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# [Putting a Ceiling on the Equilibrium Price of Oil](https://substack.com/app-link/post?publication_id=343139&post_id=140488239&utm_source=post-email-title&utm_campaign=email-post-title&isFreemail=false&r=dy18s&token=eyJ1c2VyX2lkIjoyMzQyMjkyNCwicG9zdF9pZCI6MTQwNDg4MjM5LCJpYXQiOjE3MDQ3OTQ4MTUsImV4cCI6MTcwNzM4NjgxNSwiaXNzIjoicHViLTM0MzEzOSIsInN1YiI6InBvc3QtcmVhY3Rpb24ifQ.-pbNuTGXIqm22pDqIr8byq_JIIDhqG967aeZCrntvAg)

### Modern chemistry will deliver ample and affordable supply for many decades.

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“If plan A doesn't work, the alphabet has 25 more letters—204 if you're in Japan.” – Claire Cook

In late December, we published an article with an admittedly provocative title, “[Peak Cheap Oil is a Myth](https://substack.com/redirect/c7f7c9cb-4b19-4d85-83e4-d9cdef764043?j=eyJ1IjoiZHkxOHMifQ.laaQABrT6Kq5h7PQNCtPBL4mMH-MCdUfMaVmLhrXTHo),” in which we carefully built our case for believing that there would be more than enough oil for more than long enough. We put forth four simple arguments in support of our thesis. First, pessimists on the matter regularly underestimate the pace of technological development in the energy industry. Second, much of what makes our current reserves expensive to exploit relates to political choices, and the ruling elite who prevent the development of primary energy in much of the world today would be quickly wiped out of power in response to a true supply crisis. Third, the definition of oil used by doubters is far too narrow and should be expanded to include “any hydrocarbon that finds its way into a refinery.”  Finally, when measured in ounces of gold per barrel of crude (in other words, in a currency that cannot be debased), the long-term price of oil gives no indication of meaningful shortages on the horizon.

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Still cheap

After publishing the piece, we followed it up with a rather enjoyable [conversation](https://substack.com/redirect/411e50da-5188-4ac3-86cf-eb380d9d30d6?j=eyJ1IjoiZHkxOHMifQ.laaQABrT6Kq5h7PQNCtPBL4mMH-MCdUfMaVmLhrXTHo) with Adam Taggart of Thoughtful Money that we subsequently shared with our full list of over 200,000 subscribers. (Taggart recently moved to Substack, and if you have not yet subscribed, we would encourage you to do so [here](https://substack.com/redirect/559032e8-9ae4-4244-a901-bd518c86f6ac?j=eyJ1IjoiZHkxOHMifQ.laaQABrT6Kq5h7PQNCtPBL4mMH-MCdUfMaVmLhrXTHo).) After watching the episode, our friend Brent Johnson of Santiago Capital warned us via private correspondence, “You are now going to experience what it is like when you start saying things no one wants to hear… LOL.” Perhaps we have been [off Twitter](https://substack.com/redirect/325de667-708d-4466-b817-533215e7b0fc?j=eyJ1IjoiZHkxOHMifQ.laaQABrT6Kq5h7PQNCtPBL4mMH-MCdUfMaVmLhrXTHo) for too long, but we must admit we were surprised by some of the vitriol thrown our way, even by a few who claim to be professionals. (We respectfully submit that if an idea expressed about energy causes you to descend into a public fit of vulgarity, that speaks most loudly about something quite apart from the idea.)

Among the more thoughtful rebuttals was one put forth by Chris Martenson of Peak Prosperity, who published a 36-minute [video](https://substack.com/redirect/d6e4cd7a-c0db-45c3-8b0f-e6eae40ab58e?j=eyJ1IjoiZHkxOHMifQ.laaQABrT6Kq5h7PQNCtPBL4mMH-MCdUfMaVmLhrXTHo) addressing some of our arguments on his wildly popular YouTube channel. In Martenson’s view, technology will not be able to outpace the decline rates observed in the Permian Basin, easy-to-access reserves are quickly running out there and elsewhere, and once US production rolls over, it will enter a prolonged period of energy shortage from which it will not be able to recover.

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Martenson making his case | Peak Prosperity

We were quite familiar with such arguments prior to publishing—they have been around for decades and have become ever louder even as US shale operators continue to smash production records. In our opinion, such bottom-up analyses of rig counts, decline rates, and proven reserves all suffer from one fatal flaw: they ignore the awesome power of chemists and chemical engineers to force their will upon nature from the top. If the situation Martenson predicts ever did come to pass, this insurance policy of last resort would quickly be cashed in, leveraging one rarely mentioned technology, commercially proven and ready to fill the gap, whose wide-scale deployment would forever allay any fears of permanent hydrocarbon shortages. So confident are we in its potential that we believe its existence allows us to estimate a ceiling on the long-term equilibrium price for oil.

What is this decisive technology and how quickly could society broadly pivot to its use? Let’s head to the Middle East and find out.

Sitting amongst the vast array of energy infrastructure in Qatar’s massive Ras Laffan Industrial City is one of the most important chemical complexes ever built. Brought online a little over a decade ago, Shell’s Pearl Gas-to-Liquids (GTL) plant is one of a handful of world-scale facilities in operation today that convert natural gas directly into refined products using Fischer-Tropsch (FT) technology. At just under $20 billion to construct, [Pearl GTL](https://substack.com/redirect/c28e422e-c26d-402e-995e-889a8ca83773?j=eyJ1IjoiZHkxOHMifQ.laaQABrT6Kq5h7PQNCtPBL4mMH-MCdUfMaVmLhrXTHo) is “the crown jewel in the Shell-Qatar Petroleum partnership and one of the most complex and challenging energy projects ever commissioned.”

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Pearl GTL | Shell

At the front end of the facility, natural gas is reformed into synthesis gas (syngas)—a mixture of carbon monoxide and hydrogen—in a process widely used to produce fertilizers all over the world. The syngas mixture is then converted into long-chain hydrocarbons by passing it over an FT catalyst. The technical guts of this innovative step were [developed](https://substack.com/redirect/52902c8c-084d-4f9c-9d01-627d09127cff?j=eyJ1IjoiZHkxOHMifQ.laaQABrT6Kq5h7PQNCtPBL4mMH-MCdUfMaVmLhrXTHo) nearly a century ago, and Shell spent three decades further perfecting it before commissioning Pearl. Finally, the resulting mixture of hydrocarbons is finished into products such as diesel, kerosene, jet fuel, waxes, and lubricants using traditional refinery technology.

At peak production, the Pearl GTL plant is capable of [converting](https://substack.com/redirect/f1948ea1-1bd3-41cc-948e-cc9200fcff97?j=eyJ1IjoiZHkxOHMifQ.laaQABrT6Kq5h7PQNCtPBL4mMH-MCdUfMaVmLhrXTHo) 1.6 billion cubic feet per day (bcf/d) of natural gas into 140,000 barrels of GTL liquids and a further 120,000 barrels of natural gas liquids (NGLs) and ethane. Using simple arithmetic, we deduce that it takes approximately 6,000 cubic feet of natural gas to produce a barrel of useful liquid hydrocarbons.

How much does 6,000 cubic feet of natural gas cost on the open market today? As luck would have it, 1,000 cubic feet is roughly equivalent to 1 million BTUs, which makes the calculation quite easy. In the US, natural gas is selling for approximately $3 per million BTU, while landed liquefied natural gas (LNG) can be had in Europe for roughly $10 per million BTU. Accordingly, the input material costs would currently range between $18-60 per barrel of product, and we can only assume Shell is paying below-market prices under its long-term contract to consume local supply from Qatar’s prolific gas fields.

We can thus use as a rule of thumb the following relationship, which further contextualizes Pearl GTL’s importance as a benchmark facility: 6 bcf/d of natural gas is required to theoretically displace 1 million barrels per day of oil supply. With the onset of the shale revolution in the US, the country has grown its production of natural gas by a stupendous amount—roughly 60 bcf/d in a little over a decade. Equivalent to 10 million barrels of potential oil supply, this abundance of natural gas is not used to produce liquids today, but it certainly could be, given the right motivations and market forces.

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And now, to the peak cheap oil crowd. Even in the event that their pessimistic assumptions materialize—production in the Permian Basin reaches an apex and eventually rolls over, the world continues to eschew developing the [massive shale deposits](https://substack.com/redirect/06087ed0-2d35-452e-8e49-12a0cb4b4b34?j=eyJ1IjoiZHkxOHMifQ.laaQABrT6Kq5h7PQNCtPBL4mMH-MCdUfMaVmLhrXTHo) found virtually everywhere anyone has looked, the ample traditional resources stuck in the ground in [Latin America](https://substack.com/redirect/a20aa576-3013-498b-89eb-7df1b40ab5d0?j=eyJ1IjoiZHkxOHMifQ.laaQABrT6Kq5h7PQNCtPBL4mMH-MCdUfMaVmLhrXTHo) remain under-exploited, technological progress stalls for the first time in the history of the industry, and the political will to stunt the development of fossil fuels survives the first signs of another serious energy crisis—the resulting spike in the price of oil would only serve to accelerate the deployment of GTL facilities in an effort to capitalize on the mother-of-all arbitrage plays. There is so much natural gas available in so many regions that an investment boom would swiftly materialize. The technology is perfected, the resources are there, and all that is needed is a sufficient profit incentive.

The larger the crisis, the quicker the cure.

Lest we forget, the world just lived through a warm-up act for this precise scenario. As we recently described in [*Liquefied Natural Glut*](https://substack.com/redirect/76c54338-0de7-4a10-952f-979a0db43606?j=eyJ1IjoiZHkxOHMifQ.laaQABrT6Kq5h7PQNCtPBL4mMH-MCdUfMaVmLhrXTHo), it was less than two years ago that natural gas in Europe traded hands for an incredible $100 per million BTUs, the energy-equivalent price of $560 per barrel of oil. This triggered a wave of investment in LNG export and import facilities alike—projects that rival the cost and complexity of GTL plants—with nary a second thought. Faced with the choice between collapsing standards of living or embarking on another bubble-popping cycle of over-investment, the industry’s track record in this regard is clear: the alligator jaws of arbitrage would close violently, bringing the world back into a state of energy equilibrium, even if this comes at the expense of shareholders. The industry is notorious for its overreactions, and we doubt it will resist chasing $150 or $200 oil prices for very long.

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Golden Pass LNG brings all the cranes to the yard

And what happens if the world were to bring online 5 or 10 million barrels per day of GTL capacity? Natural gas would become, in effect, just another variant of “oil.” GTL plants are nothing more than sophisticated refineries, and natural gas certainly meets the definition of a hydrocarbon. Taken together, our definition of oil—any hydrocarbon that finds its way into a refinery—would be fully met, and the vast global natural gas reserves could justifiably be combined with the existing proven reserves of oil, condensates, and natural gas liquids. Once such molecular flexibility is developed, it tends to act as a permanent deflationary force. In the long run, every hydrocarbon will be oil, and they will all trade for roughly the same price.

We close with luminous proof of just how conservative assessments of global energy reserves tend to be. At the end of 2009, the US Department of Energy [reported](https://substack.com/redirect/943991a4-1886-429f-8e89-d8c10e638c0c?j=eyJ1IjoiZHkxOHMifQ.laaQABrT6Kq5h7PQNCtPBL4mMH-MCdUfMaVmLhrXTHo) that the country’s proven reserves of natural gas stood at 284 trillion cubic feet. Between 2010-2021, the US [produced](https://substack.com/redirect/1d98f19a-f716-43a1-b9dc-2b8d120cd284?j=eyJ1IjoiZHkxOHMifQ.laaQABrT6Kq5h7PQNCtPBL4mMH-MCdUfMaVmLhrXTHo) 354 trillion cubic feet of the stuff. Where did the estimate of proven natural gas reserves stand [heading into 2022](https://substack.com/redirect/dd7d4e49-a0ca-4b1b-90d9-27c1fbf4e6ae?j=eyJ1IjoiZHkxOHMifQ.laaQABrT6Kq5h7PQNCtPBL4mMH-MCdUfMaVmLhrXTHo)?

625 trillion cubic feet.

This prepares us to propose a ceiling equilibrium price of oil, which we submit must be no higher than the net-present-value-breakeven cost of building and operating gas-to-liquids facilities. We do not know with any degree of precision what that exact number is, but the fact that several such plants are happily operating today, it can’t be much higher—and is almost certainly lower—than current market prices.