Objective Requirements for an Effective Transition to a Green Economy

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Abstract: The paper presents a critical analysis of the current approaches of the transition to a green economy also known as a "net zero" economy. The analysis is based on the identification of two hard constraints (defined as "availability condition" and "affordability condition"). The analysis puts into perspective previous technological and energy transitions that happened due to technological and market economy forces with administrative / volitive transitions in which significant changes of the economic and social environment are intended resulting from changes in the rules of the game and from mandatory standards. In this context, the paper presents several clarifications and recommendations that should be considered in order to achieve an effective and efficient transition without incurring societal and economic consequences.

Key words: green economy, technological transition, environment, Anthropocene

JEL classification: O13, O14, Q28, Q42, Q54, Q55

1. Overview on the objective necessity of limiting the impact of human activities on the environment

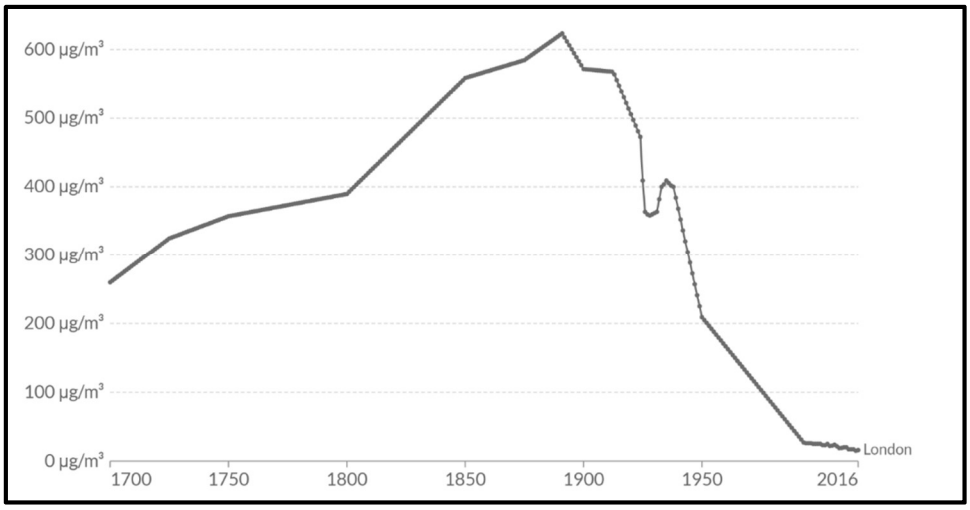
An awareness of the impact of human activity on the environment has existed for a very long time and has manifested both **locally**, in very specific circumstances, and **as a rather general idea** without any concrete strategies, targets and deadlines being set.

In the first category (local manifestations of the awareness of the impact of the human activity on the environment) we can mention the regulations on the burning of sea coal adopted in England during the reign of King Edward I (1272-1307) and revised by later monarchs, including by a tax on coal introduced in the 14th century (Alfred, 2008). A commission regulating the use of coal in London was established during the reign of King Henry V (1413-1422). More than 400 years later, in 1876, the British government established a Royal Commission on Noxious Vapors whose mission was to monitor and take measures against the air pollution caused by industrial and domestic activities. Even if these very early regulations concerning the London area or the whole of Britain during the 1st Industrial Revolution may appear as historical curiosities, their continuous observance and improvement have led centuries later, to tangible results (Wilson & Spengler, 1996), as reflected in Figure 1.

The historical data presented in Figure 1 leads us to 3 remarks, two pessimistic and one optimistic:

- A pessimistic remark is that, as far as London area is concerned, it took almost two centuries from the beginning of the 1st Industrial Revolution (around 1750) and from the implementation of various measures aimed at pollution control until a significant achievement of reduction of pollution could have been recorded;
- Another rather pessimistic remark is that it took more than a century from the moment pollution started to decline (around 1900), until a considerably lower level of pollution was achieved (after 2000);
- The optimistic remark is that pollution can be significantly reduced provided that long term, consistent efforts are made. In any case, the reduction of pollution in London area may also have certain complementary explanations related to relocation of industrial activities in other parts of the world – in the context of the globalization process, of technological innovations, of the orientation of activities towards services specific to developed countries or regions, etc.

Figure 1. Air pollution in London 1700–2016, micrograms per cubic meter



Source: Our World in Data, based on Fouquet, R., 2011: Long run trends in energy-related external costs, in volume Ecological economics, Elsevier, Volume 70, Issue 12, 15 October 2011

In our opinion, this case study is relevant because London is a large metropolitan area comprising 9.541 million inhabitants (as of 2022), as well as the capital of the country where the 1st Industrial Revolution started almost 250 years ago. At the same time, there are obvious limits in the attempt to extrapolate London's experiences and achievements in pollution control, because in its case we are talking about a large city with a coherent management, while if we analyzed a country as a whole, not to mention a continent or the entire Earth, it is much more difficult to secure a coherent and consistent management, especially over a long period of time. Speaking about large geographical regions, about continents or about the Earth as a whole, an important observation is that there are and there always have been important discrepancies in terms of development between regions of the same country, between countries and continents. Therefore, the availability of coherent management, knowledge, human skills, technologies and financial resources is very different and any single solution regarding the transition to a green economy may be difficult or even impossible to implement in a successful way during a given time interval.

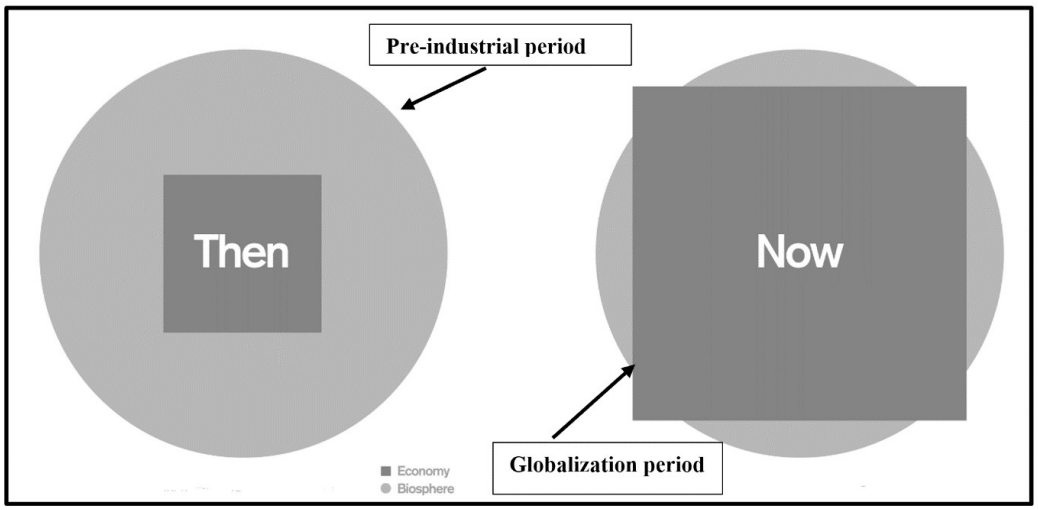
In **the second category** (a general and diffuse awareness regarding the impact of the human activity on the environment) one can first of all mention, from a chronological point of view, the reactions to illnesses that affected the cities of the Middle Ages because of the improper sanitation and waste disposal, particularly of biological waste (Castelow, 2019). In today's terms we could speak about biological pollution even if during those times the concept of pollution had not been invented yet.

Later on, reactions to environment pollution became more visible in relation to the consequences of economic activities, for example because of the large-scale use of coal during the 1st Industrial Revolution and after the beginning of the 20th century because of the large-scale use of internal combustion engines (Kiger, 2021). During this historical period (the late 1700s to about 1918) such reactions had been mostly related to local situations and very few people tried to look at the effects of the human activity at a global scale. The approach was rather based on the idea that while dangerous environmental and health-related concerns were likely to emerge at a local level due to the impact of human activities on the environment, the Earth as a planet was large enough to cope with the polluting results of human activities.

The much larger scale of the human activities undertaken after World War II, particularly in the context of globalization, made people aware of the impact of human activities on the environment, and especially on climate. Anyway, it took many decades until the concept of the "Anthropocene", a new geological era in which human activity modifies and determines the characteristics of the environment became widely accepted within the scientific world (Carrington, 2016), even if it was only validated officially in 2022 by the International Commission on Stratigraphy (Subcommission on Quaternary Stratigraphy, 2019).

If we look at the relation between economy at a global scale (human activities) and the environment, a fundamental difference appears between the period that starts with the pre-industrial era and concludes after of the World War II and after the period when globalization manifested itself most visibly (approximatively between 1980-2010) – Figure 2.

Figure 2. Relation between human economic activities and the biosphere during the pre-industrial period and during the globalization period



Source: Adapted from Global Footprint Network – Annual Report 2012, p. 21.

We can speak about a global awareness of the effects of human activities on the environment after the 1992 United Nations Framework Convention on Climate Change (UNFCCC) which recognized the existence of the global warming phenomenon and of the human responsibility for it. Several updates and extensions of the initial decisions were adopted in the following years, most notably: the Kyoto Protocol (1997) and the Paris Climate Agreement (2015) which replaced the Kyoto Protocol starting with 2016.

There are several differences between the two international agreements, but the following are significant in that they reflect the changes in the awareness of climate change and of human responsibility (Benduski, 2020):

- The Kyoto Protocol sought a reduction of greenhouse emissions by 5.2% below the 1990 levels, while the Paris Agreement aims at a limitation of global temperature increase to 2 degrees Celsius above pre-industrial era, with a more ambitious target of limiting the increase to only 1.5 degrees Celsius;
- The Kyoto Protocol referred to developed countries as being responsible for the reduction of emissions while developing countries were not targeted. It must also be mentioned that the US, a large source of emissions, did not ratify the Kyoto Protocol;
- The Paris Agreement provided obligations for all countries, developed and developing alike, irrespective of their responsibilities for past emissions;
- The Kyoto Protocol referred to 6 gases contributing to climate change, while the Paris Agreement refers to all gases influencing climate change;
- The timeframe for the Kyoto Protocol, which entered into force in February 2005 for the countries that ratified it, was shorter as its targets were supposed to be met by 2012, while the Paris Agreement, that entered into force in November 2016, has a longer perspective, i.e. 2025-2030.

2. Objective requirements for an effective transition to a green economy

We emphasize in this paper that it is necessary for certain requirements to be met in order to achieve an effective transition to a green economy. The objective nature of these requirements results from the fact that any large-scale transition from one type of economic and social organization of the human society to another should meet **2 conditions**, regardless of the level of development, of the political system, of the spiritual beliefs or of any other parameters describing the societies where such transitions are attempted:

- The access to energy and essential raw materials must be secured at all times **(the availability condition);**
- The prices for various forms of energy and essential raw materials should be affordable for the vast majority of population and for the economy **(the affordability condition).**

A failure in meeting one, if not both of these two conditions would lead not only to not achieving the proposed transition but also to social unrest, political changes, disruptions of economic activities and even wars for food, water and energy.

In order to fulfill the **availability condition,** human societies and their decision-makers seeking to make the transition to a green economy should pay attention to a very important requirement that refers to **technological capabilities**. This requirement related to technological capabilities should answer the following questions:

- Are there any feasible and mature technologies that can replace the existing ones which pollute the environment and generate climate change?
- How long does it take for these technologies to reach the maturity and stability required to make them feasible for large scale deployment?
- How long does it take to fully replace, at a global scale, the existing polluting technologies with new ones that are much less polluting or not at all?
- What is the cost of this large-scale deployment of non-polluting technologies and who is paying this cost?
- What happens during the transition period from the existing economic and social framework to the new one which defines the green economy?

Essentially, we could say that the technological capabilities of economies and of humankind as a whole are fundamental for starting and implementing the transition to a green economy. These technological capabilities are determinant for:

- What can be done?
- How long does it take to be done?
- Who can do the transition?
- How can transition itself be designed in a way as that ensures the continuity of economic and social activities?

The above statements can be illustrated by the fact that we can all agree to stop polluting the environment, we can all agree that electric cars are environment friendly, but our wishes do not transform by themselves into reality if we can non produce enough electrical cars, we do not have financial means to buy them, we do not have enough electricity and supply networks to charge the batteries, etc.

The fact that a city or a region can implement the transition to electric cars does not imply that the entire humankind can do so, and hence the problems related to:

- **a fair transition** (affordability of the transition for all);
- **a comprehensive transition** (transition for all humankind or at least for the vast majority of it);
- **an immediate or short term transition** (transition over a short period of time), etc.

From the perspective of the **accessibility condition,** the following questions must be answered before any serious attempt at an effective and efficient transition to a green economy:

- What happens with the countries / regions / populations that do not possess the technologies, the skilled labor force and the financial resources to replace the existing technologies with new ones?
- Is it possible to conceive a fair transition that will not leave any category of companies, of entrepreneurs or persons, age groups, minorities or any other social categories behind? A fair transition should be attempted within the countries, but also among the countries, whether developed or developing.
- Is it possible to avoid unfair advantages for the early adopters or for financially potent countries, companies or individuals who are able to make the transition, compared to countries, companies or individuals who are willing but are not able to do so?

In order to find valuable and pragmatic answers to at least part of these questions we can look at previous technological transitions which had a rather natural evolution, meaning they were not imposed or accelerated in any way by administrative methods. Fortunately, such examples are available in the recent periods, i.e. in the 32 years that passed since 1990. During this time important transitions took place in many parts of the world in a natural way:

- From fixed telephony to mobile telephony and then from simple cellular phones to smartphones;
- From telex and telegram to fax machines and then to the internet;
- From black and white to color TV and then to high-definition TV (4K, 8 K, etc.);
- From TV reception based on radio waves and antennas to cable TV and internet based TV;
- From film based cameras to digital cameras and then to smartphone cameras;

- From mainframe computers to PC, notebooks and laptops, tablets, etc.;
- From maps and radio communication for navigation to GPS;
- From local computing and storage to cloud computing and storage.

The examples are much more numerous, but most people have experienced these technological transitions in a personal way and still have vivid recollections of the "before" and "after" situations. It is true that some countries moved faster than others in these transitions and some of the technologies were available sooner in developed countries (some of these technologies were available even before 1990 such as color television or cable TV). But the world economy and humankind as a whole made these transitions after 1990 in a natural way and without any significant disruptions.

More related to the transition to a green economy are **the energy transitions** of the past 250 years (Bhutada, 2022):

- Before the beginning of the 1st Industrial Revolution people relied on biomass (wood and other combustible materials of resulting from agricultural activities) for domestic and economic activities and to a lesser extent on energy from the wind and water. The share of biomass in the global energy mix varied from about 98.3 in 1800 to 6.7% in 2020.
- **The first significant energy transition** was the transition to coal that took place after the beginning of the 1st Industrial Revolution and which marked a substantial increase of industrial output and of transports. The share of coal in the global energy mix increased from 1.7% in 1800 to a maximum of 54.4% in 1920 and declined afterwards to about 22.5% in 2020.
- **The second significant energy transition** took quite a long time (approximatively between 1859 and the early 1960s) and was characterized by a gradual increase of the use of oil and gas that were more and more involved in various industrial processes, in transports of all sorts (by land, sea, air, etc.) and in the generation of electricity and heat. What is remarkable is the fact that coal continues to be in 2022 the energy source used for generating about 33% of world electricity. The use of oil in the global energy mix was of 19.1% in 1950 while the use of natural gas was of 7.3% in the same year. These percentages have increased to 35.1% for oil in 2000 and 19.7% for natural gas.
- **The third significant energy transition** started after 2000 but the changes are not impressive. Between 2000 and 2020, the share of renewables in the global energy mix increased from 6.6% to 11.2%, fossil fuels actually increased from 77.3% to 78%, while nuclear energy declined from 5.9% to 4%.

From the above examples results that by **technological transitions or energy transitions achieved in a natural way** we have in view a transition characterized by:

- The emergence of new technologies that are made available gradually on an increasingly larger scale;
- Initially high prices that limit deployment, but on the medium term the new technologies enter the commoditization phase in which practically everybody (person or company) is able to afford them;
- New management techniques and forms of organization of companies and institutions are implemented in correlation with the deployment of new technologies, and what starts as a pioneering activity ends by becoming the norm. An important indicator of the large-scale adoption of new technologies is their implementation in public institutions and their transformation into commodities for the average persons.

As a result of these characteristics, the technological transitions that humankind experienced over the past 32 years as well as the energy transitions that happened since the 1st Industrial revolution were characterized by:

- A gradual implementation to avoid sudden disappearance of goods and services, jobs, international economic relations, etc.;
- Coexistence with previous technologies over reasonable periods of time;
- Affordable prices (at least in their later stages) to avoid certain socio-economic categories, regions or countries being left behind.

3. Natural versus administrative / volitive technological transitions

While the above-mentioned technological and energy transitions took place to a large extent without being in any way imposed by decision-makers, scientists or business circles, in case of the transition to a green economy the situation is different and differentiated by country or group of countries.

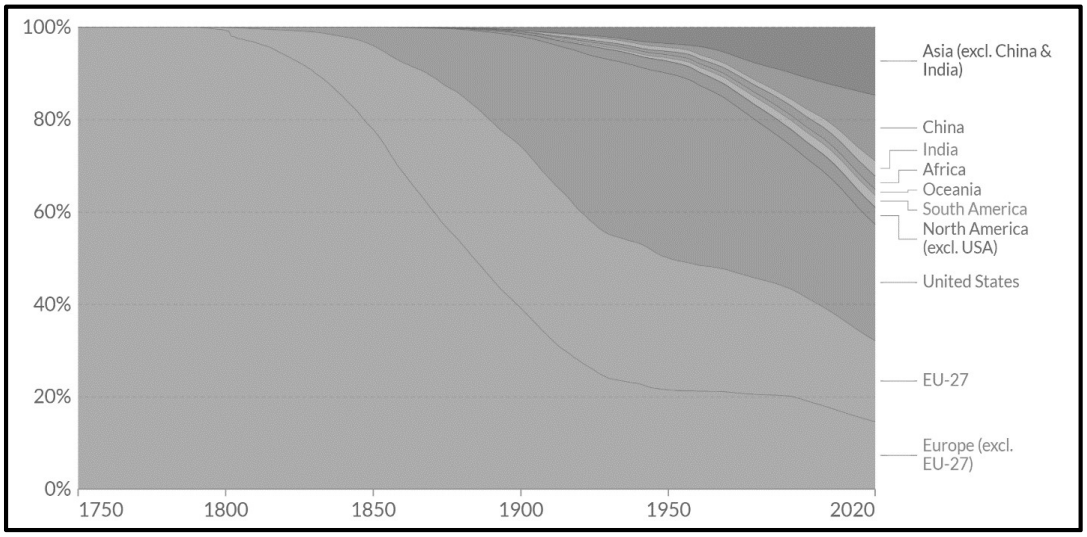
In this second case, some countries and particularly the European Union (as an organization reuniting a group of countries) have decided by means of administrative methods (normative approach) to implement certain interrelated fundamental transitions in a short to medium term:

- **from classical sources of energy to new sources of energy** which are not available on a large scale and in the required quantities, are not feasible and available at all times and are not affordable in terms of price;
- **from classical technologies to new technologies** which (with some exceptions) are not mature and stable, are not available for deployment at a global scale, lack adequate infrastructure, are prohibitively expensive, etc.;
- **from a comparative and competitive approach of the economy,** which governed international economic relations since Adam Smith and David Ricardo to the present days, **to an approach based on the responsibility for future generations and the future of planet Earth.** The problem with this approach is that it does not guarantee the results (a net zero or green economy at a global level) but expresses good will and good wishes. At the same time, this approach is not accompanied by official statements of renunciation to market economy and capitalism.

Some comments and clarifications regarding these otherwise well intended transitions related to the establishment of a green economy are necessary:

- the vast majority, if not all people, fully agree that preserving the environment, minimizing the climate change and securing a sustainable existence of economies and societies represent timely, justified and ethical goals;
- the vast majority, if not all people, fully agree that climate change is real and its economic and social implications are so substantial that they should be avoided or at least diminished to the maximum extent possible;
- the contribution of scientists and engineers to the design of such transitions is fundamental. **The decision to initiate the above-mentioned transitions is political, but their design and implementation are not.** Public exhortations of politicians, NGOs or true believers may play a useful role, they are definitely necessary, but they are not essential in achieving the desired goals. Arbitrarily chosen dates such as 2030 or 2050 (just because the figures are rounded or because some forecasts have determined that by these dates certain points of no return in climate change will be reached) as well as annual targets determined by arithmetical operations (if we want zero emissions in 2050 how much do we have to cut each year) only give the impression of a plan. The point we want to raise here is that **the decision** to reduce the impact of the human activity on the environment in such a way that it may guarantee environmental neutrality **is right**. The design of the transition and particularly how to ensure the continued supply of energy and essential raw materials during the transition period represent technical challenges that can and should be solved by scientists and engineers.
- The decisions in favor of a transition towards a green economy also raise issues related to legitimacy and ethics. The vast majority of emissions that have polluted the Earth originates in the developed countries of today – Figure 3. At the same time, the transitions to new sources of energy and new technologies are costly and many developing countries (which are not responsible for today's pollution) cannot afford them. Under these circumstances, are the developed countries of today, which contributed to the largest extent to the pollution, in a position of legitimacy to request those which did not generated the largest part of pollution to implement technologies they cannot afford? Are they ready to provide to these developing countries the financial assistance required for implementing the transitions? The COP 26 that took place in Glasgow in October 2021 gave a negative answer to that.

Figure 3. Cumulative CO2 emissions by region between 1750-2020



Source: Ritchie, H., Roser, M. (2020): "CO_2 and Greenhouse Gas Emissions". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions'

4. Conclusions

The transition to a green economy is an **objective necessity** due to the impact of human activity on environment, particularly during the era when globalization reached its maturity, starting more or less after 1980. Most of the discussions related to the objective necessity of this transition are focused on various types of emissions that affect the atmosphere, the quality of breathing air, the ozone layer, etc. Even the targets adopted in the Paris Agreement or in official documents of the European Union are primarily focused on emissions.
But emissions are **just a component** of the human impact on environment. Among other types of impacts one can mention:

- the massive deforestation which reduced the habitable land on the Earth's forested area from 57% 10,000 years ago to 52% by 1700, 48% by 1900, 44% by 1950 to 38% by 2018 (Wallach & Aboulazm, 2022);
- pollution with plastic waste currently estimated at 5 billion tons (Lim, 2021) and taking 1,000 years, on average, to decompose is everywhere, from the Arctic Ocean (Friesen (von), Hartmann, Gabrielsen, & Rist, 2021) to human blood in the form of micro-plastics (Osborne, 2022):
- pollution of the land by means of waste, incineration of waste, chemical substances resulting from industrial processes, chemical fertilizers, buried chemicals, nuclear waste, etc.;
- pollution of water due to industrial and household activities: mining industry, including oil, pulp and paper, sewage, the use of fertilizers, dumping of garbage into water, etc. (Bradford, 2018).

The list above can be extended to include light pollution, noise pollution, electromagnetic pollution, etc. As a result, the impact of the human activity on the environment is so outstanding that the impossibility to continue on the same path as until now indefinitely is beyond doubt.

Discussions and debates in relation to the transition to a green economy **start at the choices** (how to achieve the transition) and **time frames of the transition** (how fast to implement and conclude the transition). The situation is further complicated by the fact that planet Earth is not a single entity with a global governance but a complex system of inter-related entities, with different levels of development, ranked in different positions within a multi-dimensional balance of power with different assets (technological, human and financial capabilities) and liabilities (responsibilities resulting from their historical contribution to the current state of environmental damage).

Therefore, the transition to a green economy is a topic of high priority due its importance and urgency but has a variable practical priority depending on the level of development of different countries.
Developed countries with considerable financial, technological, and human skills resources may attempt to adopt a tight time frame for the transition because they have the technologies required and can afford it financially.

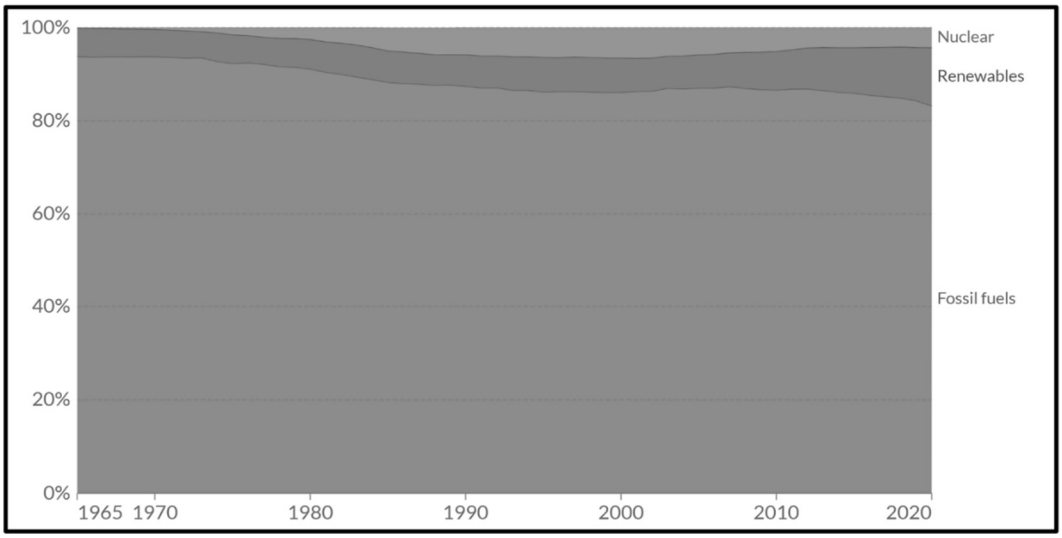
Developing countries generally agree with the necessity to preserve the environment and to adopt the transition to a green economy, but they simply cannot afford it both from a technological and a financial point of view. Decision-makers from developing countries cannot convince their populations that they should stop their development which, in many cases, was prevented or delayed by the colonial systems because they pollute the environment.

The ethical approach that calls on the support of developed countries, in the form of financial aid, to help developing countries achieve the transition to a green economy has been proposed and failed, among other occasions at the Conference of the Parties to the UN Framework Convention on Climate Change (COP26), a summit that took place in Glasgow between 31 October and 13 November, 2021. The developed countries were supposed to provide developing countries with an annual 100 billion US dollars from 2020 on in order to facilitate the adoption of new technologies that reduce the impact on environment (United Nations Office for the Coordination of Humanitarian Affairs (OCHA), 2021). The size of the financial support necessary reflects, on the one hand, the magnitude of the difficulty of achieving the transition to a green economy for the developing countries and, on the other hand, the impossibility of achieving the transition for those that want it but do not have the means to do it.

In our view, an essential aspect in designing and implementing the transition to a green economy is the understanding of **the magnitude of the process**. In Figure 4 is represented the share of fossil fuels, nuclear and renewables in the global primary consumption of energy between 1965-2020. The period analyzed is of 35 years, while there are 28 years from 2022 to 2050. In Figure 4 we can see the inertia of global energy systems and the speed of change that characterized the previous decades: fossil fuels declined their share in global primary consumption of energy from 93.7% in 1965 to 83.14%, renewables increased their share from 6.6% to 12.55% while nuclear energy increased its share from 0.17% to 4.31%.

It is true that today new technologies are available and the world leaders are more determined than ever to adopt measures that will protect the environment and stabilize climate change. But can we imagine a switch of the shares between fossil fuels and renewables? That would imply a 7 times increase of the share of renewables (from 12% to 84%) and a 7 times decline of the fossil fuels (from 83% to 12%).

Figure 4. Share of fossil fuels, nuclear and renewables in the global primary consumption of energy between 1965-2020



Source: Ritchie, H., Roser, M., (2022): Energy Mix, based on BP – Statistical Review of World Energy - 2021, published online at Our World in Data

Given the above question, in our opinion **a lesson that can be learnt** from the experiences provided by other technological and energy transitions that took place in a natural way **is that of the applicability and feasibility of a best effort approach.** In commercial services contracts there are two fundamental options: best effort and guaranteed services (McCabe, 2007). As their names show, the best effort services (which are not predictable or guaranteed) mean that the supplier is providing a service to the best of its abilities and technological

capabilities, presuming it acts in total good faith. On the other hand, the guaranteed services imply that the provider guarantees to the client certain technical parameters of the service.

In the case of the transition to a green economy **a best effort approach would mean that each country and organization will use all the knowledge, human experience and financial resources available in order to expedite the transition to a green economy as much as possible.**

The annual progress achieved could be monitored by a transparent mechanism similar with that used by the United Nations Organization in case of Millennium Development Goals (2000 – 2015) and Sustainable Development Goals (2016 – 2030). It goes without saying that the good faith of all participants is essential for the success of such an approach. This approach allows for a diversified public-private partnership and would allow for flexibility (with periods of faster and slower progress) and for diversity (letting all countries move at the best speed they are capable of).

At the same time, given the global scale of the transition to a green economy, we consider that the knowledge already available in relation to management of change processes should be used to the maximum extent possible. Maybe preparing a management of change strategy for the transition to a green economy will answer the sensitive question of replacing the Milton Friedman mantra (Friedman, 1970) that stated: "The social responsibility of business is to increase its profits", arguing that a company has no responsibility to society and people, with a more ethical and environment friendly belief.

After the beginning of the 1st Industrial Revolution, Western civilization took the lead of modernization and almost all elements that represent our current professional and personal life have been materialized in the last 150 years. One thing that is often forgotten is that, as Vaclav Smil pointed out: "We are a fossil fuel civilization" (Smil, 2017). Whatever is specific to our civilization (from fertilizers to electricity and from aviation to computers) is based primarily on the use of fossil fuels. For those who are not convinced, Figure 4 is a good place to start.

Energy transitions happened before but humankind had more time at its disposal. Will nuclear fusion manage in due time to provide the cheap infinite energy that will save civilization from extreme consequences of climate change? Will other technologies become available in order to reverse pollution and absorb emission from the atmosphere, and to concomitantly transform waste into raw materials? While we keep our hope for timely solutions provided by science and technology, we should approach the transition to a green economy with utmost seriousness, not forgetting for a moment that energy and essential raw materials should be available and affordable without discontinuities.

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