# Climate benefits from modest dips in oil demand likely underestimated

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A decreasing reliance on oil for fuel will inevitably decrease the amount of carbon released into the atmosphere throughout the fuel's lifecycle, from extraction and refining to combustion as it's used by consumers.

However, the size of that impact varies depending on market factors that until now have not been fully modeled.

New research led by Adam Brandt, associate professor of energy resources engineering at Stanford University's School of Earth, Energy & Environmental Sciences, and Mohammad Masnadi, assistant professor of chemical and petroleum engineering at the University of Pittsburgh Swanson School of Engineering, offers a closer look at the relationship between decreasing demand for oil and a resilient, varied oil market—and the carbon footprint associated with both. The study was published Nov. 3 in *Nature*.

"When oil demand drops due to, say, more rapid penetration of electric vehicles, our models find larger carbon benefits than earlier models," said Brandt, who is also the director of Stanford's Natural Gas Initiative. "Thus, it is likely that the carbon benefits of demand reduction measures and alternative vehicles have been underestimated."

The carbon intensity of producing the oil displaced by a 2.5 percent demand drop is about 25 percent to 54 percent more than the global average used in previous models estimating climate benefits.

"Previous models have treated oil producers' carbon footprint as if all barrels of oil are exactly the same, but with novel extraction technologies there is a great deal of variability in the global oil supply," said Masnadi. "It's complex, and it's not linear. Our model takes that into consideration."

The relationship between reductions in oil demand and outsized climate benefits does not necessarily hold for medium to large demand drops. The carbon intensity of the oil displaced by larger demand drops—5 percent to 10 percent—remained well above the global average in the study's perfect competition scenario. However, in the more realistic

oligopoly and cartel scenarios, the carbon intensity of producing the displaced oil was around the global average.

"In oligopoly and cartel cases, shutting down or reducing production at oilfields that are profitable is rational, since the major producer or cartel will sell less output but at a higher price," said Giacomo Benini, one of the study's co-authors and a Stanford postdoctoral scholar in Brandt's lab. "Those profitable oilfields tend to produce light and medium crudes, which on average have lower carbon intensities than heavy crudes."

## Big data, multiple models

In the paper, the researchers link econometric models of the production profitability of 1,933 global oilfields, (representing about 90 percent of the world's supply in 2015), with their production carbon intensity, a measure of the amount of carbon emitted per barrel of oil produced.

They then examined the oilfields' responses to a decline in demand under three market structures. The first structure models perfect competition between producers. The second assumes there is an oligopoly where several major players drive the most impact. The third describes a cartel structure that assumes an international entity like OPEC will adjust production to impact oil prices and maximize profits.

The model uncovers an important consideration for government agencies as they create regulations to address climate change: To reduce carbon emissions by reducing demand for oil, policymakers must take into account the global oil market's structure.

"There's an assumption that as demand decreases, oil producers who are on the margins will be pushed out of business, but we've found that's not always the case," said Masnadi, who was a postdoctoral scholar of Brandt's before joining the faculty at Pitt. "Everyone knows about these

market structures, but by considering it, we show the structure is very important in a global economy. The way the structures play out impacts the kinds of oil fields that will be at the margins and struggling to stay afloat. Even with more penetration of alternative fuels, we might not see many expected players out of business—based on the market structure and their financial situation, many will be resilient enough to adjust their costs and keep producing."

**More information:** Mohammad S. Masnadi et al, Carbon implications of marginal oils from market-derived demand shocks, *Nature* (2021). DOI: 10.1038/s41586-021-03932-2

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