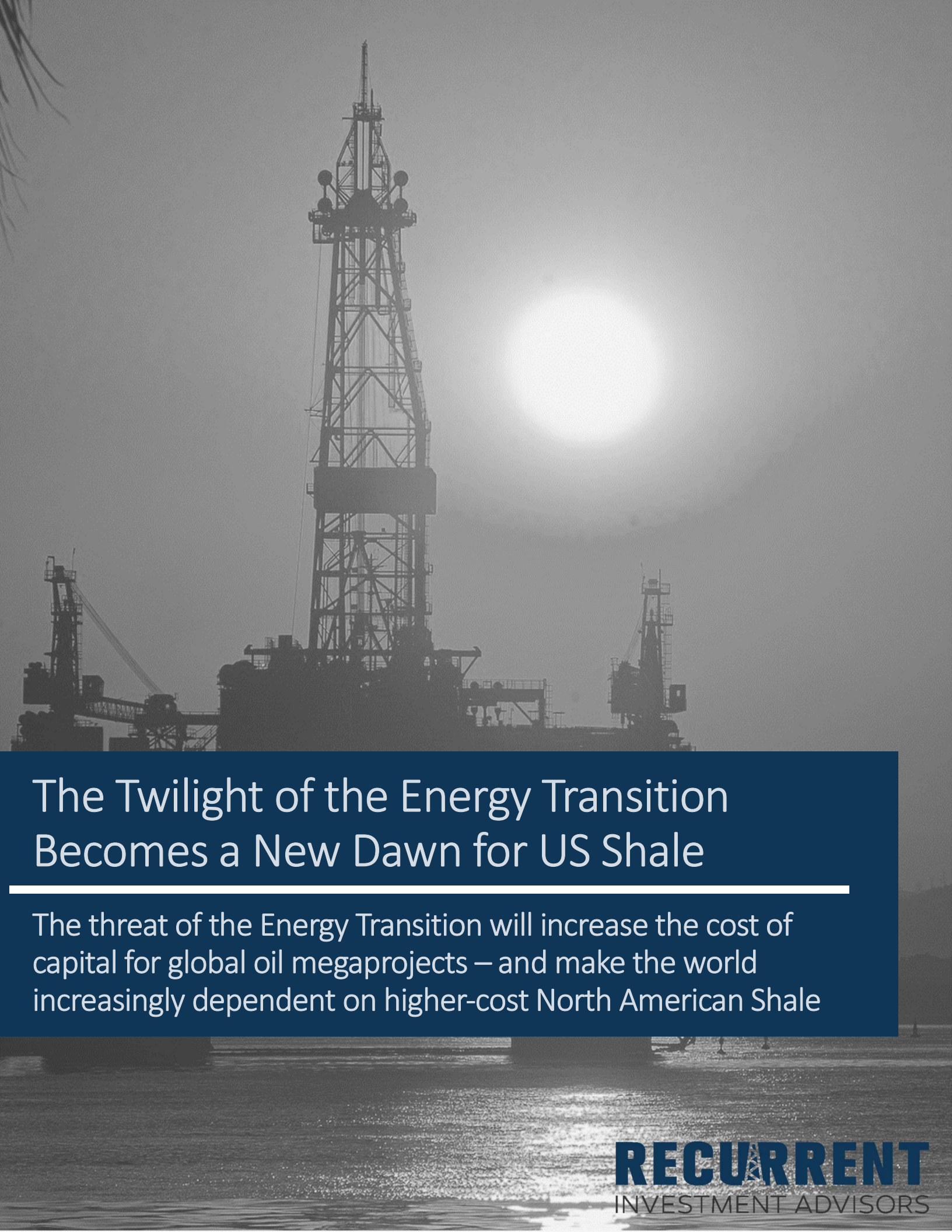


The Twilight of the Energy Transition Becomes a New Dawn for US Shale

The threat of the Energy Transition will increase the cost of capital for global oil megaprojects – and make the world increasingly dependent on higher-cost North American Shale

RECURRENT
INVESTMENT ADVISORS

Recurrent Investment Advisors – Research Material Disclaimer

This material is for informational purposes only and is an overview of the long-term structure of the oil market, and provides a description of potential future outcomes in the oil market, and is intended for educational and illustrative purposes only.

It is not designed to cover every aspect of the relevant markets and is not intended to be used as a general guide to investing or as a source of any specific investment recommendation.

It is not intended as an offer or solicitation for the purchase or sale of any financial instrument, investment product or service. This material does not constitute investment advice, nor is it a substitute for such professional advice or services, nor should it be used as a basis for any decision or action that may affect your business. Before making any decision or taking any action that may affect your business, you should consult a qualified professional adviser. In preparing this material we have relied upon data supplied to us by third parties.

The information has been compiled from sources believed to be reliable, but no representation or warranty, express or implied, is made by Recurrent Investment Advisors, LLC as to its accuracy, completeness or correctness. Recurrent Investment Advisors, LLC does not guarantee that the information supplied is accurate, complete, or timely, or make any warranties with regard to the results obtained from its use.

Recurrent Investment Advisors, LLC has no obligations to update any such information.

CONTRARY TO TRADITIONAL SUPPLY-DEMAND ECONOMICS, OIL PROJECTS are no longer focused on finding the cheapest barrels – the focus is now on high return barrels with the quickest paybacks. Defying many skeptics, Shale will represent a growing share of global supply growth in the next decade.

Over the last 10 years, US Shale has served as the oil market's balancing mechanism, or "peaker plant," as we described in our original 2016 white paper on the structure of the oil market. During periods of strong demand, Shale steadily added 1 mmbbls/d per year, and then rapidly curtailed 3 mmbbls/d (almost 25%) of US oil production during the acute phase of the COVID pandemic.

Today, the dispatch curve framework is still valuable. However, in contrast to pure supply curves based only on cost, another variable has increased in importance: **time**. Concerns around the pace of the Energy Transition to renewables and electric vehicles (EVs) have increased the cost of capital for oil and gas projects. Environmental, social, and governance (ESG) concerns, although still vaguely defined, have further curtailed capital available for oil and gas companies.

It may seem ironic that increased cost of capital will accelerate the shift in oil development **towards** US Shale, since Shale was viewed as a culprit in the pre-COVID oil market downturn. It is even more ironic that offshore is likely to be the biggest loser from this trend, as offshore projects are often lower-cost.

The perceived risks of ESG and the Energy Transition are increasing the "risk premium" for oil projects, requiring quicker paybacks. This will shift the oil industry from a cost focus to a duration focus, with allocation favoring short-duration assets like US Shale over long-duration offshore projects.

One clear implication, in our view, is that increased dependence on Shale means that more maintenance drilling will be required to offset Shale's hyperbolic declines, requiring increased drilling capex even in the event of long-term demand destruction. The need for constant reinvestment to maintain supply will eliminate the threat of multi-year oil price downcycles, even if the Energy Transition accelerates.

Secondly, higher risk premiums mean that long-dated offshore projects will increasingly fail to attract capital. The absence of these megaprojects removes a key source of long-term oversupply risk. With inelastic, low-decline barrels steadily replaced by elastic, hyperbolic-decline Shale barrels, we expect the magnitude and duration of oil market downcycles to be further reduced in the decade to come.

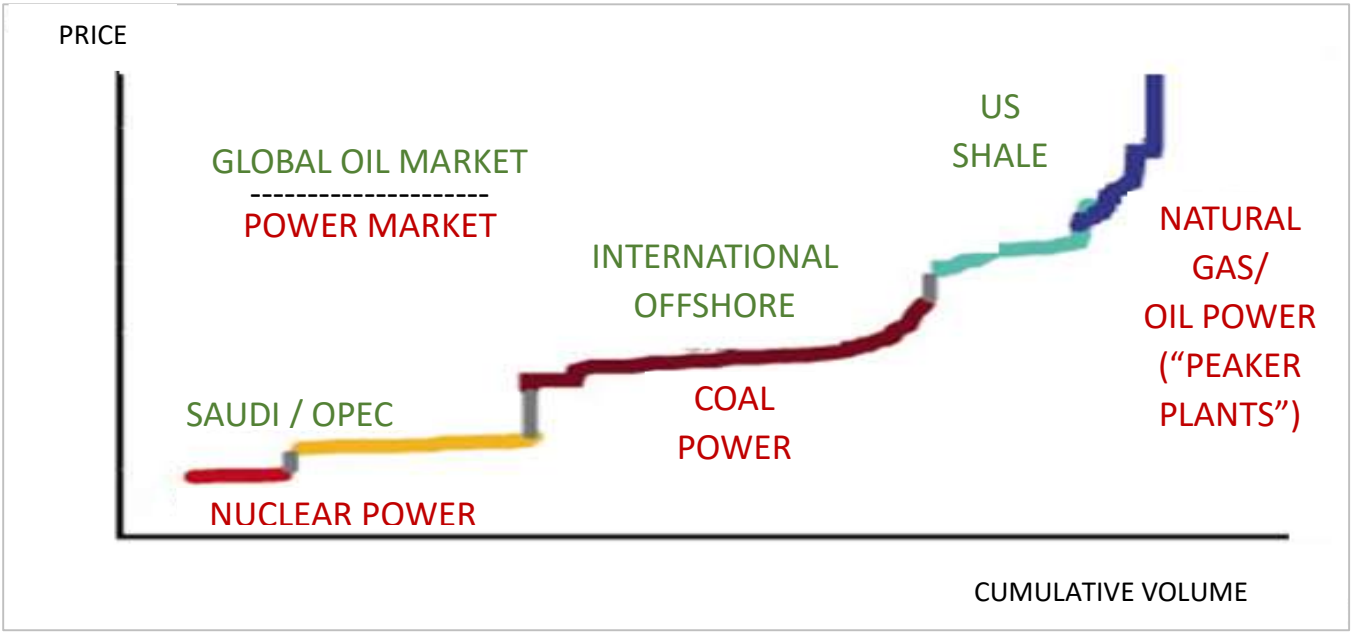
Over time, the threat of the Energy Transition will deprive megaprojects of funding – as a result, there will be less risk of oversupply from multi-decade, inelastic production. This will force the market into greater dependence on high-cost, short-duration wells – with more maintenance capex required to maintain global oil supply.

Energy Transition risks will increase reliance on Shale, oil's "peaker plant"

Several years ago, in our white paper titled "The Changing Shape of Energy Cycles", we highlighted US Shale's unique production attributes compared to other sources of global oil production. We noted that due to US Shale's high marginal cost and ability to quickly turn on/off, the economic structure of the global oil market had changed. Historically, long lead times of conventional production and slow production declines meant that oil market cycles were long – measured in decades – with high amplitude. With the introduction of US Shale, cycles became shorter, and markets could more rapidly back into balance, with cycles occurring more quickly. Never was this more evident than during COVID and its aftermath.

In electricity parlance, the market structure ranking power producers by their cost is known as a "dispatch curve", determining the order in which plants produce electricity to match demand. US Shale's role as a high marginal-cost producer, quickly matching changes in demand, is analogous to high-cost natural gas "peaker" plants in deregulated electricity markets. In the context of global oil markets, US Shale production rises and falls to meet marginal demand in a matter of months, faster than any other source of supply, causing markets to rapidly snap back into equilibrium, even during significant dislocations.

Exhibit 1: power and oil "dispatch curves" - both markets are balanced by high-cost, rapid-response resources



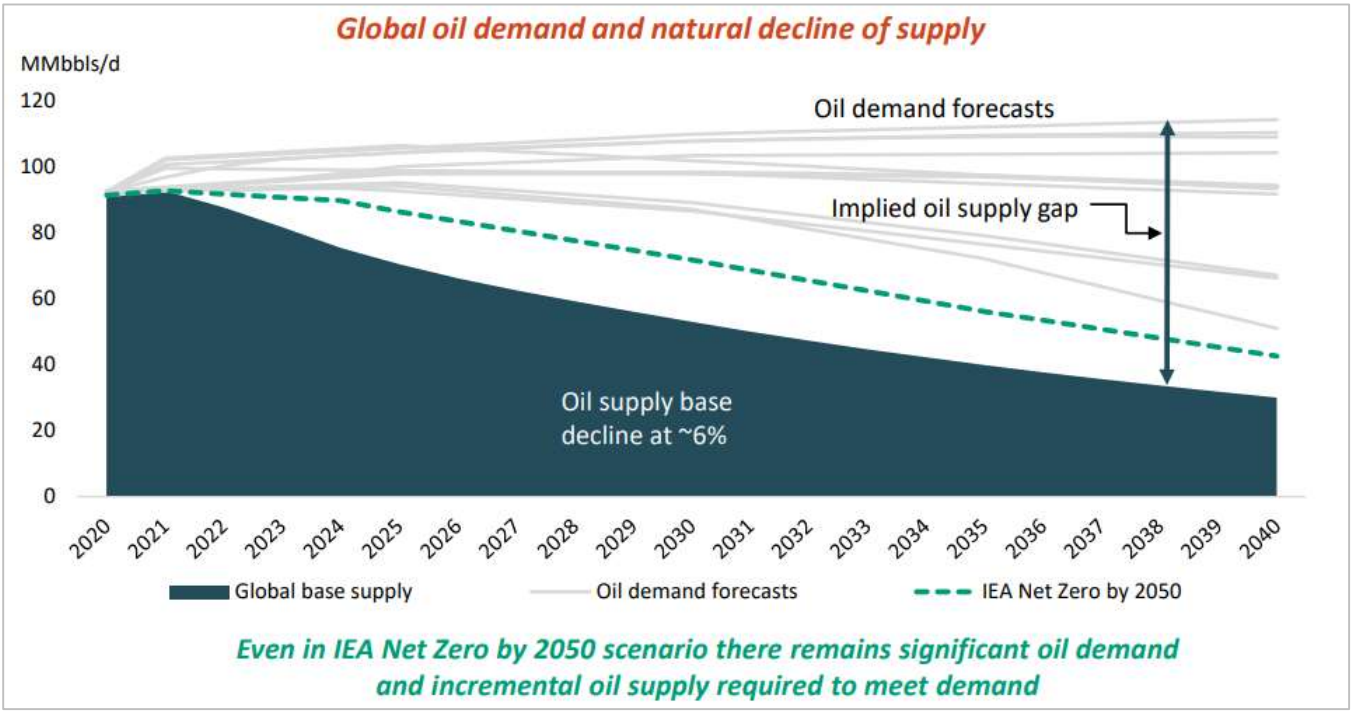
Source: Prof Liza Moyer, University of Chicago

Oil supply is unique–it must constantly be replaced, even if demand falls

The oil market differs from the traditional supply dispatch curves found in other industries. Oil production naturally declines and requires constant reinvestment to meet demand. In the absence of new investment, global oil base declines range from 5% to 10% annually. As demand has historically grown 1% to 3% annually, with annual declines being exceedingly rare since WWII, oil supply has rarely needed to be "turned off" in a significant way, with COVID offering a dramatic counterexample. In most years, meaningful investment in new wells is required to offset base declines. As shown in Exhibit [2],

even with a scenario with modest 6% base declines and a dramatic acceleration of the Energy Transition (reaching zero CO2 emissions by 2050), investment in new oil wells must continue for decades.

Exhibit 2: Even with "net zero" levels of demand destruction through 2040, oil investment must continue



Source: Cenovus Energy corporate presentation

Since oil markets will require new investment to replace base declines, we ask, "**Which type of resource – Shale or low-cost conventional reservoirs – will attract capital to offset declines and supply future oil demand?"** As natural base declines outstrip even draconian demand forecasts, the question needs to be addressed, even if the Energy Transition poses a medium-term or long-term threat to oil demand.

"Low-cost" does not answer the challenge posed by rising risk premiums

In most industries, under a purely **cost-based** dispatch curve framework, supply curves are relatively fixed, and supply is largely inelastic. Prior to Shale, this adequately described the oil market: new projects took years to develop, and once production began, it would continue at almost any price, due to exceedingly low variable costs. Once a project was sanctioned, there was no way to alter course – so the industry focused on minimizing cost per barrel to ensure major projects would generate resilient economics even in the face of unexpected, extended periods of low prices, as in the 1980s and 1990s.

If historically, the greatest perceived risk facing a new oil project was an extended period of low prices, there was little consideration given to "stranded asset risk" – the risk that a project would be rendered obsolete before its productive life was over. This was reflected in the metrics used to evaluate new projects: Megaprojects were expected to generate several dollars of undiscounted cash flow for every dollar invested; however, industry-standard 10% discount rates implied a fairly pedestrian 7- or 8-year project-level payback. Including corporate-level expenses, payback periods could exceed 10 years. **In other words, the oil industry wanted to make a lot of money – but it was not in a particular rush to get that money back.**

Exhibit 3: Historically, the oil industry focused on low-cost with less focus on time value of money

	Supply Paradigm	Demand Paradigm	Risk Premium	Target Metrics for Project Evaluation	Resource Development
Pre-Shale / Low Cost Era (pre-2005)	**Inelastic, long-dated conventional resources**	**Perpetual Growth:** Oil assumed to grow perpetually with global GDP	**Low Risk Premiums:** Perpetual demand growth implies low risk, 10% discount rates, >5-yr payback	**Cost/Barrel:** Long cycles, inelastic supply means that lowest-cost barrels attract capital	**Low-cost Resources:** 30-year mega-projects, with 3-6 year startup times
Dispatch Curve / Early Shale Era (2005-2020)	**Conventionals provide "baseload" while Shale meets incremental demand growth**	**Perpetual Growth:** Oil assumed to grow perpetually with global GDP	**Low Risk Premiums:** Perpetual demand growth implies low risk, 10% discount rates, >5-yr payback	**Net Present Value:** low-cost focus, coupled with need to match near-term demand growth	**Low-cost, with Shale meeting marginal demand:** Shale is secondary resource for balancing markets

Higher risk premiums now push economics from cost- to duration-based

10% return thresholds reflected corporate valuations for oil and gas companies that historically ranged between 6x and 10x EV/EBITDA – meaning that a payback period of 10 years or less was generally adequate. Today, valuations range from 4x to 6x EV/EBITDA, based on 2022 Wall Street consensus. Accordingly, 10-year paybacks do not compete with the increased market "risk premium" for energy companies; 4x to 6x valuations imply 25% to 33% cash flow yields on an unlevered basis.

In a world where the Energy Transition reduces the long-term visibility of oil demand, discount rates have increased and valuations have decreased, meaning that **time** – not cost – is now the dominant decision-making variable. As shown in Exhibit [4] below, the key metric has shifted from minimizing **cost per barrel** and maximizing **net present value (NPV)** – to now focusing on the **rate of return** for a given project. While $/bbl or NPV metrics favor large-scale developments, returns generally favor smaller projects, where capital can be deployed and recaptured quickly.

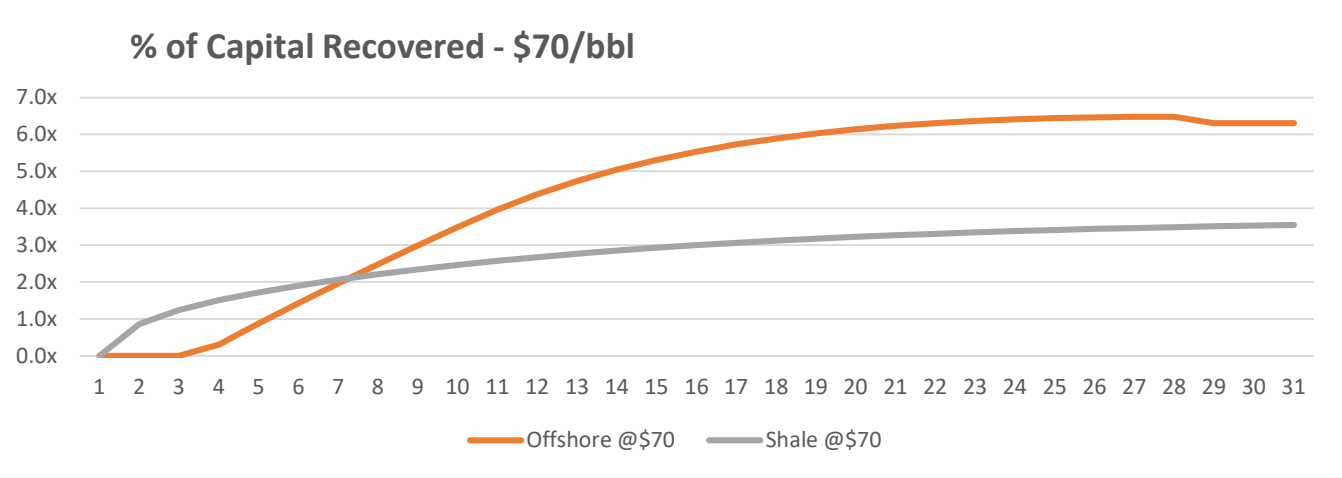
Exhibit 4: Today, as risk premiums rise, the industry is focused on high returns, quick paybacks

Low-Duration Era (2021 and beyond)	**Shale becomes dominant source of supply growth**	**Disruption Risks:** Oil perceived as subject to long-term demand risks from Energy Transition / alternatives	**Higher Risk Premium:** demand risks require higher discount rates (20%), implying <4 year paybacks	**Internal Rate of Return / ROI:** explicitly incorporating the value of time into decision-making	**Shale Dominance:** risk premiums rise, Shale becomes the primary focus for oil industry capital allocation

Examining what it means to prioritize "high returns" over "low-cost"

Over its 30-year lifespan, a hypothetical "tier 1" offshore project will generate significantly more cash flow per dollar invested than a Shale well – in almost any oil price environment. In the $70/bbl example below, offshore recovers over 6x of its capital over 30 years; Shale recovers roughly 3.5x, or 40% less. Using traditional industry assumptions of a 10% minimum acceptable return, offshore is economic at $30/bbl, while Shale requires roughly $40/bbl – 25% higher oil prices– to generate the same 10% return. In looking for low-cost barrels, it would *seem* that this "tier 1" offshore project is a clear winner.

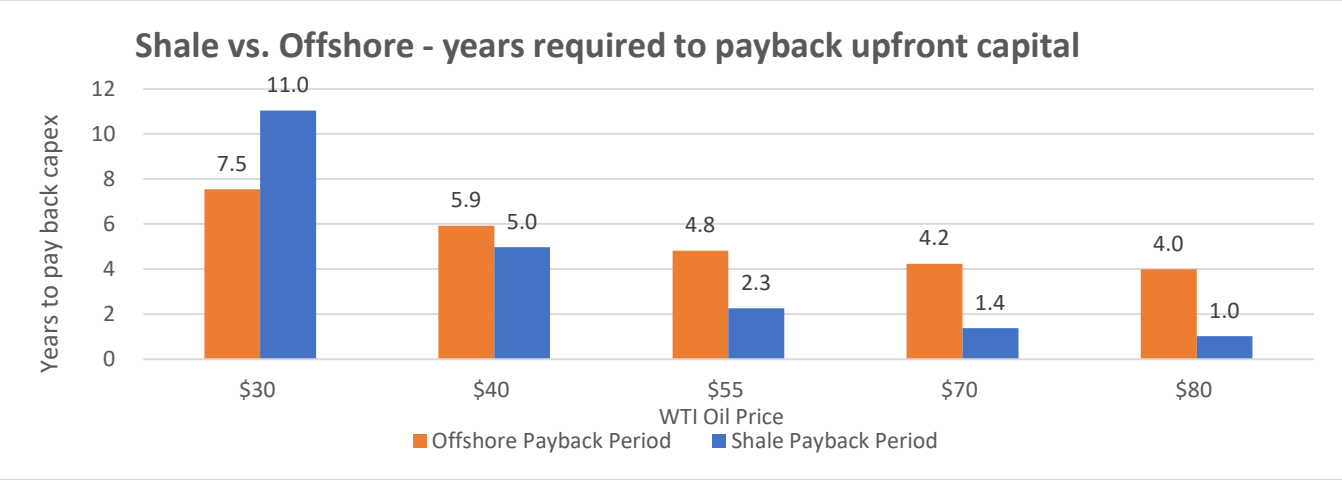
Exhibit 5: Undiscounted capital recovery on a hypothetical "Tier 1" Shale vs. "Tier 1" offshore project



Source: Recurrent research, public filings

Despite offshore clearly providing "lower-cost" barrels on the undiscounted basis shown above, ESG and Energy Transition risks are driving oil "risk premiums" – i.e. discount rates – higher. On a relative basis, new projects with long-dated cash flows (like conventional offshore) are disproportionately discounted, and quicker payback periods (Shale) benefit. Given perceived risks around long-term oil demand, Shale's ability to rapidly pay back upfront capex is highly attractive, as shown in Exhibit [6] below.

Exhibit 6: "Tier 1" Shale vs. "Tier 1" offshore, Shale provides faster payback in almost all oil environments

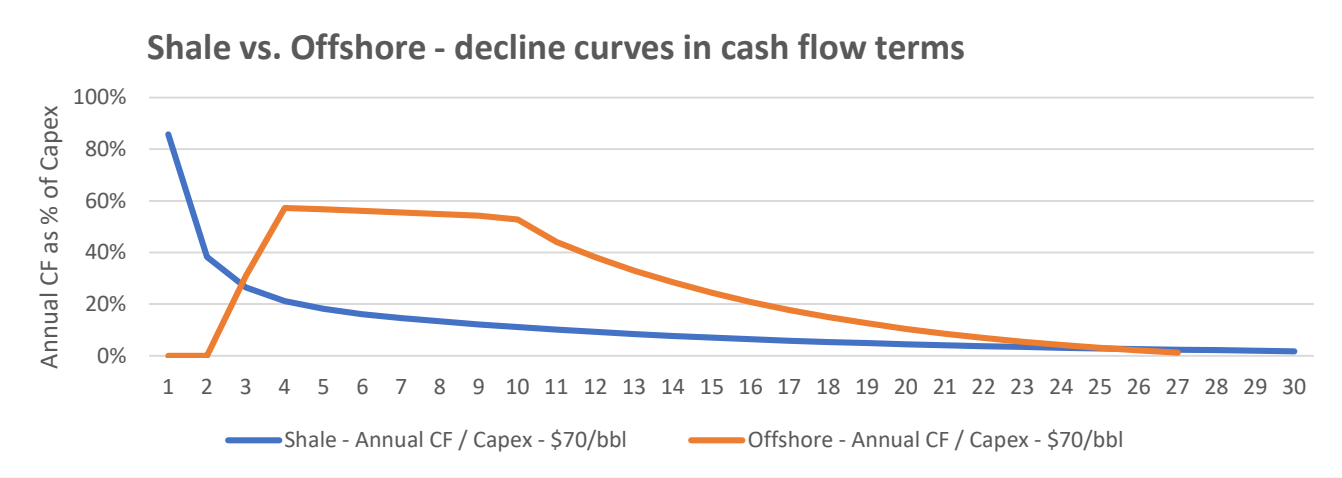


Source: Recurrent research, public filings.

Shale wins in a scarce capital world, but requires more future capex

Despite quicker paybacks in most scenarios, Shale is not without its drawbacks. Production from Shale wells falls 70% in the first 12 months, and 20-30% in subsequent years, before reaching 5-10% terminal decline after year 7. This creates a significant need for subsequent reinvestment to offset Shale's rapid declines. For conventional offshore wells, "peak" production is optimized for several years before entering into a much shallower natural decline rate of 5-10%, requiring much less aggressive reinvestment to replace base declines. However, the extended lifespan of offshore wells means that a significant portion of project economics are hostage to long-term, 10-, 20-, or 30-year demand forecasts.

Exhibit 7: two types of supply: slow, stable offshore vs. immediate Shale (with subsequent steep declines)



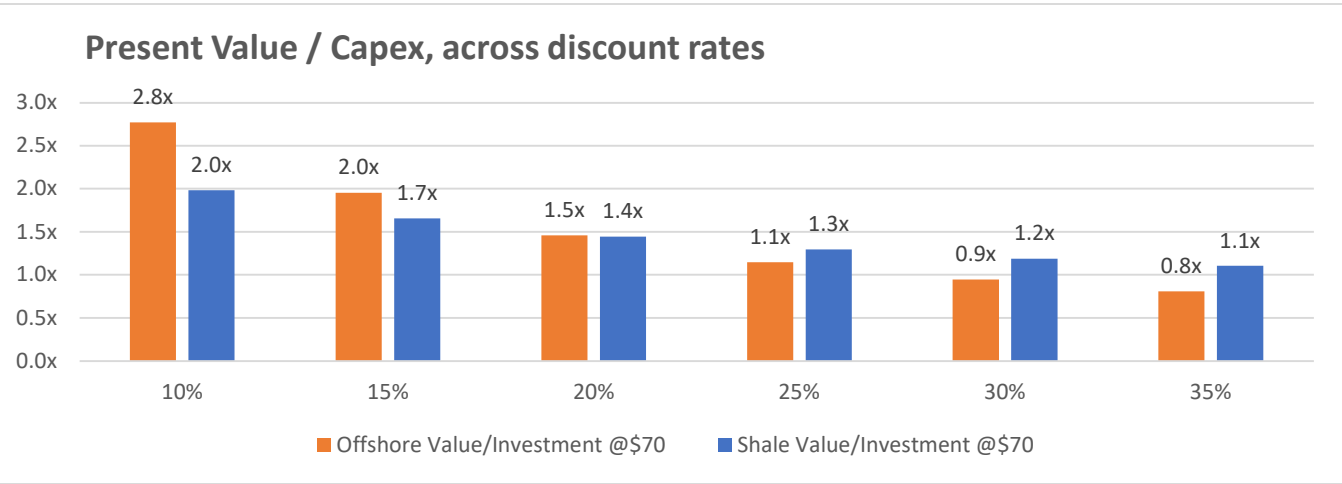
Source: Recurrent research, public filings

Just like bonds, long-duration *wells* are more vulnerable to higher rates

The capital allocation decision for energy projects is in many ways similar to valuing bonds. With two options – an offshore project or Shale development – the cost variable is well-defined, as offshore development is typically "lower-cost" than Shale – i.e. offshore wells generate acceptable returns even at low price levels where Shale drilling becomes unprofitable, below $40/bbl.

However, as we see in Exhibit [8] below, higher risk premiums have a much greater impact on long-duration projects. The present value (PV) of an offshore project declines by 70% and falls below a 1.0x PV/Capex threshold as discount rates rise from 10% to 35%. Meanwhile, PV of a Shale well declines by only 45% and still exceeds the 1.0x PV/Capex threshold.

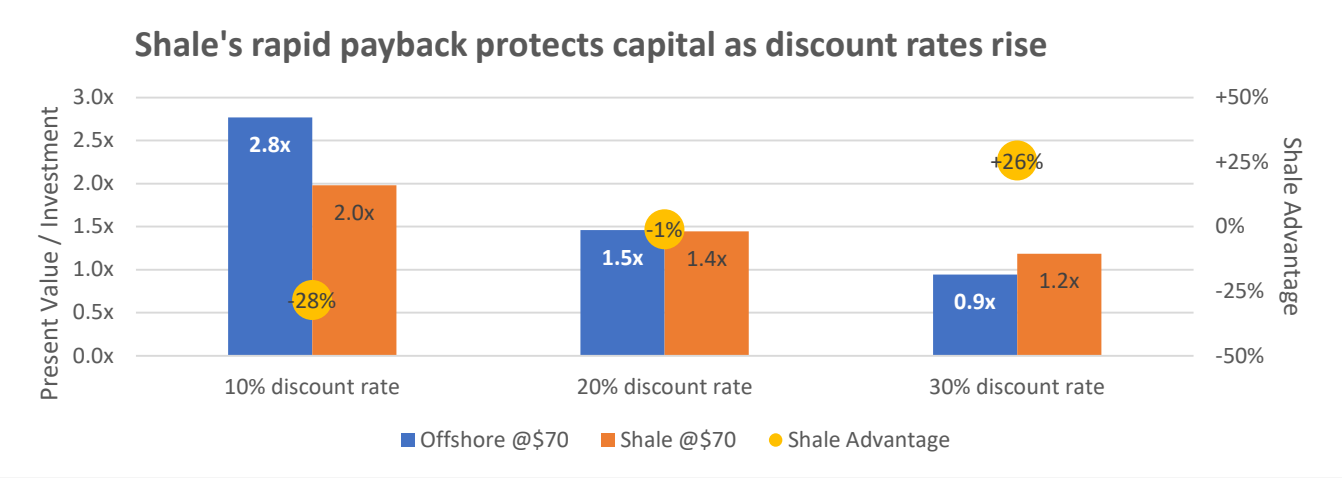
Exhibit 8: Shale's rapid payback protects capital as risk premiums / discount rates rise



Source: Recurrent research, public filings.

In a bond context, if the risk premium rises, the value of the longer duration bond would fall more than a shorter duration bond. Using the same thought process, as shown in Exhibit [9] below, the higher risk premium entailed by potential declines in long-term demand means that the relative value of long-duration assets falls more than short-duration assets.

Exhibit 9: Shale's advantage increases as discount rates and risk premiums increase

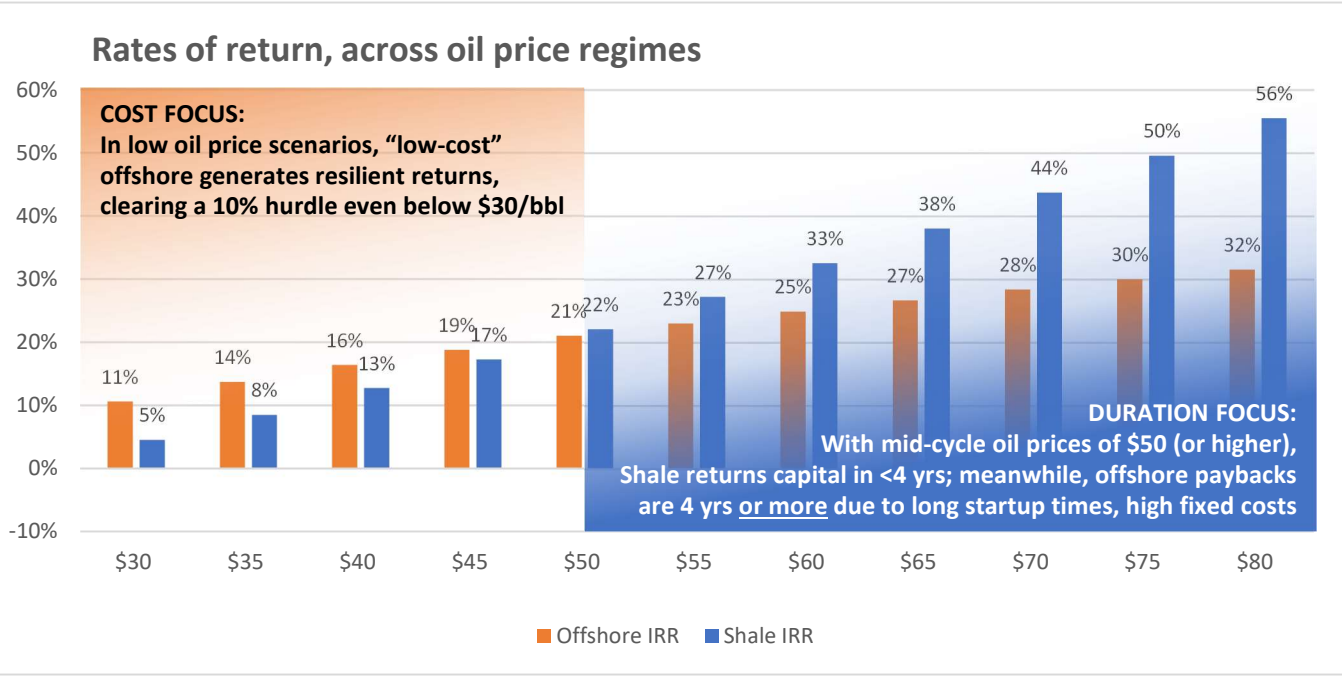


Source: Recurrent research, public filings

On a relative basis, the "Tier 1" US Shale production will become increasingly valuable relative to long-duration "Tier 1" offshore projects, despite offshore's lower breakeven oil price. In fact, even in a declining demand scenario, short-duration US Shale could conceivably be required to *increase* absolute production levels. In turn, the global oil price will remain suitably high to incentivize high-cost production to remain online, generating strong rates of return, despite higher risk premiums.

As we see above, the inclusion of **duration** into capital allocation decisions, while seemingly a small change in perspective, can portend significant impacts on both global oil prices and US Shale oil volumes. Due to its shorter duration and quicker payback, higher-cost US Shale will command an increasing share of global oil investment and increase as a percent of global supply.

Exhibit 10: Shale's rapid payback protects capital as risk premiums / discount rates rise

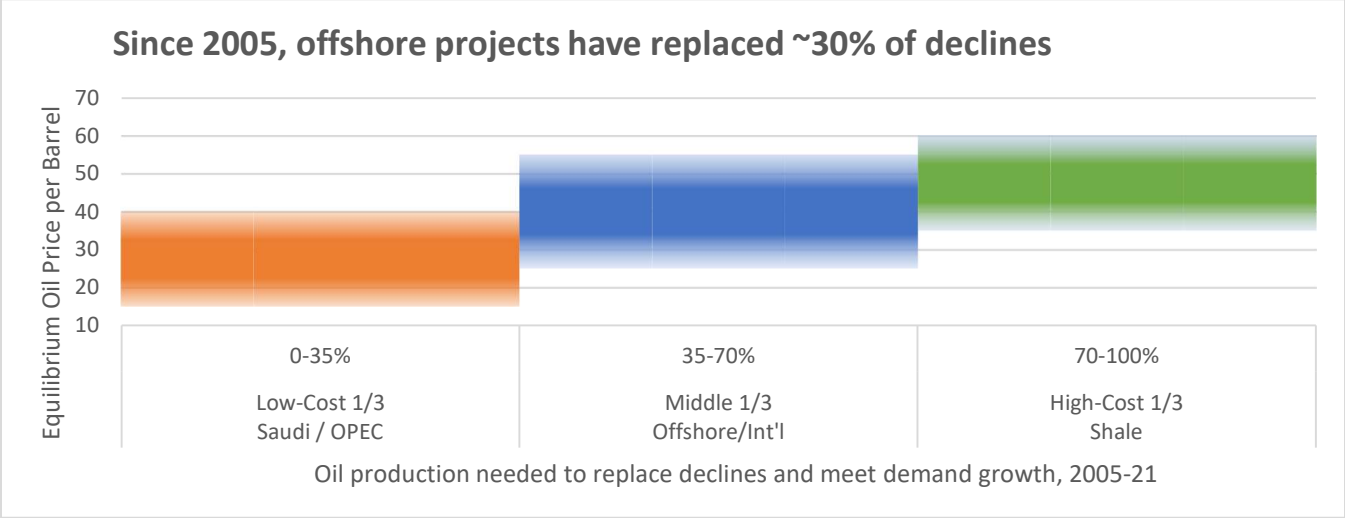


Source: Recurrent research, public filings.

Into the next decade: an increasing call on Shale, filling the offshore gap

Over the past 15 years, offshore international projects –including massive developments in the Gulf of Mexico, West Africa, Brazil, Central Asia, and the North Sea – have filled roughly one-third of the world's base declines. The simplified illustration below illustrates how onshore unconventional Shale has provided another 1/3 of base declines and met rising demand, keeping oil prices near a $60/bbl average over 15 years, with rapid-response of Shale development preventing a recurrence of 2008 price spikes.

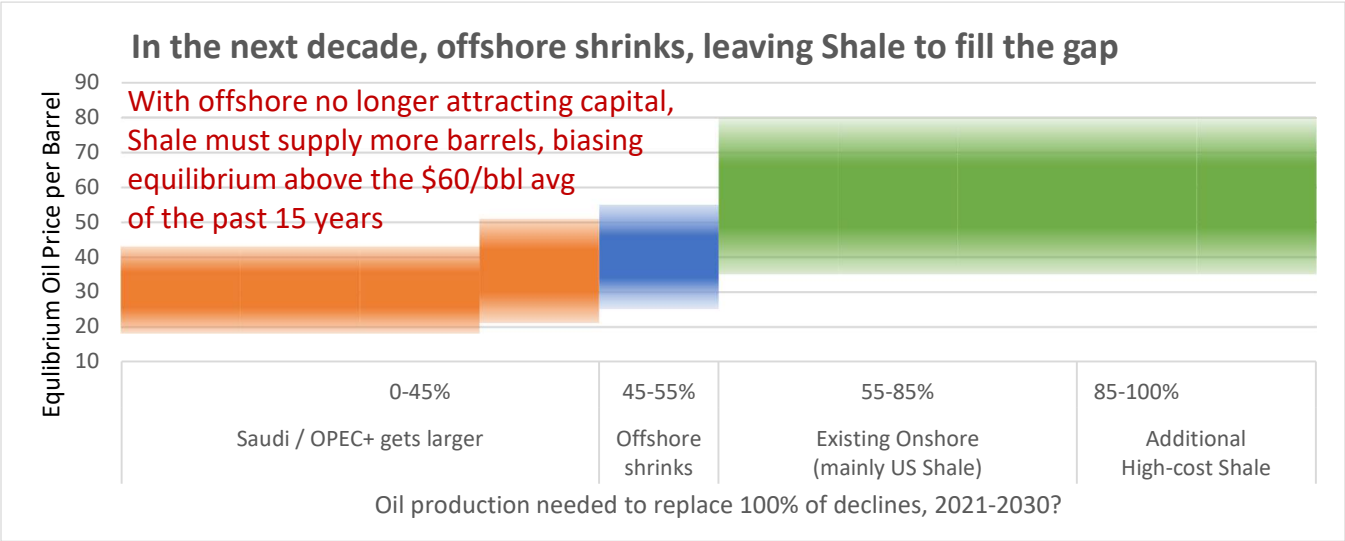
Exhibit 11: Illustrative oil market dispatch curve over the past 15 years



Source: Recurrent research

The global oil price will need to remain high enough to incentivize **additional** US Shale production as long-duration assets enter terminal decline. This is an economically rational response to a higher "risk premium," otherwise understood as a higher time value of money, or discount rate. Additionally, despite the potential for falling global oil demand, due to increases in market share, US Shale production will remain much more resilient than traditional cost-based supply forecasts would suggest.

Exhibit 12: Illustrative oil market dispatch curve as offshore declines and Shale market share increases



Source: Recurrent research

Shale – a resource uniquely suited to grow in a world of scarce capital

In a growing demand environment, production declines create scarcity value, warranting a premium for undeveloped reserves, irrespective of time to production. In a falling global demand environment, the cost structure of an individual project must be balanced against the ability of that project to recover capital quickly, and limit risk to potential unforeseen deteriorations in the long-term demand outlook.

While in most industries, falling demand would cause capital to move away from the highest-cost sources of supply, in oil markets, differences in production decline curves cause different outcomes. While offshore megaprojects can take anywhere from 3 to 6 years to reach peak production, US Shale wells can recover all upfront investment in less than 2 years in a $70/barrel environment. This uniquely short duration dramatically increases their relative value compared to long duration projects.

Counter to the conventional economic theory relevant in traditional manufacturing industries, the high-cost nature of US Shale production is outweighed by the desirability of its front-end weighted production profile, which allows Shale to recover capital rapidly, generating higher rates of return than is possible even for the lowest-cost offshore megaprojects. Accordingly, Shale is likely to increase its market share in a variety of demand environments – even if oil demand falls as decarbonization initiatives gain momentum.

Contrary to many analysts' predictions that Shale will disproportionately lose market share if oil demand falls, the reality could not be more different: North American Shale production will see market share gains, leading production to remain flat or even increase for many years after global oil demand peaks.

From an investment perspective, Shale's dominance will support North American production volumes in a variety of demand environments. This will ensure the value of North American energy infrastructure for years to come. Furthermore, the value of assets that are already producing, with low declines (and low maintenance requirements) will increase, since the oil price will be set by high-cost assets with high maintenance requirements. Ironically, continued Shale development will ensure that the lowest-quality, highest-cost Shale resources remain in active development, but also ensures that those marginal assets will struggle to generate economic value above and beyond the increasing cost of capital.