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Shale gas revolution could paralyse the energy transition

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The shale gas revolution has provided a cheap and relatively clean alternative for coal, but it also threatens the future market for renewables. Recent projections indicate that without tightening climate policy, shale gas will indefinitely delay the transition to net zero.

Unconventional 'shale' gas production has created new jobs in the United States since the early 2000s[1] and US natural gas prices have almost halved over the past two decades. On the other side of the Atlantic, the Ukrainian war has made Europe aware of its energy dependence; energy prices in Europe spiked while the United States and Canada still enjoyed low gas prices. For climate policy, it is good news that gas is cleaner and cheaper than coal. Now, a recent study by Acemoglu et al. shows that the carbon intensity of the total energy supply fell so much that US CO_2 emissions came down despite the overall increase in energy use[2]. However, they highlight that this is not a reason to celebrate as the shale gas boom might lock the economy into a path without much investment in renewables. On the basis of a careful projection of the effects on future investment and innovation in different energy technologies, the authors argue that cheap shale gas benefits are short-lived while the long-run costs of shale gas exceed by far the short-run gains.

Like any investment activity, innovations by entrepreneurs – both gas explorers and renewables producers – are driven by expected profits, which scale with the prospective market size. Low gas prices lead to a booming market of gas-driven power plants and applications. This sets in motion a virtuous circle of cascading innovations in this sector, which explains how the gas boom accelerated over the years. But, by the same logic, the gas boom reduces the market size for renewables, resulting in shrinking innovation efforts (see the solid blue line in Fig. 1 after 2010).

The challenge in assessing the shale gas revolution is the quantification of the long-run indirect effects. Treating the 50% decline in gas prices as a natural experiment, the authors estimate the innovation response, based on the remarkable fall in renewables patent applications observed at about the same time. They then project the effects into the future and find that the effect of low gas prices on renewable innovations cumulates. Lower renewables patent activity reduces the future market size of renewables, reducing future patenting as well. Ultimately, innovations for renewables might be paralysed – an extreme lock-in that makes the transition to net zero unreachable in most of the report's scenarios without climate policy. Only in the scenarios with strong policy shifts, the paralysis is avoided.

The pessimist outlook hinges on the close connection between the gas boom and the market for renewables and renewables patenting. Regarding the first link, worldwide data are not so clear-cut.

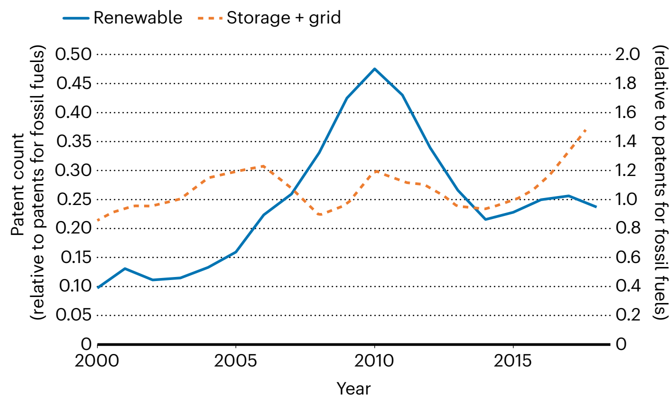

Fig. 1 | Patenting in renewables, storage and grid, relative to fossil. Patent counts for renewables (blue solid line, left axis) and for storage plus grid (orange dashed line, right axis). Both series are relative to patents related to fossil fuels, based on triadic (high value) patent families. Data from PATSTAT, processed by Rik Rozendaal for this article.

The renewables share has steadily increased despite the drop in shale gas prices, as is documented for the United States (orange area in Fig. 2). For the second link, recent literature mentions various alternative causes for the decline in registered renewable patenting. The 2008 financial crisis affected start-up firms developing renewables more severely than it affected established oil and gas companies (Aghion, P., Bergeaud, A., de Ridder, M. & Van Reenen, J., manuscript in preparation). The credit crunch also led to government research budget cuts and increasing uncertainty regarding government support for renewables[3]. And while the United States spent government research and development funds on and gave tax credits to unconventional gas development, China spearheaded solar panel technology, but this is less visible in the patent registry data[4]. Finally, part of patenting has moved from renewable energy production to energy storage and electricity grid innovations, which may help further roll-out of renewable energy (Fig. 1, orange dashed line).

As far as possible, the authors' statistical estimation controls for the above alternative mechanisms explaining the past innovation patterns. Yet the most important reason not to jump to conclusions too quickly is that innovation markets, which shape the future, adjust to expectations[5] (https://go.nature.com/3uW4Uq1). We cannot evaluate the current situation only on the basis of current policies; the long-run policy context is key. If short-run gas euphoria prevails, policymakers delay more stringent climate policy to secure the short-run gains, and a gas boom may result in a permanent delay of the net-zero target. This scenario may reflect the US policy context where firms lack clarity on the future energy transition and gas innovations may drive out renewables. Alternatively, a smart adaptive policy that responds

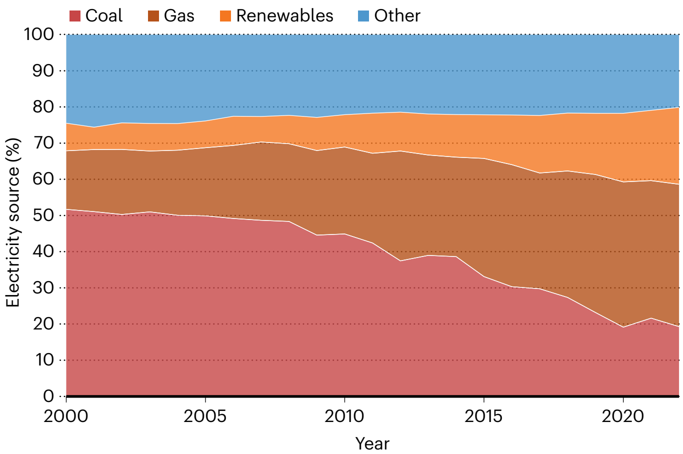

Fig. 2 | Shares of electricity sources for the United States. Other includes oil, nuclear and biomass. Data from Our-World-in-Data, processed by Rik Rozendaal for this article.

automatically avoids the bad outcome. European Union policy aims at exactly this. With CO_2 emissions capped by the European Trading System, and the ceiling going down each year, crashing to zero by 2040, the expectations are clear: there is an end to fossil fuels whatever gas innovations come. Supported by that policy, firms keep investing in renewable innovations, to bring costs down. Expectation-driven innovation can support a zero-emissions policy to become self-sustaining, while undermining climate policy with less clear emissions targets.

A main take-away is that the sudden advent of cheap clean gas can be harnessed to lower the costs of gradual decarbonization. Yet it also lowers the price of fossil energy, which is already underpriced vis-à-vis renewables. The market for fossil energy becomes too large and distorts innovation decisions, making the transition more, rather than less, costly. As the scenarios in the study illustrate, the appropriate climate policy response is to have more stringent climate policies, capturing the windfall gains of the shale gas revolution without allowing these gains to undermine the long-term emissions targets. The study underlines that innovation responses magnify the effect of policies — good adaptive policies are important, even more so than what we already imagined.

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Competing interests

The authors declare no competing interests.