Jean-Marie Rousseau, 18 May 2018*

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Could a Greener Economy Lead to a Polluted Planet?

There seems to be a worldwide consensus that "*fossil fuels are no longer the solution, they have become the problem.*" The French minister of the Environmental and Solidarity-based Transition, Nicolas Hulot, repeated this on December 12, 2017 (Île Seguin, Boulogne-Billancourt) at the *One Planet Summit*, that dealt with the financing of climate change policies.

The American president, Donald Trump, despite world pressure to make him reverse his decision to leave the *Paris Climate Agreement*, remains convinced that the commitment of his predecessor was "*very unfair to the United-States.*" Laying particular emphasis on the adverse impact of this Agreement, his main point was the targets set for the USA proved over-ambitious in comparison with those of its largest rival, China. In contrast, China, which is now the biggest consumer of energy in the world and the main polluter on the planet, is not only establishing itself as the leader in the battle against global warming, but also as the undisputed champion of renewable energy.

But isn't there a potential paradox here between this European quest for energy self-sufficiency and a growing heavy dependency on the suppliers of the strategic minerals essential for the production of renewable energy? Does this really genuinely allow us to associate renewable form of energy with cleantechs, solely because they don't pollute our immediate environment, while having a harmful effect on a global scale?

From "the nature of things" to "the "quietness of mind and soul"

It has been said that Boticelli's masterpiece "*Primavera*" was inspired by the Roman poet-philosopher Lucretius (98-55 B.C.) – "*De rerum natura*" (*On the nature of things*) - to break open the heavy locks at nature's gateway "and access the quietness of mind and soul".

Le Printemps, Sandro Botticelli (1482), Galerie des Offices, Florence

Some 455 years later, Raoul Dufy was to be inspired again by Lucretius "*On the nature of things*", for his monumental wall fresco (600 m²) of "*La Fée Électricité*" at the 1937 *International Exhibition* in Paris. Today, this ties together energy with the awakening of nature, enshrining the absolute triumph of the "*Electricity Fairy*" in a sustainable and environmentally friendly way.

La Fée Électricité, Raoul Dufy (1937), Musée d'art moderne, Paris

COP 21 resulted in a new international climate agreement, applicable to all countries, with the global objective of limiting global warming to less than 2°C by 2100 and reducing the impact of a climate change that is already in evidence. This need to combat climate change has forced countries to gradually refrain from the burning of fossil fuels. Today, such a scheduled victory for renewable energy would mainly be based on primary resources whose carbon footprint would favor the targets for reducing greenhouse gas emissions. In 2015, renewable energy already accounted for about 17% of our energy use – including 28% of our electricity. Similarly, in order to reduce pollution and greenhouse gas emissions, a growing number of countries have opted for the gradual replacement of cars with petrol engines by electric cars.

According to the latest available figures from the *International Energy Agency* (IEA) in the *World Energy Outlook*, the collapse in the cost of solar energy (-70% since 2010) and wind energy (-25%), has led to a sharp increase in the building of new facilities, particularly in Germany and in Denmark, even though this comes with massive subsidies. But it is China that is the biggest investor in solar power, and to such an extent as to represent 53 of the 160 gigawatts capacity installed worldwide in 2017. Through this dead-weight effect, Beijing does indeed aim to ensure its energy sovereignty and to fight against pollution, but it also aims to capture this incremental market

potential while controlling from upstream the entire value chain of this sector, thanks to its quasi monopoly in the supply of mining resources that are essential to technologies' storage… In addition, China has positioned itself as "the best student in the class", as the champion of global ecology against the United States, by displaying a policy which at least appears to respond to contemporary environmental challenges.

Surprisingly, the same political conformism is prevailing in countries such as Switzerland, though the holder of an almost totally low-carbon electric power park, is nevertheless considering adopting objectives excluding nuclear power (non-GHG emitter) simply to stay in line with the principle of caution. Perhaps even more amazing is the attitude of Norway, where the electricity production is almost entirely hydraulic, but which invests in renewable energy without any prospect of increasing the quality and security of its electricity supply. If Norway produces through hydroelectricity almost 100% of its electricity power at the lowest cost, it exports 99% of its abundant natural gas… However, even as a paragon of renewable energy, this country plans to launch the manufacture of electric vehicles and in turn scale up the inherent production of batteries, without properly assessing the impact on the national economy or the global carbon footprint.

The French *Agency for Environment and Energy Management* (ADEME), in its 2030-2050 energy vision, is planning several scenarios, inculding consumption composed solely of renewable energy, without paying attention to the raw materials required for this transition…

Wishful thinking of a world infinitely "renewable" …

Amid all this general euphoria surrounding renewable energy, there should be a thorough analysis, transcending all ideologies, of the reality of their deployment and the promises they hold. Renewable energy sources are intermittent by nature and thus require several additional services and devices to support efficiency – batteries, smart grids – for storage and the diverse means of transportation - to the consumer. In response to this need, it becomes necessary to work up the value chain, right at the starting point where renewable energy sources converge with information technologies and mineral resources, in order to maximise efficiency.

Sadly we must face the fact that the dirtiest technologies are not necessarily those that we have got into the habit of condemning. For instance, a 3.5-megawatt wind energy project consumes approximately 600 kg of rare earths but that's only the beginning of the story…

In fact, renewable energy remains subject to many intrinsic determinants, of which the intermittent supply is the key feature: the wind turbines can hardly produce electricity when there is no wind; photovoltaic panels also show little efficiency when the sun is not shining. Even if the source of energy is infinitely renewable, the device that converts it into electricity remains limited by its own technological capabilities. According to the *Energy Information Administration* of the US, renewable energy sources are characterised by very poor availability – 41% for onshore wind and 25% for the solar photovoltaic – compared to the performances of other types of energy, such as nuclear (90%) and gas (87%).

Recent studies by the French *National Alliance of Coordination of the Energy Research* (ANCRE) state that, for the same energy production, windmills and solar plants require up to fifteen times more concrete, ninety times more aluminum and fifty times more copper and iron compared to power generating plants based on traditional fuels. The six-megawatt and 170meter-tall wind turbines of the future will use about 1,500 tons of steel, about 70% times more than existing technologies. The next generation of 3.6- to 10-megawatt off-shore wind energy stations may require per unit between 1,200 and 1,800 tons of steel, from 350 to 500 tons/megawatts, that is, between 130% and 380% times more than the current consumptions. More than 800 six-megawatt wind turbines, that is, 1.2 million tons of steel, are needed to produce the same amount of energy as a 1,300-megawatt nuclear energy plant that contains three to eight times less steel, with an extended lifetime of four times longer. Each floating wind turbine would also use twenty tons of copper and several kilometers of undersea cables of copper linking them and reaching the continent. What are we therefore to make of the scheduled installation of 45,000 km of extra high-voltage lines in Europe?

Similarly, for hybrid and electric vehicles (HEVs), the batteries account for the most significant part of the investment in a dizzying race in terms of advanced technology capability and market domination. A hybrid car uses between 10 and 15 kg of rare earths

as well as many other minerals including platinoids. With increasing consumption of hybrid cars, the demand for minerals will present an ever-increasing risk. Finally, the electronic technologies used in the smart grids for the smart cities are equally as much consumers of strategic minerals.

The US company TESLA is attempting to position itself as the disruptive leader in the world lithium market while its "*Gigafactory*" – battery factory founded in 2016 in Sparks, Nevada – aims to produce 500,000 vehicles per year as early as this current year, with 35 GWh of electric capacity a year. While the medium-term targets (2040) of Chinese manufacturing is about 46% of the electric vehicles and batteries market, TESLA intends to emerge as the future leader of the world batteries' market, whereas a 2017 USB report estimates that the production of lithium, in order to deal with a market of 100% electric vehicles, will have to grow by 2,898% compared with current figures.

According to the *United Geological Survey* (USGS), the total proven world reserves of the metal lithium amount to 14 million tons – with a yearly production of less than 40 000 tons – the main holders of which would be Chile, Argentina and Australia. Even though probable reserves would extend considerably further – to around 50 million tons, mostly available in Bolivia, Chile, Argentina, United-States, Russia and China – a highly concentrated use of these resources should be recognised.

The ecological footprint of the energy transition is compounded by a production of strategic minerals requiring considerable energy in terms of extraction processes and also very sophisticated chemical and industrial processes. The almost sole control of this market by China can be explained by an *Energy return on investment* (EROI) still too haphazard and uncertain.

Global Climatic Warming versus Cold-Feet Attitude of a Hibernating Europe

Furthermore, either knowing or otherwise, according to the *NIMBY* syndrome (*Not In My Back Yard*), developed countries will be reluctant to pollute their inhabited regions as long as the disastrous consequences of the strategic metals' extraction may not be seen in their immediate environment.

The *French Committee of Strategic Metals* (COMES) seminar held in December 2017 in the *Grande Arche* of La Defense (Paris), confirmed the existence of particularly critical substances for current and future industries. The geo-strategic issues highlight the need to implement national or European policies with regards to mining extraction and exploitation: for instance, China accounts for 84% of the world production of tungsten, 87% of antimony while primarily producing rare earths metals, be they light or heavy, equal to 95% of the world level, whereas South Africa produces 83% of platinoids such as iridium, platin, rhodium, ruthenium, and Russia 46% of palladium… Similarly, a handful of 'must-have' metals for the various technologies of the energy transition, are mainly concentrated in a few countries: cobalt in D.R. of Congo at 64%, lithium in Australia at 33% and Chile at 33%, tantalum in Rwanda at 31%, in D.R. of Congo at 19%, Brazil at 14%, China at 5% and also copper in Chile (30%), Peru (11%), China (8%), USA (7%), D.R. of Congo (6%)…

Around fifteen countries control the strategic minerals' production, but China holds an obvious monopoly over many of them, with an ambitious industrial agenda, opening multiple rare earth mines on its territory, buying out its competitors, and, where necessary, casting a wide net over all the technologies that are linked to them. In fact, since the 1990s, western countries have relocated the extraction and refining of these raw materials in countries prepared to sacrifice their environment in order to boost their economy, foremost among them being China. This is what has taken place in France with Rhône-Poulenc – which is now Rhodia, one of the biggest chemical producers of rare metals in the world – the company gave up its production, transferring it in China and allowing, among other strategies, for the creation of one of the most polluting industries. In Baotou (Inner Mongolia, China), world capital of rare earths, highly toxic wastes are dumped into the lakes constituting, in a Dantean-like environment, the shameful reality of the energy transition. In fact, the concealment, in China and in some other countries concerned with mining extraction, of the dubious origin of the metals, has allowed green technologies or alleged "cleantechs" to be given a positive image, highlighting a contradiction, hidden for decades from the public eye: a greener world increasingly dependent on dirtier metals.

Bjørn Lomborg, Danish statistician, professor at *Copenhagen Business School* and director of the *Environmental Assessment Institute*, author of scientific books, including *The Skeptical Environmentalist*,

wrote in the *Wall Street Journal* on March 11, 2018 that: "*many of the elaborate and expensive actions now being considered to stop global warming will cost hundreds of billions of dollars, are often based on emotional rather than strictly scientific assumptions and may very well have little impact on the world's temperature.*"

Since 2011, during the crisis of Diaoyu/Sensaku islands, China, confronting what it considered as a threat to its sovereignty, prohibited exports of rare earths to Japan, therefore depriving its industry of key materials, and a few months later, established a quota policy for rare earths to all the western countries. The sudden public awareness of the Chinese monopoly on rare earths, has highlighted the vulnerability of western-countries. Already in early 2001, Laurent Désiré Kabila, president of the D.R. Congo, after announcing his intent to sign the "contract of the century" with China – for mining projects of copper, cobalt and coltan (columbite-tantalite) – was murdered… The principal African seaports are no more Dakar or Lagos, but Dar-es-Salam in Tanzania and Mombasa in Kenya, as a result of a particularly active Chinese strategy in Africa to fund in road and port infrastructure.

The United States is trying to restore a lasting balance and make the entire value chain of critical metals and strategic materials safer. In this sector, just as with most other sectors, the rivalry between the two superpowers of the twenty-first century, shapes the overall global competition.

The European initiatives will, however, be far overweighed by the Chinese and American policies, to mention just two examples – since we shall probably also have to take Russia into account. Sadly, this reflects a blatant lack of any room for manoeuvre for the European institutions. European society finds very difficult to accept the existence of polluting mines, alongside populations concerned – whether rightly or wrongly – by environmental issues.

***Jean-Marie Rousseau**, Brussels, May 7, 2018, is currently working as an independent consultant in Brussels in Territorial Intelligence and Regional Innovation Strategies [TAO-ITINeRIS] and yet actively contributed to many reports for international institutions and national or regional governments all over the world, including Europe, Mediterranean countries, South-America and China. He is member of CIFE's Scientific Council.

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