interest rates to limit the money supply and thus inflation – consistently with monetarism,

Based on the Energy and Prosperity Chair's working paper *Les objectifs écologiques et sociaux font-ils partie du mandat des banques centrales?* by Esther Jeffers and Dominique Plihon, and on an interview with Dominique Plihon.



**Dominique Plihon** is Professor Emeritus in Economic Sciences at Sorbonne University Paris Nord, a member of the Centre d’Economie de Paris-Nord (CEPN) attached to the CNRS, and associate researcher in the Energy & Prosperity Chair. A former spokesman for ATTAC and member of its scientific council, he is also a member of the Economistes Atterrés network. He is the co-author of the report by the Conseil d’Analyse Economique, “Banques centrales et stabilité financière” (2011), and of “La monnaie, un enjeu politique – Manuel critique d’économie monétaire”, PUF (2018).

### Methodology

To shed light on the role that central banks should play in the face of the climate and social crises, the researchers studied the historical development of central banking. The originality of their work lies in the fact that they link the trajectory of central banking to the different phases of capitalism, monetary regimes, and the dominant energy sources of each era. In addition to the historical approach, the researchers also analysed theoretical aspects, including the role of money in the economy, as well as institutional contexts. They also make recommendations for central banks to broaden their remit to include climate and social objectives.

the current of economic thought emanating from the American economist Milton Friedman. According to Friedman, the state should intervene as little as possible in the economy and let the markets regulate themselves and achieve equilibrium. This doctrine was abandoned, however, in the wake of the 2007 financial crisis, during which governments were obliged to massively support and revive their economies with the help of central banks in order to avoid economic and financial collapse.

### ... AND SINCE 2007 A RADICAL CHANGE HAS OCCURRED

Indeed, in the aftermath of the financial crisis, central banks in developed countries have had to work hard to keep the financial system afloat. Doing so resulted in drastic interest rate cuts, and above all the implementation of so-called unconventional policies, particularly through massive asset buybacks (quantitative easing). “The crisis marked the failure of monetarism. Reforms were introduced to provide a better framework for financial actors and central banks were at the forefront of financial stabilisation, although in the previous period this had not been among their objectives. The current era thus has much in common with the first two, in which central banks played a very important role for both monetary and financial stability,” Dominique Plihon explains. Nor should it be forgotten that over the last ten years or more, central banks have undergone another change with the extending of their objectives to growth, employment and reduction of inequality. So where does the climate come into the picture? “Looking more closely at the ECB statutes,

we see that Article 127 states that monetary stability and other objectives, including the environment, must be taken into account. Moreover, central banks cannot disregard the climate because of the risks it may pose for financial stability. For example, the ECB must play a leading role in the financing of the ecological transition, under the 2015 Paris Climate Agreement, one of whose articles stipulates that financial flows must be consistent with climate objectives,” says Dominique Plihon. But despite the fact that on the financial stability front the Network of Central Banks and Supervisors for the Greening of the Financial System (NGFS), bringing together the Fed, the ECB and more than 60 central banks in total, was set up at the end of 2017 with an ambitious agenda for international cooperation, financing the green transition is not yet on the agenda. According to the researchers, this aspect should be linked to monetary policy, which would be responsible for implementing it with, for example, the application of differential interest rates according to the colour (green or brown) of the activities to be financed or the buyback of assets originating primarily from green activities. From this standpoint, a change in the monetary paradigm needs to occur so that money is no longer a neutral instrument, but an economic and social institution in its own right. ●

### Key points

- Central banks have constantly evolved throughout history and adapted to the different contexts they have had to face (the industrial revolution, wars, recessions, etc.).
- The monetarist phase of central banking (from the 1970s to the crisis of 2008) was something of a historical exception to the other three, as this period was characterised by a substantial decline in public action in favour of self-regulation by the financial markets.
- A new monetary paradigm is needed for central banks to play their role in financing the ecological transition. Money is thus not simply an instrument of monetary policy, but an economic and social institution linked to finance.

# THE COVID-19 CRISIS HAS WEAKENED ELECTRICITY MARKETS

The economic consequences of the first lockdown in France were very severe and in particular were reflected in the electricity markets, where there was a sharp drop in demand. The researcher David Benatia has investigated the impact of this episode on the sector's actors, while linking it to the future energy transition, which will take shape with a greater proportion of renewables in the energy mix.

**T**he health crisis has given rise to problems in France's electricity production capacities, 70% of which are nuclear. In November, the Minister for Ecological Transition, Barbara Pompili, suggested that there might even be brief power cuts in February 2021 in the event of an extreme cold spell. Among the reasons cited was the postponement of maintenance operations at nuclear power stations, which usually take place in the spring and summer. Is this risk of power shortages likely to recur in the future? No one knows at present, but the objective of reducing the proportion of nuclear power to 50% in the French energy mix by 2030 in favour of renewable energies as part of the energy transition must be taken into account. "Renewables have a very low marginal production cost, close to zero in fact, which means that the production of additional electricity from these energy sources costs practically nothing, and this drives electricity prices down," says David Benatia. While these future price cuts are good news for consumers and their purchasing power, that is not necessarily the case for the sector's actors – network operators, producers, distributors –, who have to organise themselves and ensure a return on their investments.

## FALL IN DEMAND AND PRICES DURING THE FIRST PERIOD OF LOCKDOWN

To get a clearer view of the problems mentioned above, David Benatia conducted a study on electricity markets in France during the first lockdown. "Initially, my objective was to measure the short-term economic consequences



**Wholesale electricity prices fell by an average of 40%, of which 60% was due to low oil and gas prices.**

of the epidemic by observing changes in electricity consumption, which is a barometer of the economy," the researcher explains. "A closer look at the data revealed that electricity consumption fell by nearly 12% during the first lockdown. This figure is very similar to the amount of energy that will need to be produced by renewables by 2030, whose share in the French energy mix is projected to increase from 27% to 40%." In other words, the fall in demand for electricity and the average 40% drop in prices in the wholesale markets, observed during the first lockdown, point to future problems in electricity production during the gradual implementation of the energy transition, which will necessarily entail lower prices. In more detail, the results of the study show that CO<sub>2</sub> emissions fell by 42%, that wholesale electricity prices were down on average by 40% – of which 60% was due to low oil and gas prices – and that the financial revenue of sellers (producers) and buyers (suppliers) fell by 45%, representing a total reduction in turnover of €1.2 billion, around €700 million of which was in the nuclear sector. Moreover, most of this loss of income was borne by EDF, even though other suppliers (Total Direct Energie, Eni, etc.) were also impacted.

Based on CREST's working paper *Ring the Alarm! Electricity Markets, Renewables, and the Pandemic* by David Benatia and on an interview with him.



**David Benatia** is an assistant professor in the Department of Applied Economics at HEC Montréal. He is also affiliated as a researcher and teacher to the Economics Department of CREST (ENSAE, Institut Polytechnique de Paris), France. His research focuses on econometrics and industrial organisation, particularly applications in energy and environmental economics.

### Methodology

The researcher analysed the impact of the first lockdown on the electricity markets in France. He developed a structural econometric model to calculate the counterfactual demand for electricity, i.e. assuming that there was no decrease due to the pandemic. To this end, he used an innovative machine learning model, trained with numerous variables, particularly meteorological variables, to obtain predictions on hourly electricity demand. After the demand function, he estimated aggregated supply functions on the French market, taking into account cross-border exchanges. These different steps then enabled him to calculate the consequences on electricity prices for the sector's participants and to make recommendations in the context of the current and future energy transition.

## OVERLY LOW PRICES THREATEN THE DEPENDABILITY OF THE POWER SYSTEM

Does this loss of revenue resulting from lockdown foreshadow the configuration of the electricity market in 2030 in the context of the energy transition? "With the increase in renewable energy production in the future, electricity prices will be even lower, along with the possibility of more frequent negative prices, as happened during the first lockdown. Under these conditions, the viability of some power plants could be jeopardised," says David Benatia. In fact, while traditional electricity generation from oil and gas will be used less in response to the energy transition, overly low electricity prices may eliminate this capacity from the sector. Although this is good news for the climate, it poses problems for electricity production, which requires back-up thermal power plants to meet occasional peaks in demand.

## ENCOURAGING CONVENTIONAL PRODUCERS

Consequently, in order to avoid the possible risk of occasional electricity shortages in the event of heat waves or cold spells, the complex mechanisms of the electricity markets need to be modified. Remember that the supply of electricity must always respond to demand in real time. Moreover, the remuneration of the actors in the sector depends on various parameters: demand forecasts, market price levels or regulated contracts between producers and distributors with prices fixed in advance. Given these complexities specific to electricity markets

– which in economic theory are considered incomplete – the introduction of remuneration linked to production capacity would be an incentive for electricity generators to maintain and ensure the profitability of certain back-up thermal power plants. "This compensation would need to be stable to send a shortage signal to electricity markets. It should also depend on the generators' contribution to the overall electricity system and flexibility in operating their plants," David Benatia proposes. The ball is in the court of the public authorities, who will have to be doubly vigilant in order to sustain the French electricity system and ensure its reliability. ●

### Key points

➤ The impact of the first lockdown on the electricity markets was very severe in France, variously on prices, demand, and revenues of participants in the sector (grid operators, generators and distributors).

➤ These effects provide valuable indications in terms of lower prices and production uncertainties in the context of the coming energy transition, which will be characterised by a greater proportion of intermittent renewables in the energy mix.

➤ To ensure the reliability of electricity markets and to encourage producers to keep power plants operational for use in the event of demand peaks, the remuneration of production capacities should be introduced in accordance with their flexibility. If this is not done, overly low prices will be unable to send the right signals to the markets, particularly in the event of power shortages.

# HYDROGEN ENERGY: “TRIGGERING A VIRTUOUS CIRCLE OF COST REDUCTION”

France has great ambitions for developing the carbon-free hydrogen energy industry, i.e. hydrogen produced from electricity from renewable energies and nuclear power. Evidence of this can be seen in the recovery plan, which is allocating 7.2 billion euros to this energy source with the aim of accelerating the ecological transition and reducing the CO<sub>2</sub> emissions produced by industry and transport. In addition to the environmental challenges, French public investment in hydrogen is aiming to create jobs and ensure energy and technological independence. As to whether this wager pays off, only time will tell. In the meantime, Jean-Pierre Ponsard, a specialist in the ecological transition and sustainable mobility (see biography), discusses the government announcements and the scale of the challenges to be met if France is to become a hydrogen champion. Interview.

**ILB:** The recovery plan will devote €3.4 billion euros to hydrogen up to 2023, out of a total of €7.2 billion by 2030. What are your views on the sums involved?

**Jean-Pierre Ponsard:** This recovery plan unquestionably involves a change of scale compared to the Hulot Plan, which only amounted to 100 million euros. It is comparable in scale to the sums committed by some of our neighbours, notably Germany (€7 billion) and Spain (€8.9 billion), and at the European level. As regards the crucial breakdown of this amount, the first priority will be the production of low-cost hydrogen for industrial uses, because of the need to decarbonise industry. A second component will focus on heavy transportation in the medium term (2025-2030). There is also the need to support research & development over the entire value chain (electrolysers, fuel cells, high-pressure tanks, etc.) and to develop top-quality training in the sector.

**Can you say something about the need to develop sustainable mobility as part of the ecological transition?**

**J-P P:** Sustainable mobility is responding to two major challenges. The first is global and linked to global warming, as the CO<sub>2</sub> emissions generated by transport in the broadest sense (cars, heavy goods vehicles, trains, aircraft, maritime transport, etc.) account for 20 to 25% of the

global emissions released into the atmosphere. Moreover, emissions in this sector have not fallen much since the early 2000s, unlike those generated by energy production and manufacturing industry (chemicals, steelworks, cement works, etc.). Moreover, the demand for transport increases with rising living standards, especially in the emerging countries. The second challenge is at the local level, with the problem of urban pollution in large metropolises. This is something that also affects developing countries. Transport emits fine particles and nitrogen oxide (NOx), through exhaust fumes and the wear and tear of brake discs and tyres, causing respiratory diseases and premature mortality. Vigorous action is being taken by local officials to drastically limit the use of fossil fuels in urban transport. The development of battery-powered electric vehicles and hydrogen vehicles comes within this logic.

**What are the advantages and disadvantages of hydrogen compared to the electric battery for the ecological transition?**

**J-P P:** Hydrogen as an energy source has several advantages compared to batteries. Firstly, although it requires platinum, the use of natural resources is less problematic for hydrogen fuel cells, unlike batteries which are made from cobalt and rare earths among other materials. Secondly, hydrogen is lighter than a battery, the



**Jean-Pierre Ponsard** is scientific director of the Energy & Prosperity Chair, emeritus research director at the CNRS (CREST) and associate researcher at the Institut Louis Bachelier, CIRANO and CESifo. His fields of research concern environmental economics, industrial organisation and game theory. He has been Professor of Economics at the École polytechnique and Director of the Econometrics Laboratory.

autonomy of vehicles is greater and the recharging time is faster. On the other hand, hydrogen is less energy efficient than a battery (around 22% compared to 73%). Contrary to the current situation where energy for transport comes overwhelmingly from fossil fuels, there will be a segmentation of the market, with batteries and hydrogen separated according to their respective advantages (with hydrogen likely to be used more for heavy transport).

### **How can a hydrogen mobility sector be developed in France, when the costs of this technology are very high and pilot initiatives are struggling to meet their objectives?**

**J-P P:** The development of the sector has to reconcile two objectives: the setting up of an infrastructure for the production and distribution of hydrogen on the one hand, and large volumes in terms of vehicles so as to reduce costs on the other. For several years now, France has adopted a strategy of regional clusters, in contrast to Germany which has opted for a national approach with the creation of refuelling stations throughout the country. Preliminary feedback has been highly instructive. The French strategy is struggling to generate significant volumes, as shown by the EAS-HyMob project in the Channel or ZEV (Zero Emission Valley) in Rhône Alpes, while in Germany many refuelling stations have had to close for lack of customers. Two other approaches, however, underline the merits of a concerted approach

between infrastructures and vehicles through the deployment of “captive” fleets. In Paris, the Hype hydrogen taxis project has been quite a success. The project is based on a captive fleet of several hundred vehicles and operates in a consortium with several partners, including Air Liquide to supply hydrogen. The deployment of hydrogen-powered urban buses provides a second example of success, this time at the European level. In this case, local authorities are directly or indirectly operators of public transport. Thanks to the support of European programmes such as JIVE (Joint Initiative for hydrogen Vehicles across Europe), they have drawn up their deployment plan and obtained substantial national and European subsidies. The combined volumes have provided an incentive for new bus producers – Safran in France, CaetanoBus in Portugal, Solaris in Poland, etc. – alongside VanHooel, the already well-established Belgian producer. Large cities in France have launched the programme rather later than in Northern Europe, but with the recent plan of 1000 buses managed by UGAP (Union of Public Purchasing Groups), this gap is likely to be remedied. The sector needs subsidies. But the money by itself is not everything: it still needs to be deployed within a sustainable long-term approach. It should not be forgotten that the development of electric vehicles in Norway, where it now has a market share of more than 50%, has worked thanks to various and well targeted state subsidies (direct aid for

the purchase of vehicles, as well as massive support for infrastructure).

### **Carbon prices in the markets are currently too low to justify massive investments in hydrogen. What solutions are there to remedy this?**

**J-P P:** An increase in the price of carbon would be a considerable incentive. One possibility would be to target the carbon tax at the most polluting segments, such as heavy goods vehicles. In Germany and Switzerland, for example, a carbon tax per kilometre has been introduced on HGVs. In Switzerland, the existence of this tax may have led to the launch of the H2-Energy consortium, bringing together transport operators, energy suppliers and a car manufacturer, South Korea’s Hyundai. The objective is to have 1500 hydrogen-powered trucks on the road by 2025. To achieve this, the cost per kilometre is guaranteed to operators and is no greater than that (including taxes) of diesel trucks.

### **What other challenges need to be addressed for hydrogen mobility to be successful?**

**J-P P:** The electric battery sector is developing very quickly and is in competition with the fuel cell sector. There is also a certain delay in this on the part of the French automobile manufacturers in completing the value chain comprising of energy producers and equipment manufacturers. Moreover, to produce hydrogen, large electrolyzers need to be installed, and these must be supplied with carbon-free energy, preferably renewable. According to some scenarios, this is likely to be in short supply. If so, it will be necessary to find ways of importing hydrogen produced by renewable energy in Southern Europe, or even in North Africa. Japan, for example, has signed an agreement with Australia for this purpose. Nuclear power in France is a possible solution, but one that is somewhat controversial. →

**For several years now, France has adopted a strategy of regional clusters, in contrast to Germany which has adopted a national approach with the creation of refuelling stations throughout the country.**

### What role can or should Europe play in the development of the hydrogen sector?

**J-P P:** Alongside local multi-stakeholder initiatives, Europe should act as coordinator and promoter of the ecological transition. In fact, this is precisely what it is doing in the bus segment, with a specific subsidy programme to encourage European regions in this regard. The French recovery plan is aligned with European Union initiatives such as the European Clean Hydrogen Alliance.

### Other countries are competing in the hydrogen race: Germany, but also China, Japan and South Korea. Where is France situated?

**J-P P:** The leading countries are Japan and South Korea. Bunched just behind them are China, Germany and France. The latter two countries have to commit themselves to the right segments in order to succeed. In Northern Europe, “blue” hydrogen is favoured (for example in the H2-Vision project in Rotterdam) and is produced from the capture and storage of CO<sub>2</sub>. In France, a different direction has been taken with the aim of producing “green” hydrogen with large electrolyzers that transform water into hydrogen through electricity

**Alongside local multi-stakeholder initiatives, Europe must play a role as coordinator and promoter of the ecological transition.**

generated by renewables or nuclear power. This technology takes longer to set up, but it is more favourable to the ecological transition in the medium term.

### To conclude, what are the next research projects you are going to implement on mobility, and more generally the ecological transition, in the Energy & Prosperity Chair?

**J-P P:** The Chair was renewed in 2020 with the ongoing support of ADEME, Caisse des Dépôts et Consignations, Agence Française de Développement, and SNCF. Two new partners have joined us: Engie and Renault. We also have a partnership with GRDF dedicated to biomass. We are going to continue our work on sustainable mobility, pollution problems in cities, and access to decentralised energy in Africa. ●

#### Further reading

The Energy & Prosperity Chair has carried out a number of studies on hydrogen and the ecological transition. Some of this work can be consulted on the links below:

[http://www.chair-energy-prosperity.org/category/publications/?s=&wcf\\_taxonomy%5B5743440a75760%5D=all&wcf\\_taxonomy%5B575ddf80df489%5D=all&wcf\\_taxonomy%5B575de0b6ac385%5D=all&form\\_id=553&post\\_types=post&posts\\_per\\_page=500](http://www.chair-energy-prosperity.org/category/publications/?s=&wcf_taxonomy%5B5743440a75760%5D=all&wcf_taxonomy%5B575ddf80df489%5D=all&wcf_taxonomy%5B575de0b6ac385%5D=all&form_id=553&post_types=post&posts_per_page=500)

<https://www.i4ce.org/hydrogene-en-france-climat/>

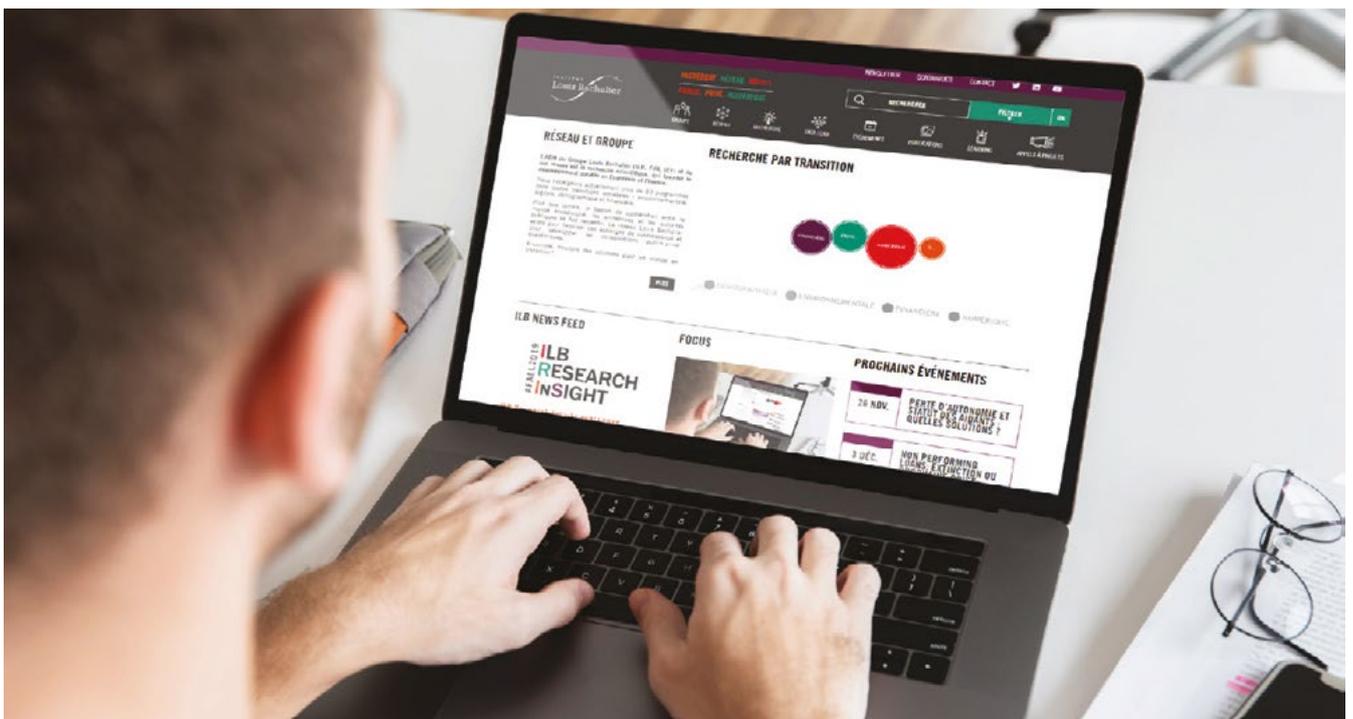
<https://www.ipp.eu/publication/juillet-2020-quelles-politiques-publiques-pour-la-filiere-hydrogene-les-enseignements-tires-du-cas-des-bus-urbains>



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