

LES CAHIERS DE L'ÉCONOMIE

IFP SCHOOL - IFPEN

N° 126

MARS • 2019

ÉTUDE & SYNTHÈSE

SOME GEOPOLITICAL ISSUES OF THE ENERGY TRANSITION

This article is a summary in English of the Policy Paper published in January 2019 under the title “Vers une géopolitique de l'énergie plus complexe ? Une analyse prospective tridimensionnelle de la transition énergétique”, Policy Research Working Paper, Projet GENERATE, IRIS – IFP Énergies nouvelles – ANR.

Emmanuel Hache
Samuel Carcanague
Clément Bonnet
Gondia Seck
Marine Simoën

La collection “Les Cahiers de l’Économie” a pour objectif de présenter les travaux réalisés à IFP Energies nouvelles et IFP School qui traitent d’économie, de finance ou de gestion de la transition énergétique. La forme et le fond peuvent encore être provisoires, notamment pour susciter des échanges de points de vue sur les sujets abordés. Les opinions exprimées dans cette collection appartiennent à leurs auteurs et ne reflètent pas nécessairement le point de vue d’IFP Energies nouvelles ou d’IFP School. Ni ces institutions ni les auteurs n’acceptent une quelconque responsabilité pour les pertes ou dommages éventuellement subis suite à l’utilisation ou à la confiance accordée au contenu de ces publications.

Pour toute information sur le contenu, contacter directement l’auteur.

The collection “Les Cahiers de l’Économie” aims to present work carried out at IFP Energies nouvelles and IFP School dealing with economics, finance or energy transition management . The form and content may still be provisional, in particular to encourage an exchange of views on the subjects covered. The opinions expressed in this collection are those of the authors and do not necessarily reflect the views of IFP Energies nouvelles or IFP School. Neither these institutions nor the authors accept any liability for loss or damage incurred as a result of the use of or reliance on the content of these publications.

For any information on the content, please contact the author directly.

**Pour toute information complémentaire
For any additional information**

Victor Court

IFP School

Centre Economie et Management de l’Energie

Energy Economics and Management Center

victor.court@ifpen.fr

Tél +33 1 47 52 73 17

This article is a summary in English of the Policy Paper published in January 2019 under the title “*Vers une géopolitique de l’énergie plus complexe ? Une analyse prospective tridimensionnelle de la transition énergétique*”, Policy Research Working Paper, Projet GENERATE, IRIS – IFP Énergies nouvelles – ANR, January 2019.

Authors

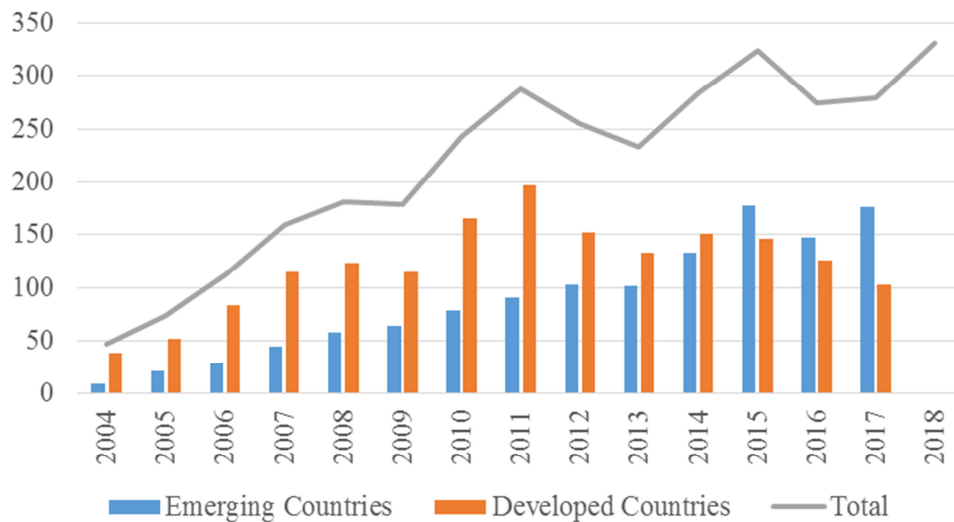
- Dr Clément Bonnet, IFP Energies nouvelles: clement.bonnet@ifpen.fr
- Samuel Carcanague, IRIS: carcanague@iris-france.org
- Dr Emmanuel Hache, IFP Energies nouvelles (Project Leader): emmanuel.hache@ifpen.fr
- Dr Gondia Sokhna Seck, IFP Energies nouvelles : gondia-sokhna.seck@ifpen.fr
- Marine Simoën, IFP Énergies nouvelles : marine.simoen@ifpen.fr

The views expressed herein are strictly those of the authors and are not to be construed as representing those of IFP Énergies Nouvelles and IRIS.



Why should geopolitics focus on energy transition issues? In many parts of the world, the decarbonisation of the energy and electricity mix has become a priority in order to meet international climate objectives and address local pollution issues. Investments made in renewable energies (REs) represented around \$332 billion in 2018¹ (Figure 1) and those needed to meet the targets set in Paris in 2015 at the 21st Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC) could reshape the concept of energy security. The expression “Geopolitics of Renewable Energies” is not widely used at present, and the geopolitical implications of new energy policies and investments in REs are not very well explored.

Figure 1: Investments in Renewable Energies*



Source: Frankfurt School-UN Environment Programme Centre/Bloomberg New Energy Finance 2018.

*Breakdown between developed countries and emerging countries not available for 2018.

¹ Bloomberg New Energy Finance, “Clean Energy Investment Trends, 2018”, 2018.

While some authors (Criekemans, 2018; Hache, 2016, 2018; O'Sullivan, 2017; Scholten and Bosman, 2016) have begun to consider various transformations linked to the global energy transition dynamic, most research still focuses on the technical aspects of integrating REs into the electricity grid (Connoly et al., 2014; Hache et Palle, 2017, 2019), on national (Alazard-Toux et al., 2014, 2015, 2017; ADEME, 2017, NégaWatt, 2017) or international energy transition policy scenarios (AIE, 2013, 2015, 2016, 2017), or on the economic instruments and technologies needed for their deployment. Geopolitical and geographical aspects dealing with the concepts of power, rivalries, security or dependencies associated with these dynamics are rarely considered and analysed.

In the context of the energy transition, the deployment of REs seems, at first glance, to be moving away from the traditional geopolitical issues related to energy. Indeed, many REs (wind, solar, small hydropower) come from cyclical and renewable natural sources (tide, wind, sun), unlike non-renewable fossil resources which are more geographically concentrated. The concepts of availability and accessibility, which are central to the traditional definition of energy security (Jewell et al., 2014), should therefore have less impact in the case of REs. However, the need to re-examine these concepts arises in the context of energy transition policies requiring non-energy resources, such as all non-ferrous, ferrous and rare earth metal resources as well as patents on decarbonisation technologies, that indirectly influence energy security. Indeed, a State's dependency on fossil resources could be replaced by a reliance on other resources such as strategic metals or structural materials supported by a major technological component, closely linked to intellectual property systems and essential both to understanding the new competitiveness challenges around decarbonisation technologies and to defining conceptual frameworks for their deployment in the developing countries. The question of international cooperation on this point is fundamental and is fully integrated into the many challenges of the geopolitics of renewable energies. The growth of these REs in the global energy mix will likely also affect oil-producing countries, in particular through a slow-down in their export volumes, especially of oil and coal after 2040. For them, the issue of demand security could have broad macroeconomic implications, particularly in

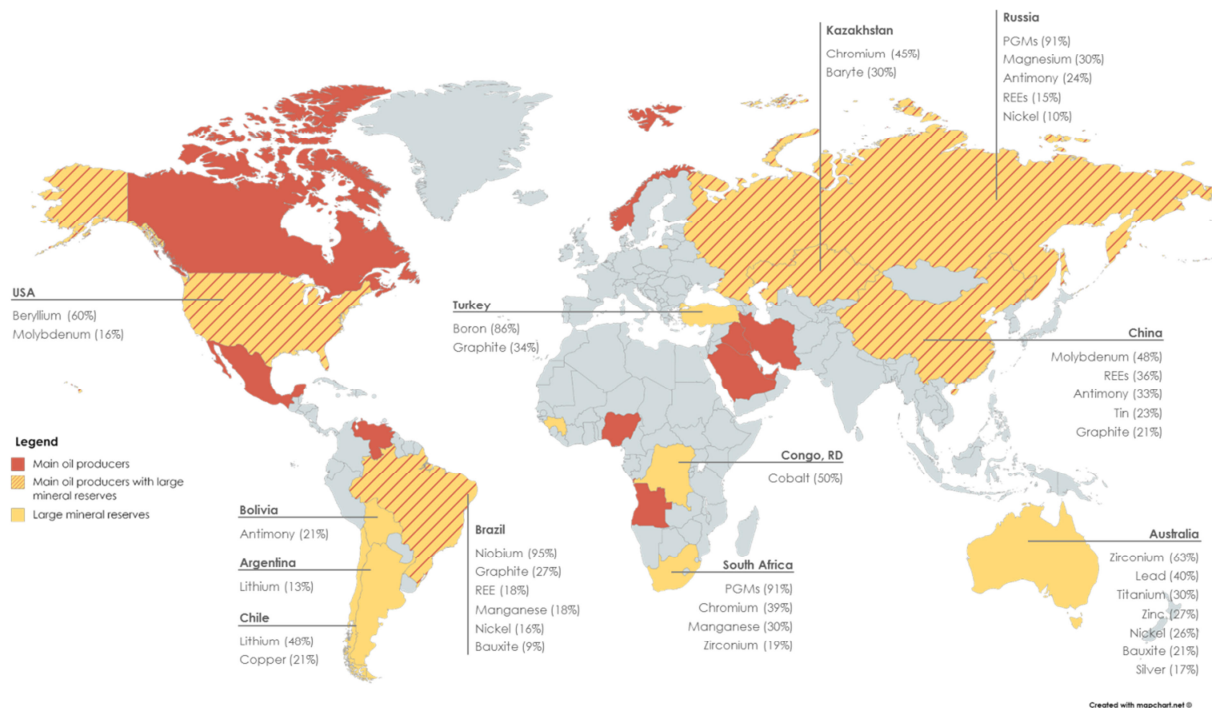
terms of investments, and could eventually require a change in their development model with significant consequences in terms of power on the international scene.

A NEW DEPENDENCE ON MATERIALS?

The issue of mineral resource dependency is a relevant illustration of the challenges the world is likely to face in the energy transition process. Many studies (ANCRE, 2015, World Bank, 2017; OECD, 2018; Bonnet et al., 2019) underline the need to take these constraints into account in the dynamics of the global energy transition, and more especially the location of resources, the organisation of industrial markets or actors' strategies that can make the use of a raw material critical. This notion of criticality thus covers all the risks related to the production, use or end-of-life management of a raw material (Graedel et Nuss, 2014): geopolitical risks (the case of rare earths is widely illustrated in economic literature because more than 85% of rare earths are produced in China), economic risks (embargo, market manipulation, lack of financial contracts to hedge price volatility, etc.), production risks (under-investment and time-lag between investment decisions and production) and environmental or social risks (emissions of pollutants related to production, health consequences, landscape destruction, etc.). The notion of criticality actually varies according to the chosen geographical scale (lithium is thus considered critical in the United States, but does not appear in the European Commission's list of critical materials), to the time scale (chromium was critical for the European Commission in 2014 but disappeared from the list in 2017) and to the consumer unit considered (national economy, industry, company or technology). Ultimately, it depends on the economic (commercial, technological, financial) and political (national security, defence industry, foreign policy) interests of a State, of which it is necessarily the consequence of its energy policy. The notion of criticality is thus neither universal, timeless, nor binary (Bonnet et al., 2019). It requires an understanding and quantification of economic, technological and geopolitical factors for each of the strategic materials required in the energy transition and is a key to understanding a country's relations with its international partners. The need to take into account the geopolitical dimension and to refine the quantitative and qualitative evaluation of

criticality thus appears to be a fundamental challenge for researchers, manufacturers and policy-makers.

Figure 2: Mineral Reserves

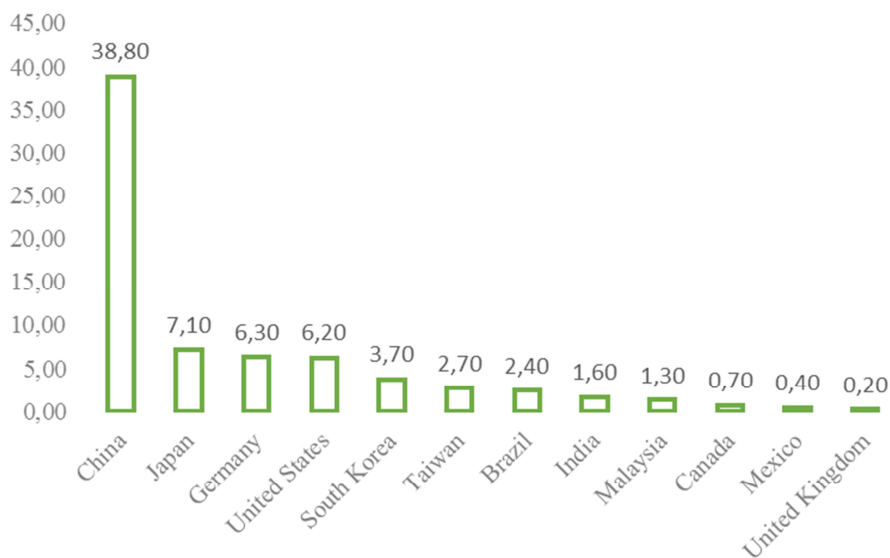


Source: authors based on USGS data

The modelling work carried out as part of the GENERATE project on lithium and copper is interesting. Indeed, on the basis of a comparison of several climate scenarios, they tend to show that it is relevant to focus not only on “technological” materials (cobalt, lithium, rare earths, etc.) but also on structural materials (non-ferrous metals, etc.) in the context of the energy transition (Bonnet et al., 2019; Hache et al., 2019). The deployment of REs invites all stakeholders to consider possible new market powers (Figure 2). The factors that explain price formation (concentration of reserves and companies on markets, existence of financial markets, etc.), the industrial and technological strategies of the various States, and environmental or social constraints (opposition to the opening of new mining projects, increasing demand for more environmentally-friendly extraction processes, water stress, etc.) need to be clearly explained in order to understand the future international and geopolitical energy

landscape. In this context, the question of public policies seems essential. While recycling policies are, for instance, regularly put forward because they reduce external dependency and generate less local pollution than the production of metals extracted from a mine, they are only a partial response to the problem. Transportation policy, the establishment of strategic stocks and investment in Research and Development (R&D) in order to find substitutes for strategic materials are key avenues in this context. Raw material dependency also questions the role of industrial policies, corporate strategies (vertical integration, technological dependence, etc.) and the dominant economic paradigm observed in large geographical areas. Thus, the choice made at European level to focus on liberalisation of energy markets without real strategies to build a European renewable energy sector is a relevant factor to understand the current positions of China and Europe on these issues. In just a few years, China has become a major industrial player in the renewable energy sector: in 2014, the value added of its renewable energy manufacturing sector reached nearly \$40 billion, while that of the manufacturing sector of the leading European country, Germany, was barely over \$6 billion² (Figure 3).

Figure 3: Manufacturing Value Added for four clean energy technologies in billions of dollars (Wind Turbine, PV module, LED package, Li-ion battery cell) in 2014



Source: Clean Energy Manufacturing Analysis Center, 2017

² Clean Energy Manufacturing Analysis Center, 2017.

CLIMATE TECHNOLOGIES AND POLICIES

The issue of criticality remains intrinsically linked to the spread of low-carbon technologies and, ultimately, to their design and marketing. It is therefore necessary to go beyond the framework of energy transition materials to analyse industrial property and all related issues – spread of technology, transfer of knowledge, international negotiation framework, etc. – in order to identify the most appropriate solutions and thus determine to what extent low-carbon patents can constitute a major geopolitical weapon in the upcoming upheaval of the global energy mix.

While the low-carbon energy transition requires a disruption of consumption habits and a profound transformation of the economic organisation of energy production, distribution and consumption, it is still dependent on radical change in the technological base on which the energy system is founded. Of all the energy consumed worldwide in 2015, 67% was of fossil origin, according to the International Energy Agency (IEA)³. This share will have to be drastically reduced to limit the rise in the global average temperature to 2°C, with a probability of occurrence between 66 and 100% by 2100. Under the most ambitious scenarios, overall emissions from the energy supply sector must be reduced by 90% or more between 2040 and 2070 compared to 2010 levels (IPCC, 2014)⁴.

The climate and innovation support policies implemented by governments are the two main levers to foster low-carbon innovation. Indeed, the economic profitability of low-carbon innovation currently remains dependent on the policies put in place by governments. The latter are involved at three levels in the dynamics of innovation, through their weight in the energy sector (stake in energy companies), their role in financing innovation, and the lack of technological neutrality in supporting low-carbon technologies: innovation is an expression of their geo-economic strategies in the energy sector.

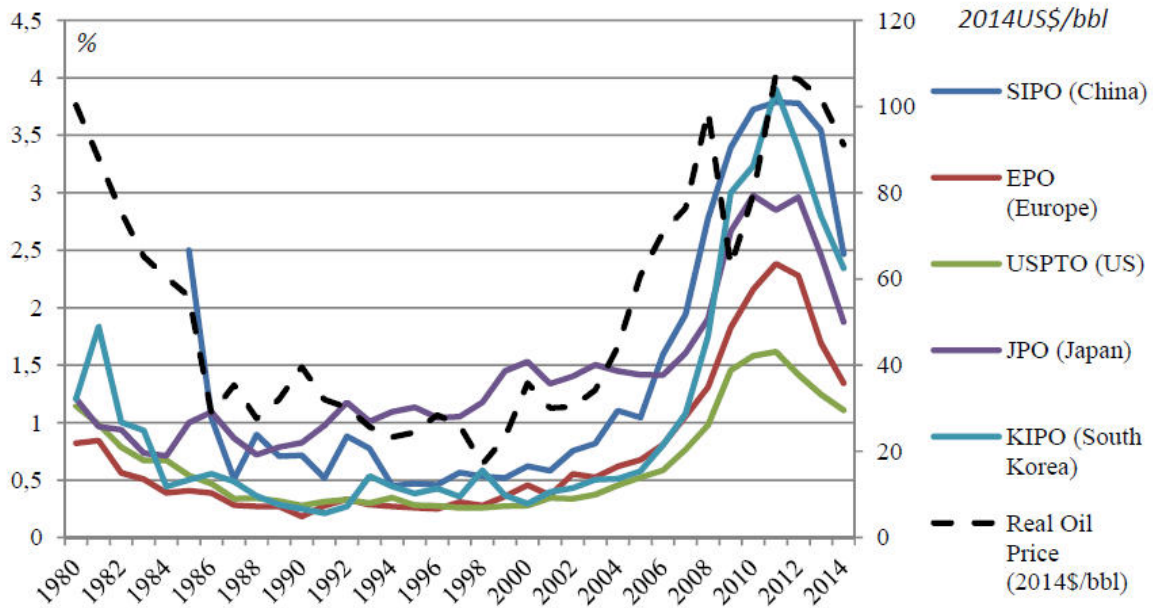
³ Data can be found at iea.org/classicstats.

⁴ Intergovernmental Panel on Climate Change (IPCC), Climate Change 2014: Synthesis Report, Geneva, 2014.

Low-carbon technologies are thus the subject of intense geo-economic competition between States. In many sectors, innovation and its protection are proving essential for the sustainability of economic growth, security and national sovereignty more generally. In the case of renewable energy sources, China's emergence and the western countries' fear of losing a technological advantage have revived protection against foreign investment and increased in recent years. Germany, for example, changed its system in July 2017 after several takeovers of companies in sensitive sectors by foreign investors, including a wind energy company, WindMW GmbH, which came under Chinese control in 2016. The United States, the United Kingdom and China, for their part, amended their legislation to this effect in 2018, and France is set to adapt its legislation under the PACTE Act. Although the energy sector in general is subject to protection measures, more explicit inclusion of low-carbon technologies is being considered in the areas subject to foreign investment protections, particularly in France, regardless of the nature of the measures put in place (total ban, control, etc.).

Innovation in RE technologies has thus become a global challenge in recent decades. No geographical area seems to have escaped the acceleration of the acquisition of industrial property rights on new technologies in the renewable energy sectors, reflecting the anticipation among the various players that they will become key assets. Significant efforts have been made by several Asian countries, notably China and South Korea, to specialise in these technologies. Finally, several studies have demonstrated the high dependence of low-carbon innovation on fossil fuel prices (Newell et al., 1999; Popp, 2002; Crabb and Johnson, 2010; Verdolini and Galeotti, 2011), a link that gives hydrocarbon-producing countries a central role in the geopolitics of renewable energy sources (Figure 4).

Figure 4: Evolution of the share of RE patents in the total number of patents granted by the five main intellectual property offices and oil prices



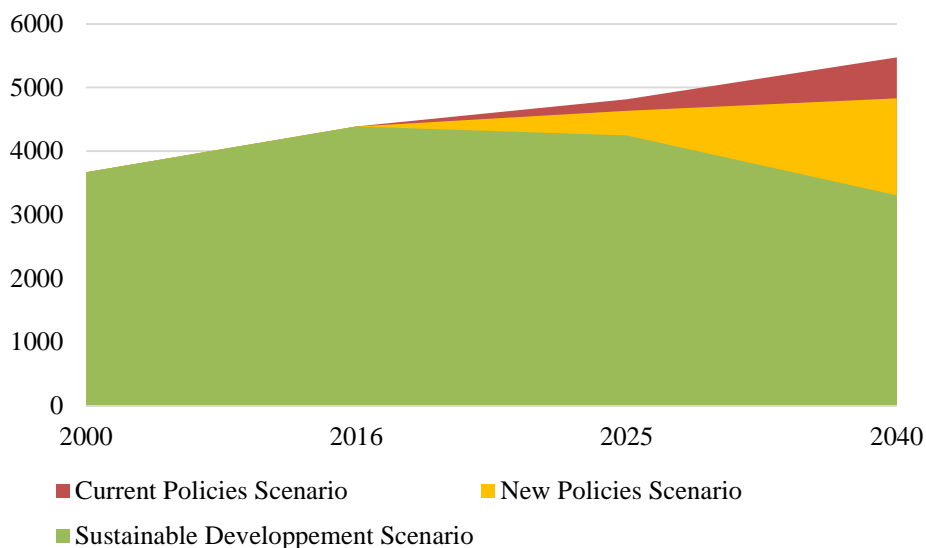
Source: PATSTAT

THE KEY ROLE OF TRADITIONAL ACTORS

If we are to define the outlines of a renewable energy geopolitics, we have to consider the consequences of their spread on the “traditional” actors of energy geopolitics, whose political and economic models will be transformed. These countries face many uncertainties related to ongoing changes in the energy sector and, in particular, on the international scene. Uncertainties regarding the pace of the energy transition, the future of oil demand (Figure 5) and future oil prices weaken the position of oil-exporting States, which are forced to take a number of strategic decisions in an evolving international context. Vulnerable to these changes to varying degrees, they will face the need to redefine their economic, social and political model and should reconsider their role on the international scene. Their economic attractiveness is likely to be affected, particularly by investors’ fear of seeing a multiplication of stranded assets – investments that will not be profitable over the life of the infrastructure due, in particular, to the implementation of climate policies.

In this context, the evolution of fossil energy prices is fundamental, and two theoretical strategies can be adopted by producing countries. The first reflects the choice to export their remaining reserves at low prices. The second is the cartelisation of producing countries, which would agree to maximise their unit margins by selling fossil fuels at a high price.

Figure 5: Oil demand in different IEA scenarios (in Mtoe)



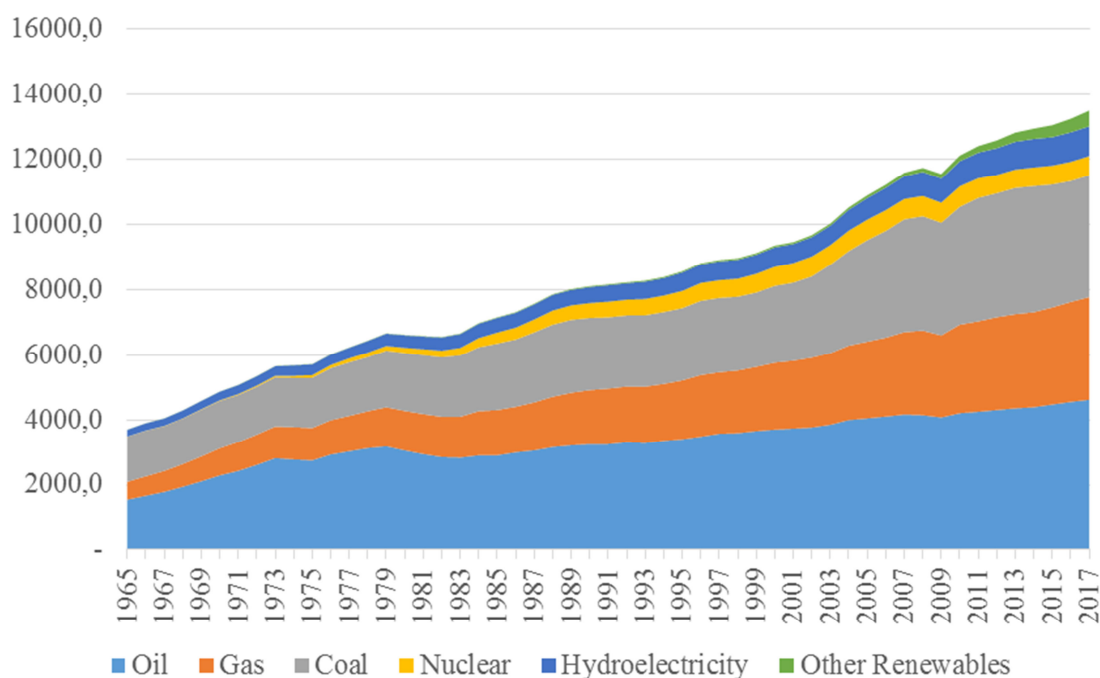
Source: IEA, World Energy Outlook 2017

Countries with fossil resources will choose between these two strategies according to the degree of diversification they wish to achieve. The diversification of their economies requires major investments that a fiscally constrained state will be more able to realise if it can generate significant income in the short-term from the use of its reserves. Oil prices and the stability of climate policies implemented by consumer countries thus remain key factors in the energy transition process. In the event of high uncertainty about the continuation of climate policies, hydrocarbon-producing countries will be encouraged to maintain the dependency of consuming countries by charging relatively low prices. Conversely, anticipating a gradual exit from fossil fuels would require the implementation of strategies to diversify their long-term economies.

TOWARDS A MORE COMPLEX GEOPOLITICS OF ENERGY

De Perthuis and Solier (2018) have made a historical study of past energy transitions and estimate “that one of the common characteristics of these energy transitions is to have reproduced an additive scheme in which new primary sources are added to those that already exist, without replacing them”⁵. With regard to global energy consumption data, consumption increased from 9,256 million tonnes of oil equivalent (Mtoe) to 13,511 Mtoe between 2000 and 2017, a trend that illustrates the addition of primary energy sources, but there is also partial substitution of the different sources. Oil, which represented nearly 50% of primary energy consumption on the eve of the first oil crisis, thus accounted for about 34% in 2017. This trend was partly offset by the increase in the share of gas (23.36% in 2017 compared with 17.2% in 1973), renewable energies (3.6% in 2017 compared with 0.13% in 1973) and nuclear energy (4.4% in 2017 compared with 0.8% in 1973). In absolute terms, all primary energy sources recorded a sharp increase, with oil (102%), gas (276%), coal (154%), nuclear (3,269%), hydroelectricity (246%) and renewable energy (8,293%) illustrating the trend of energy addition (Figure 6).

⁵ Christian De Perthuis and Boris Solier, “La transition énergétique face au tempo de l’horloge climatique”, *Connaissance des Énergies*, May 2018.

Figure 6: Energy consumption by sources (in Mtoe) since 1965

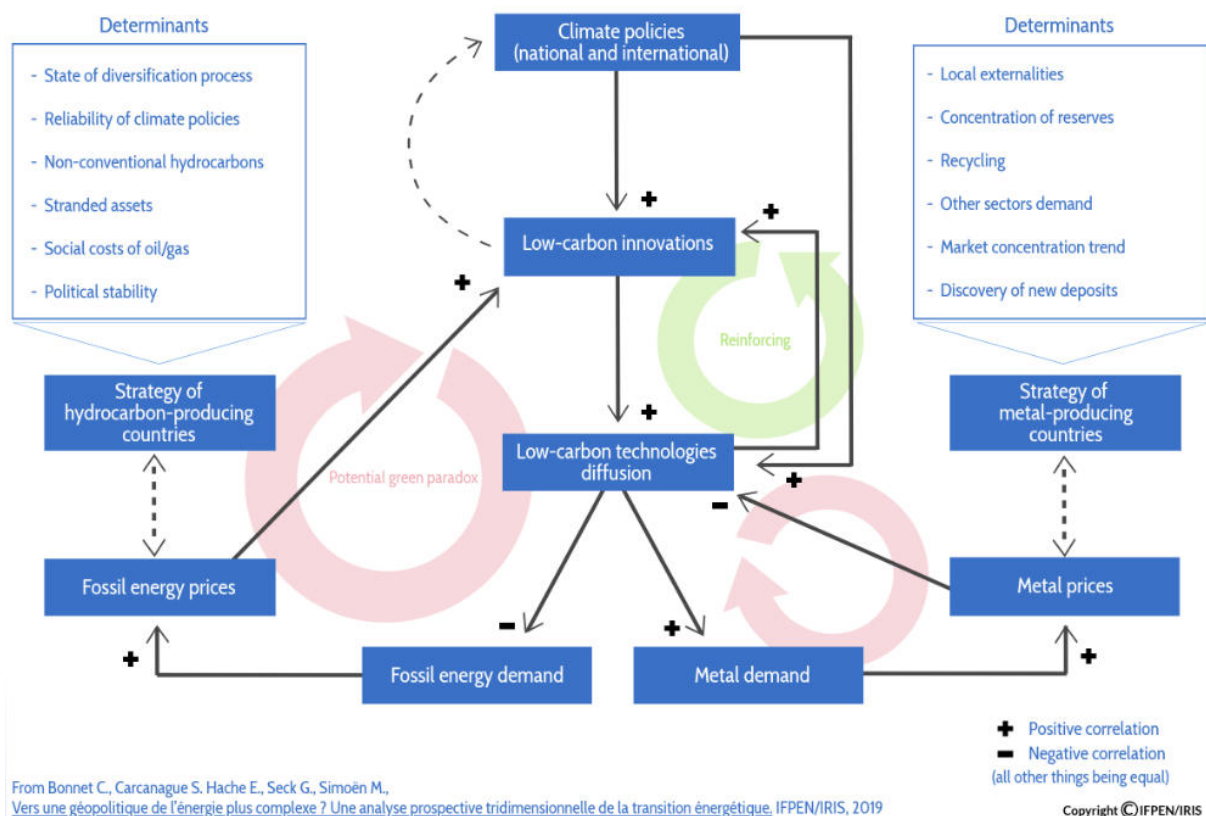
Source: BP Statistical Review, 2018

This dynamic has consequences for the understanding of the geopolitical issues raised by the energy transition. Indeed, in a world of energy source addition, the related issues should also add up and respond to each other to form a much more complex geopolitics of energy than that linked solely to hydrocarbons (Figure 7). The field of reflection opened by the energy transition is therefore vast and questions our consumption patterns and our understanding of technology, particularly with regard to the question of technological sobriety. More broadly, it questions our society's model, our vision of development and the way humanity approaches the fight against climate change.

Within this global framework, the global deployment of REs raises more new geopolitical issues than it solves. The question of intellectual property rights on low-carbon technologies and competition between States, the diversification models of oil-producing countries, energy security issues and new forms of dependence and how to overcome them (recycling and urban mines) constitute part of the global problem to be addressed.

In terms of international development, this dynamic questions the notion of economic confinement in certain specialisations for countries producing materials for the energy transition (Chile, Democratic Republic of Congo) and how they can diversify in the medium term. Finally, it raises the question of the Chinese economy, its energy model and the evolution of its manufacturing sector.

Figure 7: Complex System of a New Energy Geopolitics



Source: Authors

In terms of governance, the energy transition requires a distribution of collective efforts between the various actors and between the different geographical scales. While the generalisation of decentralised electricity grids could constitute a real opportunity for economic development in certain regions – such as Africa – it could also lead to strong territorial disparities and difficulty in understanding the notion of a national social contract, leading in the future to possible separatist temptations (O’Sullivan, 2017). For some countries, these developments thus raise questions about the role of the central government and its relationship with the periphery (territories, regions, provinces,

borders). Electricity networks, which are already fundamental in the current context, will strengthen their role as geopolitical nodes in the coming years with the development of large-scale regional networks (super grids). And while the issue of cybersecurity is often highlighted, a geopolitics of power cuts will have to be addressed. All these factors seem to converge on one point: the energy transition is fundamentally a geopolitical issue. ■

REFERENCES

ADEME (2017), « Les scénarios 2030-2050 ». <https://www.ademe.fr/connaître/priorités-stratégiques-missions-lademe/scenarios-2030-2050>

Alazard-Toux, N., Criqui, P., Devezeaux De Lavergne, J.-G., Hache, E., Le Net, E., Lorne, D., Mathy, S., Menanteau, P., Safa, H., Teissier, O., Topper, B., (2014). « Les scénarios de transition énergétique de l'ANCRE ». HAL Post-Print, halshs-01017874.

Alazard-Toux, N., Criqui, P., Devezeaux de Lavergne, J-G., Chevallet, L., Gentier, S., Hache, E., Le Net, E., Menanteau, P., Thais, F., (2015), "Decarbonization Wedges Report", Novembre, HAL Post-Print, hal-01241910, 55p.

Alazard-Toux, N., Criqui, P., Devezeaux De Lavergne, J.-G., Hache, E., Le Net, E., Lorne, D., S., Menanteau, S. Mima, F. Thais. (2017). « Scénario "loi de transition énergétique pour la croissance verte" de l'ANCRE : focus sur le mix énergétique ». HAL Post-Print, hal-01569649.

Alliance Nationale de Coordination de la Recherche pour l'Energie (ANCRE), (2015). Rapport Ressources minérales et énergie, 75p. (Disponible à l'adresse suivante : https://www.allianceenergie.fr/wp-content/uploads/2017/06/Ancre_Rapport_2015-Ressources_minerales_et_energie_0.pdf)

Alliance Nationale de Coordination de la Recherche pour l'Energie (ANCRE) (2014), "Les scénarios de l'ANCRE pour la transition énergétique", 115p.

Bonnet, C., Carcanague, Hache, E., S., Seck, G., Simoen, M. (2018) "The nexus between Climate Negotiations and low-carbon innovation: A Geopolitics of Renewable Energy Patents", Working Paper Economix 2018-45, 39p.

Bonnet, C., Carcanague, Hache, E., S., Seck, G., Simoen, M. (2019) "The Impact of Future Generation on Cement Demand : An Assessment based on Climate Scenarios", Working Paper GENERATE n°2, 44p.

Bonnet, C., Carcanague, S., Hache, E., Seck, G., Simoën, M., (2019) « Vers une géopolitique de l'énergie plus complexe ? Une analyse prospective tridimensionnelle de la transition énergétique », Policy Research Working Paper, Projet GENERATE, IRIS – IFP Énergies nouvelles – ANR, janvier.

BP Statistical Review of World Energy (2018), <https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html>

Clean Energy Manufacturing Analysis Center, (2017), Benchmark of Clean Energy Manufacturing, 208p. <https://www.manufacturingcleanenergy.org/>

Connolly, D., H. Lund, B.V. Mathiesen, et M. Leahy. (2010), « A Review of Computer Tools for Analysing the Integration of Renewable Energy into Various Energy Systems ». *Applied Energy* 87 (4): 1059-82. doi:10.1016/j.apenergy.2009.09.026

Crabb, J., M., Johnson, D., K.N., (2010). Fueling innovation: the impact of oil prices and CAFE standards on energy-efficient automotive technology. *The Energy Journal*, Vol. 31, n°1, pp. 199-216.

Criekemans, D., (2018) « Geopolitics of Renewable Energy Game and Its Potential Impact upon Global Power Relations », in Daniel Scholten (dir.), *The Geopolitics of Renewables*, Bâle, Springer.

Hache, E. (2016), « La géopolitique des énergies renouvelables : amélioration de la sécurité énergétique et / ou nouvelles dépendances ? », *La Revue internationale et stratégique*, n° 101, IRIS Éditions – Armand Colin, printemps.

Hache, E., (2018), "Do renewable energies improve energy security in the long run?", *International Economics*. Volume 156, Décembre, pp.127-135.

Hache, E., Palle, A. (2019), "Renewable energy source integration into power networks, research trends and policy implications: A bibliometric and research actors survey analysis", *Energy Policy*, 124, Janvier, pp.23-35.

Hache, E., Palle, E. (2017), "Intégration des énergies renouvelables (EnR) variables sur les réseaux électriques : méthodologies, scénarios et conséquences industrielles", *Rapport pour le CVT-Ancre*, octobre, 128p.

Hache, E., S., Seck, G., Simoen, M., Bonnet, C., Carcanague, (2019), Critical raw materials and transportation sector electrification: A detailed bottom-up analysis in world transport, *Applied Energy*, 40, pp.6-25.

International Energy Agency (IEA), « World Energy Outlook », Éditions 2011, 2012, 2013, 2014, 2015, 2016, 2017.

Newell, R., G., Jaffe, A., B., Stavins, R., N., (1999). The induced innovation hypothesis and energy-saving technological change. *The quarterly journal of economics*, Vol. 114, Issue 3, pp. 941-975.

O'Sullivan, M., Overland, I., Sandalow, D., (2017) « The geopolitics of Renewable Energy », Faculty Research Working Paper Series, Harvard Kennedy School, juin.

OECD (2018), *Global Material Resources Outlook to 2060. Economic drivers and environmental consequences*, Paris, Éditions OCDE, octobre.

Popp, D., (2002). Induced innovation and energy prices. *American Economic Review*, Vol. 92, n° 1, pp. 160-180.

Scholten, D., Bosman, R., (2016) « The Geopolitics of Renewables; Exploring the Political Implications of Renewable Energy Systems », Technological Forecasting and Social Change, n° 103, février.

United Nations Environment Programme, Bloomberg New Energy Finance, (2018). Global trends in renewable energy investment 2018, 86p. [http://fs-unepcentre.org/sites/default/files/publications/gtr2018v2.pdf](http://fs.unepcentre.org/sites/default/files/publications/gtr2018v2.pdf)

Verdolini, E., Galeotti, M., (2011). At home and abroad: An empirical analysis of innovation and diffusion in energy policy. Journal of Environmental Economics and Management, Vol. 61, Issue 2, pp. 119-134.

World Bank, (2018) The Growing Role of Minerals and Metals for a Low Carbon Future, Washington, juin.



Retrouvez toute la collection

<https://www.ifpenergiesnouvelles.fr/article/les-cahiers-leconomie>



228 - 232 avenue Napoléon Bonaparte
92852 Rueil-Malmaison
www.ifpschool.com



1-4 avenue de Bois-Préau
92852 Rueil-Malmaison
www.ifpenergiesnouvelles.fr

