The Economics of Climate Change

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Climate change poses a problem for the economic system that fostered the polluting industrial revolutions of coal and oil. Today, the digital economy revolution offers significant hope for reducing pollution and promoting decarbonisation. However, the economic interest struggles of the powerful lobbies of the polluting sectors seem to reduce the potential for transformation of an economic system driven by the search for short-term profit. The major powers want to preserve their economic gains and are undertaking this revolution at a pace that suits them, which is not without conflict, given the urgency of action in the face of the harmful transformations undergone by eco-systems. Furthermore, the GAFAMs, the powerful providers of digital services and instruments, together with their Chinese competitors, have a considerable economic and strategic force that could undermine freedoms and human and citizens' rights. Finally, for the production of digital tools, rare earths are likely to pose new problems, those relating to the pollution involved in their production and their relative scarcity compared to the stocks known today.

Le changement climatique pose un problème au système économique qui a favorisé les révolutions industrielles polluantes du charbon et du pétrole. Aujourd'hui, la révolution de l'économie numérique offre un espoir important pour réduire la pollution et promouvoir la décarbonisation. Cependant, les luttes d'intérêts économiques des puissants lobbies des secteurs polluants semblent réduire le potentiel de transformation d'un système économique guidé par la recherche du profit à court terme. Les grandes puissances veulent préserver leurs acquis économiques et entreprennent cette révolution au rythme qui leur convient, ce qui n'est pas sans conflit, vu l'urgence d'agir face aux transformations néfastes subies par les écosystèmes. Par ailleurs, les GAFAM, puissants fournisseurs de services et d'instruments numériques, disposent, avec leurs concurrents chinois, d'une force économique et stratégique considérable qui pourrait porter atteinte aux libertés et aux droits de l'homme et du citoyen. Enfin, pour la production d'outils numériques, les terres rares sont susceptibles de poser de nouveaux problèmes, ceux liés à la pollution liée à leur production et à leur relative rareté par rapport aux stocks connus aujourd'hui.

Keywords : Digital economy, climate change, GAFAM, Rare Earths
Economie digitale, changement de climat, GAFAM, Terres rares

National security is not limited to the potential of military conflicts alone. It encompasses issues of citizen security as a whole, such as the potential for food self-sufficiency, the capacity for independence in health matters or the technological potential of the digital economy. Today, the three biggest carbon polluters in the world are the biggest powers, the USA[1], China and Europe. Environmental issues are also essential to human life and could even be at the heart of future inter-state conflicts, given the international nature of pollution and its transmission to neighbouring countries. Global warming[2] is a global problem that states cannot solve alone. It is therefore necessary to find collective solutions, to radically modify our fossil and consumerist production and consumption processes. However, when it comes to ecology and the environment, borders do not exist and the minor and greedy interests of others can thwart the efforts of some nations. A global industrial plan should be put in place, but no international authority can commit to it without the voluntary agreement of states. To avoid a frightening future, our fossil fuel and consumerist production and consumption processes should be radically changed.

During the Davos Forum, many participants considered that a tax on carbon dioxide emissions is the most effective way to reduce CO2 emissions and to force private or public economic actors to prefer new energies. Under these conditions, technological innovation in favour of a green economy would be encouraged, by increasing the price of carbon production, provided that an appropriate social policy is implemented at the same time. According to Jeremy Rifkin, the discounted energy cost of large-scale solar and wind power[3] is lower than that of gas refineries, coal plants or nuclear reactors. Technological progress in decarbonising fossil fuels would be needed to limit the stranded assets of oil or coal reserves. In this context, the economic interest struggles of the powerful lobbies of the polluting sectors seem to reduce the potential for transformation of an economic system driven by the search for short-term profit, all the more so as many economic activities are directly affected by these activities, notably the financial, metallurgical or steel sectors. Despite its obstacles, it is a question of launching a third industrial revolution, abandoning those of coal and oil.

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[1] A "New Green Deal" was proposed in February 2019 in the US Senate. It would aim to generate 100% of the US's electricity from clean, renewable sources and increase national energy efficiency, particularly in transport and buildings

[2] According to the IPCC, human activity has caused temperatures to rise by 1 degree Celsius compared to pre-industrial times. However, it seems that if it goes beyond 1.5 degrees, a cascade of unprecedentedly violent climatic events would decimate ecosystems and change human living conditions.

[3] The LCOE (Levelized Cost of Energy) assesses the average total cost of building, operating and destroying an energy source, based on its lifetime and the total energy yield over the period.

However, today's digital economy presents undeniable risks, regarding its neutrality, data security, cybercrime, cyber terrorism and cyber warfare[4]. Without government intervention, the Internet giants have exceptional economic, political and social power that they could continue to use for commercial, but also other political or ideological purposes[5]. Regulatory bodies at each level of operation must be put in place, controlled by democratically established bodies.

Finally, resources remain scarce, especially the so-called "rare earths" that are so necessary for the development of modern technologies, especially digital ones.

The technological platform of the third industrial revolution

In any revolution, a technological platform, consisting of a communication medium (Internet), an energy source (wind and sun) and a means of transport (automated cars) is necessary. The Internet is a powerful communication medium that supports autonomous electric vehicles and renewable electricity. Sensors will link each individual to a global digital network. The IDO (Internet of Things) allows us to connect easily with our work environment, our homes, our business activities, our social relationships and our supply chains. The transaction of services and goods takes place instantaneously, at any time. The marginal cost of goods and services becomes almost zero and profit margins will be very low. In this case, the market can no longer be the dominant instance of choice. Ownership gives way to access; suppliers and users replace buyers and sellers. Smart grids operate continuously, at very low cost, but with continuous traffic. There is a growing demand for collective facilities, from car sharing to co-location. Many activities are non-profit or cooperative, with non-market exchanges, such as Wikipedia, which is completely free to access. This circular economy saves carbon emissions. The sun and wind never send their bill. The collaborative economy will grow.

On the other hand, as a first step, it is necessary to disable and dismantle the blocked infrastructure, to transform the electricity networks (replaced by a high voltage smart grid)[6], to change the logic of transport, logistics, traffic flows, to renovate buildings (by equipping them with

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[4] Fontanel, J., Corvaisier-Drouart, B. (2014), For a general concept of economic and human security, in The evolving boundaries of defence : an assessment of récent shifts in defence activities, (Bellais, R. Ed.), Emerald, Bingley, U.K., 2014.

[5] Fontanel, J., Sushcheva, N. (2019), La puissance des GAFAM : réalités, apports et dangers, AFRI, Annuaire Français des Relations Internationales, Paris.

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[6] On average, 86% of the energy of the second industrial revolution was lost in transmission in the US.

devices capable of capturing renewable energy and storing energy) with the implementation of a smart infrastructure. This could lead to a change in skills, with non-profitable, collective sharing activities. This was the objective of the first creators of the Internet, financed by public funds, which private companies have managed to privatise, at least in part. With IDO, we can hope to improve this productivity, with a resilient and carbon-free circular economy. The first two industrial revolutions improved living conditions on Earth, but even today more than 46% of the world's population survives on $5.5 a day.

The third revolution must be more democratic and egalitarian, given the importance of public services that are almost free, thanks to technological progress in digital technology and renewable energy. The tipping point will also depend on the price of oil and gas, two fuels that still largely dominate the market. However, as in all financial matters, as long as these sectors are making large profits, they will continue to speculate on keeping their businesses. The US (the world's largest producer) and Canada (4th largest) are still exploiting natural gas, with heavy investment. Pipeline investments risk becoming stranded assets in less than a decade. At this rate, there could be $1 trillion of stranded capital by 2030[7]. In 2018, the World Bank published a report highlighting its concerns about what lies ahead for carbon-rich countries[8].

Barriers to the rapid emergence of the third industrial revolution

The issue is above all the sustainability and stability of such a system compared to the old process which, in any case, leads to natural disasters with considerable costs. However, the cost of the operation will undoubtedly be considerable and the problem is to know who will bear it. The transition arises from the convergence of the infrastructure sectors of the "second industrial revolution", telecommunications, fossil fuels, mobility, logistics and housing stock. The change in technology will completely depreciate the value of existing assets. According to Citygroup, it is expected to lead to the tying up of $100 trillion in stranded assets, if the Paris Conference target of a 2°C temperature increase on Earth is not exceeded[9]. In this context, given the enormous revenues of carbon energy producers and the power of lobbies that are often directly or indirectly

[7] Dyson, M., Engel, A., Farbes, J. (2018), The Economics of Clean Energy Portfolios : How renewable and Distributed Energu Resources Are Outcompeting and Can Strand Investment in Natural Gas-Fured Géeneration, Rocky LMounstain Institute, mai 2018. https://www.rmi.org/wp-content/uploads/2018/05/RMI_Rxecutive_Summary_Economics_of_Clean_Energy_Portfolios. Pdf

[8] Lange, G-M, Wodon, Q., _Carey, K. (2018) The Changing Wealth of Nations 2018 ; Building a Sustainable Future », World Bank, Washington.

[9] Channel, J. and al (2015) Energy DarwinismII : Why a low Carbon future doent have to cost the Earth, Citi GPS Report.

enriched by fossil fuel reserves, we can expect strong reactions from owners to delay a process that, given current knowledge, should eventually be definitively established.

China, the world leader in renewable energy, is now expressing its desire in the thirteenth five-year plan to develop an "ecological civilisation"[10]. Green infrastructure offers the same possibilities as fossil fuels, while protecting the Earth from excess carbon production, which is triggering a deadly upheaval of the Earth's climate. This energy internet is one of China's key programmes, and it already employs nearly 4 million people in the renewable energy sector. In the US, companies would like to privatise infrastructure, but it is not possible to hand over the daily lives of citizens to the private sector, without control. Privatisation of all intelligent infrastructures is not conceivable, given the collective responsibilities that the state must assume. For Jacobson (et al) of the University of Berkeley[11], the United States can provide for its needs with renewable energy (notably with 57% sun and 38% wind). Buildings need to be renewed on the basis of a smart infrastructure that allows consumers to become active managers of their own electricity. Governments can help with the installation of this equipment, through subsidies or tax reductions, particularly for households and businesses, for residential and industrial premises. In 2007, Europe appeared to be ahead of the US in proposing the 20-20-20 plan. Member States were to increase energy efficiency, reduce greenhouse gas emissions and increase renewable energy production by 20% by 2020, but the results have not matched this proposal. Through the Energy Performance of Buildings Directive, the European Union encourages parties involved in the renovation of buildings to install on-site renewable energy and to create an intelligent energy infrastructure with adequate energy storage, with an energy performance certificate. Without support for this type of operation, the results are almost non-existent. The United Nations Environment Programme (UNEP) has also proposed a new "green deal" to revive the global economy in the wake of the 2008 economic and financial crisis.

The automobile is beginning to convert to the electric system and shared mobility is expected to increase the life span of vehicles by 10 times (more than 800,000 kilometres and double that in 10 years). According to Jeremy Rifkin, autonomous vehicle transport, operating at almost zero marginal cost, powered by solar or wind electricity, should develop in the coming

[10] As part of the 13th Five-Year Plan, the People's Bank of China's strategy is to raise $1.5 trillion in "green" projects.

[11] Jacobson, M.Z., Delucci, M.A., Bauer, Z., Wang, J., Weiner, E., Yachanin, A. (2017), 100% Clean and Renewable Wind, Water and Sunlight All-Sector Energy Roadmaps for 139 Countries in the World, Joule, vol. 1, 6 Septembre.https://doi.org/10.1016/j.joule.2017.07.005.

Deutch, J. (2017) Decoupling Economic Growth and Carbon Emissions, *Joule*, vol. 1, 6 Septembre. https://doi.org/10.1016/j.joule.2017.07.005.

decade. While GDP will fall, household welfare should improve[12]. On the other hand, public debt, at least in the short term, should increase due to the new public investments in indispensable infrastructures, concerning ICT, but also real estate, a quasi-blocked asset[13], to be renovated, which only changes by 2% per year. Buildings will no longer be private, passive and walled-in spaces, but active entities committed to sharing renewable energy.

Finally, we must prepare the workforce for the "green era" and develop intelligent ecological agriculture. Livestock farming is a major contributor to the production of greenhouse gases and uses 26% of the world's land area. It must be completely rethought in the context of human survival[14]. Ecological and organic agriculture is having great difficulty in developing (6.7% in Europe, 0.6% in the USA). We need to rethink the very concept of sustainable food.

International finance is being questioned. Banks believe that climate change threatens a wide range of assets in almost all sectors, but few banks see this as a matter of corporate social responsibility. Pension funds (20% of equity and 40% of US companies' shares), with their highly speculative actions, should start valuing oil companies downwards, but the taste for privatised profits is stronger than the immediate collective interest (the capitalist will sell the rope to hang him, said Lenin). Trade unions and states have ceded control to financial institutions.

Socially responsible investment (SRI) is going to be at the centre of the economic and financial concerns of economic actors. Today, the principle should be that of Benjamin Franklin: Doing Well by Doing Good. The boundary between productive and commercial practices and morally and socially correct financial performance must be removed. Younger generations are interested in SRI and infrastructure modernisation. Today, fossil fuels have had their day; we should no longer invest in them. We need a smart national grid that feeds the flow of green electricity, but many elements will be completely decentralised such as solar panels, wind power, charging stations, electric vehicles, implemented through tax

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[12] Guilhaudis, J-F., Fontanel, J. (2019), Les effets « pervers » de l'usage du PIB pour la décision politique et les relations internationales. Comment en sortir ?, AFRI, Annuaire Français des Relations Internationales, Paris.

[13] With investments in insulation, solar panels, micro power plants, charging equipment for electric vehicles and objects and storage technologies.

[14] According to Rifkin, with 1.4 billion cows emitting methane, a gas 25 times more potent than CO2 for its warming potential, and nitrous oxide in their excrement, with a warming potential 288 times that of carbon dioxide, the question arises as to the value of livestock farming to the future of humanity. Beef requires 20 times more land and generates 20 times more greenhouse gases than vegetables per unit of protein consumed. It is also a cause of deforestation, which means that fewer trees absorb the gas emissions.

credits. However, this third industrial revolution has two main dangers: the weight of GAFAMs and scarce earth.

The GAFAMs

ICTs (telecommunications, Internet, data centres) are major consumers of energy. If left unchecked, this emission of greenhouse gases could represent 14% of total emissions in 2040. However, this estimate does not include the manufacture of these electrical products, their short lifespan[15] due to double planned obsolescence (change of more efficient devices and reduced use of the same device over time), or the extraction of rare earths, nor the storage of waste. ICT infrastructure is very electricity intensive (70% of the total ICT carbon footprint). Moreover, the GAFAMs seem to want to reinvest in this sector, Google uses 100% renewable energy in its data centres in green energy and Microsoft wants to achieve this result in 2023 (50% is already used on the basis of renewable energy). The GAFAMs want to secure their data centres and control their energy networks, particularly in the face of the risks of natural disasters and cyber attacks.

Initially, the Internet was a public good, managed by the state technocracy of the American military-industrial complex and fed by university research. At the end of the 20th century, the GAFAMs (Google, Apple, Facebook, Amazon, Microsoft) benefited from the process of commodification of the Internet. Today, the financial, technological, economic and security power of GAFAM over modern society is immense, perhaps excessive. The massive use of the Internet has allowed the emergence of a digital economy with increasing returns, drastically reduced transaction costs, permanent processes of financial concentration and active support for deregulation, thus favouring vertical and horizontal integration operations[16].

The GAFAMs are developing technologies that are changing the way we think. Today, their power is of concern and is being criticised for, among other things, their commercial use of normally private information, their patent-protected application of domineering technology, their lobbying to avoid anti-trust laws, their use of financial speculation, their penchant for

[15] The energy consumed to manufacture these appliances accounts for 85-95% of their annual lifetime carbon footprint.

[16] Fontanel, J. (2016), Paradis fiscaux, Etats filous, La fuite organise des impôts vers les pays complices. L'Harmattan, Paris,
Fontanel, J., Sushcheva, N. (2019), La puissance des GAFAM : réalités, apports et dangers, AFRI, Annuaire Français des Relations Internationales, Paris.

tax trading and optimisation in tax havens, and the creation of a society of control and surveillance of consumers and citizens.

Google cannot be allowed to settle in public governance, even if it proposes the creation of smart cities (Toronto). Controlled by private interests, the sources of profit are gigantic. However, the decisions of these private interests raise many questions concerning human rights, individual freedom and the democratic control of these monopolistic oligopolies. Google's proposed Smart City for Privacy in Toronto would have turned the city into a Smart City for Surveillance. Only local governments can initiate equivalent procedures. In this context, Lander Germany is better equipped than Jacobin France.

GAFAM are companies that do business first. Therefore, despite their public denials, they have little regard for the protection of democratic societies and do not feel responsible for the societal consequences of their actions. These commercial monopolies will not change on their own without a political will to regulate their activities.

Rare earths

Rare earths[17] are characterised by their exceptional properties, which are necessary for "green tech"; in particular, they enable the production of clean electricity and are essential for new information and communication technologies. However, they are often expensive and their extraction, which often causes pollution, is difficult in the context of a separation operation with the abundant materials in the earth's crust that cover them. Small quantities are produced each year, in territories that are both small in number and sparsely urbanised, under difficult social conditions. Finally, China is the producer of two-thirds of the mineral resources essential to the modern economy. It pays a price for this[18], but economic development takes precedence over any negative external effects. The thirst for power and the race to catch up economically is leading China to the greatest excesses, especially in the less touristy regions. The demand for germanium, tantalum, palladium, scandium and cobalt will accelerate in the coming years. Consumption of the main metals is growing at a rate of 3% per year, which will quickly lead to increased scarcity, higher prices, reduced environmental constraints and cross-conflicts between firms and states. It even raises the question of economic and military power. The violence of the high-tech boom, combined with the accompanying scarcity of metals, raises the question of the "sustainability" of "green" development and the

[17] Guillaume Pitron (2019), La guerre des métaux, LLL, Les liens qui Libèrent.
[18] 80% of underground wells in the "Middle Kingdom" are unfit for consumption according to European health standards.

balance of power between the superpowers. Some metals could quickly become endangered, such as vanadium, terbium, europium, neodymium, titanium, indium, dysprosium and cobalt[19]. The shortage of metals is an obstacle to the so-called green revolution. Waste will have to be reprocessed, but for the time being the cost of reprocessing is not yet profitable for many rare earths.

The idea that digital technology can help us reduce energy costs is an assumption. Certainly, the digital economy can a priori design smart electricity grids that can optimise expenditure, depending on the permanence and intermittency of energy sources. It also reduces the carbon impact of human activities, with the third industrial revolution proposed by Rifkin[20]. Dematerialisation leads to teleworking and data storage, which reduces energy expenditure.

However, this picture remains incomplete. This reflection works "ceteris paribus", all other things being equal. Upstream, new rarities are appearing that are likely to create 'bottlenecks', which will inevitably lead to an increase in the price of raw materials and to a slowing down, or even a partial halt, to the widespread application of new technologies. Rare earths" are the first supplies concerned. The digital industry uses metals (22% mercury, but also silver, gold, lead, etc.). A single chip weighing two grams requires the disposal of 1,000 times more material[21].

The idea, often mentioned, of exporting polluting industries to poor countries, then materialised in China, under the direction of an authoritarian state, which was not very concerned about environmental constraints at the time, and was in the process of regaining its economic power. The European REACH regulation also protects European citizens by requiring the development of good ecological practices. Under these conditions, industrialists are in collusion, buying cheaply, having a cheap workforce and little regard for working conditions. Consumers have not taken any action to discourage this movement, which is dangerous for their safety. As long as pollution does not affect them, polluting importers from distant lands can easily dominate the markets.

China, because of its reserves, its protection policy and its ability to attract companies in the sector, can become master of the geo-economic game, with all the dangers that such a position could have for world peace and the

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[19] Marscheider-Weidemean, F., Langkau, S., Hummen, T., Erdmann, L., Tercero Espinoza, L. (2016), Raw materials for Emerging Technologies 2016, German Mineral Resources Agency (DERA), March.

[20] Rifkin, Jeremy (2019), Le New Deal Vert Mondial. Pourquoi la civilisation fossile va s'effondrer d'ici 2028. Le plan économique pour sauver la vie sur Terre, Editions « Les Liens qui libèrent ».

Fontanel, J. (2020), Le New Deal Vert, la troisième révolution industrielle ? Une analyse de la pensée de Jeremy Rifkin, Pax Economica, Grenoble

[21] Flipo, F., Dobré, Lichot, M. (2013), La face cachée du numérique. L'impact environnemental des nouvelles technologies, L'Echappée.

maintenance of today's international institutions[22]. In 2020, the conflict with Huawei highlights the violence of the relationship for global technological power. The US is at risk of losing Chinese supplies of rare earths. Will Washington announce the reopening of the mines to limit Chinese imports, especially Mountain Pass? It needs to strengthen the resistance of the supply chains for the basic products needed by the US army, but also for dual production. The Americans are thinking of introducing a "Buy American Clause" in military contracts. Faced with the threat of a Chinese embargo, it was eventually planned to develop the production of vital materials, without any significant achievement by 2020. The Pentagon is questioning whether malicious viruses are being planted on Chinese imports to prevent the equipment from functioning properly. Even today, the F-35 carries rare earths from China in its cockpit. The economic war could soon take on a worrying aspect in the event of a conflict between the two great powers[23].

Today, the US is setting its own policy of independence by engaging in a process of reducing vulnerabilities of "critical" minerals, developing recycling technologies, analysing alternative possibilities (and their costs), prioritising access to these metals through exchange with allies and partners, initiating exploration of available domestic resources, implementing recommendations to streamline permitting and lease review processes, and providing financial incentives to increase the discovery, production and domestic refining of critical minerals.

Strategies to strengthen and support supply chains for these materials are needed to avoid vulnerability to disruption. It will even be possible to change laws and rules according to the urgency of specific demand[24].

Conclusions

Dominated by liberal ideas, economic globalization[25] led people to believe that the interdependence of states was a factor of peace. However, power relations become more apparent when a country becomes dependent on products necessary for its own development. Mercantilist reasoning reminds us that the future of a country also depends on its ability to resist the power relations that states that do not share its values want to

[22] Fontanel, J. (2016), La sécurité économique et sociétale : pour une conceptualisation humanistes multidimensionnelle, PSEI, Paix et Sécurité Européenne et Internationale.

[23] President USA (2017), Presidential Executive Order on Assessing and Strengthening the manufacturing and defense industrial base and supply chain resiliency of the United States, White House, 21 July.

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impose on it by force in the supply of goods and services essential to its survival. The clash of civilisations is not always a fable, when a country that recommends itself to communism asks for openness to international competition[26].

Significant progress has yet to be made. Without human action, the evolution of the planet will become uncontrollable because no technology on a global scale is capable of protecting humanity from this situation. However, the aversion to loss is greater than the aversion to gain. Those who have power do not want to risk losing it either. Man has established institutions that could improve his condition, but they have now become obstacles to his own liberation. We must think as a species. But in the long run, we will all be dead. And the long term is increasingly in the short term.

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