The Efficiency of the Energy Transition – Doubts and Clarifications

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Abstract

Decarbonization of energy represents a key goal of the fighting against global warming and in particular of the European "Green Pact", the Green Deal, proposed by the European Commission (EC) on 14 July 2021 to achieve carbon neutrality in 2050. This strategy will lead to the implementation of an energy system in which “clean” energy, the production and use of which do not emit CO2, would play a major role, in particular the electricity generation sectors (hydraulic, solar, and wind). Nevertheless, some people doubt the efficiency of this energy transition. The novelty of this paper consists in the analysis of the vulnerabilities in several areas of different technologies and raw materials that are essential in the strategic development of the energy infrastructure and economy. The practical objective is to understand what the new challenges are deriving from the implementation of the last environment strategy. We used comparative analysis to present the global renewable energy capacity storage in different parts of the world, as well as the descriptive analysis to emphasize the global energy investment in 2018, or the estimation of the world electric vehicles sales, by 2050. Considering the actual European geostrategic evolution, it looks like the EU's "green pact" as well as national strategies for the energy transition has not yet updated to the new realities concerning the renewable energy.

Keywords

global warming, renewable energy, “clean” investments, fossil fuels.

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Introduction

More and more often we hear the commitment of the European Community authorities to reduce CO2 pollution and increase the generation of energy from green sources. On the 14th of July 2021, the Commission announced a new objective regarding the EU energy mix: by 2030, 40% of necessary energy should come from renewable sources (European Commission, 2021). The consequence of this purpose is to reduce greenhouse gas emissions by at least 55% by 2030, compared with 1990 levels. In the document, there are mentioned other sectorial targets (buildings, electrical cars, aviation, industry, etc.). Political ambitions are also supported by technological developments that seem to further advance the generation of green sources (Sarbu et al., 2021). However, at the same time, we notice the popularization of some arguments in the media space, which come to contradict the feasibility of the energy transition (Diaconu et al., 2019). Whether it is about price or the stability of the renewable energy system, should these arguments be discussed in order to understand whether it is possible to have a successful energy transition or whether our social, political, and environmental goals are just unattainable ambitions?

1. Research methodology

To analyze what are the doubts are expressed in different public media regarding the “clean energy” performances and expectations, as research methodology, we use the methods the comparative and descriptive analysis. We have collected and confronted information from different databases and public sources.

2. Renewable energy cost

First, we have to see if we do not pay too much for renewables. To answer this question, we will start with the most frequently cited "problem" related to renewables, focusing on scientific arguments to see if these problems are or are not insurmountable obstacles to the energy transition (Angheluta et al., 2019).

An argument that challenges the feasibility of the energy transition has to do with price (Bodislav et al., 2020). To analyze this issue, we started from the data found in a paper published in the journal Energies between 2011 and 2018, $ 3.666 billion was spent globally on climate change projects. Of this amount, 55% ($ 2.030 billion) was spent on the implementation of solar and wind energy. According to global energy reports, the contribution of wind and solar to global energy consumption increased from 0.5% to 3% during that period. At the same time, coal, oil, and natural gas provided 85% of global energy consumption, the rest of 12% being covered by hydro and nuclear energy (ÓhAiseadha et al., 2020).

At first glance, these costs seem high and unjustified, given that they have increased the contribution of renewable energy to the global mix by only 2.5%. If we were to divide these investments over the 8 years (2011-2018), it would be about $ 250 billion spent annually on the implementation of renewable energy.

There is a debate since these numbers do not differentiate between capital expenditures and operational expenditures. An energy system totally based on fossil fuel-specific technologies would need to buy these fuels in order to function (so other expensive operational costs will be added in the final bill). On the other hand, investments in renewable energy are generally CAPEX-type, once the investment is made, they produce energy with low operating costs because those fuels come from solar or wind energy, respectively have an OPEX close to zero.

For a better understanding of how much that OPEX means for fossil fuel-based technologies, Overseas Development Institute and Climate Action Network - CAN (Whitley, Gencsu and Worall, 2020) shows that only 11 countries of the European Union spend around € 112 billion per year for production and consumption of the necessary fuels. If we extrapolate the number it means that about 1 billion EUR/ year is paid to companies that sell these fuels, in general, to non-EU countries (such as Russia, the US or Saudi Arabia, major oil producers). This EU-specific amount is almost double that of all annual global renewable energy investments.

It is important to understand the context of global energy spending. According to the International Energy Agency, total energy investments in 2018 were $ 1.850 billion. Of this amount, approximately $ 1 trillion has been invested in projects related to the extraction, refining, and construction of new thermal power plants dedicated to fossil fuels. Only $ 300 billion has been invested in renewable energy.

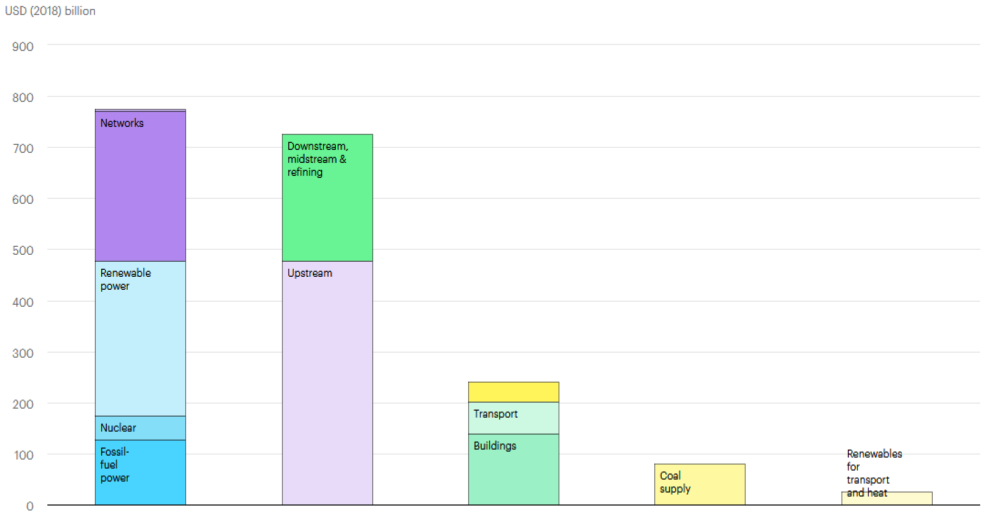

Figure no. 1. Global energy investment in 2018
Source: International Energy Agency, 2019

Moreover, according to the researchers from the International Monetary Fund (Coady and International Monetary Fund, 2019), the countries of the world subsidized in 2018 with approximately $ 5 trillion the purchase of fossil fuels. And this money represents just subsidies; the total cost of purchased fossil fuels is therefore much higher. Annual investments in renewable energy were $ 300 billion in the same year, about 20 times lower (if we include the $ 1,000 billion dedicated to investments in fossil fuels).

Therefore, saying that the cost of investment and producing green energy is too high omit the fact that we don't see the full side of the picture, namely that we cannot talk about the price of renewables without understanding how much we spend on fossil fuels and energy in general.

3. Renewable energy density

Another issue highlighted by the opponents of "clean energy" is the density of renewable energy, which requires more space than equivalent fossil fuel systems. Do we lose useful space?

Wind, solar, or biomass have low spatial densities, in other words more space is needed to install "clean energy" capacities. But the versatility of renewable solutions must be emphasized. For example, solar panels can be installed on the roofs of buildings, requiring virtually no additional dedicated space. Moreover, they can be installed in spaces that are not used for other purposes, such as in the desert, swampy areas, or even on the surface of the water. Wind turbines can be placed offshore, which cannot be done with a coal-fired power plant. Such systems can be distributed in many locations in different capacities, which cannot be said of a nuclear power plant. Distributing energy production among smaller or larger producers over a more diverse geographical area means lower costs of energy production and transportation, as well as access to energy for disadvantaged communities, which can help solve the problem of energy poverty (Simon, 2021).

Biomass, in sustainable quantities, can be an important resource, despite its low energy density. Currently, these resources, such as forest and agricultural waste, are stored or incinerated without energy recovery and with high greenhouse gas emissions. For example, the production of biogas from animal or human manure is a method of treating waste that captures methane gas, which would otherwise be released into the atmosphere (methane being a strong greenhouse gas). Dry forest residues can be converted to liquid or gaseous fuels in processes that can even store carbon in the soil or be used as fertilizer (Mohammed, Kabbashi and Alade, 2018).

In other words, although they have lower spatial densities than fossil fuel systems, renewable solutions can mostly use those surfaces or resources that would otherwise be wasted, and can be a step forward in streamlining the way we exploit them. It is too simplistic to talk about the fault of renewables in the exploitation of useful space, when the non-use of these resources could even limit our useful space in some situations, leaving room for more fossil fuel exploitation.

4. Renewable energy variability

Another criticism of renewable energy is its variability – the problem when the wind is not blowing. Specifically speaking, it is about the discrepancy between electricity production and consumer energy demand, and the lack of the so-called "base load" (Matek and Gawell, 2015). In other words, how do we produce the energy we need from the solar panel if we don't have sun during the night or from the wind when we don't have wind?

Renewable energy is variable because it is dependent on the movement of air masses (the presence of wind), or the number of hours of sunshine for solar. Numerous studies (Brown et al., 2018) have already demonstrated the feasibility of energy systems with a high degree or even 100% penetration of wind and solar energy. For example, Denmark already has an average of 50% of its electricity from wind sources, and on many days of the year, more wind energy is produced than total electricity demand. Currently, this energy is exported to neighboring countries, but in the future, it can be stored in batteries, as thermal energy, or in the form of alternative fuels. The issue of energy storage is covered in the next section.

However, the is one thing that is often overlooked or misunderstood by critics of renewable energy is that renewable energy systems will not work like they do today. Specifically, in a classical energy system, such as today, fossil fuels deliver the energy needed for each sector. One part of fossil fuels will be used for electricity production; another side of fuels will count for heating production, other fuels for industry, and other fuels for transportation. Future renewable energy systems will be more integrated and efficient because they will not waste as much energy as current ones. This maximizes the use of renewables and makes feasible systems based on 100% renewables. Somehow, this situation should reassure most of the developed countries that are afraid of electricity shortages. For example, the highest risk perceived

Switzerland experts is power shortage, as great as the risk of pandemic (Swissinfo, 2015). It was calculated that in such a situation, the economy will suffer a loss of 105billion USD; for a better understanding the GDP of Switzerland in 2020 was 752 billion.

The variability of renewable energy is often understood as a factor of instability as if we will have to accept that in the future we will live in a continuing power outage if we make this transition. There is no basis for this statement; on the contrary, experience so far indicates that future energy systems maybe even more stable than existing ones. The example comes again from Denmark, which, although it has the highest penetration of renewable energy, also has the fewest power outages in Europe (Danish Ministry of Climate Energy and Utilities, 2019).

5. Renewable energy storage

Another criticism of renewable energy is that of energy storage. Can we produce enough batteries? This criticism says that huge storage capacities in batteries or storage lakes are needed to cope with only a small part of the current energy demand.

Unquestionably, fossil fuels have the advantage of being stored in solid (coal), liquid (oil), or gaseous (natural gas) form at minimal costs for an indefinite period. On the other hand, renewable energy, mainly represented by wind and photovoltaics, is more difficult to store because it comes under an electrical form, which requires batteries or hydropower, and this type of storage is a very expensive solution, unsustainable and dependent on the geographical area, requiring enormous storage capacity.

Today, according to Bloomberg, it is estimated that global energy storage can grow from 942 GW in 2018 to 2,857 GW by 2040. It is also believed that this can be achieved by an investment of 620 Billion USD over the next 22 years. So it is obvious that there is a huge potential investment into the storage capacity during the next decades.

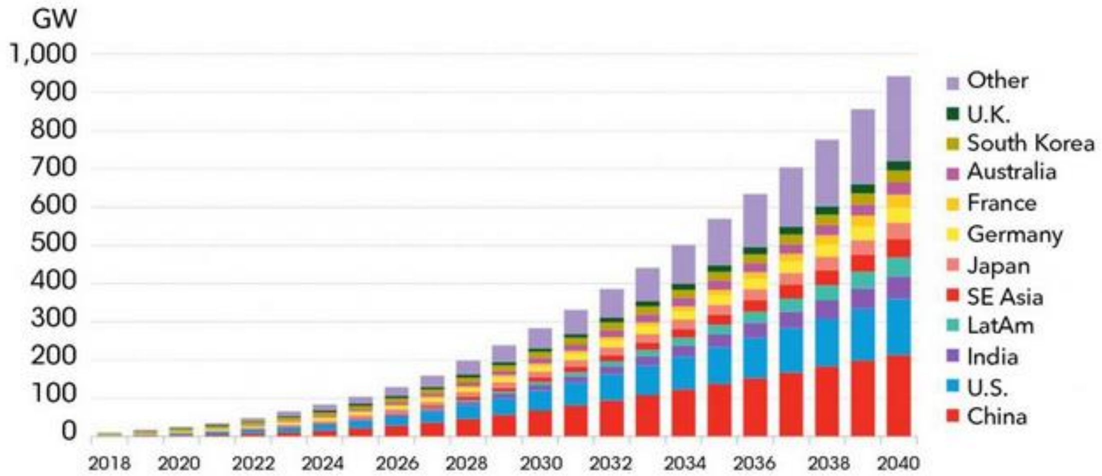

Figure no. 2. Global renewable energy capacity storage

Source: Henze, 2018

However, what is not explained is that no one will make the transition to renewable energy just by installing batteries and wind turbines. Although batteries are imported in some situations, such as electric vehicles, there are other technological solutions to store this energy, which can be cheaper and more feasible. Electricity from wind and photovoltaics can be converted into thermal energy or liquid or gaseous fuels. This is also desirable, as thermal or gaseous or liquid fuel storage media are cheaper than direct electrical storage.

6. Battery production

In the previous section, we mentioned that in some cases batteries are needed to store renewable energy. Do we have enough resources? The most discussed method of storing electricity in batteries is in electric vehicles. However, an issue that is often debated when it comes to electric cars is the resources used to produce these batteries, which would make electric cars more harmful to the environment than internal combustion engines.

Rightly so, battery production is not the most environmentally friendly, at least not yet. Concerns are mainly about the need for cobalt, lithium, nickel, or copper but also about carbon dioxide emissions.

However, this approach is not the real truth, and all these difficulties are often exploited by oil companies as a way to increase distrust in the potential of electric mobility. A recent report by the Transport & Environment think-tank in Brussels indicated that in fact most of the materials used in the production of batteries can be recycled. They estimate that only 30 kg of material is practically unusable after the end of the life cycle of a battery (which continues even after the machine is taken out of use). On the other hand, the materials lost during the life of an internal combustion vehicle are 300-400 times larger, an internal combustion engine using no less than 17,000 liters of fuel during the period of use (Mathieu, 2021).

On the energy consumption side, studies show that over the throughout a lifetime, an electric car uses 58% less energy than its gasoline-equivalent. Even with current production methods and the existing energy mix at the EU level, which is still based on fossil fuels, an electric vehicle emits an average of 63% less lifetime CO2 than its fossil fuel equivalent (Choudhury, 2021).

The current dependence on petroleum products to meet EU transport demand is several times higher than the demand for battery-powered materials even in the scenario where all cars in Europe become electric by 2035. The report also indicates that in the future, fewer raw materials will be needed to produce batteries as a result of improved production processes. By 2030 alone, the amount of lithium can be halved, that of cobalt can be 4 times lower, and that of nickel can be one-fifth less.

The number of electric cars is predicted to grow extremely fast. It is predicted that sales of EVs will exceed the combustion engine cars in 2033 (Europe, China, and the U.S.). Europe will tip the scale in favor of electric cars in 2028 (Bloomberg, 2021). The lithium-ion batteries that equip the vast majority of electric cars, use a dozen materials that, in addition to lithium, graphite (in the anodes), cobalt (in the cathodes), and possibly titanium, silicon, and niobium are considered critical; manganese and nickel could be used in new anodes.

Other studies found that 1 billion of batteries electric cars will be on the roads by 2050.

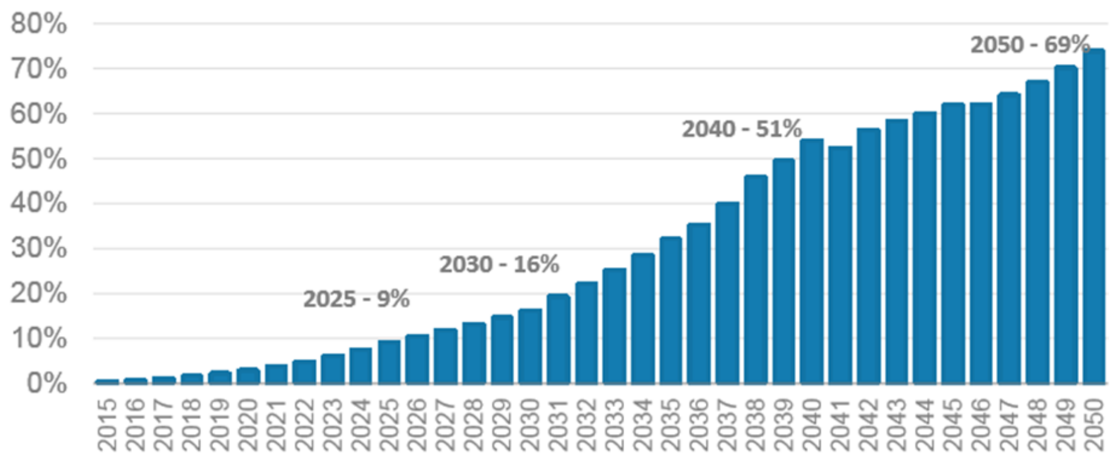

Figure no. 3. World EV sales

Source: Mirhaydari, 2017

Year after year we find out that the numbers of EVs are expected to grow in a faster path. The International Energy Agency (IEA) estimates that metal ore reserves can meet demand, but their concentration would decrease (this is already the case for copper and lithium) so an increase in production costs is likely (with higher consumption), unless new metallurgical processes increase extraction yields and metal recycling makes progress - currently very limited for rare-earth (Papon, 2021).

It is also good to know that not only batteries use cobalt, but many other industrial processes, even the production of fossil fuels. Batteries use only a portion (true, and most) of cobalt production, but batteries are already used in many other products. However, companies such as Tesla already use much less cobalt in the production of their batteries, and will even remove this material from their composition in the future.

In other words, there is a lot of room to improve the production process, but only and only combined with high battery recycling rates. The environmental impact of battery and vehicle production is still high, but the potential for reducing this impact is much greater than for internal combustion vehicles.

Conclusions

It is important that when debating future energy solutions, we balance all aspects of them. It is also important to be informed about all technical advancements because the choices made today will remain with us for decades to come.

This paper does not pretend to be considered complete or to present optimal solutions but seeks to present a more objective and scientifically based perspective on future energy solutions. In this regard, it is important to make sure that the information we read is sufficiently contextualized and based on multiple studies and scientific arguments. Unfortunately, we are increasingly faced with criticisms regarding the renewable solutions that are intentionally misled, presenting only half-truths and avoiding the broader context. Or if we are to have an effective dialogue, it needs to be transparent and inclusive.

The "zero-carbon" strategy makes it necessary: investment planning to ensure the security of supply, a policy to promote technical innovations, especially in metallurgy and for metal recycling.

The EU's "green pact" as well as national strategies for the energy transition has not yet taken into account the new geopolitical situation of the rise of renewable energy: access to "critical" materials will be a major geopolitical issue, as the risk of market dominance by producers cannot be ignored.

It is also necessary that responsible public institutions improve their communication, in order to not let the snowball of mistrust roll too much; otherwise, at some point, it will be complicated to get all people on the same boat. To produce fast results, having all parties pulling in the same direction is a must.

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