

IT CHANGES EVERYTHING

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$\text{CO}_2 = \text{ZERO?}$ THE EQUATION THAT MATTERS



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Decarbonise is the watchword for our century. Major, universal, urgent. It is on everyone’s lips. Of young people marching in the streets of major capitals, who want to act now and are looking far into the future. Of profoundly responsible citizens who want to do their bit. Of city authorities rethinking their networks; of villages undertaking a local project. Of industry leaders faced with crucial investment choices, sometimes spanning several decades. Of politicians in all countries promising their people that they will act as never before and trying to convince their reluctant counterparts. The targets are set for 2050. The future looms large on the horizon.

Decarbonise? Yes, but... For some, it is the path to salvation that we must follow without concession. Humanity – in every sense of the word – men and women, how we see our existence on Earth and even the planet itself are at stake. Others see it as a contradiction. Consume less, forget about dreams and the routines of daily life. Wouldn’t taking this path mean giving up almost everything? An unbearable loss of purchasing power, a profound injustice. How could we accept it in those parts of the world where famine threatens, where life is just too hard, where people lack everything every day?

Energy production is at the heart of the answers to all these ambitions. It must help with the solution to this dual challenge: to protect both the environment, and economic and social well-being. All that within our shared democratic framework and on a global scale, listening to everyone. EDF is working on the transition everywhere: storage capacities, network modernisation, new infrastructure, and solutions adapted to each and every person. Responding to the global challenge means starting a new dialogue between technology and society. And

IT CHANGES
EVERYTHING

How do we solve the equation of a low-carbon society?

Is a low-carbon society synonymous with moderation? How can the efforts needed be made more equitable? These questions were put to **Laurence Monnoyer Smith (L.M.S.)**, Director of Sustainable Development at CNES, **Stewart Chau (S.C.)**, Head of Political and Societal Studies at the Viavoice Institute, and **Léa Falco (L.F.)**, student at Sciences-Po and member of the *Pour un réveil écologique* collective, on 11 November 2021, in the podcast “Ça change tout”, hosted by Thierry Keller.

Discussion highlights.

L.M.S.: Growth is linked to the production of goods and services, and therefore to energy consumption. Growth, as we know it today, is absolutely not compatible with climate change. We must therefore redefine this term and ask ourselves what we will have to give up.

L.F.: Today, growth is a religion, it's iconic. The word growth in itself is something that is worshipped, it makes no sense! There is a need for structural transformation, and therefore for strong political will to help citizens to accept, but also to want, the transition.

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T.K.: The “end of the world” is often pitted against “making ends meet”. Is the public ready to pay more tax to save the planet?



L.F.: This expression is problematic: it individualises responsibility. Economic difficulties will go hand-in-hand with environmental difficulties. It is up to companies and public authorities – which have the most potential leverage – to take responsibility.

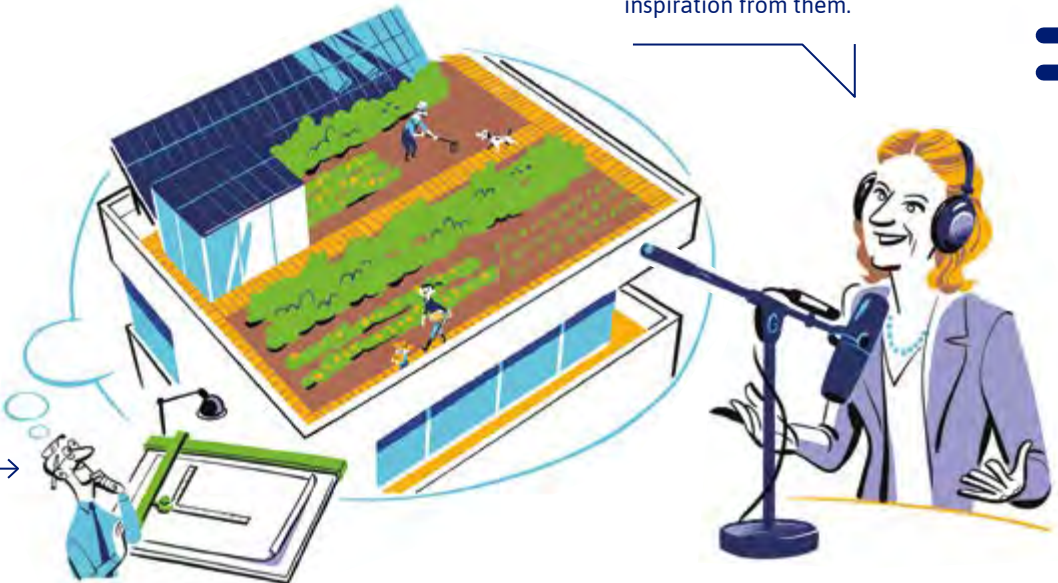
S.C.: The French have only a vague notion of carbon neutrality. A vision of society is needed: perhaps the environment is the new term for the social conflict of the 19th century.

L.M.S.: The French are not indifferent to ecological issues, but currently they are resigned. The challenge for public authorities and politicians is to listen and in response to find a certain number of solutions that will re-engage society around these issues. Public debate and referenda are the tools at their disposal.



T.K.: What gives you hope?

L.M.S.: The transformation of vision and imagination. This is both crucial and urgent. What do we imagine a carbon-free society will be? We have artists, architects, scientists and writers working on this, and we must draw inspiration from them.



The podcast “Ça change tout” is available on all platforms and can be downloaded on Apple Podcasts, Spotify, Deezer, Podcast Addict, Google Podcasts and many more, including edf.fr.



“Climate is not just about climate. It is about the overall resilience of our societies.”

Valérie Masson-Delmotte

Climate scientist, Director at CEA,
co-chair of IPCC Working Group 1

Interview

Co-chair of the Intergovernmental Panel on Climate Change (IPCC) Working Group 1, member of France’s High Council on Climate, climate scientist Valérie Masson-Delmotte looks back at the highlights of COP26. She defends a pragmatic approach, based on scientific data, rejecting vague terms and alarmist slogans. Explanations and progress report with one of the leading experts on global warming.

— You attended COP26, which took place from 1 to 13 November 2021 in Glasgow. What were your takeaways from this event?

Valérie Masson-Delmotte: First of all, the increased attention paid to scientific information. This is essential because climate discussions must be based on factual and accurate data in order to be as concrete as possible. In Glasgow, for example, we saw that CO₂ emissions are now stagnating. This assessment was made taking into account and correcting for the effects of the pandemic. The commitments made before this COP meant a warming of +2.7 °C or more by the end of the century. The increase is continuing, but it seems to be less than expected. We would rather be on a trajectory of +2 °C.

— Did this COP result in any new decisions?

V.M.-D.: Yes, especially on the issue of methane. This greenhouse gas degrades air quality, but it had not been clearly targeted until today. It has now, with a new agreement on this point. Of course, it is important to remain pragmatic and realistic: the countries concerned account for only 50% of methane emissions. Nevertheless, the subject is now on the table, and it will be possible to move forward. Furthermore, COP26 saw a consensus emerge on Article 6 of the Paris Agreement. This concerns the carbon market, in which each country can trade CO₂ reduction units in order to achieve its own emission reduction targets. This provision had divided states for six years, and negotiations finally reached an outcome. Lastly, discussions have started on infrastructure adaptation and emergency situations. The former mainly concerns developing countries, which are obliged to adapt their economies to the requirements of the fight against global warming. Emergencies usually affect small island states. In both cases, the question of financing is crucial in order to provide appropriate responses after a tragedy, but also upstream in order to avoid them.

— Would you qualify the Glasgow meeting as a success?

V.M.-D.: I would say that we need to stop talking about these events in terms of failure or success. Just as we need to get away from the tendency to scaremonger with phrases like “it’s now or never” or the “COP of the last chance”. An event like this is based on a precise and complex mechanism. Each country announces its CO₂ reduction targets. The COP then aggregates this data and measures the effect of each commitment made to determine whether or not global warming can be reduced under these conditions. Countries do not just formulate short-term ambitions but must also think long-term. And every plan is scrutinised for its credibility. When you are told, as in some scenarios, that emissions will rise until 2030 and then fall sharply, it is realistic to have doubts. When a country like Australia says it wants to continue mining coal, it is logical to focus on this decision. It makes each state accountable. It is a major task on a global scale. That’s why I think it’s meaningless to talk about “success”, “failure” or “last chance”. What really counts is the cumulative CO₂ emissions. At the current rate, by the beginning of 2030, we will have consumed the entire carbon budget that allows us to limit warming to 1.5 °C. Let’s leverage this data rather than repeating slogans.

— Global warming has also become a question of semantics.

Concerned but non-specialist citizens may feel lost when speeches blithely mix “sustainable”, “responsible” or even “eco-responsible”. Today, we hear a lot of talk about “low carbon”. Do you think the expression is appropriate?

V.M.-D.: Not exactly. It seems to me to stem from questionable logic: an approach that mixes various criteria to determine what emits the least carbon at a given moment. And then, when we say “low”, it is in relation to what? And the word “carbon”? Does this mean that only CO₂ is taken into account? What about other gases? The concept of “carbon neutrality” also seems problematic to me. It makes sense on the scale of a state or even the planet, but for a company or a product, it becomes much vaguer. “Carbon-neutral” labels are appearing on clothing, for example. It implies that the same amount of CO₂ emitted into the atmosphere to make these products has been removed, disposed of and stored sustainably. But we know that this is often just offsetting. This kind of wording is confusing.



IPCC: its mission and organisation

For more than 30 years, the IPCC has been assessing the state of knowledge on climate change, and its causes and impacts. It has three working groups:

- Group 1 assesses the scientific aspects of the climate system and climate change
- Group 2 focuses on issues concerning the vulnerability of socio-economic and natural systems to climate change
- Group 3 assesses options for limiting greenhouse gas emissions or mitigating climate change by any other means.

— What words would be most appropriate in your opinion?

V.M.-D.: I prefer to talk about emissions, about net zero emissions. A term that implies low carbon emissions and high offsets for gases such as methane. It’s a more concrete, realistic term.

— After the numerous “COPs of the last chance” and the effect of grandiose announcements, a large part of the population believes that it is already too late, that nothing will change. How can we combat this fatalism?

V.M.-D.: First and foremost, by showing what has worked. For example, Group 3 of the IPCC quantifies the emissions that have been avoided thanks to virtuous practices or new technologies. Then, we need to promote the notion of adaptation. For example, the heat wave that hit Western Europe in 2003 gave rise to several warning systems. Such an event would not have the same consequences today. Finally, I think it is essential to make people understand the effects of each tenth of a degree of warming. Between 1.1 °C and 1.5 °C, there is a considerable difference that will have various impacts on daily life, extreme events and glacier retreat. We are not prepared for these consequences. The IPCC provides access to this type of information. This is important. The Covid-19 pandemic showed that citizens do want access to useful data themselves.

— Discussions around global warming are also affected by the current political atmosphere. On the one hand, voters no longer trust their elected representatives to provide answers to such serious problems. On the other hand, governments are reluctant to impose binding and unpopular rules.

V.M.-D.: Indeed, governments are reluctant, although their political will is crucial. In order to take real decisions, they need to understand all the dimensions of the issue. By making a real commitment to climate protection, they can influence their country’s energy independence and energy price controls. By guaranteeing air quality, they act for the wellbeing of everyone and limit health expenses, sick leave, etc. In short, it could be said that climate is not just about climate. It is about the overall resilience of our societies.

— What are you optimistic about today?

V.M.-D.: Mentalities are changing. This is perceptible in consumer habits, for example. But I can also see an evolution among young engineers, and their growing awareness of the need to look for new solutions. Access to and use of data inform the development of innovative monitoring tools and new services. Companies reflect all these changes. Some of them have realised that grand declarations of intent are no longer of any use, and that they need to do real in-depth work. This awareness affects all levels of their hierarchy: boards of directors are increasingly aware of the issues at stake, and young employees are very attentive to climate issues. When these two levels share the same concerns, things can really change.

“We need to stop talking about COP in terms of failure or success. It’s meaningless...”

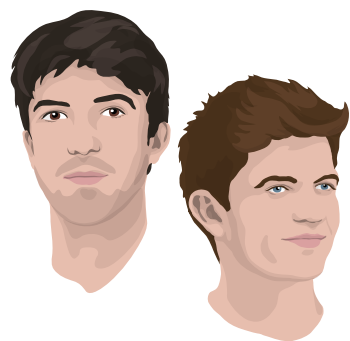
Valérie Masson-Delmotte

CLIMATE CRISIS IS STEPPING UP THE PACE TOGETHER



Everyone's on board. Carbon neutrality is a goal that cuts across all levels of society. Citizens are getting involved, like the students of the "climate generation". Local authorities are inventing new solutions with their residents and the planet in mind. Companies, large and small, are making crucial investments for the future of all. Politicians around the world are demonstrating leadership in overcoming reluctance.





Joint interview

THÉO MILOCHE

25 years old, is a graduate of HEC and Sciences Po Paris. He is the spokesperson for the student collective *Pour un réveil écologique*.



ARTHUR GOSSET

24 years old, is a graduate of *École centrale de Nantes* and the Imperial College of London. He wrote and directed the documentary *Ruptures*.

CITIZENS

driven by
the climate
generation?



Committed young graduates

— You are both graduates of prestigious professional schools. As part of your commitment to the climate, who do you talk to? And what do they say to you?

Théo Miloche: The student collective *Pour un réveil écologique* targets tertiary education institutions and companies. We say to schools and universities that all students must be trained in ecological issues. This is important for their civic awareness but also for their employability: recruiters will require it to be part of their skills. We ask companies to implement an ambitious transition in their business models. It is a question of their attractiveness to young graduates, who are very sensitive to the climate cause. At the beginning, they were curious and showed goodwill towards our message. Now that we are putting forward concrete solutions, the discussion is more intense.

Arthur Gosset: Initially, I made this documentary for my parents, thinking that it would reach their age group but also young graduates who are wondering about the meaningfulness of their future career. The film aims to create a link by explaining how our generation feels. It has been very well received because it is not accusatory. I show that young people can find their way without replicating the old models.

— What do you think is the best way to convince people: discussions, demonstrations, activism?

T.M.: Some people demonstrate their commitment through several approaches because they feel up to it. But it is not the same for everyone: you have to find a suitable structure and take ownership of the public nature of your demands. The transition to action is not always self-evident.

A.G.: There is no best way. It depends on personal preferences. It is just as possible to take action in an association as in a company. The most important thing is to feel at ease and to have fun.

— Théo, you talk with economic and industrial players. Do they listen to you?

T.M.: In general, yes. Our collective is called in by companies. Then, within an organisation, how our message is received depends on who we are talking to, their personal commitment and their decision-making weight.

— Arthur, why did you make your documentary?

A.G.: By showing my documentary in schools, companies and associations, I noticed that the best way to get through to people was through their emotions. That is the way images and sound work. Business leaders have thanked me for it, saying: “Your film has opened my eyes.” That is really gratifying.

— A question for both of you, what is needed to effect change?

A.G.: As an engineer, I see the urgency in reducing greenhouse gases if we are to keep warming below the 2 °C threshold recommended by the IPCC. As a utopian, I think that everyone should be able to ask themselves: Am I part of the solution or part of the problem?

T.M.: For a long time, I thought that the massive sharing of information on climate issues would raise awareness across the board. But that won’t happen. To change everything, you have to build a powerful movement over time, keep a stringent goal in mind and not get discouraged by failures along the way. ◆

Interview ANNE MUXEL

Sociologist, Director of Research at CEVIPOF (CNRS/Sciences Po), author of *Politiquement jeune* (Éditions de l'Aube, 2018). Her latest publication is *L'Autre à distance. Quand une pandémie touche à l'intime* (Odile Jacob, 2021).



“Youth mobilisation puts climate on the policy agenda”

— As 83% of young people believe that previous generations have failed to take care of the planet, environmental issues are at the heart of their concerns. Are they ready to get involved and take action?

Anne Muxel: Ecological issues are indeed a major concern for young people. And this is quite normal because they are in the front line. But it is also because they are no longer driven by purely political issues. Their action takes many forms. Some will follow Greta Thunberg's demonstrations, while others will join the more activist camps, such as Extinction Rebellion, or even adopt very radical resolutions ranging from degrowth to the idea that we should no longer have children.

— You say that youth is not depoliticised but politicised in other ways. What does this mean?

A.M.: Before answering, I want to emphasise the fact that it is difficult to talk about youth as a cohesive group. Like society, it is criss-crossed by many social, political and regional divisions. There are young urban people who tend to be better educated

about environmental actions, while others, particularly young working people with few or no qualifications, may be attracted by populist or authoritarian leadership. The fact remains that, overall, young people are looking for ways to express themselves other than those traditionally offered by the institutions of representative democracy: political parties, trade unions, etc. They believe in combining direct individual action rather than in delegated action, in direct participation rather than in representation. It is also interesting to note that the environmentalist parties benefit only marginally from this youth vote. They are tarred with the same brush as all institutional political organisations, of which young people are suspicious.

— In fact, what influence does youth have on the rest of society?

A.M.: The collective mobilisation of young people is based on more individualised factors, free of conventional political mediation. The scope of their action and expression is putting major issues for the future of contemporary societies on the political agenda. They are making themselves heard and cannot be ignored. ◆



LOCAL AUTHORITIES

The level for action



Opinion BETTINA LAVILLE

Honorary State Councillor, Chair of Comité 21

“Ecological citizenship and decarbonisation must go hand-in-hand”

→ **CARBON NEUTRALITY** is a global concept affirmed in the 2018 special report of the IPCC⁽¹⁾, which recommends a target of net zero CO₂ emissions by 2050. In this respect, for the French Agency for Ecological Transition (Ademe), no one stakeholder can claim to be “carbon neutral” on their own; everyone must adopt “zero carbon” strategies by 2050. Carbon neutrality therefore implies a structural transformation of our society, under the banner of each stakeholder's climate responsibility. It involves a two-pronged approach: reduce emissions and increase sequestration capacity, which can be applied at the level of local authorities.

Emission reduction remains the priority. Local authorities are already subject to pathway obligations that they have translated into regional plans for sustainable development and regional equality⁽²⁾, or regional climate-energy plans⁽³⁾. However, these express more of a will than a pathway, apart from the renewable energy sector where quantified objectives exist. Moreover, elected representatives – already faced with the complexity of the expertise required in a technically difficult field – must define new solidarities without any guiding principle enshrined in law. In order to achieve this, we will need to use all the tools at our disposal: first, know how to measure by referring to systems such as those provided by Ademe, or use artificial intelligence, which is highly effective in improving knowledge of the energy consumption of buildings; leverage all the techniques for reducing

emissions, from the most socially responsible (reducing heating, eliminating short car journeys, etc.) to the most sophisticated (using smart grids to set up a local flexibility service, encouraging collective self-consumption, etc.).

Another thing is the local organisation of carbon sequestration, a prerequisite for offsetting, which must be based on two essential principles: reciprocity between regions with a high carbon content (and which will not be able to reduce as much as they would like to unless they lose population or become deindustrialised) and those with a high CO₂ storage capacity, and stakeholder accountability within a region through integrated regional reporting, or even carbon quota trading at the local level.

In fact, it is nothing less than the introduction of new regional planning based on local projects “all looking in the same direction”, with new citizen approaches. Citizenship and decarbonisation must go hand-in-hand. ◆

⁽¹⁾ IPCC Global Warming of 1.5 °C: An IPCC Special Report on the Impacts of Global Warming of 1.5 °C Above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty, 2018.

⁽²⁾ The SRADDET is a planning document which, at the regional level, specifies the strategy, objectives and rules set by the region in several areas of regional development, including the protection and restoration of biodiversity.

⁽³⁾ The PCAET is a strategic and operational planning tool which enables local authorities to address the whole range of air-energy-climate issues in their region.



CITIES IN
TRANSITION

Dijon
Côte-d'Or

40%
fewer greenhouse gas emissions
across its region by 2040

Hydrogen all the way In 2012, Dijon returned one of its main thoroughfares to pedestrians. Since then, it has driven cars out of the entire city centre, while at the same time investing in a “clean” public transport network, powered by hydrogen. Greater Dijon is engaged in a major project to produce gas in a short-chain process. This green fuel, produced in two plants, will be supplied to the bus fleet (180 vehicles in the long term) and waste collection vehicles (44 trucks). This will save more than 4,000 tonnes of CO₂ a year. Additionally, Dijon Énergies is working with Dalkia to create heating networks serving 55,000 homes. Using wood and biomass as the energy source, they will reduce carbon emissions by 38,500 tonnes a year.

Brest
Finistère

4,470
tonnes oil equivalent
substituted in 20 years

Brest goes wood powered Brest is a pioneer in the field of district heating. Its heating network has doubled in size over the past decade to 52 km. In 2016, an innovative project implemented by Dalkia provided the university with space heating using energy recovered from a biomass heating plant and an urban incinerator. The result: 12,700 tonnes of CO₂ saved. In addition to continuing to invest in wood-fired heating, the local authorities of the Finistère region are following a diversified climate plan including housing renovation assistance, development of public transport and cycling, support for businesses and small municipalities in the area, a solar cadastre, etc. The Pays de Brest is aiming for energy autonomy.

Alès
Gard

80%
reduction
in lighting bill

Alès, solar energy reigns The Cévennes city has carried out the first collective self-consumption operation in a residence in France, installing 600 m² of photovoltaic panels on the roofs of a complex of 100 flats. The energy produced covers 20% of the needs of the households, i.e., a potential annual saving of €100 per household. The scheme is managed by EDF Renouvelables. In addition, the greater Alès municipal area has supported the creation of several photovoltaic parks in its territory and subsidises private individuals' projects for both solar electricity and heating. Its commitment to the climate does not stop there. Alès has equipped its public lighting with LEDs (15,000 light points and an 80% reduction in the lighting bill) and has built a hospital granted France's HQE™ (High Environmental Quality) certification, a biomass heating plant, etc. And, by 2030, half its bus fleet will be powered by hydrogen.

COM- PANIES

in the front line

Interview ÉLISABETH LAVILLE

Founder of consultants Utopies
specialised in sustainable
development for companies



“Radical change
is needed,
disruptive
strategies.”

— Do you think that companies have now understood what carbon neutrality means, and that it is not just a matter of continuing to emit greenhouse gases while planting trees?
Élisabeth Laville: When applied to companies, carbon neutrality is a simplifying concept, but it has the educational merit of making it clear that there is no “business as usual” strategy under the Paris Agreement. Radical change is needed, disruptive strategies. In 2020, when the economy was at a standstill, emissions fell by 6–7%. That is what would have to be achieved every year until 2050 to meet the Paris agreement targets, with the economy running at full speed again. That said, the idea that companies are simply planting trees and doing nothing to reduce their CO₂ emissions is an oversimplification. A study⁽¹⁾ shows that companies that offset their emissions are three times more likely to reduce their emissions and five times more likely to have put in place an internal carbon pricing mechanism.

— You often say that we don’t change individually but collectively, what do you mean?
É.L.: The International Energy Agency maintains that half of the changes will be technological and half behavioural.

Let’s take the example of fashion: only 1% of the clothes sold each year are recycled, and production is increasing by 4–5% each year. The solution does not (just) lie in recycling, or in eco-materials, but in changing the culture of fast fashion. The social norms of institutions, companies and consumers need to change.

— How can we overcome the terribly divisive discussions about the growth needed by companies and the planet’s conservation?
É.L.: The opposition between growth and degrowth is an old discussion that dates back to before the Rio Summit in 1992. Bush came in saying that the American way of life was non-negotiable. So we focused first on less energy-intensive production, without touching economic models or consumption. Thirty years later, we can now say that we want selective growth, to reduce CO₂ emissions, waste and pollution while increasing jobs, health and well-being.

— Do you think that companies will have achieved their targets by 2050?
É.L.: 2050 is 30 years away and that’s at least two generations of leaders. Even though a company must have a long-term vision, it is important that the concrete targets are thought through in terms of a single term of office. I have more admiration for those who are prepared to act within the coming decade than for those who lay down targets for periods when they will no longer be in charge.

— Which companies will still be around in thirty years’ time?
É.L.: The ones that have been able to change radically. We have our backs to the wall, and I like Churchill’s phrase: “If you don’t take change by the hand, it will take you by the throat.” ●

(1) “The bottom line: taking stock of the role of offsets in corporate carbon strategies” funded by JP Morgan, 2015. (2) “D’où proviennent les émissions de la France en 2019 ?”, 2021 Annual Report of the Haut Conseil pour le Climat, June 2021. (3) French legal framework in which businesses pursue a set social and environmental purpose with specific sustainability goals.

Carbon weight by major sector in France⁽²⁾

Greenhouse gas
emissions fell by 1.9%
in 2019 compared
with the previous year.
France needs to double
this rate if it is to meet its
commitments.

31%

Transport
This is the largest
emitter. Cars account
for more than half
these emissions (53%),
followed by trucks
(25%). Domestic
air transport
represents 4%.

19%

Industry
Chemicals (25%), and
construction materials
and metallurgy (23%
combined) are the
main emitters.

19%

Agriculture
Stock breeding –
especially industrial
– accounts for almost
half these emissions
(48%); crop farming
represents 40%.

17%

**Building and
Construction**
At 61%, housing
is by far the main
source of emissions.

10%

Energy processing
Of which 47%
for electricity supply,
21% for oil refining,
9% for heating.

4%

Waste
The bulk of these
emissions – 83% – is
attributable to landfills.



Encouraging companies to get involved

Two measures aim to encourage companies to commit to the climate issue.
The first follows France’s PACTE law (2019). While the notion of social interest did not exist for companies in French law, this new law now opens up this possibility by introducing the “entreprise à mission”⁽³⁾. From now on, a company can not only state its purpose but also commit to social and environmental targets in the course of its business. The second measure, “Say on Climate”, refers to the “Say on Pay” principle, which allows shareholders to give their opinion on directors’ and officers’ remuneration. At general meetings, a company or its shareholders can table a resolution to have shareholders vote on the company’s climate policy. However, these two measures are not legally binding. A company cannot be forced to live up to its purpose and commitments. The shareholder vote in the “Say on Climate” is advisory only.

Interview
CAROLE MATHIEU

Head of EU energy and climate policies at the French Institute for International Relations (Ifri)



“The Paris Agreement:
A solid foundation”

— Carbon neutrality has become a key issue in international negotiations between states. Why has this issue taken precedence over other environmental concerns?

Carole Mathieu: There are several reasons. Firstly, global warming caused by greenhouse gases has been observed for a long time. The first warnings date back to the late 1970s. The work of scientists was then presented in international forums, notably the UN. Moreover, this problem is undeniably global, unlike other more localised issues. Regardless of the origin of the CO₂, the emissions threaten everyone. The solution can be shared: everyone must reduce their emissions. This global approach is now tending to spread to other issues, such as the oceans, forests and biodiversity.

— The consensus built through the Paris agreement seemed fragile, especially when the US walked out. Is the diplomatic process reversible?

C.M.: No, I don't think so, on the contrary. Donald Trump's presidency proved that the Paris Agreement was a solid foundation for orchestrating international efforts: there was no domino effect. All the other countries felt it was better to stay in. Joe Biden decided that his country should rejoin. The process respects the sovereignty of States, it does not dictate policy choices, while committing each nation to its share of the collective effort.

— Does State action on climate change rely solely on goodwill?

C.M.: In a way. There are no sanctions if a country that has signed the Paris Agreement fails to meet its commitments. But, if it does, it will be judged by its peers, the media and public opinion. It is a question of reputation, responsibility and morality. In return, each country is free to take the decisions that are best suited to its situation. The international community has learned the lessons of the past. The Kyoto Protocol set strict targets for States. But it was never ratified by the United States, and Japan abandoned it.

— Can other stakeholders, such as companies, achieve global goals on their own, without State intervention? Or is State intervention essential?

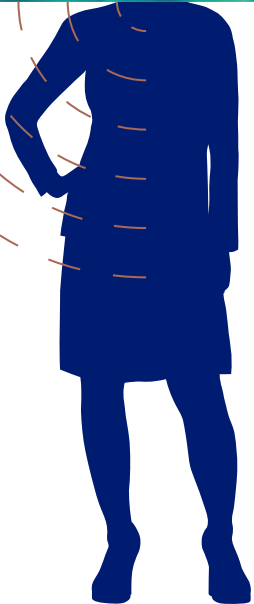
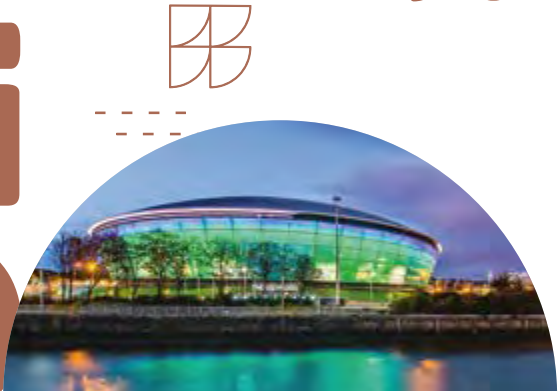
C.M.: Action by businesses, NGOs or local authorities is welcome. Their initiatives have the advantage of giving governments confidence. Project announcements are timely at COP time, for example. The public authorities then feel reassured in the decisions to be taken. When all the stakeholders are moving in the same direction, it makes sense for the public. However, a global framework is still needed to coordinate efforts and give them coherence. This includes avoiding distortions of competition in industry. There need to be advantages for companies that release low-carbon products on the market.

— What are the expected milestones for the international community on the road to carbon neutrality by 2050?

C.M.: Climate neutrality is a relatively recent goal for many countries. A majority of nations, representing two-thirds of the world's economy, have made mid-century commitments. This is a huge step forward. But the decisions to achieve it are being made now. The heart of the transformation lies before 2030. 🌱

POLICY:

Responsibility
for the framework to be set



The major milestones
of international action



United Nations Conference on the Human Environment
Held in Stockholm, Sweden. This was the first time that the international community examined environmental issues.

1972

First World Climate Conference
Held in Geneva, Switzerland. Scientists stated the need for collective action to combat global warming.

1979



First IPCC Assessment Report
Under the authority of the United Nations, scientists demonstrated the influence of human activity on climate change.

1990

1995

First COP in Berlin, Germany
The participants took note of the failure of the 1992 convention. It saw the start of a negotiation process.



2005

EU introduced a CO₂ quota system
The European Union created the first carbon market, one of the pillars of its environmental policy.

2018

IPCC Special Report on the 1.5 °C target
Scientists demonstrated that efforts need to go beyond the commitments made.



Adoption of the Kyoto Protocol, Japan
This international treaty targeted a reduction in emissions of about 5% over the years 2008–2012 with numerical targets for each country.

1997



COP21, Paris Agreement, France
Countries committed – through their own decisions – to work towards a temperature increase of no more than 1.5 °C.

2015



United Nations Framework Convention on Climate Change and the Earth Summit
Greenhouse gas reduction targets were set for industrialised nations.

1992



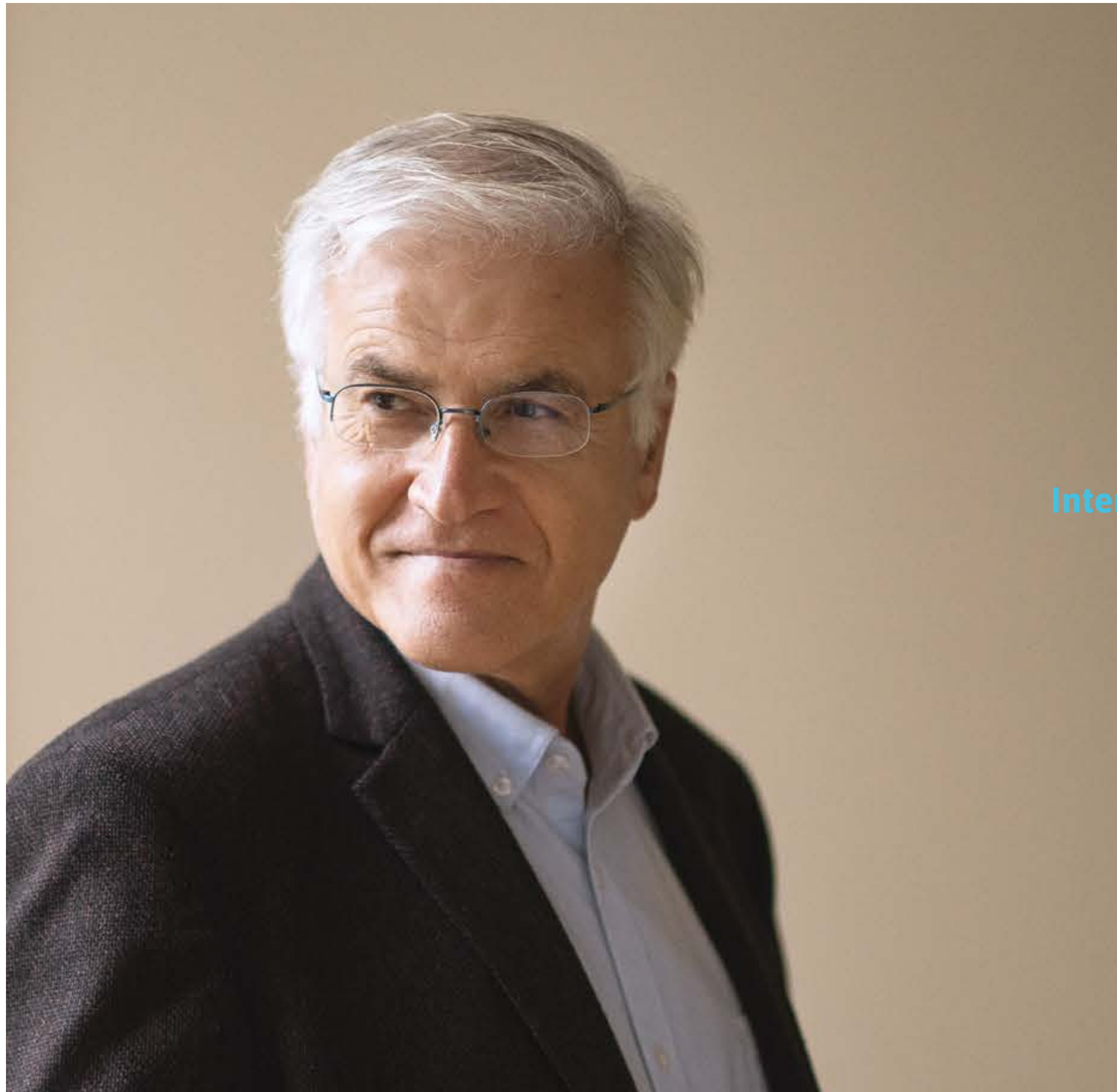
Montreal Protocol, Canada
Announced the restrictions against the use of chemicals that damage the ozone layer.



2020

European Climate Law
Europe committed to reduce its CO₂ emissions by 60% by 2030 and to be climate neutral by 2050.





Interview

“The ‘polluter pays’ rationale is inappropriate for climate issues. Thinking about the idea of justice is absolutely essential.”

Armand Hatchuel

Professor and researcher in management sciences and design theory at Mines Paris Tech

What if the issue of climate change hasn't been approached from the right angle? What if we had to go back to the beginning of our discussions and think first and foremost about the notion of justice in the hope of coming up with concrete solutions? Professor and researcher in management sciences and design theory, and a pioneer in the work on the status of the "entreprise à mission", Armand Hatchuel draws on ancient history to provide new answers to today's major challenge. Interview.

— How can we avoid penalising the most economically vulnerable? When global warming is mentioned, the notion of justice quickly enters the debate. Why is this so?

Armand Hatchuel: Thinking about the idea of justice is absolutely essential. Because, of course, we need to provide a fair framework so that the environmental transition does not fall on the shoulders of a single category of people or countries. But also because, if we think about it in this way, we quickly realise that we are approaching the climate issue based on the inappropriate rationale of "polluter pays".

— Whoever pollutes the most, pays the most or changes their habits. This seems logical. Why is it wrong?

A.H.: This model comes from the theory of market equilibrium. In order to reduce the consumption of a product, all you have to do is increase its price. This mechanism has nothing to do with justice. Whoever can afford to pay does so. Full stop. Moreover, in the context of global warming, it is not really a question of "pollution". Historically, CO₂ has never been considered a dangerous substance. We emit it when we breathe, but we are not polluters. I think it is more accurate to talk about a common peril. But market mechanisms are proving ineffective in the face of a common peril.

— So how do we deal with it?

A.H.: The Rhodian Sea Law, formulated in ancient times, shows us the way. It stipulates that, in order to save his ship, the captain can sacrifice part of the merchandise onboard. On arrival in port, some will get their goods, others will not, since the captain will have seen fit to throw them overboard. They will then be compensated by the others, who are more fortunate, commensurately to what was saved. The sacrifice they have accepted has been useful to all, so it is normal to provide compensation.

— In the context of global warming, how would this ancient law be applied?

A.H.: India and China emit more CO₂. Their transition to a less carbon-dependent economy could be partly financed by other nations, with amounts calculated according to the geographical location and geopolitical links between the countries concerned. In domestic politics, the same reasoning also holds. Some French people have to change their cars, give up diesel, even though they do not necessarily have the means to do so. Instead of treating them as polluters, the whole country could contribute, as it would have everything to gain from this change.

— But, in Rhodian law, the ship is commanded by a single, uncontested captain. This is not really the case in the international community.

A.H.: This is why we need to encourage the emergence of a body like CERN, the European Organisation for Nuclear Research, but for global warming. Perhaps the IPCC, for example, could move towards this role and not limit itself to simply observing and issuing warnings.

— Do you think that popular support could be obtained with a citizen conference, as we have seen recently?

A.H.: Why not, but this solution seems to me to be particularly effective when we are faced with moral or ethical dilemmas. It seems to me to be more complex to set up for a subject requiring a certain level of technical information, however. Who would be the experts authorised to moderate the citizen conference? How will the information be presented while guaranteeing neutrality? How would opposing opinions be taken into account? These are not easy questions to answer. The construction of a principle of justice seems to me to be accessible today without organising this kind of consultation. Public opinion is evolving: it will demand proposals, another vision. And Rhodian law has proved its worth: it has existed for 2,500 years and is still applied in marine law.

— But isn't this approach too theoretical when the current urgency calls for very concrete actions?

A.H.: On the contrary, it opens the way to real, concrete innovations, because it defines a very precise ethical and legislative framework. If you simply ask engineers to design a more "responsible" solution, they will answer, "But what responsibility are we talking about?" By clearly formulating the principle of justice, we will get fairer, more appropriate solutions.

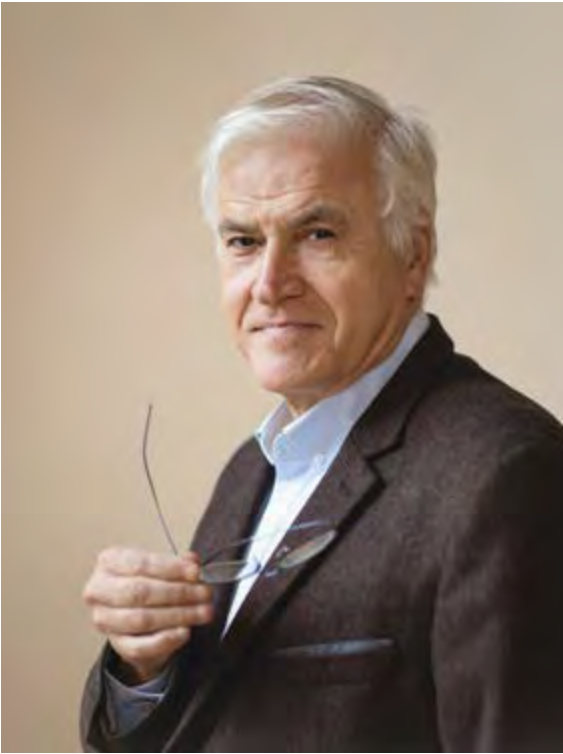
— You mentioned citizens and institutions.

What role can business play in the 2050 challenge?

A.H.: It is an important stakeholder. Provided we start several revolutions.

— Which ones?

A.H.: First of all – and this is a very positive point – one of them is already underway: the "entreprise à mission" status, under which companies redefine their role in relation to the common good, the general interest. This approach opens up many avenues for action, and changes the contribution companies make to society as a whole. Another revolution that is essential in my opinion – and very complex to implement – is the need to move away from shareholder capitalism as it has existed since the 1980s, restructuring the financial world and shifting towards micro-trading, placing a value on shares using algorithms and robots. In this system, the general interest has no place, no common peril can be taken into account. This is a major task, but one that will also sort out the truly committed players from the others.



“We need to encourage the emergence of a body like CERN, the European Organisation for Nuclear Research, but for global warming.”

Armand Hatchuel

DE- GROW+H, GREEN GROW+H OR MODERA- +ION ?

“Once the world is massively producing clean energy, there will be less discussion around our consumption model.”

LAURENCE DAZIANO

Interview LAURENCE DAZIANO

Lecturer in economics at Sciences-Po and member of the scientific council of the Foundation for Political Innovation (Fondapol), established to contribute to the pluralism of thought and the renewal of public debate



— To decarbonise the economy, do we need to change our model and our consumption?

Laurence Daziano: The model to change, at the global level, is that of energy production. Of the 34 million tonnes of CO₂ emitted in 2019, China generated 10 million, the United States 5 million and India 2.5 million. If these three countries do not act, no transition is possible. China has pledged to be carbon neutral only by 2060, but is still building coal-fired power plants. The Indian Prime Minister is aiming for 2070 and the US for 2050. Once the world is massively producing clean energy, there will be less discussion around our consumption model.

— Are protecting the planet and raising our standard of living compatible?

L.D.: Yes, with progress and innovation. Changing lifestyles will lead to increased energy consumption. The solution lies in electricity storage, carbon capture, efficient transport and buildings, etc. The needs in the Global South remain immense. In 2021, one in two Africans were still without electricity. Emerging countries aspire to reach our standard of living. It would be indecent to tell them that they should “live less well to live longer”.

— What are the conditions for a low-carbon future?

— Economists often recommend increasing the price of fossil fuels and carbon products. In France, this policy provoked the gilets jaunes protest movement. What lessons can we learn from this?

L.D.: We should not make the French feel guilty about global warming. We have one of the least carbon-intensive electricity systems in the EU, thanks to nuclear and hydroelectric power. Germany accounts for 25% of greenhouse gas emissions in Europe. We must move towards an ecological taxonomy⁽¹⁾ by encouraging investment in sustainable energy, passive buildings, electric vehicles, etc. Leaders are announcing measures, but there is little change, for domestic political reasons. This hardly encourages companies to invest in the transition.

— What other economic policy tools are available to decarbonise our production systems?

L.D.: The European Union’s “Fit for 55” plan provides for a carbon tax at its borders, with the aim of reducing greenhouse gas emissions by 55% by 2030. I had advocated for this measure back in 2017 in a Fondapol paper. The carbon tax would restore a competitive balance between Europe, where environmental standards are respected, and countries that are not subject to the same standards.

— Who ideally should finance the ecological transition: consumers, the state, investors?

L.D.: The expenditure required for the transition is estimated at US\$7 trillion by 2030. States have financed stimulus packages, but they can only go so far. Consumers and companies will pay their share with the taxonomy. For the latter, non-financial ratings are becoming increasingly important. Investors are paying attention to ESG (Environmental, Social and corporate Governance) criteria, which provide quantitative data for waste management, greenhouse gas reductions and environmental risk mitigation. This is a significant step forward.

⁽¹⁾ Control system based on taxation and regulations.

Towards a post-carbon society?

The ecological transition and its contradictions

64%

of French people say they are "ready to spend a little more to have a product of French origin".

67%

of French people expect companies to be concerned about the effects of their actions on the environment.

56%

of French people recognise that they have to change some of their lifestyle choices because of climate change.

73%

of French people think that "consuming better means consuming less".



Opinion

RÉMY OUDGHIRI

Sociologist,
Director of Sociovision (Ifop)

French society entered a new cycle a few years ago. The transition to a more sustainable way of life has become an obvious necessity for most French people. And the health crisis has only increased this awareness. When asked what the most desirable actions for the next decade are, 94% of respondents say environmental protection. In fact, changes in behaviour are occurring rapidly. In 2002, 25% of French people acknowledged that they had to change some of their lifestyle choices because of climate change. Today, that figure is 56%. In many areas (mobility, energy, consumption, etc.), people are coming to terms with the idea that we need to move towards greater moderation: in 2021, 73% think that "consuming better means consuming less".

RESPONSIBLE BEHAVIOUR: THE MAIN OBSTACLES

This change dynamic is hindered by many obstacles. While the battle of ideas has been won, the battle of behaviour is still in its infancy. Today, five types of obstacles that slow down the transition to a more sustainable world have been identified:

- The weight of habits: it is not so easy to change behaviour. Adopting a responsible lifestyle requires effort. Indeed, 35% of French people say: "I often tell myself that I should consume less but, in the end, I still buy as much as ever."
- The price barrier: 64% of French people say they are "prepared to spend a little more to have a product of French origin". However, these products must be available at affordable prices. In reality, only a minority of consumers really have the financial means to consume responsibly.
- Lack of information: despite extensive awareness, the general public still has little knowledge of many issues.

The pollution generated by our use of digital technology, for example. In the "all-digital" age, only one in two French people are aware of the problem.

- The pleasure principle: the attachment to the comfort values inherited from the consumer society runs deep. Indeed, 43% of the French (51% of 15–34 year olds) admit that they often think they don't really need the things they buy. But they buy them anyway.
- The influence of collapse theories. For some years now, "collapsologists" have been repeating over and over again that our civilisation is going to collapse. This is enough to demotivate part of the population. After all, since "everything is doomed", what is the point of engaging in a battle that is already lost?

THE TRANSITION STAKEHOLDERS

How can we overcome these contradictions? This will be the great challenge of the 2020s. Certain categories of stakeholders are expected to play a role. The State, of course, but also companies. Indeed, 67% of the French expect them to be concerned about the effects of their business activity on the environment. This figure has risen sharply since 2015.

In society, several types of people are strongly committed to the transition. First, there are the "utopian reformers". This group tends to be predominantly female, very committed, either through associations or through increased consumer demands, focused on more naturalness and moderation. These people, a mixture of working people and retirees (18% in France in 2021), are trying, through their behaviour, to "reform" society by accelerating the transition. Alongside them, a section of young people, often urban, is also committed. It is this group that has taken part in the climate marches in recent years. But its representatives are sometimes caught between their desire to accelerate the transition and their attachment to consumerism.

The success of the transition will depend on the alliance between companies that play the game and are truly committed to the transition, committed consumers who change their behaviour, and young people who gradually take over the reins and become more powerful.

Data source: Sociovision, Observatoire France 2021.

About Observatoire France

Sociovision has conducted this study every year since 1975 on a sample of 6,000 people, representative of the French population aged between 15 and 74 (based on criteria of age, gender, social class, habitat and region). It examines the lives of French people from all angles: values, lifestyles and consumption patterns, behaviour, mobility, relationship with the media, health, eating habits, etc.

Preparing for change: Role of public debate

“A culture of shared decision-making is needed to prepare French society for the transition.”

SARAH GRAU

Joint interview

DOMINIQUE BOURG

Philosopher



SARAH GRAU

Co-director of the think tank *Décider Ensemble*, which aims to promote a culture of shared decision-making through stakeholder participation, consultation and dialogue



Let's Talk Energies with EDF

In 2018, EDF launched Let's Talk Energies, an internal process for listening and contributing.

Around 20,000 employees were able to define a shared vision of the energy transition and the Group's purpose. In 2021, EDF employees then went out to meet citizens throughout France. The aim was to gather their expectations of EDF and electricity in the context of climate change. The 3,000 interviews provided input for the "EDF of the Future Notebook" and the Group's commitments, which were made public at the end of 2021.

◆ What are the conditions for a low-carbon future?

— Carbon neutrality is one of the objectives in the fight against climate change. Are the French ready for such a change?

Sarah Grau: The French are aware that efforts must be made, but they have not yet realised that it is our social model that must be transformed.

Dominique Bourg: They are even less ready because we talk to them about technological solutions, whereas we should be focusing on consumption patterns and behaviour. The underlying issues are enormous, and we are a long way from solving them.

— Both of you believe that our democratic systems need to evolve in order to actively choose rather than to passively accept, can you tell us how?

D.B.: When we talk about climate, everyone thinks about the average temperature increases that the IPCC talks about. But what interests us and makes us understand what climate change means are the extreme events. Recently, two regions of the world, one in Pakistan and the other in the Persian Gulf, experienced a level of humid heat that would make such regions uninhabitable (because it is impossible for the body to evacuate heat by sweating). Not to mention hurricanes, mega-fires, etc. It is no longer a matter of choosing or just accepting. We have to stop thinking that we are talking about the future. Climate change is happening now, and it will be worse tomorrow.

S.G.: I am just as pessimistic. The question today is how to prepare French society. The solution is to develop a culture of shared decision-making, starting by improving education in democracy. Especially since there are many structures allowing for participatory democracy, even if they are a bit confusing.

D.B.: The changes that are coming do indeed presuppose informed citizens. But social networks can be a disaster for people who allow themselves to be trapped in bubbles of disinformation. In the United States, 16% of the population thinks the Earth is flat.

— How can trust between citizens and their institutions be restored? And, in turn, how can they each show that they can be trusted?

S.G.: Citizens need to be brought into the law-making process. Decision-makers also need to understand that trusting citizens is in their interest.

D.B.: This idea is very close to what we put forward in 2011 with the creation of a third chamber, alongside the National Assembly and the Senate in France. The problem is not to abolish representative democracy but to enrich it with deliberative democracy. The zadistes (environmental militants) think they are alone in the world; others dream of a green dictatorship... But the rule is consensus about observations and major directions.

— Isn't the follow-up to the citizens' climate convention a counter-example?

D.B.: The case was well made but the legal framework was missing. Popular deliberation cannot be left to an act of government alone.

S.G.: When such an approach is put in place, the rules must be well thought out. When they are badly thought out, the consequences can be catastrophic. This is what happened with the climate convention, even though the participants were incredibly committed. We have a problem with the link between representative and participatory democracy, and we need to find the right path. ◆

The need for time

Continuously improve practices in preparation for the transition.

Interview GUY SIDOS

CEO of French cement group Vicat
(almost 10,000 employees
and revenue of nearly €3 billion).
Active in 12 countries,
the company is highly committed
to decarbonisation



— You are the head of a large cement group, what are the main steps your company is taking to reduce its carbon footprint?

Guy Sidos: Cement manufacturing emits CO₂ on two levels. Firstly, energy is needed to run the plants. Secondly, the process uses limestone, from which the carbon has to be extracted, releasing it. We have acted on both counts. Upstream, we are massively substituting alternative fuels (such as biomass) for fossil fuels. Downstream, for example, we are replacing limestone with a type of clay, and we are working on CO₂ capture technologies. We are constantly improving our practices.

— Why did you decide to do this and when did you start?

G.S.: We started this transition about 30 years ago. It is guided by our awareness of ecological issues and by world demography. Population growth is expected to be very strong, and the need for cement will be colossal. To be efficient, our business requires cement plants close to where people live. The right investments must be made now.

— What impact do you see your decisions having on the environment?

G.S.: In France, we are already approaching 100% clean energy to power our sites. Vicat's carbon emissions have fallen by 15% in 30 years. This trend will be amplified through investments. For example, we are developing an integrated solution for capturing CO₂ and producing synthetic, carbon-free methanol in partnership with Hynamics, an EDF subsidiary specialising

in hydrogen production. In the long term, this will prevent the release of half a million tonnes of CO₂ a year. It should be noted that the cement sector as a whole accounts for 1.8% of France's carbon footprint, compared with 5–7% worldwide.

— Can the company measure a return on these ecological investments?

G.S.: We anticipate a strong increase in demand for low-carbon products. Selling our products is the main economic and ecological challenge. Our approach is proactive: we will soon be offering revolutionary solutions. In the future, we can have nuclear power plants made of low-carbon concrete.

— What needs to be done at the industrial level to further decarbonise the economy?

G.S.: The consultation on ecology must be more open to industry. We are not involved enough in the major decisions. Furthermore, I am a great believer in partnerships between companies, research and public authorities. We can never succeed alone. —

“In France, we are already approaching 100% clean energy to power our sites.”



Interview

“The issue of energy mix is crucial, but reducing energy consumption remains a determining factor in making progress towards the 2050 target.”

Veronica Bermudez

Photovoltaic systems expert,
Senior Research Director,
Energy Centre, Qatar Environment
and Energy Research Institute

Increasing renewable energy, intensifying electrification, investing massively to promote the transition of industrial sites... The solutions for fighting global warming seem to be common knowledge, to the point of becoming slogans that sometimes lose their true meaning. Veronica Bermudez, an expert in photovoltaic systems and Senior Research Director, Energy Centre, Qatar Environment and Energy Research Institute (QEERI), calls for nuanced approaches in order to develop realistic and effective responses.

— Oversimplifying, the solution to global warming is “massive electrification + an increase in renewable energy”. That’s the way to go, isn’t it?

Veronica Bermudez: Once you have stated this basic principle, the difficulties begin. Electrification is decisive, but only if the conditions for its production are under control. Too much of it still comes from burning fossil fuels. CO₂ emissions from the electricity sector must fall by 60% between 2019 and 2030. And let’s not forget that some activities, like heavy industry, steel production or transport, cannot be electrified immediately. So your equation “massive electrification + increase in renewables” is missing an important element.

— What?

V.B.: Carbon capture. Today, there is 150% more CO₂ in the atmosphere than before the industrial revolution of the 19th century and, as I said, some sectors will take a long time to reach zero emissions. It is therefore essential to capture and absorb carbon, whether at source (near the industrial sites concerned) or from the atmosphere.

— These technologies are still very expensive.

V.B.: Some of them are. This is why products should be taxed according to their carbon footprint. Part of the money raised could be used to fund research into low-cost solutions.

— Aren’t we relying too much on technological progress?

The much-vaunted “individual responsibility” that was so widely talked about a few years ago now seems to have stalled.

V.B.: And that’s a shame. We still need to reduce our consumption. In 2010, fossil fuels, commonly referred to as “oil and gas” in many studies, accounted for 80% of overall consumption. Today, this figure is the same. Renewables have progressed in the meantime. But we have never emitted so much CO₂ as today. The conclusion is obvious: consumption has increased. Reducing energy consumption therefore remains absolutely crucial if we are progress towards the 2050 target.

— The energy mix is also one of the key elements. Is there an ideal mix?

V.B.: No, and for a good reason: while the issue is global, the mix depends on the local situation. Natural resources vary from country to country. In Qatar, for example, wind is scarce but sunlight is abundant. The government is therefore playing the solar energy card. However, the much larger neighbouring country, Saudi Arabia, has a strong wind in the north and high temperatures in the south. It can therefore move towards a mix of wind and solar power.

It is clear that generalising this solution for the entire region would not make sense. The quality of the network is also a factor. France, for example, has good natural resources and a very reliable grid. It is therefore possible to introduce renewable energy gradually without destabilising the country. The challenge will be to maintain and modernise the nuclear infrastructure, and to pass on know-how and skills. There is therefore no miracle mix, each country must find its own way to achieve the same objective.

— All the scenarios have one thing in common: renewables must be given a major boost. How can this be achieved?

V.B.: The challenge is considerable: the share of renewable energy must be doubled. Sometimes more for energies such as solar or wind power, which must increase from 10% to 60%, with hydroelectricity being more advanced. Only a combination of vision and investment can radically change the situation. For example, the production capacity of photovoltaic panels must be improved. A classic model today produces 20 kW; we need to reach 30 kW. This requires research, innovation, and perhaps even a shift to relocating component production to Europe.

— So, above all, it requires political will.

V.B.: Exactly. Today, economic reality is taking precedence over long-term vision. In order to protect jobs in certain sectors and maintain social peace, investment continues in fuel oil and coal. This approach is understandable, but only to a certain extent: not acting now will cost much more in the long term, both socially and economically. It takes time to initiate such major changes, and we are already behind the 2050 target.



“Not acting now
will cost much more
in the long term,
both socially and
economically.”

Veronica Bermudez

Consume less and better:

ELECTRIFICATION AT THE CENTER OF THE EQUATION

Already highly decarbonised in France, electricity has a major role to play in our transition to decarbonised energy. In three sectors, which account for 85%⁽¹⁾ of the country's CO₂ emissions, the electrification of end uses has already begun.

TRANSPORT

Fossil fuels are used 91%⁽²⁾ of the time to transport people and goods. If rapid and massive electrification is a priority – a target of 94%⁽²⁾ of cars and 21%⁽²⁾ of trucks by 2050 – it is because it will have a mechanical effect on reducing energy consumption. Electric cars are 90% efficient, compared with 25–35%⁽²⁾ for internal combustion models. EDF has been involved in the electrification of light vehicles for four years through its Electric Mobility Plan. In France, the Group has already Installed 20,000 charging stations and, with smart charging, is paving the way for electromobility to contribute to demand management and balancing the electricity system.

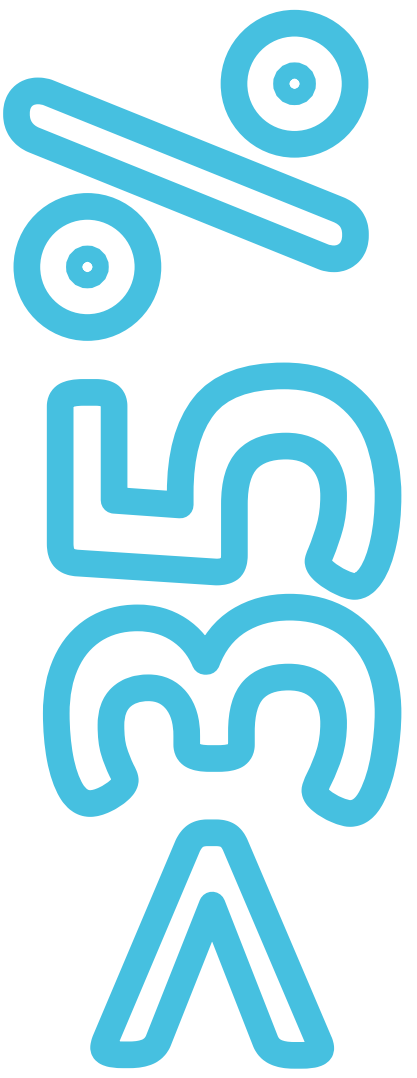
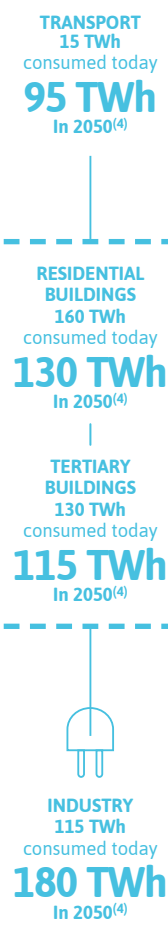
BUILDINGS

In buildings that cannot be connected to a collective renewable heat network, the heat pump will shift the need for heat – but also for air conditioning – to low carbon. Compared with an oil or gas boiler, this thermodynamic electrical system emits up to nine and seven times less CO₂ respectively⁽³⁾. It also consumes three times less energy. Within the EDF Group, heat pump development is backed by the installation and maintenance subsidiary IZI confort and by IZI by EDF, the service platform for private individuals and small businesses, which had tripled its sales of air-to-water heat pumps by 2021. The electrification of new end uses in the residential and tertiary sectors will be partially offset by the energy savings achieved through thermal renovation and more efficient equipment (lighting, household appliances, etc.).

INDUSTRY

With 75%⁽¹⁾ of its CO₂ emissions linked to the need for high-temperature heat for its processes, and the rest from non-energy fossil uses, industry is the most complex sector to decarbonise. Energy efficiency, mainly through heat recovery, is the first important step in this decarbonisation process. Furthermore, electrical equipment for the provision of thermal solutions has now reach maturity.

These include high-temperature heat pumps, mechanical steam compression, and furnaces (induction, resistance and electric arc). Dalkia, EDF Group's energy services subsidiary, is currently installing new HV heat pump technology at five of its industrial customers' premises. It takes the waste energy in the liquid effluent discharged at the sites and releases it in the form of heat at 140 °C.



(1) EDF stakeholder paper, February 2022, published as part of the voluntary public consultation launched by the Ministry of Ecological Transition to contribute to work on developing the future French strategy on energy and climate. (2) RTE's "Energy Futures 2050" report, October 2021. (3) Source: Cham (EDF). (4) SNBC figures. Introduced by the Law on Energy Transition for Green Growth (LTECV), France's Low Carbon Strategy (SNBC) is the country's roadmap for fighting climate change. It provides guidelines for implementing the transition to a low-carbon, circular and sustainable economy in all business sectors. It sets out a trajectory for reducing greenhouse gas emissions through to 2050.



“As we know, we need to consume less energy and consume better. Better means giving priority to the consumption of energy that does not emit CO₂. Electricity must play a central role in this transition because it is both a source of energy efficiency and a source of decarbonisation, thanks to the interrelation between nuclear power and renewable energy.”

Catherine Bauby, Director of Strategy, EDF Group



0 TWh
consumed today
50–170 TWh
in 2050⁽²⁾

EDF hydrogen plan

On 13 April 2022, EDF announced its aim to develop 3 GW of gross electrolytic hydrogen production worldwide by 2030. The aim of this new industrial plan is for EDF to become one of the European leaders in 100% low-carbon hydrogen production. To do this, hydrogen will be produced exclusively by electrolysis, using low-carbon electricity to split water molecules (H₂O) into hydrogen (H₂) and oxygen (O₂). The stakes are high: the aim is to deeply decarbonise end uses for which there are few or no technically or economically viable alternatives, mainly in industry and heavy transport. In industry, low-carbon hydrogen will replace the fossil hydrogen currently used as a raw material in the chemical industry (production of ammonia and methanol) and in refining; it will also allow the decarbonisation of the steel industry. In transport, in addition to its direct use in certain applications (trains in non-electrified areas, trucks, etc.), hydrogen will be used mainly to produce synthetic fuels (or e-fuels) for maritime transport (e-methanol or e-ammonia) and air transport (e-kerosene). The production of some of these e-fuels (e-methanol and e-kerosene) is achieved through carbon capture and utilisation (CCU), by combining hydrogen and CO₂, which in turn also contributes to reducing the industrial process emissions from which the CO₂ is recovered (e.g. a cement plant). Hynamics, a Group subsidiary created in 2019 to provide low-carbon electrolytic hydrogen, commissioned its first electrolyser for local mobility in Auxerre at the end of 2021 and is currently developing a number of industrial-scale projects (ammonia, refining, e-methanol, etc.), illustrating how the Group is upscaling to match its goals.

Develop LOW-CARBON ENERGY and improve ENERGY EFFICIENCY

“Each era faces its own challenges, and each challenge has its own energy. Yesterday, we had the illusion of abundance, an almost unlimited abundance of energy. Tomorrow, thanks to electricity, we will provide everyone with carbon-neutral energy.”

Jean-Bernard Lévy, Chairman and CEO

Moving away from fossil fuels will mean that by 2050 France will have an energy mix made up of both low-carbon electricity and other forms of decarbonised energy (renewable heat, decarbonised gases). Managing our consumption will allow further decarbonisation. Spotlight on EDF's action to help consume better and less.

Dalkia is building a low-temperature water loop network for the **city of Sète**, France, 73% of which is supplied by the Mediterranean. By 2023, it will meet the heating, air conditioning and domestic hot water needs of buildings with a floor area of 370,000 square metres.

Dalkia will create a heating and cooling network for the **Futuroscope** theme park, France, that will draw heat from groundwater and will itself be powered by 'solar photovoltaic' electricity. Futuroscope is aiming for 70% self-consumption of energy by 2025.

Dalkia is developing a tool for managing station operations and maintenance for **SNCF Gares & Connexions**, France. Between now and 2023, the EDF subsidiary will create digital twins of 122 stations, a world first, with the aim of creating a BIM (building information modelling) platform used to manage and optimise technical service operations in 60% of France's 3,000 stations.

Renewable heat: exploit local resources

Decarbonising thermal production (heating, domestic hot water) is a major challenge. Respectively, they account for 80%⁽¹⁾ and 60%⁽¹⁾ of the final energy consumed by households and tertiary buildings. Along with renewable gas and heat pumps, the use of heat networks in densely populated areas is a choice that is all the more virtuous in that it is a collective facility using locally available renewable or recovered energy: networks of the **low-temperature water loop** type that use heat energy from rivers, lakes, seas and wastewater; but also biomass, geothermal energy or the recovery of waste heat. In Dunkirk, France, for example, the EDF subsidiary used the heat from the blast furnaces at the ArcelorMittal site to create a 40km network in 2020 that now heats the homes of 6,000 residents. Dalkia manages more than 330 district heating and cooling networks – out of the 833⁽²⁾ in France – 57.7% of which use renewable and recovered energy sources. The goal is to reach 65% by 2026.

Stepping up energy efficiency Reducing our consumption through energy efficiency is crucial to achieving carbon neutrality by 2050. The electrification of cars and heating (with heat pumps) and technological progress in equipment will mechanically increase the efficiency of many of our energy uses. But this approach also implies stepping up the pace of the thermal and energy renovation of buildings. EDF Group is making a major contribution to this, both for households, with the IZI by EDF service, and for businesses, local authorities and landlords, through the expertise of its subsidiary Dalkia. Dalkia and its specialised subsidiaries are also heavily involved in energy performance contracts, which guarantee contractual results for customers, and in optimising public lighting. Dalkia Analytics uses **artificial intelligence and blockchain** to cross-reference production and consumption data at around 100 industrial customer sites.

Mitigat

CO₂ EMISSIONS AVOIDED BY EDF CLIENTS

in 2021 as a result of the Group's actions to electrify its subsidiary Dalkia's end uses and energy services⁽³⁾.

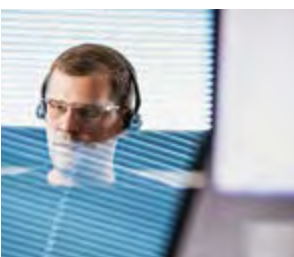
Target: reach 15 Mt/year by 2030



⁽¹⁾ "Transition(s) 2050. Choisir maintenant. Agir pour le climat", Ademe, November 2021.

⁽²⁾ Heating and cooling network observatory.

⁽³⁾ Universal Registration Document 2021.



Interview with

CATHERINE
BAUBY

Director of Strategy, EDF Group

“The challenge is twofold:
on the one hand, to massively
electrify energy uses and,
on the other hand, to continue
the development
of our low-carbon electricity
production facilities.”

Catherine Bauby

— In the global electricity mix, France is unique in that 92% of its electricity is already decarbonised thanks to its mix of nuclear and renewable energy. Has our country already taken the hardest step towards carbon neutrality?

Catherine Bauby: That would be too good! We know how to produce decarbonised electricity using nuclear power and renewable energy (hydro, wind and solar photovoltaic). France is certainly ahead of the game, but the challenge is to maintain that position. Behind the question of tomorrow’s electricity mix, the real challenge in the fight against global warming and achieving carbon neutrality by 2050 is to move away from fossil fuels (oil, coal, gas), which are high emitters of CO₂ and which account for almost two-thirds of our consumption, for transport, heating, and industry.

— There is no real consensus around the projection of electricity demand in 2050, on which public authorities’ decisions are based. RTE is basing its central scenario on 645 TWh, while Ademe is looking at between 410 and 840 TWh depending on the scenario.

C.B.: These projections are based on serious studies, but the baselines for the hypotheses are very different: a higher or lower rate of industry electrification, a more or less rapid growth in the use of hydrogen, more or less advanced energy sobriety, etc. What we must understand is that, in order to achieve carbon neutrality, it is essential to make progress on energy efficiency and also to massively electrify our end uses. This electrification will generate new needs that are greater than the savings generated by energy efficiency. So, electricity consumption will grow significantly. Moreover, the uncertainties about the precise projection of consumption between now and 2050 mean that we must remain responsive in how we define the electricity mix of tomorrow.

— In February 2022, French President Emmanuel Macron announced the construction of six second-generation EPRs, with the first reactor to be commissioned in 2035. Is this new nuclear fleet sufficient to remain “responsive” by 2050?

C.B.: This decision is in line with EDF’s recommendations to maintain a significant nuclear base. Today, we have 61.4 GW of installed nuclear generation. But, in 2050, only 15 GW will not have reached



60 years of operation. The President of the Republic also announced that he was examining the construction of eight additional EPR2s. And he laid down the targets for renewable energies: to increase the capacity of onshore wind farms to 37 GW (18.5 GW today), to develop 40 GW of offshore wind power and to exceed 100 GW of photovoltaic energy. The government is therefore planning to take France towards a mix close to the RTE’s N2 scenario⁽¹⁾ for 2050, i.e. an electricity mix made up of around 40% nuclear power – 40 GW – and around 60% renewable energy – around 200 GW. The question is not so much whether it will ultimately be 40% nuclear or 50%. We don’t need to set this mix today. The important thing is that this nuclear base will allow France to keep some room for manoeuvre, particularly in order to respond to higher than projected electricity consumption.

— What levers would allow EDF to increase nuclear power to 50% of the mix by 2050?

C.B.: Achieving 50% nuclear in the power mix by 2050 requires a nuclear fleet of about 50 GW. This is an industrial challenge, but we have several technical solutions to help us meet it. First of all, it is obvious that we will have to maintain a high pace in the EPR2 construction programme. In addition, the development of several small modular reactors (SMRs, 340 MW) could also contribute to achieving this mix. For example, the construction of a first SMR demonstrator in France by 2030–2035 will show us the economic and industrial viability of this option. Finally, let’s not forget that we are investigating the possibility of continuing to operate the existing units beyond the age of 60. This study involves several EDF teams and is obviously being carried out in consultation with the Nuclear Safety Authority. For example, in the United States, several reactors have already been granted an operating licence for eighty years.

— For the past ten years, France has been developing an average of 2–3 GW per year of new wind and photovoltaic capacity. Achieving 60% of renewable energy in the electricity mix would imply a rate of 6 GW/year. Is this realistic?

C.B.: At present, France is not progressing fast enough, nor is it aligned with the trajectory set by the State in its multi-annual energy programme for the period 2019–2023. The target of 6 GW/year for 30 years is very ambitious. It is important to bear in mind that currently there are obstacles, particularly administrative ones, that need to be removed in order to speed up the installation of renewable energies. For example, for onshore wind power, it takes an average of five to eight years from the call for tenders to commissioning, compared with four years in Germany.



(1) In 2021, in its report “Futures énergétiques 2050”, RTE studied six electricity mix scenarios to take France towards carbon neutrality by 2050.

— What will be EDF's contribution be to the development of renewable generation?

C.B.: We are already making a significant contribution. In terms of installed capacity and development, EDF is the leader in onshore and offshore wind power in France's. With our solar plan, we aim to install 30% of new photovoltaic capacity each year. And let's not forget our hydroelectric plants, which will continue to produce 8% of France's electricity. Along with nuclear power, it will play an essential role in providing some of the flexibility needed to manage the intermittent nature of wind and solar power.

— Production of course, but how can you help customers make the shift to carbon neutrality?

C.B.: There are two main aspects to consider: decarbonisation and energy efficiency. At EDF, we support our customers so that they consume less energy while maintaining the same level of use. To decarbonise transport, we have created the Electric Mobility Plan with the aim of supplying low-carbon electricity to 30% of motorists in our markets. For industry, we are working on solutions for the electrification of industrial processes and on solutions to recover heat from these processes. Finally, in the building sector, we are active in the market for heat pumps, the installation of solar panels, and collective heating networks powered by recovered or renewable energy.

— Two years after being adopted, is the 2019–2023 multi-year energy plan already out of date?

C.B.: Actually, yes, because of the lag in developing renewable energies. The current multi-year energy plan was drawn up in a world that was significantly different from the one we live in today. Since then, the European Union has raised its 2030 target for reducing CO₂ emissions to 55% compared to 1990, up from a 40% reduction when the multi-year energy plan was prepared. And this requires a very marked change in trajectory. We will have to accelerate the electrification of end uses over the 2020–2030 decade compared to what was projected one or two years ago. The best strategy is therefore to maximise the production of low-carbon electricity, in particular by stepping up the development of renewables and by re-examining the trajectory for the closure of existing nuclear units. As part of the consultation on the future French Strategy for Energy and Climate, and the preparation of the next multi-year energy plan, we published our stakeholder paper in mid-February. We are asking for the multi-year energy plan to evolve in order to allow the continued safe operation of the existing nuclear fleet and thus maintain the margins essential to ensuring the success of the energy transition.

“To meet our 2030 decarbonisation targets, we will need to accelerate the electrification of our economy now, and therefore produce much more low-carbon electricity.”

Catherine Bauby

OUR GOAL: Double new wind and solar power generation annually for the next 30 years

Whatever France's electricity mix in 2050, it is crucial to produce more low-carbon electricity now. Creating the conditions for this ramp-up involves collectively taking up three major challenges: accepting wind and solar plants, adapting electricity networks to the intermittency of renewables, and developing new flexibilities to guarantee supply security.

M

At the end of 2021⁽¹⁾,
61.4 GW
 of installed capacity and
59.8 GW
 of renewables capacity
 of which:
25.7 GW of hydro power
18.8 GW of onshore
 wind power and
13.1 GW of solar PV.

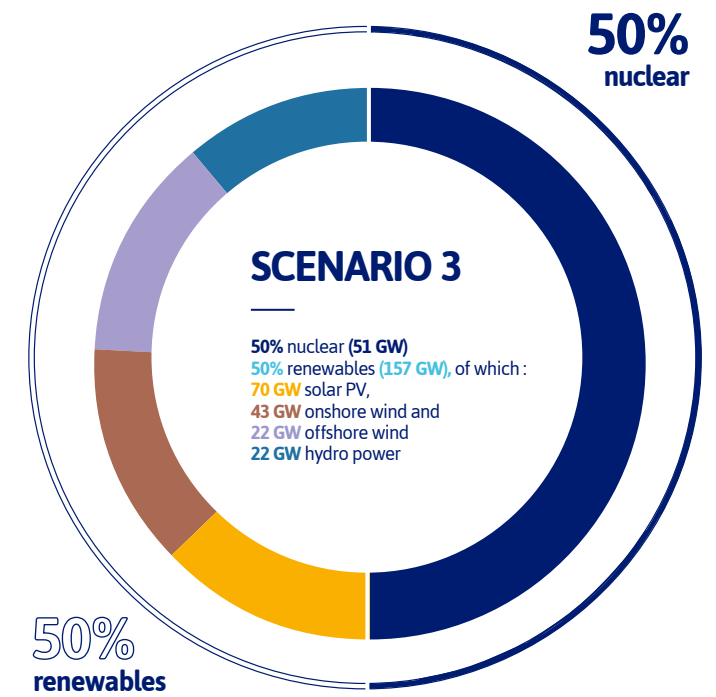
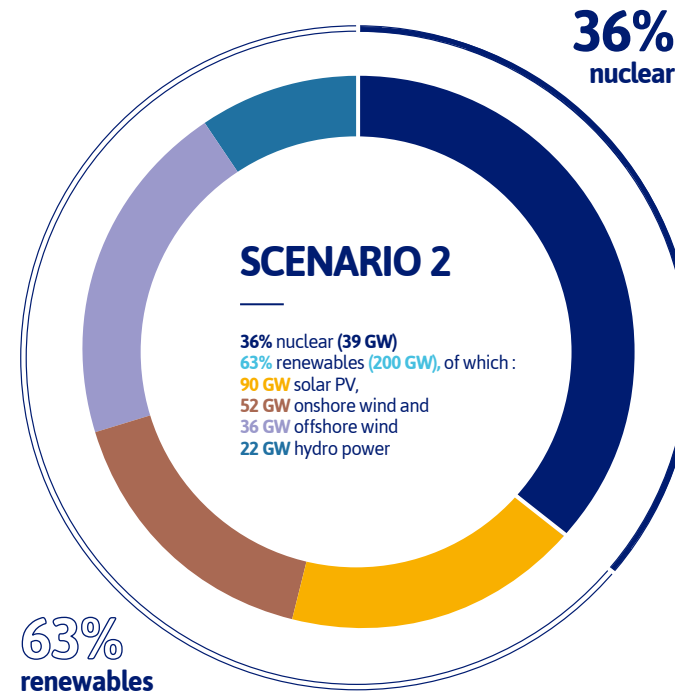
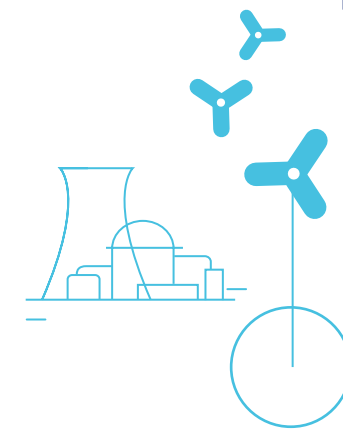
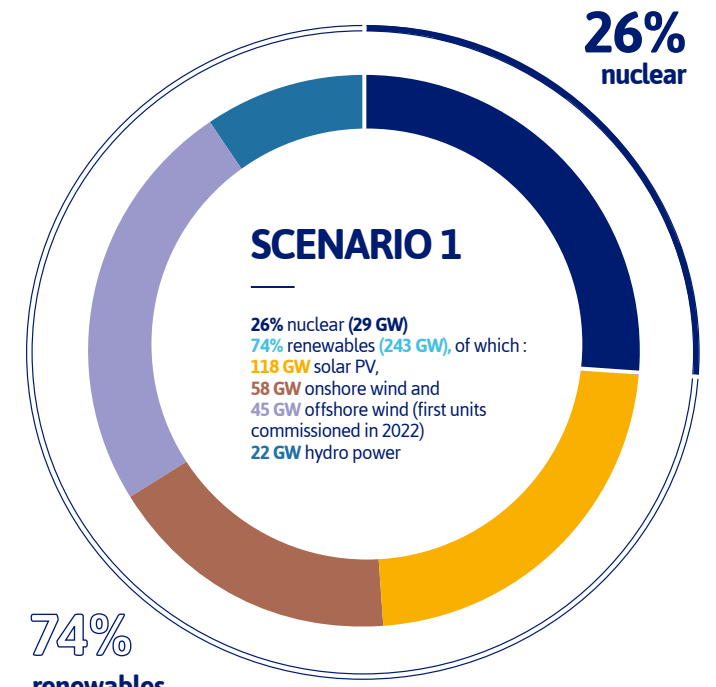
(1) Source: "Bilan électrique 2021",
 RTE, March 2022.

2050 ELECTRIC MIX: 3 POTENTIAL SCENARIOS



◆ With what energy?

At the request of the French government, RTE worked for two years on developing six scenarios for the electricity production mix in 2050 enabling France to achieve carbon neutrality, including three with 100% renewable energy. Published in 2021, this study, entitled "Energy Futures 2050", reviews the technical feasibility of each scenario and details its implications in economic and environmental terms, and for our lifestyles. At this point, **three potential scenarios are being considered.**



Hypotheses for renewables common to all three scenarios: 2 GW of bioenergy, and between 0 and 3 GW of marine energy.



An issue OF ACCEPTANCE

Consultation Renewable energy makes electricity production far more visible across our regions. Onshore wind projects, which can give rise to discussions about their impact on the landscape, and offshore projects, which raise questions about their coexistence with fishing, are subject to appeals, as are all land development projects. Hence the importance of involving a panel of people that is as representative as possible of the issues at stake, and of informing and continuing the dialogue and consultation process throughout the life of the infrastructure.

Ownership Empowering local residents and citizens to feel a sense of affinity with renewable energy projects and their own decarbonisation targets is a determining factor in speeding up their rollout. Today, many installations use participative financing. And the next multi-year energy plan will encourage the creation of local governance.

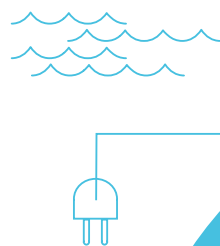
Solutions The development of renewable energy raises the issue of space sharing. Innovation will provide answers to this. Faced with the scarcity of so-called “degraded” sites (industrial wasteland) for installing photovoltaic power plants, agrivoltaics can provide a major opportunity by allowing electricity production with photovoltaic panels and agricultural activity to coexist on the same land area. For offshore wind energy, RTE’s R&D is working on the design of multi-use connection platforms which, in addition to electricity transmission, could accommodate environmental scientific stations, telecommunications infrastructure and even create local industrial tourism. Protecting birds and bats from the risk of collision with wind turbine blades is another issue on which research is progressing, in particular with deterrent systems or wildlife detection systems that automatically stop the rotation.

Windfarm off the shore of Dunkirk: a regional project

EDF Renewables and its partners are the project owners of this offshore wind farm (600 MW), which will produce the equivalent of the annual consumption of nearly one million people. It is expected to be commissioned in 2028 and to operate for thirty years. This project, located in a Natura 2000 area, was the subject of a public debate from September to December 2020. During these three months, a vast system allowed all stakeholders to express their views: nine public meetings, a dedicated website and participative platform, pages on Facebook and Twitter, etc. Following the debate, working groups were set up around five so-called essential topics: “Environment and biodiversity”, “Living environment and tourism”, “Professional fishing and marine culture”, “Regional impact and economy” and “Navigation and maritime safety”. Extensive environmental studies have been carried out. The results will be made public and presented in detail to government departments, academics and associations. Finally, a bird detection radar has been installed in the port of Dunkirk. Consultation continues under the aegis of three guarantors appointed by France’s National Commission for Public Debate. This will allow information work and the collection of contributions about the project to continue through to the public enquiry.

Poutès dam: reconfiguration favourable to biodiversity

The result of 10 years of joint development with environmental protection associations and elected officials, the large-scale redevelopment of the Poutès dam, which supplies water to the Monistrol-d’Allier hydroelectric power plant, was completed at the end of 2021. Lowering the dam – from 17 m to less than 5 m – has given salmon easier access to the spawning grounds located upstream from the structure, which account for 47% of the juvenile production potential of the Allier basin.



EDF R&D experiments with agrivoltaics

Agrivoltaics is the simultaneous use of areas of land for both photovoltaic electricity production and agriculture. Agricultural production and the conservation of arable land must remain a priority over photovoltaic electricity production. By allowing agricultural production and photovoltaic solar energy to coexist, agrivoltaics limits the competition for land between the two. Agrivoltaics could also offer other potential benefits, such as protecting against bad weather and heat waves, and limiting soil evapotranspiration. However, these techniques are still at the experimental stage in France. Under a cooperation between EDF Renewables and the French National Institute for Agricultural, Food and

Environmental Research (INRAE), which is responsible for agronomic monitoring, the teams are testing a demonstrator (115 kWp) at the EDF Lab’s Les Renardières site, France. It has been installed on a 1,700 m² field of alfalfa. The panels, equipped with a tracking system to adjust the shadow cast under the modules, are located 5 metres above the ground to allow space for agricultural machinery. The first results are encouraging. After a very hot and dry summer, the mid-September 2020 harvest produced a yield twelve times higher than that of the neighbouring control field. R&D is also a partner in two other projects on vineyards in the Nouvelle-Aquitaine region.



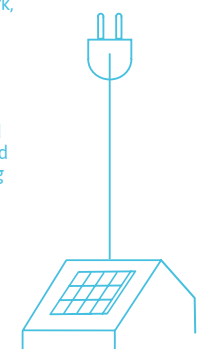
An issue OF NETWORKS

Between strengthening and developing infrastructure, the adaptation of electricity transmission and distribution networks has already begun. The aim is to grow them to accompany the increase in renewable energy production and the electrification of end uses and, therefore, in the long term, to transport more electricity. However, the challenges of ensuring a permanent balance between supply and demand are far more complex than they appear. It will require, among other things, a greater contribution from technology to network operation. Little by little, production, until now centralised and controllable, is becoming diffuse and variable. The electricity system itself is moving from a top-down to a two-way operation, with consumers who are now producers feeding electricity into the network intermittently. In this all-encompassing transformation, the biggest current project is the connection of new production, at a rate that is set to accelerate.

Concept Grid: to simulate and test under actual conditions

With the addition of intermittent generation and new equipment (storage batteries, charging stations for electric vehicles, etc.) into the electricity grid, its operation will change significantly. Simulating its behaviour under actual conditions, but on a reduced scale, is the role of the EDF electricity test network, and more particularly of the Concept Grid platform, installed at the EDF Lab’s Les Renardières R&D site, France. EDF SEI, which manages distribution networks in island or isolated areas, recently used it to secure the commissioning of the new 100% renewable energy microgrid in Saint-Georges de l’Oyapock (population 4,000), in French Guiana in 2021. The arrival of solid biomass production (wood waste) and the installation of a battery –

in addition to the existing hydroelectric power station – will allow a gradual reduction in the use of its diesel power station. Eventually, it will only be used as a back-up. Using the Concept Grid, EDF SEI was able to conduct an accelerated test of the types of incidents likely to occur on this network (short-circuit, cable insulation defects, etc.), and, as a result, to add an appropriate protection system.





An issue OF FLEXIBILITY

In a production mix composed in 2050 of 40%–60% of intermittent wind and solar energy (23% in 2021, representing 10% of the country's annual production), the electricity system will need to incorporate new flexibility. A range of flexible approaches will be needed. The first consists in guaranteeing a base of controllable power plants (nuclear and hydraulic) in France. Between now and 2030, the second approach consists in reinforcing the interconnections between France and its European neighbours in order to import and export electricity. This project, which RTE has been working on for several years, should increase import capacity to 39 GW⁽¹⁾ compared to 13 GW today. In order for this strategy to be coherent, it is necessary for the other European countries to also produce sufficient decarbonised electricity. The third is demand management, i.e., to manage the variability of production on a daily or weekly basis. This will be greatly increased by smart charging electric vehicles, for example during hours of high solar production. Combined with a nuclear and hydraulic base, this new flexibility will also limit the need for electricity storage in batteries.

On the other hand, the significant development of wind and solar power will increase the need for inter-seasonal flexibilities. The solution envisaged is to use decarbonised thermal power stations, which can be brought on stream according to needs. This will require the use of decarbonised gases, such as biogas, or even synthetic gases (e.g. hydrogen) for these plants.

(1) "Futurs énergétiques 2050" report published by RTE, October 2021.

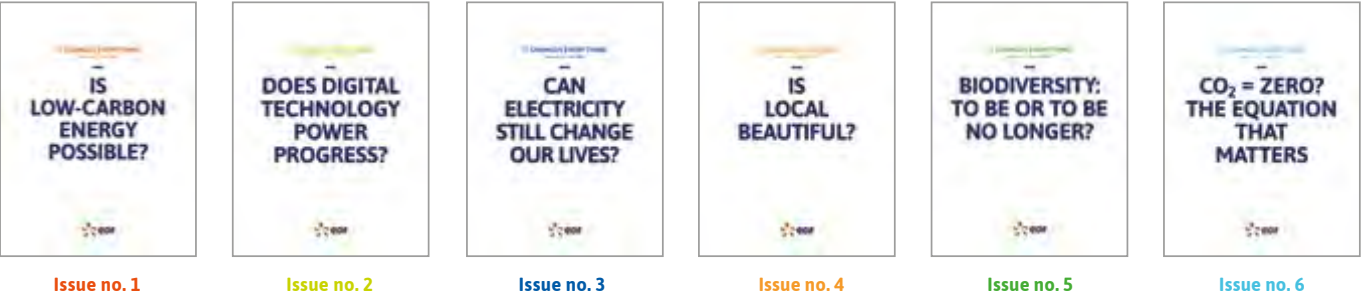


EV batteries as a giant storage facility

Storing excess renewable electricity is not the only advanced feature of smart charging, for which EDF wants to be the European leader. The batteries in electric vehicles will also have the capacity to feed this energy back into the electricity grid – known as “vehicle-to-grid” or V2G – or to power a house or building. Dreev, a joint venture between EDF and NUVVE, has been testing these technologies in real-life situations for three years. From 2022 onwards, they will be tested on a large scale with the European Environmental Valorization of Virtual Electricity (EVVE) storage project, for which Dreev is the lead partner: 800 V2G charging stations will be installed in several countries, with a controlled battery capacity of 8.36 MW. Dreev's aim is to control the charging and discharging of a hundred or so electric vehicles on its platform, which enables it to optimise flows in real time on the basis of the state of vehicle charge, user needs, electricity tariffs and the state of the electricity grid.

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Change pace together to achieve carbon neutrality

"Climate is not just about climate. It is about the overall resilience of our societies," says Valérie Masson-Delmotte, paleoclimatologist and co-chair of IPCC Group 1. Carbon neutrality is now a goal that cuts across all levels of society: citizens, local authorities, companies and political leaders are all committing to speeding up the transition to a low-carbon society.

P. 04

What are the conditions for a low-carbon future?

"The 'polluter pays' rationale is inappropriate for climate issues. Thinking about the idea of justice is absolutely essential." Faced with the urgency of the situation, Armand Hatchuel, professor and researcher in management sciences and design theory at Mines ParisTech, urges us to look for solutions that will enable us to overcome our contradictions and reconcile progress and energy sobriety.

P. 22

A CO₂-neutral world by 2050: with which energies?

"The issue of energy mix is crucial, but reducing energy consumption remains a determining factor in making progress towards the 2050 target," confirms Veronica Bermudez, Director of the QEERI Energy Centre. Everywhere at EDF, work is underway to decarbonise end uses and improve energy efficiency, with the aim of consuming less and better and helping customers and regions to become carbon neutral.

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