ENERGY CHALLENGES IN THE POST HEALTH CRISIS PERIOD

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ABSTRACT

The health crisis that the world is experiencing with the Covid-19 virus has not really created new challenges; it has made those we were facing stronger, as it has made us more aware of the need to protect our environment. All countries are seeking to organise an energy transition to a low-carbon society, but not all have the same ambitions, the same constraints or the same means to achieve it. Several challenges need to be addressed.

Keywords: Energy transition; Climate change; Inovations; Technologies; Renewables.

RESUMO

A crise de saúde que o mundo está enfrentando com o vírus Covid-19 não criou realmente novos desafios; fortaleceu aqueles que enfrentamos e nos tornou mais conscientes da necessidade de proteger o meio ambiente. Todos os países estão procurando organizar uma transição energética para uma sociedade de baixo carbono, mas nem todos têm as mesmas ambições, as mesmas restrições ou os mesmos meios para alcançá-la. Vários desafios precisam ser enfrentados.

Palavras-chave: Transição energética, Mudanças climáticas, Inovações, Tecnologias, Renováveis.

1. GIVING A VALUE, AND THEREFORE A PRICE, TO THE CLIMATE

The health crisis has caused global greenhouse gas emissions to fall by 6 to 7% in 2020. This would have to happen every year for 30 years if global warming is to stabilise at around 1.5°C by the end of the century, which seems unrealistic. Failing to reduce global emissions, many countries are announcing that they want to become carbon neutral by 2050. The stock of carbon emitted would stabilise by that date either because emissions would no longer increase or because new emissions would be captured and stored. Sustainable economic decline is not the answer because economic growth is needed to finance innovation to improve energy efficiency and develop new technologies.

Faced with global warming, two attitudes are possible simultaneously: reducing greenhouse gas emissions and adapting to the consequences of global warming. In both cases, this is costly. If the climate is a *common good*, it has a value and it must be given a price. We must also fight against free riding strategies, which consist of some people doing nothing and relying on others to make the effort. Putting a price on the climate requires accounting for negative externalities in the price of goods and services consumed. Several means are possible: setting emission standards not to be exceeded, introducing a carbon tax or using a carbon market. A carbon tax is probably the most effective means and many countries around the world have already adopted it. It is necessary to tax the carbon directly emitted in the production, transport and consumption of goods, but also to take into account the carbon emitted indirectly via raw materials and imported products, which requires a life-cycle analysis of the products. Many industrialised countries have relocated polluting activities to developing or emerging countries (such as China), which also means relocating carbon emissions.

But in parallel with the taxation of environmental externalities, direct and indirect subsidies to polluting fossil fuels must be stopped. The International Energy Agency (IEA) estimates that the subsidies paid to fossil fuels amounted to 318 billion dollars in 2019 on a global scale, i.e. about 15% of the price paid by the end consumer. These subsidies concern oil products, i.e. fuels (47% of total subsidies), fossil fuels used for electricity production (36%) and also final gas consumption (17%). It is true that these subsidies have been in decline over the last ten years (it was $506 billion in 2012), but it must be taken into account that the price of oil has fallen over the period (GOULD, 2020). Removing or at least reducing the subsidies granted to fossil fuels is therefore a priority for public policy.

If we want to take into account externalities and evaluate the full costs of fossil fuels, we would also have to take into account the costs linked to carbon emissions and subsidies would then be estimated according to the International Monetary Fund (IMF) at nearly 5,000 billion dollars worldwide (4,700 in 2015 and 5,200 in 2017). These are hidden costs that are not borne by the consumers of these products but by the community. Unsurprisingly, coal comes first with 44% of the hidden subsidies, ahead of oil (41%), gas (10%) and electricity (5%). Fossil energies used as fuel in the production of electricity are accounted for here with each fossil energy; the subsidies granted toelectricity therefore concern externalities associated with hydropower, biomass or other forms of electricity. The main countries concerned are, in decreasing order, China, the United States, Russia, the European Union and India (COADY, 2019).

Implementing a policy of true prices therefore consists as much in abolishing subsidies for fossil fuels as in making people pay for the externalities that these energies generate. This requires a profound change in consumer behaviour and the implementation of more efficient technologies. The health crisis has changed certain behaviours: less air travel, greater use of teleworking, development of local shops. The question is whether or not these changes will be reversible. The health crisis must not be just a bad memory that generates amnesia. It must serve as an indicator and an incentive for reform.

2. REPLACE CARBON-BASED ENERGIES WITH DECARBONATED ENERGIES

It is not enough to add decarbonated energies to carbon-based energies to achieve carbon neutrality. The former must be substituted for the latter. But it is not easy for countries with significant coal or hydrocarbon resources to give up exploiting these resources, which are often the main domestic source of energy and the main source of foreign exchange for exports, especially since many oil and gas exporting countries are developing countries that need foreign exchange to modernise. Can India move away from coal to generate electricity? Can Saudi Arabia give up oil as a source of foreign exchange, at least in the medium term?

The announcement made by many hydrocarbon importing countries that they wish in the long term to reduce their oil purchases may have a perverse effect. It is the *green paradox*. Exporting countries that anticipate a drop in oil demand tomorrow may be encouraged to produce more today to turn their stock into cash. This can bring down the price of oil today, thus boosting demand via a *rebound effect*, because for these exporting countries it is better to sell today at a low price an oil that cannot be sold tomorrow for lack of demand. Transforming a stock of oil in the ground into a monetary stock corresponds to the inter-temporal optimum described by Harold Hotelling.

We can also see that certain large oil companies have already begun to exit the oil market and are seeking to diversify into new energies where they will compete more and more with the electricity companies. Such is the case, for example, of the French oil company Total, which has changed its name to TotalEnergies and intends to compete with EDF (Electricité de France) in renewables. Because of the development of electric mobility and the eventual disappearance of the thermal vehicle using petroleum products, oil companies are encouraged to invest in the production or at least the supply of electricity in the same way as the GAFAMs (Google, Apple, Facebook, Amazom, Microsoft).

The growing weight of connected objects is encouraging digital companies to also start supplying electricity.

It has been observed, moreover, that over the last ten years, global investments in the energy transition have been on the increase while those linked to the exploration and production of hydrocarbons have been falling steadily. In 2010, investments in renewable energy amounted to $235 billion worldwide, and they exceeded $500 billion in 2020. In 2014 investment in oil exploration peaked at $880 billion but has been declining steadily since then. It was still at $540 billion in 2019 but has not exceeded $380 billion globally in 2020 (IFPEN, 2020). The market capitalisation of the GAFAMs is reaching record highs while that of the oil companies is falling. Some power companies with a strong presence in renewable energy have a stock market value that sometimes exceeds that of the oil multinationals (NextEra Energy for instance). Mergers and acquisitions in the energy world are therefore expected to take place. Oil and digital companies will probably be encouraged to take control of certain electricity companies because for these companies “energy transition” is synonymous with energy diversification. Their core business is changing.

3. ENSURING INCREASING FLEXIBILITY OF THE ELECTRICAL SYSTEM

The massive development of renewable energies will significantly modify the functioning of the electricity sector, in particular that of the wholesale electricity market. There are two types of power plants: the so-called “controllable” power plants which follow the evolution of electricity demand in real time, and the so-called “non-controllable” power plants which produce electricity when there is sun, wind or water in the river, independently of the evolution of demand. Only nuclear power plants, biomass power plants and dams can be considered carbon-free controllable plants. Other controllable power plants (gas, oil or coal-fired) are not decarbonised. Wind and solar power plants are decarbonised but not controllable. In the latter case it is necessary either to adjust the demand for electricity to the supply, using digital applications that allow demand to be erased at certain times, or to store and release electricity.

Electricity can be stored in a number of ways: batteries, hydraulic pumping stations, power-to-gas. Hydrogen is produced by electrolysis of water during off-peak hours when there is excess electricity production and stored to convert it into electricity when demand requires it. All of these systems are still expensive today, but their cost is expected to fall.

In countries where there is a wholesale electricity market as a result of the liberalisation of the electricity sector, power plants are called up not on the basis of the average cost per MWh but on the basis of the marginal cost per MWh. Calling up is done on the basis of variables costs, i.e. mainly on the basis of fuel costs. This is the logic of the *merit order*, which consists in calling first solar and wind power plants or run-of-river hydropower plants, whose marginal cost is zero, then nuclear power plants, whose marginal cost is low, and finally coal and gas power plants. Sub-marginal power plants recover their fixed costs at peak times when electricity prices are high. But some plants are not present on the market at peak hours and the price per MWh is often insufficient to recover fixed costs. It was therefore necessary to introduce a so-called *capacity market* to finance investments.

The merit order can be modified by taking into account the full cost, i.e. by introducing the externalities linked to the production of the MWh, hour by hour. In the case of fossil fuels, this is already the case when there is a carbon price as in Europe (around 40 euros per tonne of CO_2 in February 2021). For nuclear power, the cost of radioactive waste storage should be taken into account since the volume of waste is proportional to the volume of electricity produced. In the case of renewables, the cost of storage and retrieval of MWh should be taken into account (GRAHAM, 2018; PERCEBOIS, 2019). This would allow the calculation of pivot values on the basis of which the substitution between power plants is made. If the cost of storing renewable electricity is high, a high carbon price is needed for renewables to be called before gas or coal-fired power plants, especially if at the same time the price of gas is low. If the carbon price is high, gas-fired plants will be called before coal-fired plants, even at low coal prices, given the high carbon intensity of the MWh produced from coal.

The search for greater flexibility also involves strengthening electricity transmission and distribution networks. It will be necessary to connect low-powered solar or wind power installations scattered throughout the territory and also to strengthen transnational interconnections. Increasing the weight of intermittent renewables in the electricity mix requires exporting part of its excess electricity when production is high due to sunshine or wind and requires importing more electricity from neighbouring countries during periods of low sunshine or when wind production is insufficient.

The decline in the carbon content of the kWh observed in almost all European countries has been accompanied by a growing dependence on imports, although the profiles are contrasting. This reflects greater exchanges of electricity, partly due to growing interconnections linked to market liberalisation and partly due to the development of intermittent renewables, which require more interdependence due to their fatal nature. It must be possible to export the overflow and import when necessary depending on the availability of wind and sun, or even hydropower.

The European Union as a whole also depends more and more on trade with other non-EU countries (Norway, Switzerland but also some Central and Eastern European countries including Ukraine). Electricity imports from countries bordering the European Union have increased last ten years and are mainly carbon-based electricity, which deteriorates the Union's carbon balance. These imports now come mainly from Russia (to the Baltic countries) but also from Ukraine and other Balkan countries (Albania, Bosnia, Kosovo, Northern Macedonia, Montenegro and Serbia).

The price to be paid for a reduction in carbon intensity through the development of renewables in almost all European countries is a greater dependence on other countries. This is due to the intermittent nature of renewables, which requires being able to rely on neighbouring countries to manage the balance between electricity supply and demand, at least as long as significant storage capacity is not available. This dependence is also a consequence of the liberalisation of electricity markets, as increasing electricity interconnection should lead to some convergence of electricity prices between EU countries. This has been a reality for wholesale electricity prices on the spot market, but this is far from being the case for the all-inclusive electricity prices paid by final consumers due to the wide disparities in taxation.

The question is to what extent the share of non-pilot renewable sources can be increased, as the expansion of consumption remains limited on the European copper plate at least until a competitive and large-scale storage technology is available.

4. CONCERN ABOUT DEPENDENCE ON STRATEGIC MINERALS

The concern of oil and gas importing countries has always been to secure their supplies through long-term agreements with their suppliers and diversification of geographical sources. Their main suppliers have been located in the politically unstable Middle East, which explains the concerns. This dependence has been reduced with the decline in the weight of oil in the energy balance, the discovery of oil in many more politically stable regions of the world and the development of shale oil, particularly in the United States. The energy transition to renewable energies risks replacing this dependence with another dependence, that on strategic metals and rare earths. Reserves of lithium, a strategic raw material for the manufacture of batteries, are found mainly in Bolivia, Chile, Argentina, China and Australia. Those of cobalt, a mineral used in the manufacture of batteries, are largely located in Congo. Rare earths, needed in the manufacture of magnets used in electric motors, are now largely produced in China, although reserves are fairly well distributed around the world. Of the top ten companies producing batteries, seven are in China, two in Korea and one in Japan. China's strategy of dumping has largely destroyed the nascent solar industry in

Europe. The European Union now imports almost all the photovoltaic cells it uses, mainly from China.

The search for a certain national sovereignty now involves relocating, in each of the countries, certain industrial activities that had been located abroad. Europe's dependence on China during the health crisis with regard to pharmaceutical products serves as a bit of a lesson. The countries that seem to be resisting the health crisis best are those with a strong industrial base. The risk is the rise of nationalism and inward-looking attitudes that would jeopardise the development of international trade. The strategic nature of certain energy equipment is no longer in doubt and everyone understands that the recovery of sovereignty requires local production of this equipment.

Rare metals (lead, zinc, copper, nickel, tungsten, but above all cobalt, lithium and palladium) and "rare earths" (17 metallic elements such as lanthanum, cerium or neodymium) are indispensable to the energy transition and the digital revolution, but the problem is that of the concentration of resources and reserves and especially today that of the concentration of production. China alone controls nearly 90% of the production of rare earths. The risk of dependence should not be underestimated, even if the search for new deposits, the recycling of these metals and the development of substitutes are credible solutions in the long term. It is in any case a subject that deserves attention as it is a potential vulnerability factor for some companies and states. Thus the geographical centre of gravity of resource dependence is slowly shifting from the Middle East to Asia (China) and perhaps also Latin America (Chile, Brazil, Argentina). Will the "war of rare metals" replace the war for oil? This is unlikely on a large scale because the stakes are not the same, but the question should not be totally avoided.

5. INVESTING IN RESEARCH AND ADDRESSING INEQUALITIES

It is difficult to anticipate what the world energy balance will be like by 2050 and even more so by 2100. What we do know is that it will be different from what it is today and probably different from what we think it will be at that horizon. What will be the role of hydrogen? We are talking about decarbonated hydrogen, produced from renewable or nuclear sources. Will hydrogen have replaced electricity as a vector, especially for mobility? What will be the role of nuclear power, in particular that of SMR (Small Modular Reactors) and Generation IV? Will nuclear fusion be operational? Will electricity be transported through large interconnected networks linking China to Europe (the famous "electric silk roads") and using ultra-high voltage, or only in small local networks linking multiple self-producers? Or both at the same time? Quantum technologies represent a major digital shift that can completely overturn the energy sector.

It is today's efforts in academic and applied research that will shape the energy future. These efforts should also make it possible to find solutions for access to electricity for populations that, especially in Africa, still lack it. When we talk about access to electricity, we generally think of interconnection to a network. This is the dominant model that was historically observed in industrialised countries and is also observed today in Asia and Latin America. However, technical progress linked to new digital technologies and the drop in costs observed in the field of renewable energies (solar, wind) now make it possible to envisage electrification based on two coexisting models: that of the "star" and that of the "leopard's spots". In the first case, it is the public sector that develops the network by gradually connecting rural areas from a power plant (often hydraulic but which can be a gas or coal-fired plant), generally installed in or near an urban centre. In the second case, it is the rural consumers themselves who invest in small-scale equipment using photovoltaic panels. All that is then needed is a battery to store some of this electricity. It is the gradual interconnection of these small networks that will eventually lead to the creation of a national grid.

It is not only people in developing countries who have difficulty accessing energy. Poor people in industrialised countries are often in an *energy poverty* situation. The "energy" budget for heating, lighting and mobility is often very high. These populations must also have access to new technologies, particularly in the field of electric (or hydrogen) mobility. The switch to electric vehicles is irremediable and will probably happen fairly quickly once the proportion of those who have made this choice has exceeded a certain threshold (which is difficult to determine, however). The modest and precarious populations must not remain outside this evolution. More generally, we should not add a "clean mobility" divide to the two other divides that are already a reality: the social divide and the digital divide. The poor risk being the main victims of the health crisis. They must not also be the victims of the economic rebound.

6. CONCLUSION

"Science discovers, technology applies and the economy adds value", as we are used to say. The evolution of the global energy balance has been shaped by technological breakthroughs. Other major revolutions are expected, such as that of large-scale electricity storage, under conditions of economic profitability. Tomorrow may see the development of large-scale carbon sequestration or controlled nuclear fusion. What's new today with digital technology is that this revolution concerns not only the producer, transporter or distributor of energy but also, and increasingly, the consumer who will have to manage a growing amount of information to adapt his behaviour to technological developments. All technological progress will be channelled into the fight against global warming, whether through energy efficiency technologies or through technologies to develop low-carbon or carbon-free energy sources. But this progress must benefit as many people as possible and not leave the poorest people on the sidelines, whether in emerging or industrialised countries.

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