THE ENERGY TRANSITION UP AGAINST THE CLIMATE CLOCK

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Overview

The concept of energy transition emerged almost unnoticed following the oil shocks of the 1970s, then reappeared in the 1980s, following the oil countershock. The term came back into vogue, in the 2000s, with the rise in energy prices and growing awareness of climate change. Since then, the use of the term 'energy transition' has spread and actually covers a wide variety of national strategies. In the United States for instance, the energy transition aims to reduce the country's dependence on hydrocarbon imports, and provides a justification for the large-scale exploitation of shale oil and gas. In emerging countries, its aim is to provide an increase in energy sources compatible with economic growth. In Europe, the concept in principle justifies policies simultaneously aimed at reducing greenhouse gas emissions, promoting renewable energies and encouraging energy efficiency. This malleability of the concept is dangerous because it can lead to undesirable futures with regard to the climate.

This article aims at enlightening the specificity of the low-carbon transition with respect to past energy transitions and emphasising the necessary role of carbon pricing in speeding ut the exit from fossil fuels. After provinding a rigorous formulation of the concept of energy transition, we revisit the historical analyses showing how previous transitions involved the stacking up of primary energy sources. The proliferation of sources led to an unprecedented increase in global energy consumption and to massive emissions of CO_2 into the atmosphere. Unstack these sources by giving up fossil fuels will take time. Yet the amount of CO_2 already accumulated in the atmosphere means that there is very little time left. Thus, reducing the discrepancy between the pace of eliminating fossil fuels and the countdown of the climate clock constitutes the major challenge of the low-carbon transition. Based on scenario of the energy sector in 2050, we show that while the voluntary commitments of the Paris agreement help to curb emissions compared to past trends they prove to fall far short of the target of keeping warming below 2°C. This justifies the use of carbon pricing instruments that could provide the right incentives on both the supply side and the demand side.

Methods

Our approach proceeds in two steps: the first part of the article deals with the long-term analysis of past energy transitions while in a second part we focus on the prospects of the low-carbon transition. Our analysis starts with an interdisciplinary approach combining historical and economics analyses to identify the structural changes that fostered energy transitions over time. This long-term approach allows us to emphasize the drivers of energy transitions as well as the time that separated technical innovations and their impact on energy and economic growth. We then rely on historical data to identify long-term relationships between population growth, energy consumption, and CO_2 emissions at the global level. This allows us to discuss the extent to which past energy transitions together with population growth have contributed to the accumulation of CO_2 emissions into the atmosphere.

Regarding the prospects of the low-carbon transition, we present different scenarios of the energy sector in 2050 based on the average amount of energy consumed per capita and the energy coming from fossil sources. Each of these scenarios has been given a colour label reflecting its distance from the 2°C target, which is measured as the difference between total CO_2 emissions in 2050 and emissions corresponding to the safe carbon budget estimated by the Internal Panel on Climate Change (IPCC). Three scenarios are considered: the first (red) scenario which arises from a continuation of past trends; a second (blue) scenario based on the application of the emission reduction commitments by countries under the Intended Nationally Determined Contributions (INDCs) process ; and a third (green) scenario where emissions have been reduced by a factor of four due to an acceleration of the low-carbon transition.

Results

The historical analysis shows that since the beginning of the industrial revolution, energy transitions have been based on a stacking up of primary sources, in which new energies come on stream without the existing ones being given up. This additive system contrasts with the traditional view of energy transitions described by Marchetti and Nakicenovic (1979), in which the transition from one dominant energy to the next operates according to a logic of substitution. Very slow during the first two transitions, the accumulation of energy per capita accelerated rapidly with the introduction of the new fossil sources. Due to the demographic transition occurring at the same time, the result has been the unprecedented growth in energy consumption worldwide over the last two centuries which have triggered a cumulative mechanism of stacking up new sources of CO_2 emissions never before encountered in human history.

The challenge of the low-carbon transition thus lies in the disaccumulation of CO_2 emissions at a pace which is consistent with the 2°C target of the Paris agreement. The scenarios of the energy sector in 2050 draw different emission paths. But which path are we taking? Red, blue, green? The red scenario, which continues the historical pattern of stacking up energies, can no longer be viewed as the route we are destined spontaneously to follow, due to the decline in renewables costs and political initiatives namely. Under the blue scenario resulting from the Paris agreement, the consumption stabilizes between 2015 and 2050, despite its never having done so over a comparable period at any point during the twentieth century. New carbon-free sources expand rapidly but only partially replace coal and oil and do not reduce the share of fossil gas. This scenario must be viewed as inadequate, in that it misses the 2°C target. To achieve the 2°C target, we need to aim for the green, disaccumulation scenario. Under the green scenario, average per capita energy consumption falls by a third, an even greater departure from the historical norm, that would allow energy sources to be disaccumulated and would give a reasonable chance of stabilizing warming by the end of the century. This requires the use of carbon pricing instruments to accelerate the retreat from fossil fuels through the by-passing of the oil rent mechanisms resulting from an hotelling dynamic.

Conclusions

Altough the end point of this fifth transition will in any case be a system entirely free of fossil sources, the fact is that the Earth's crust contains much more exploitable fossil fuel reserves than the atmosphere can absorb without disrupting the climate system. Compared to the energy transitions of the past, this necessity leads to a threefold reversal of perspective: (i) despite the inertia of the energy system, the shift must take place in accordance with the pace of the climate clock, which is regulated by the growing stock carbon in the atmosphere; (ii) rather than the stacking-up mechanism of the past, it is essential to institute a system in which carbon-free sources do not simply supplement existing sources, but instead replace fossil energies; (iii) energy efficiency gains must no longer lead, through the fall in relative prices, to higher energy consumption per capita, which contributes significantly to the escalation of emissions.

To accelerate the pace of the low-carbon transition and hasten the withdrawal of fossil energies, the relative price scale needs to be changed by means of carbon pricing. In a carbon-rent economy, virtuous consumer incentives are no longer counterbalanced by a counter-effect of expanding fossil-producing capabilities on the producer side prompted by rising prices. Once the carbon price becomes the guiding light of the energy transition, carbon rent takes precedence over oil rent. It becomes increasingly less profitable to invest in fossil fuels as the cost of CO_2 rises, unless carbon capture and storage technologies allow the use of fossil energy from CO_2 to be dissociated from emissions. The rising cost of CO_2 thus turns both producers and consumers away from CO_2-emitting fossil sources.

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