AN UNEXPECTED FUTURE FOR OIL AND GAS

The crisis in Ukraine has driven up energy prices, obscuring a dilemma that we're likely to face in the near future: if many countries are increasingly able to generate energy without using oil and natural gas, the price of these commodities will fall. This means that the use of fossil fuels will become more attractive again for countries that cannot afford or do not want to make the transition to renewable energies. Against this backdrop, our author advocates speeding up the search for alternative uses, starting now.

Around the world, there are huge gas and oil reserves that – if burned – will produce large quantities of greenhouse gases. If global warming is to be kept within manageable limits, the energy industry must wean itself off fossil fuels. Recent studies indicate that in order to achieve the climate targets that have been set, 60 percent of oil and gas reserves should not be burned – not to mention coal deposits. But how can this be accomplished?

When it comes to decarbonization, current national and international climate policy relies on suppressing demand for fossil fuels – for example, by means of internationally tradable carbon emission certificates, taxes on CO_2 emissions, an announced ban on oil heating systems, or the phasing out of combustion engines. At the same time, subsidies for climate-neutral forms of energy are intended to kick-start the substitution processes to move away from oil and gas. The problem is that demand for fossil fuels must be suppressed at the global level, and this objective cannot be achieved by non-binding agreements or by trusting all countries to do the right thing. Rather, we would need an agreement with binding commit-

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VIEW POINT

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ments between sovereign states that not only defines the total reduction in emissions but also regulates how this is divided up. An agreement like this is not only grueling to negotiate, but also very difficult to enforce and monitor. There have been some constructive approaches – as well as more than 25 annual UN Climate Change Conferences that have provided a forum for negotiations. However, the progress made so far gives little cause for optimism.

Moreover, even if these collective efforts were to succeed in reducing global demand for oil and gas, a second problem would arise. The world's oil and natural gas reserves will not simply disappear when demand for them collapses. For example, the deposits under the desert sands of Saudi Arabia still hold billions of barrels of fossil fuels – with a value of billions upon billions of euros at today's market prices. But what would it mean for Saudi Arabia if global demand for oil and gas were to dry up within a few decades? The remaining reserves would become largely worthless, and so it's better for Saudi Arabia – and any other country with large oil and gas deposits – to pump its own reserves out of the ground quickly and sell them before they lose their value. From an economic perspective, these considerations can be understood via intertemporal equilibrium models for exhaustible natural resources, and are consistent with fundamental scientific insights in the field of resource economics. Market logic dictates that falling demand in the future will lead to a rapidly increasing supply of oil and gas in the present and hence to a fall in prices. As prices fall, the use of oil and gas will increase, and so will CO_2 emissions in countries that are not party to a climate agreement – and elsewhere – until the demand restrictions imposed by such an agreement take effect. The drop in prices will also make it difficult for alternative energy sources to assert themselves in a market flooded with cheap oil and gas. Moreover, there will be a decrease in the natural incentives for innovation in green technologies.

DEMAND RESTRICTIONS ON CARBON BASED ENERGY ARE SUPPOSED TO TRIGGER A HARMFUL RUSH TO BURN

The impact of war and sanctions has meant that gas and oil prices have not followed this pattern in recent weeks. Although it will take a while to compensate for disruptions in the supply coming from Russia, these disruptions do not affect the total quantity of oil and gas available for extraction over time. In this respect, this price volatility does not contradict the supply decisions outlined here – and these decisions are likely to be taken in the coming years and decades should a binding and effective global climate agreement be adopted.

Scientists refer to this problem commonly as "rush to burn" or "green paradox." Though it may sound paradoxical, the increasing severity of political measures seeking to restrict the future use of fossil hydrocarbons in energy production actually counteracts the desired policy impacts of a

climate agreement in the present day. These risks have been highlighted in extensive theoretical literature relating to the green paradox. The literature has also provided empirical evidence of market responses in line with the theory predictions. In 2009, the economist Hans-Werner Sinn received the "Dinosaur of the Year" award for delivering this bad news. Since then, word of the compelling logic of this correlation has gotten around – at least among climate economists.

A few years ago, in light of these problems, it was suggested that countries with oil and gas reserves should be paid not to extract them and instead to leave these resources in the ground forever. This approach does not offer a compelling solution however, for it would quickly require unimaginably large annual compensation payments to the resource owning countries. Moreover, international negotiations regarding financing by the international community would be just as challenging as the ongoing climate negotiations aimed at securing measures to address demand.

It would be better to extract oil and gas and put them to good use, albeit not in a way that is harmful to the climate but rather for climate-neutral or climate-friendly products. This would usher in a radical transformation of the market. Oil and gas – as raw materials for products – would be more valuable than they are today, putting an end to the rush to burn. Resource-rich countries would not need to extract their stocks as quickly as possible or sell them at dumping prices. Rather, they could take their time to extract and commercialize the reserves over decades. As a result, oil and gas would already be in shorter supply today, and prices would be higher. Higher prices would stimulate the energy transition by making alternative, climate-friendly energy concepts more competitive on the market and their innovation economically more attractive. Ideally, oil and gas would become too valuable and expensive to burn – and there would be no need for an international climate agreement, carbon taxes or prohibitions on the use of oil and gas for combustion.

Although some of these economically attractive climate-neutral products made from oil and gas may not be ready for the market for years or decades to come, equilibrium-theory considerations show that they would have an immediate effect on the market. This is because of a special feature of markets for exhaustible natural resources: since oil and gas reserves are known and finite quantities, those who squander their reserves today will have nothing to sell tomorrow. Just as the impending worthlessness of oil and gas spurs on faster extraction, the prospect of a more economically attractive future application leads resource owners to withhold supply today. It makes sense for them to preserve their stocks and sell them at a later stage. This intuitive conclusion is also backed up by the results of economic-theoretical models.

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These considerations would be purely academic wishful thinking in the absence of clear, climate-friendly alternative uses of oil and gas. But what might these climate-neutral applications actually be? Perhaps one of the most interesting ideas is to produce hydrogen from methane, which is the main constituent of natural gas and accounts for approximately 75 to 99 percent of the mixture. This is also the subject of research at some institutes inside the Max Planck Society. So far, insights relate primarily to the production of "grey" or "blue hydrogen," in which methane is broken down and at least some CO_2 results as a byproduct. More elegant solutions lie in processes such as catalytic pyrolysis, which avoids the release of CO_2 and produces not only hydrogen but also carbon, that can take the form of valuable nanomaterials. Lively publication activity stands as a testament to advances in the production of this "turquoise hydrogen." Although catalytic decomposition requires an input of energy, it only needs about an eighth of that used to produce the "green hydrogen" that everyone is talking about nowadays.

WE MUST INNOVATE AND PROMOTE ENVIRONMENTALLY FRIENDLY PRODUCTS FROM OIL AND GAS

As a climate-friendly and carbon-neutral energy carrier, hydrogen will be a key energy input to the economy following the energy transition. And the carbon nanomaterials – e.g., carbon nanotubes (CNTs) – produced during pyrolysis might actually be even more important than the hydrogen. Products made from carbon nanomaterials have potential applications in areas like construction, the automotive industry and aerospace engineering, where they could replace traditional materials such as steel, aluminum or concrete. As the production of these materials usually carries a considerable carbon footprint, replacing them could also lead to major reductions in CO_2 emissions.

It may be some time before we see the large-scale application of CO_2 emission-free catalytic pyrolysis, but the theoretical analysis of intertemporal relationships in markets for exhaustible natural resources shows that an effective reversal of the rush to burn does not depend on the immediate availability of climate-friendly uses of oil and gas. Rather, the mere promise of these potential future applications is sufficient to prevent the resources from being sold off.

Climate-friendly uses of hydrocarbons needn't be limited to the decomposition of methane. Indeed, such uses already exist for oil today. Examples include synthetic fibers, insulating materials for the construction industry, and products made of plastic. In quantitative terms, these applications still play something of a subordinate role, although that may change. For many people, mentioning plastic will immediately raise concerns about the pollution of our oceans by plastic waste, the biological impact of microplastic particles in fish, animals and humans, and the fact that the plastic

that doesn't drift into the oceans via rivers all too often ends up in thermal power plants, where it's burned in a manner that's harmful to the climate. However, that is not an argument against using oil to produce useful plastics per se. Rather, the problem is the way that plastics are handled in our current economy and society. After all, it's not a law of nature that products made of plastic have to end up in oceans or have to be burned. For example, if plastic is buried deep in the soil at the end of its useful life – in other words, if it ends up where the raw material for plastic originally comes from – the use of plastics doesn't have a negative impact on the environment or the climate. Plastics would then become an application that made crude oil valuable, that withdrew it from carbon-intensive use in energy production, and that could bind fossil hydrocarbons in a climate-neutral manner for long periods of time.

Turquoise hydrogen, carbon fibers, plastics and other oil products would be a good first step toward combating the rush to burn. Perhaps even more important than the oil and gas products named here, however, are the products that don't yet exist but might be invented over the coming years. The right government policies can help set these processes in motion by setting a clear course forward and creating stable, long-term framework conditions.

The key thing when it comes to reversing the rush to burn will be to make natural gas and oil a scarce and valuable resource for climate-neutral uses. With this in mind, it is not very helpful to promote new substitute products derived from sustainable resources like wood or renewable plants. Such substitutes can reduce the demand for climate-neutral applications of fossil fuels. Paradoxically, these products and their promotion are actually more likely to encourage the rush to burn.

SUCH PRODUCTS CAN UNLEASH MARKET FORCES FOR THE TECHNOLOGY SHIFT TOWARDS A CLIMATE-FRIENDLY ENERGY SUPPLY

Instead, it would be more expedient to adopt policies that encourage innovation in climate-friendly products made from oil and gas. Instead of relying on building materials from the Middle Ages, the construction industry should accelerate the replacement of steel, aluminum and concrete with carbon-based building materials. In the automotive or aviation sectors, carbon-based construction materials produced in a climate-neutral manner could probably replace building materials from carbon-intensive production processes – potentially even having a positive effect on the limits of technical feasibility. And if this approach succeeds in making gas and oil sufficiently attractive and therefore expensive, it can also pave the way for a successful energy transition that is in accordance with a free market economy and actually relies on market mechanisms rather than on large subsidies for a successful energy transition that is in accordance with a free market economy and actually relies on market mechanisms rather than on large subsidies.