# Changing World Oil Markets and the Texas Economy

## The Impact of Scenarios for Future Oil Prices on our State's GDP, Employment and Public Education Funding


PREPARED BY

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# Executive Summary

This report summarizes research conducted by Center for Houston's Future (CHF) on behalf of Texas 2036 to assess the potential implications for the Texas economy and its fiscal health if oil prices were to remain weak for the next 15 years through 2036, the State's bicentennial. Texas 2036 commissioned this report to focus attention on the state's need to evaluate long-term revenues sources, especially for education funding, in order to prepare for the possibility of a future with declining global dependence on oil.

While the Texas economy has become more diversified over the last several decades, our state's oil and gas sector continues to play an important role in the state's economy in terms of GDP and employment. It also remains a significant contributor to the state's budget, and more specifically, K-12 public education funding. Over the last several years, it has become increasingly apparent that changing oil prices translate into significant impacts on our state's economy and the state's budget. This is because Texas' oil production, now driven mostly by shale production, is highly sensitive to changing world oil prices, as we have seen during the pandemic.

In particular, the state's K-12 educational funding system, which remains heavily dependent on revenues generated from the state's exploration and production activity, is linked to global energy market trends and world oil prices. As a result, there is a growing concern that the underlying revenue sources for public education could be at risk as world energy markets transition. This study arose from a concern that trends in oil market conditions could lead to significant economic impacts on the state and, in particular, to a risk that the underfunding of the K-12 education system might endanger the public education of the future youth of Texas.

The research presented was conducted between April-November 2020 in the following four phases:

- **Develop oil price scenarios**. By convening an expert industry panel and reviewing substantial information about global oil demand, supply and economics, we agreed on four "low-but-plausible" scenarios of future oil prices through 2036.

- **Forecast Texas oil/gas production**. Leveraging the proprietary resource modeling on Texas geologic formations developed by the Bureau of Economic Geology (BEG) at the University of Texas, we projected statewide oil/gas production volumes under each scenario.

- **Estimate impacts on Texas economy and budget.** Using future prices and volumes for oil and gas as inputs, we developed and used a spreadsheet model to calculate revenue collections from Texas exploration and production (E&P) activity under each scenario.

- **Calculate impacts on Texas public K-12 funding.** Given the size and importance of K-12 funding as a public policy concern, we analyzed revenue collections from E&P activity to estimate contributions via various mechanisms to Texas public school expenditures under each scenario.

We reached several conclusions regarding the future of world oil markets, and the implications of potential oil market weakness to the health of the state's economy and public finances.

With respect to oil market conditions:

- Hydraulic fracturing in shale rock formations spawned a revolution in oil production. Texas has been the biggest beneficiary of this revolution, given the massive size of the Permian Basin's shale resources.

- OPEC still plays a dominant role in setting world oil prices, despite the shale revolution. It is in OPEC's interests to choreograph supply decisions among leading oil suppliers to keep prices in a band between $40-60/bbl.

- Oil prices in this range can economically support continued meaningful production volumes from the Permian Basin, albeit at lower growth rates than during the last decade. Permian shale production is likely to serve as the marginal supplier of oil in world markets for years to come.

- Under more adverse oil market conditions – such as unanticipated large declines in global oil demand if the global economy shifts away from fossil fuels at an accelerated pace – production volumes from the Permian could decline significantly.

Regarding the Texas economy:

- During most of the 20th century, the Texas economy was tightly coupled with the oil industry, rising and falling with state production. The Texas economy has significantly diversified since the oil market collapse of the mid-1980s, and oil booms and busts do not have as much economic impact.

- E&P activity, however, is still a major force in the Texas economy, accounting for roughly 250,000 direct jobs and about 10% of gross state product.

- Moreover, some degree of economic volatility due to oil market swings remains: The effects of the COVID-19 pandemic – combined with the collapse in oil prices earlier in 2020 – caused E&P employment in Texas to fall by roughly 20%.

- Under the "low-but-plausible" oil price scenarios we analyzed, we found that the state's macroeconomic activity stemming from the E&P sector would likely not grow significantly from 2019 levels and could decline by 25-50% by 2036.

Finally, on Texas fiscal matters:

- 2019 E&P activity in Texas contributed an estimated $13.5 billion in revenue to public coffers. Of this total, severance taxes accounted for $5.6 billion, sales taxes $2.9 billion, property taxes $2.1 billion and royalties $2.1 billion.

- The Economic Stabilization Fund, known as the Rainy-Day Fund, is funded solely by severance taxes on oil and natural gas production, and was valued at about $10 billion before the COVID-19 pandemic. Its value may decline under more pessimistic oil market scenarios, assuming continuation of current trends of appropriations from the ESF.

- About $6 billion of Texas public K-12 school funding in 2019 (20% of roughly $30 billion total annual expenditure) can be attributed to the E&P sector. 25% of this amount is collected by ISDs via property taxes on oil and gas producing properties, with the remaining 75% collected by the state as royalties and taxes (primarily, severance taxes and state taxes).  Weak oil market conditions in the future would put significant downward pressure on these amounts.

- The Permanent School Fund, currently valued at about $46.5 billion, is also funded solely by E&P activity, via royalties on oil and gas produced from state-owned lands. Under current disbursement trends and assuming historical investment performance continues, the PSF, because of its large size, will continue to grow even if oil and gas royalty collections were to fall to zero.

- To better insulate Texas K-12 education from downside risks of weak oil markets, Texas policymakers may consider a variety of changes to public finance mechanisms.

## Introduction: How will Texas and education funding in Texas fare in a world of declining oil markets?

During 2020, Texas has gotten a strong foretaste of this question. As a result of the COVID-19 pandemic and associated economic downturn, including dramatic declines in travel, 2020 has been an adverse year for Texas oil production volumes and more generally for the Texas economy.

With emerging vaccines and improved therapeutic treatments leading the way, there is hope the pandemic will soon be mitigated, thus enabling robust economic recovery around the world, including in Texas. As that occurs, growth in global oil demand is likely to resume.

But, how much, how quickly, and for how long will oil demand rebound? After more than 100 years of nearly uninterrupted market growth, the global outlook for oil no longer assumes ever-increasing demand.

Even before COVID-19, it was becoming increasingly clear to most industry observers that oil demand likely will peak sometime in the next few decades and then gradually decline during the remainder of the 21st century. OPEC, the organization with the most to lose from a shift away from oil, believes global oil demand will peak sometime after 2040.[1] The pandemic has done nothing but accelerate the timing of this shift. Rystad Energy recently forecasted that COVID-19 advanced the point of peak oil demand to the late 2020s.[2]

The shift away from fossil fuels is being driven by two factors: (1) ongoing cost declines for various technologies that enable greater penetration of renewable energy to power all aspects of the global economy, and (2) increasing concern about climate change motivating nations worldwide to reduce carbon emissions.

The pace and timing of this "energy transition" away from fossil fuels may be uncertain, but the overall conclusion is clear: The state's reliance on oil as a transportation fuel and an economic driver will almost certainly decline over time.

In this report, we project beyond the COVID-19 era with a medium-term view of the relationship between world oil markets and the Texas economy. We use the year 2036 – the bicentennial of the state of Texas, 15 years from today – as a waypoint toward a longer-range future in which oil plays a much lesser role in human affairs.

This investigation involved four phases of activity:

- Developing "low-but-plausible" scenarios of oil prices through 2036 through analysis of world oil market conditions and interviews with industry experts.
- Forecasting the implications of these oil price scenarios on Texas oil and natural gas production volumes through 2036.
- Estimating the impacts of forecasted Texas oil and gas production volumes under these price scenarios on various measures of the Texas macroeconomic activity and Texas fiscal health.

[1] "OPEC Dismisses Concerns That Peak Oil Demand Is Close," Financial Times, October 8, 2020.
[2] "Coronavirus Will Hasten 'Peak Oil' by Three Years, Says Research Firm," Financial Times, June 18, 2020.

- Calculating the implications of changes in revenue contributions from oil and gas production for Texas public K-12 school funding.

It is important to highlight that we explicitly limited our research to oil price scenarios that some observers may consider too pessimistic. We made this deliberate choice so that Texas policymakers and thought leaders can begin to grapple with the potential consequences of low oil prices and reduced levels of Texas oil production.

Forecasting oil prices is intrinsically difficult, and no one is known to consistently do it accurately, especially for anything beyond the shortest time horizons. As a result, most oil market participants facing strategic decisions prefer to think in terms of future "scenarios" for oil markets, and we adopt this approach as well.

Moreover, by focusing only on oil market scenarios that result in prices on the lower end of the potential future spectrum, we ignore a real possibility that world oil markets during the next 15 years rebound strongly. If such a rebound occurs, at least for the intermediate term, the Texas economy would continue to be assisted rather than harmed by oil market conditions. That would be a good problem for Texas to have – although there is no guarantee it will happen.

Therefore, the results we present should not be considered forecasts of what will happen through 2036. Instead, they are scenarios intended to provoke thoughtful evaluation of potential actions that Texas might take to better insulate its economy from possible negative consequences as the role of oil shrinks in coming decades. The priority is to ensure that school funding mechanisms like the Permanent School Fund, which could be impacted by decreasing oil prices, do not become catastrophic issues for future legislators to face.

Also important for our analysis, we assume no major regulatory or legislative changes at either the federal or state levels. As a result, current policy regimes – both environmental and taxation – facing oil and gas production in Texas are assumed to continue through the horizon of our analysis. (It is possible, for example, that new requirements will be enacted on methane releases at the wellhead and that in turn could affect costs and volumes of Texas oil and gas production, but such changes are beyond the scope of this study).

Section One provides historical context on the role of oil in the Texas economy and Section Two describes four phases of research we used to analyze potential implications for the state's economy if oil markets are weak through 2036.

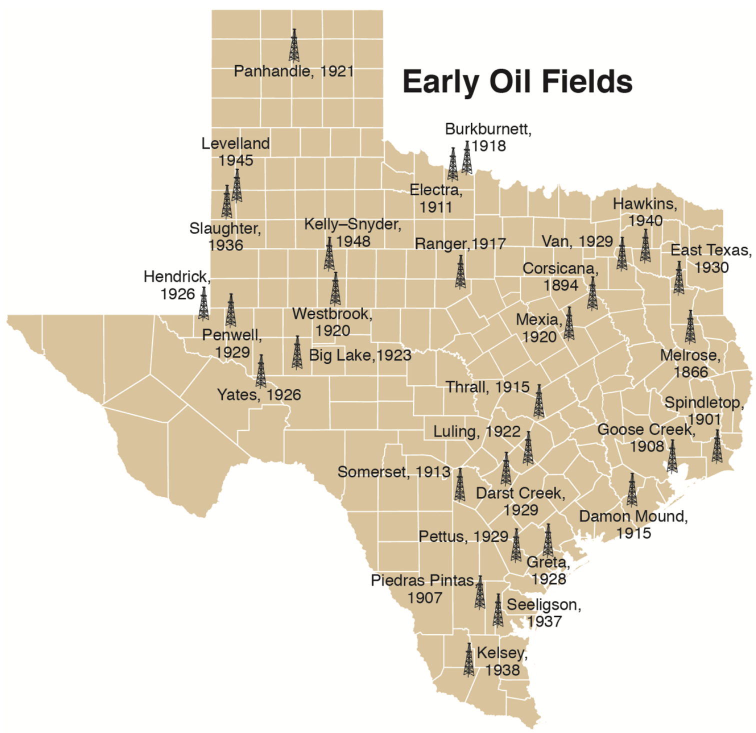
## Section One:
## The Historical Relationship Between
## Oil Production and Economic/Fiscal Health in Texas

Before considering the future of oil production in Texas and its potential implications on the Texas economy, it is first useful to reflect on how the Texas oil industry rose to its current prominence, shaping the state's economy in many ways over the past century.

### TEXAS OIL PRODUCTION DURING THE 20TH CENTURY

The Spindletop gusher, drilled near Beaumont in early January 1901, gave birth to the Texas oil industry. Soon after, oil exploration and production (E&P) activity quickly spread across Texas, with major fields found in many of the state's 254 counties, as shown in Figure 1.

**Figure 1: Significant Texas Oil Discoveries Pre-1950[3]**




The discovery with the greatest long-term significance was the May 1923 Big Lake oil strike in Reagan County, which presaged the emergence of the Permian Basin of West Texas as a major and enduring source of oil and natural gas for decades to come.

The crude oil widely available from Texas fields became known worldwide as West Texas Intermediate (WTI), highly desirable because of its low (<0.42%) sulfur content and high specific gravity (between 37°-42° on the API scale) that made for easier and cheaper refining into a variety of fuels. Between high quality and ample quantity, Texas oil quickly became dominant on the world stage: On a standalone

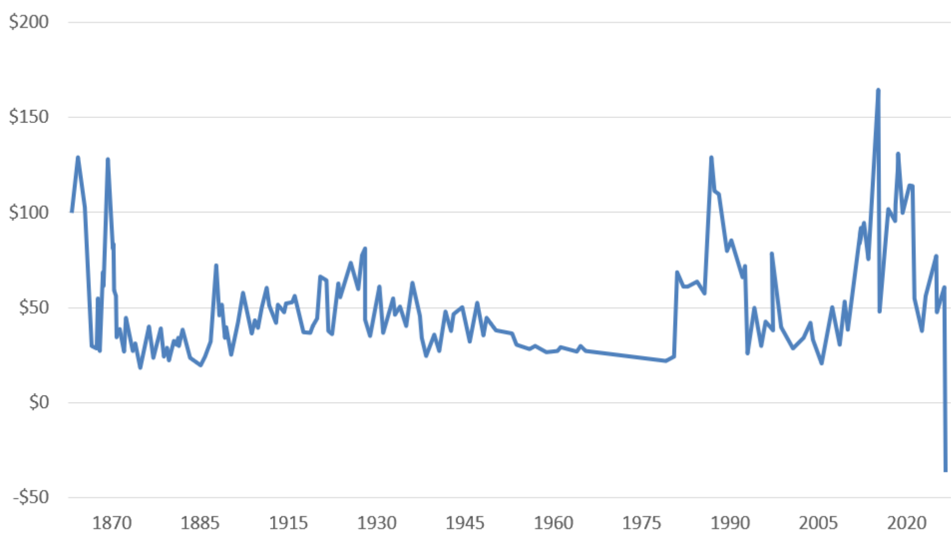
[3] Texas State Historical Association. Texas Almanac website, "History of Oil Discoveries in Texas." Used by permission.

basis, by the late 1940s, Texas was responsible for roughly 10% of global oil supply, nearly 2.5 million barrels per day (mmbpd).

During the first thirty years of the 20th century, to help bring order to a burgeoning but chaotic industry, the Texas Railroad Commission (RRC) was gradually given increasing authority over many aspects of the oil sector. In August 1930, the RRC issued its first order setting a statewide output limit, effectively regulating supply – and consequently price – of oil production.

Firms in Texas E&P activity prospered under this arrangement over the four decades that followed. Between 1935 and 1970, to meet ever-increasing global demands for transportation fuels, Texas oil production averaged 3.3% per year growth. Meanwhile, under the RRC's oversight on production volumes, oil prices remained stable, on a slow but steady decline from about $50/bbl to $25/bbl (in 2020 dollars) through this prolonged period, as shown in Figure 2.

**Figure 2: Real Crude Oil Prices, 1870-2020 ($/bbl)[4]**




Over these four decades in the middle of the 20th century other sources of oil supply emerged to play an ever-growing role in world oil markets. Particularly due to the discovery of enormous resources in the Middle East, the global market share of Texas oil production fell by the early 1970s to 2%, even though in absolute terms Texas oil production grew to 3.5 mmbpd.

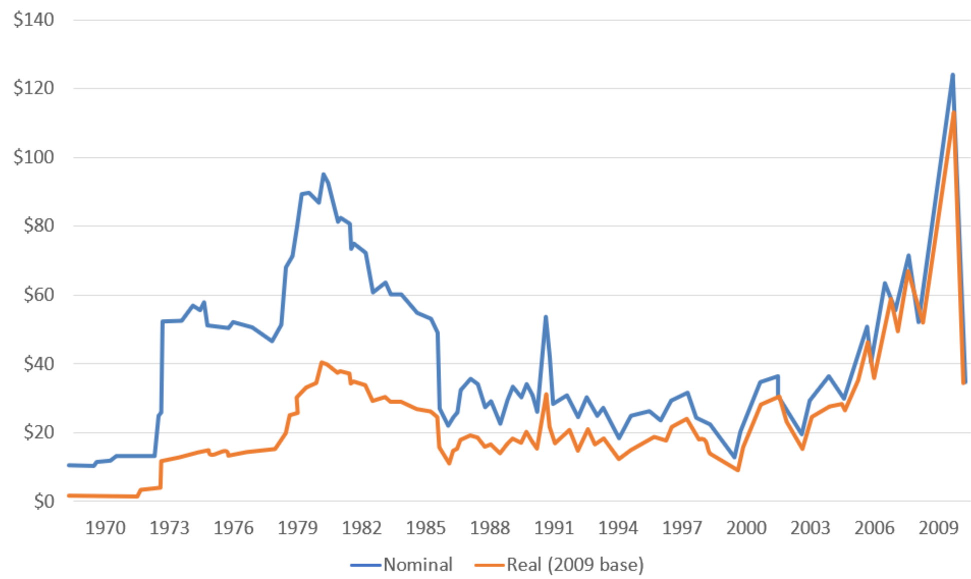
Having effectively lost the ability to manage oil market dynamics due to a shrunken role of Texas in world oil markets, the RRC set limits on Texas oil production for the last time in March 1971. Since then, E&P activity has been subject to the vagaries of global oil market conditions.

This was made highly apparent in the wake of the supply embargo initiated in October 1973 by the Organization of Petroleum Exporting Countries (OPEC). OPEC's strategic withdrawal of supplies from world oil markets – first in 1973-1974 and then again in 1978-1979 – caused oil prices to rise dramatically during the decade. Oil prices more than quintupled to over $100/bbl (in 2020 dollars).

[4] "About 150-Years of Oil-Price History in One Chart Illustrates Crude's Spectacular Plunge Below $0 a Barrel," MarketWatch, April 24, 2020.

Suddenly, the price of a barrel of oil became common knowledge to households around the world. After decades of relative stability, the high degree of volatility in the real price of oil in the years following 1973 is vividly illustrated in Figure 3.

**Figure 3: Crude Oil Prices, 1970-2010 ($/bbl)[5]**




Oil price increases of the 1970s benefitted oil producers worldwide, including those in Texas. The profitability of Texas oil production surged, but the good times masked a downturn in Texas production volumes. Simply put, the oil fields discovered decades previously in Texas were now declining after many years of consistent production, and new discoveries were no longer keeping pace.

The state's deteriorating fundamental position in world markets may have remained hidden to most Texans as oil prices remained high. However, the growing vulnerability of Texas to weak oil market conditions became vividly clear in the mid-1980s.

After relying on more than a decade of oil prices above $60/bbl (in 2020 dollars), OPEC itself began suffering as a result of demand reductions (through increased fuel efficiency, primarily in autos) and new non-OPEC supply sources (e.g., Alaska, North Sea). In response to declining revenues due to falling market share, OPEC initiated a price war at the end of 1985 to drive out high-cost oil producers.

In just a few months in 1985-1986, oil prices fell by 70%, devastating Texas oil producers and the state's economy. This would not be merely a transitory decline in oil markets for producers to briefly weather. Except for a brief spike during the 1990-1991 Gulf War, oil prices would remain relatively flat in the $35-50/bbl range (in 2020 dollars) for the next two decades. During the last years of the 20th century, oil surpluses grew so abundant that prices dipped briefly to all-time lows below $20/bbl (in 2020 dollars).

[5] Smith, James L., "World Oil: Market or Mayhem?" *Journal of Economic Perspectives*, Summer 2009.

Low oil prices did not justify capital expenditures by oil companies and Texas oil production continued to deteriorate. By 2000, Texas oil production had fallen to levels last seen in the early 1930s, and it became evident to most observers at the time that peak production levels for Texas oil were reached back in 1972 at nearly 3.5 mmpbd.

As the 20th century ended, after a good 100-year run, the picture looked modest at best for the future of Texas oil production.

## 21ST CENTURY OIL PRODUCTION FROM SHALE

Ironically, it was oil's often-overlooked hydrocarbon cousin, natural gas, that played a huge role in the 21st century rebound of Texas E&P activity.

Through the years, natural gas, often referred to as gas, was often a byproduct of oil extraction. Much of the time, considered a nuisance fuel with insufficient market value to justify investments for storing and transporting it, gas was simply vented or burned at the wellhead. Slowly, during the middle decades of the 20th century, since it was viable for burning in power generation boilers, gas was used by the growing fleet of Texas power plants. As a result, a marketplace and supporting infrastructure for Texas gas production steadily emerged.

With increasing demand for gas across the nation during the 1980s and 1990s – not only for power generation, but also for heating – natural gas gradually shed its lower-tier status and grew in importance among fuels.

Indeed, by the early 2000s, while oil prices remained relatively low (~$40/bbl in 2020 dollars), natural gas prices were surging to historically unparalleled prices in winter months to meet seasonal demands for electricity and heating. By late 2005, prices at Henry Hub – the U.S. trading point for wholesale natural gas transactions – exceeded $13/mmBtu (in 2020 dollars), having climbed from $2.50/mmBtu just four years earlier.

These high prices led industry innovators into exploring unconventional resources for new sources of natural gas supply. They spawned a revolution.

Lifelong Texan George P. Mitchell was in the right place at the right time: After years of experimentation, his sustained development of a set of hydrocarbon extraction techniques called hydraulic fracturing – now known more commonly as "fracking" – finally matured, achieving cost-effectiveness in liberating natural gas from shale rock.

With conventional wells drilled in traditional fields, underground pressures are sufficient to cause continuous reservoirs of hydrocarbons to flow vertically to the surface. Fracking in shale involves a combination of horizontal directional drilling and using fluids to force more fractured shale-based trapped hydrocarbons to migrate horizontally to collection wells distant from the primary drill site.

These differences translate into large consequences for the cost structure of oil and gas production. Output from conventional wells requires limited onsite labor after drilling, and good volumes can be expected with modest decline rates for many years, resulting in low operating costs and long lifetimes. In contrast, fracking involves almost continuous onsite activity – and consequently ongoing working capital investment in equipment, supplies and labor – to maintain production volumes in the face of steep decline curves.

Initially employed in the Barnett field of north Texas near Fort Worth, fracking subsequently was deployed to produce gas in many other shale beds in Texas and around the U.S. as the first decade of the 21st century came to a close. And, as oil prices finally began to rise again from long-depressed levels, fracking also began to be used in shale in pursuit of oil.

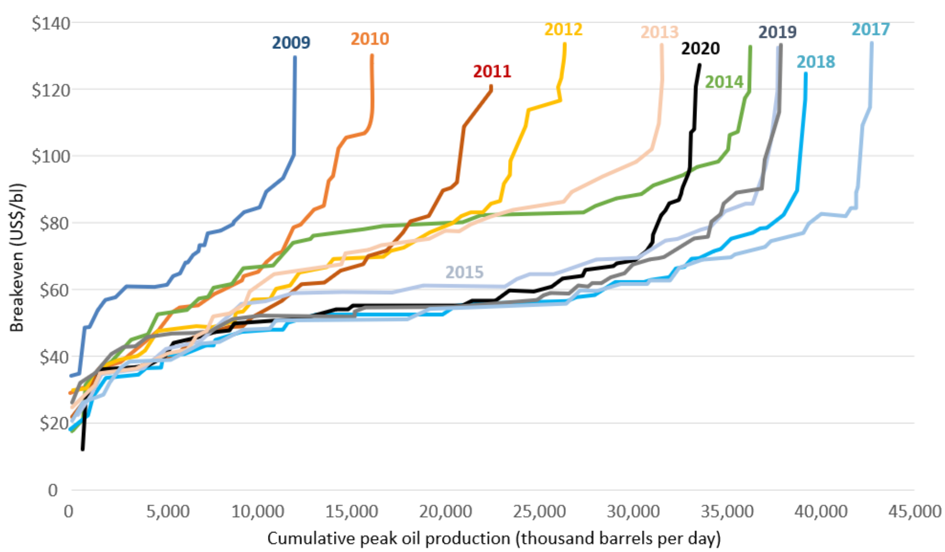
In Texas, fracking spurred substantial growth in natural gas production as the fuel became a highly valued commodity. It also resuscitated oil E&P activity, as prices surged, peaking at more than $150/bbl (in 2020 dollars) just before the worldwide financial crisis of 2008.

Suffering only a brief setback during the resulting Great Recession, crude oil prices rebounded to near $100/bbl (in 2020 dollars) by 2010. With oil prices this high, E&P firms continued investing abundantly around the world, especially in shale activities.

As fracking techniques matured, numerous productivity improvements followed and enabled significant reductions in costs to extract oil from shale during the 2010s, making large volumes of new production from the U.S. economically viable in world markets.

Figure 4 shows the lowering and flattening of the supply curve of incremental U.S. oil production capabilities (as represented by so-called "Top Projects" monitored by Goldman Sachs) in the last decade, with growing quantities of volumes available at in the $50-60/bbl range.

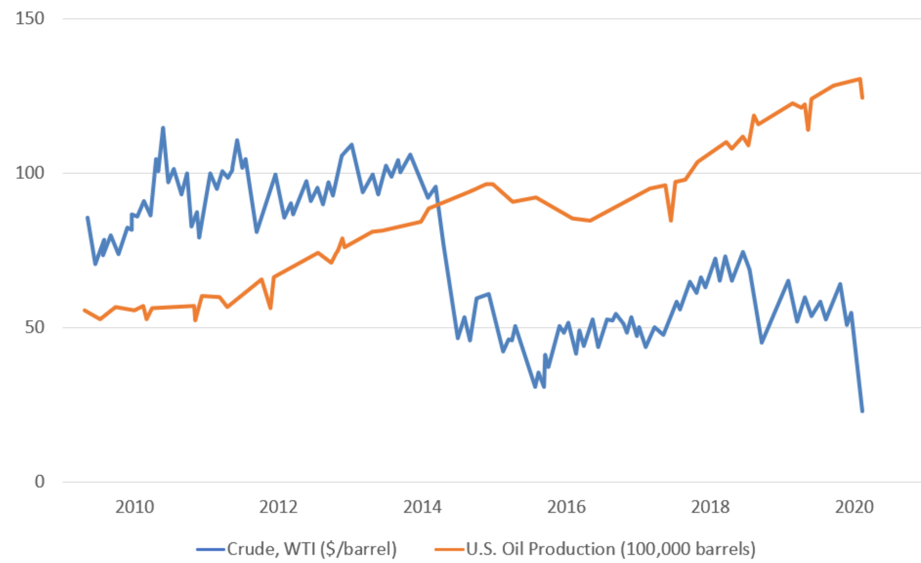
**Figure 4: Lowering and Flattening of the U.S. Incremental Oil Supply Curve During 2010s[6]**




By the second half of the decade, the increases in supply availability from U.S. shale resources at declining per-barrel costs had driven oil prices down by nearly 50% to the $50-60/bbl range, as shown in Figure 5.

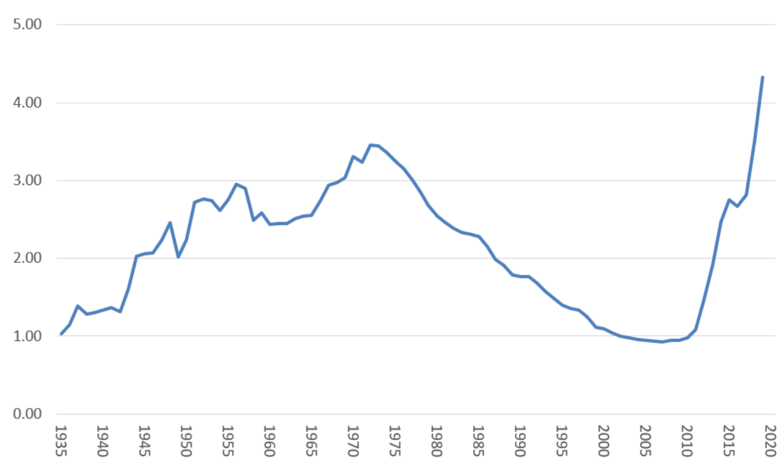
[6] "Five Key Questions on Oil Equities from Investors," Goldman Sachs Investment Research, April 20, 2020.

**Figure 5: Oil Prices and U.S. Oil Production During 2010-2020**[7]




Texas was the biggest beneficiary from this confluence of forces. After having consistently hovered below 1 mmbpd during the 2000s, Texas oil production grew by 15% per year during the 2010s, reaching 4.3 mmbpd by 2019. Fully attributable to the introduction of fracking, Texas oil production rebounded in the 10 years between 2010 and 2019, from levels in the early 1930s to levels beyond previous peak volumes in the early 1970s, as shown in Figure 6.

**Figure 6: Texas Oil Production Since 1935 (mmbpd)**[8]




The value of Texas production was equally split between oil and gas in 2010, Figure 7 shows that due to its unprecedented growth during the decade <u>oil accounted for 90% of the total value of Texas oil and gas production by 2019</u>.

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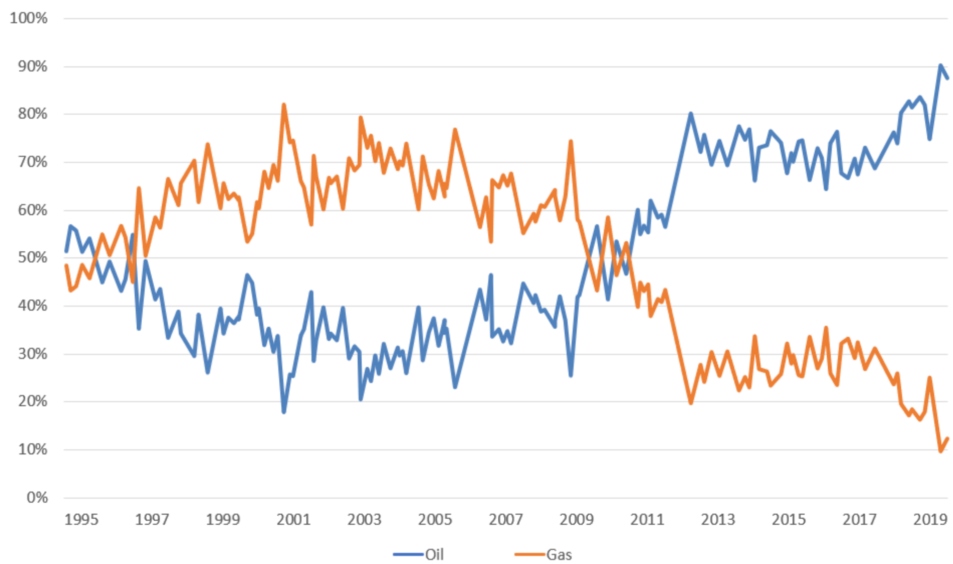
[7] "Don't Count the Fracking Industry Out Just Yet," Bloomberg, April 15, 2020.

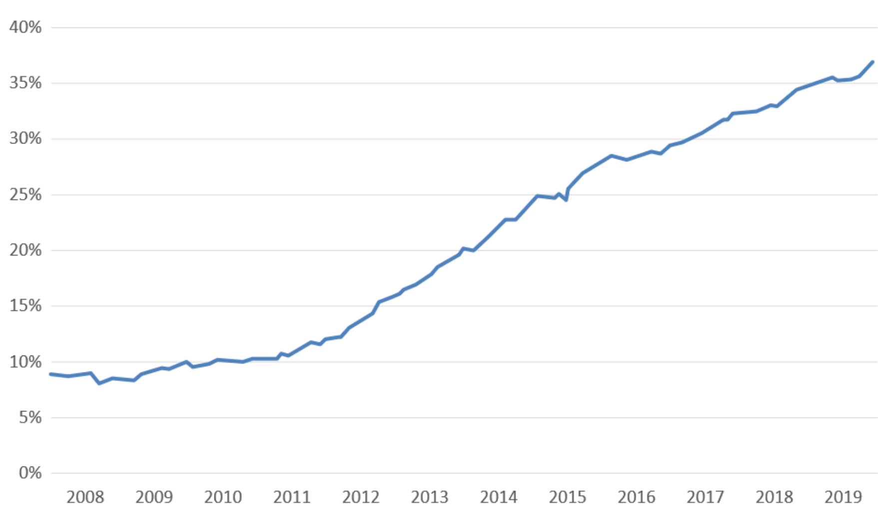
[8] Data from Railroad Commission of Texas, "Crude Oil Production and Well Counts (since 1935)."

**Figure 7: Share of Value of Texas Oil and Gas Production**[9]




Resulting from this shift, natural gas is increasingly being relegated back to its historical role as an associated byproduct of oil production rather than a dedicated target of E&P activity, as shown in Figure 8.

**Figure 8: Fraction of Texas Natural Gas Production "Associated" With Oil Extraction**[10]

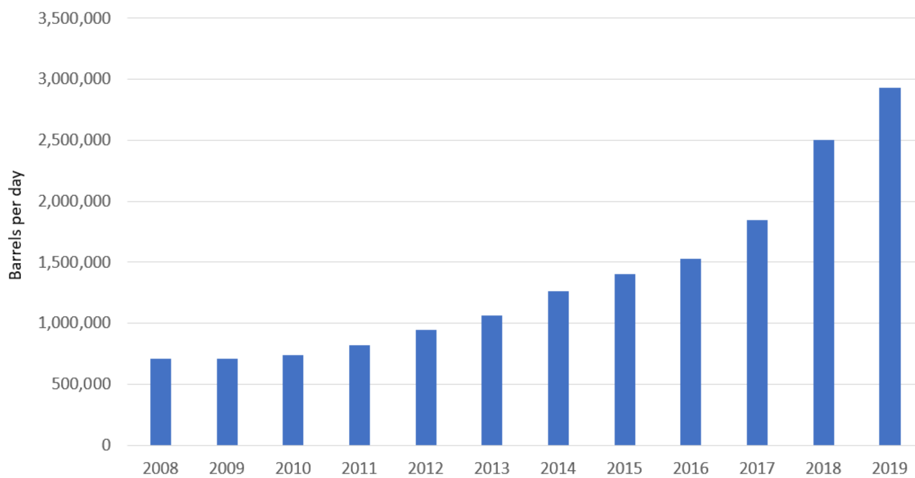



In Texas, while natural gas E&P interests focused on other basins – initially the Barnett and then the Haynesville – significant activity to extract oil from shale began in 2011 in the Eagle Ford basin. By mid-decade, attention had shifted primarily to the Permian Basin, long the giant of the industry.

[9] Ingham, Karr, "The State of the Texas Upstream Oil & Gas Economy," Texas Alliance of Energy Producers, July 31, 2019.
[10] Ingham, Karr, "The State of the Texas Upstream Oil & Gas Economy," Texas Alliance of Energy Producers, July 31, 2019.

After 70 years of depletion from heavy production, the Permian's best days seemed long ago in the past as recently as 2008, when volumes had fallen to 0.7 mmbpd after four decades of steady decline. However, 2008 represented the nadir. As illustrated in Figure 9, Texas Permian oil production volumes began a 12-year run of uninterrupted growth averaging 14% per year, reaching 2.9 mmbpd by the end of 2019.

**Figure 9: Texas Permian Basin Oil Production: 2008-2019[11]**




Today, the Permian dominates Texas E&P activity. As shown in Figure 10, the Permian alone was responsible for 68% of 2019 Texas oil production (not to mention 41% of Texas gas production). When Texas Permian production is added to output from the Eagle Ford, fully 87% of 2019 Texas oil production was attributable to shale resources.

**Figure 10: Texas Oil and Gas Production in 2019[12]**

| | Oil production | | Gas production | |
|---|---|---|---|---|
| **Basin** | **Mmbpd** | **% of TX** | **Bcf/d** | **% of TX** |
| Permian (Total) | 2.93 | 68.3% | 11.61 | 40.8% |
| • Conventional | 0.20 | 4.7% | 1.89 | 6.6% |
| • Shale | 2.73 | 63.6% | 972 | 34.2% |
| Eagle Ford Shale | 1.01 | 23.5% | 5.25 | 18.5% |
| Granite Wash | 0.00 | 0.0% | 0.49 | 1.7% |
| Haynesville/Bossier Shale | 0.00 | 0.0% | 2.38 | 8.4% |
| Barnett Shale | 0.00 | 0.0% | 2.89 | 10.2% |
| Other | 0.35 | 8.2% | 5.82 | 20.5% |
| Total TX | 4.29 | 100.0% | 28.44 | 100.0% |
| | | | | |
| Permian Shale + Eagle Ford | 3.74 | 87.2% | 14.97 | 52.6% |

[11] Railroad Commission of Texas, "Texas Permian Basin Average Daily Oil Production 2008 through September 2020."
[12] Data from Railroad Commission of Texas, "Major Oil and Gas Formations" and "Monthly Oil and Gas Productions by Year."

The Permian remains well positioned for additional production growth. It has an immense remaining resource base of an estimated 92 billion barrels of recoverable oil – 38 times the proven reserves of Alaska – plus 300 trillion cubic feet of recoverable natural gas.[13] Just as important, to be discussed further below, Permian shale has a notable cost advantage over other U.S. shale basins, due to the favorability of its geologic deposits.

Heading into the 2020s, the future of Texas E&P activity seemed almost limitless, to be led by the Permian Basin. And then, in response to the COVID-19 pandemic, governments around the world imposed economic restrictions, dramatically curtailing travel and consequently driving oil demand strongly downward.

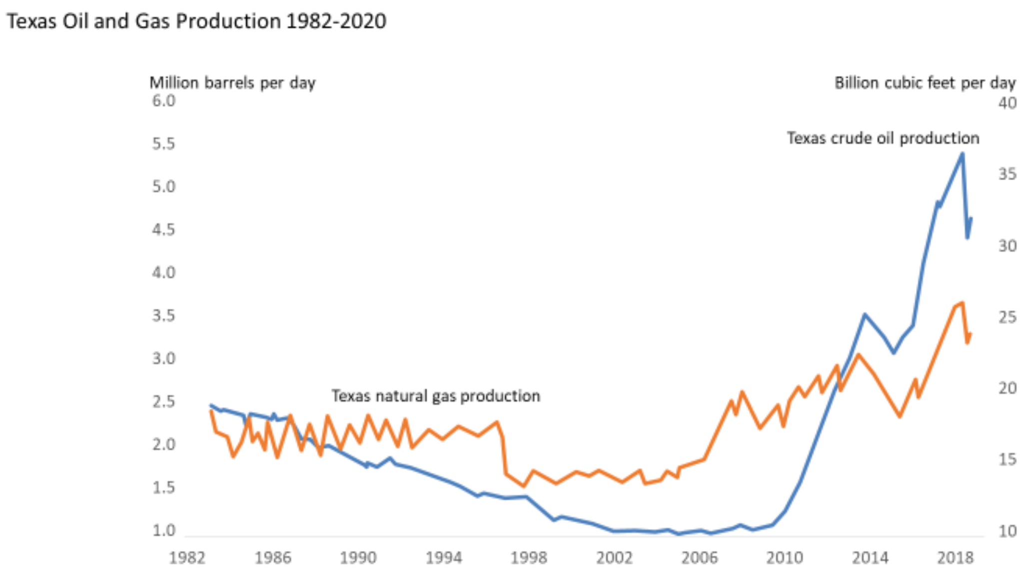
Exacerbating a virtually instantaneous 15% drop in global oil demand (from 100 mmbpd to 85 mmbpd)[14] as most discretionary travel ceased, Saudi Arabia in early March 2020 decided that – after sacrificing for the past 20 years to accommodate new oil suppliers – it could no longer accept both market share and prices below target levels, announcing a 2.6 mmbpd (27%) oil production increase and a corresponding $6-8/bbl price cut.

The combined impact of increased production and reduced demand caused world oil prices to crash. In fact, until adjustments in output were made, production soon exceeded what the market could absorb, and oil prices were momentarily driven negative in April 2020 when storage capacity reached its limits.

In response, oil producers around the world significantly cut output. As shown in Figure 11, Texas oil production took its fair share of the hit, falling by about 1 mmbpd (or ~10% of global production cutbacks) during the second quarter of 2020.

**Figure 11: Texas Oil and Gas Production: 1982-2020[15]**

[13] Permian Strategic Partnership, The Permian Basin: Unlocking the Full Potential, 2020.
[14] "Energy Slideshow," Federal Reserve Bank of Dallas, September 4, 2020.
[15] "Energy Slideshow," Federal Reserve Bank of Dallas, September 4, 2020.




Due to these massive disruptions and major uncertainty about the post-pandemic rebound in oil demand and prices, the growth visions projected only a year ago for Texas E&P activity during the 2020s are now on hold. In the meantime, the Texas economy is attempting to adjust.

## OIL AND THE TEXAS ECONOMY

Since the 1901 Spindletop discovery, the oil industry has had a profound impact on the growth of Texas and its economy.

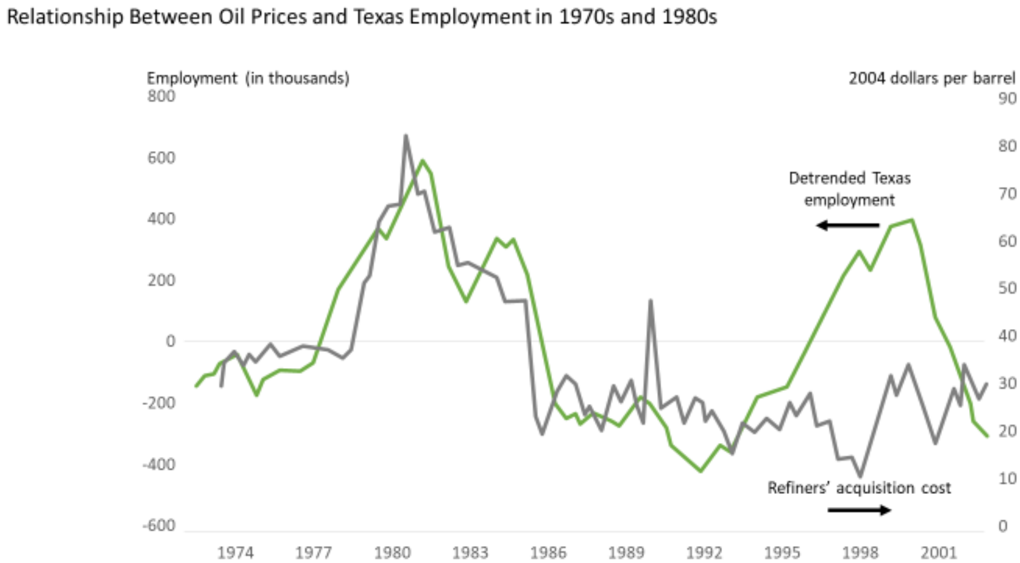
Similar to gold propelling California's development in the mid-1800's, the prospect of oil riches in Texas attracted waves of migration during the first half of the 20th century, with surges in commercial activity of all kinds to support intensive levels of E&P activity.

In the forty years between 1930 and 1970, while Texas oil production steadily grew at roughly 3% per year, the state's population nearly doubled, from 5.8 million to 11.2 million. With the oil industry as the engine of growth, Houston and Dallas blossomed into major cities. Wealth created by Texas oil production created legends, spawned fortunes and funded much of the state's budget.

The health of the oil industry and the health of the Texas economy became highly intertwined. When OPEC initiated the energy crisis of the 1970s, the inflationary pressures caused by the resulting oil price shock damaged most economies around the world. But in Texas, E&P firms and associated industries saw increased activity. As Figure 12 illustrates, changes in Texas employment closely followed the trajectory of oil prices during the 1970s and 1980s.

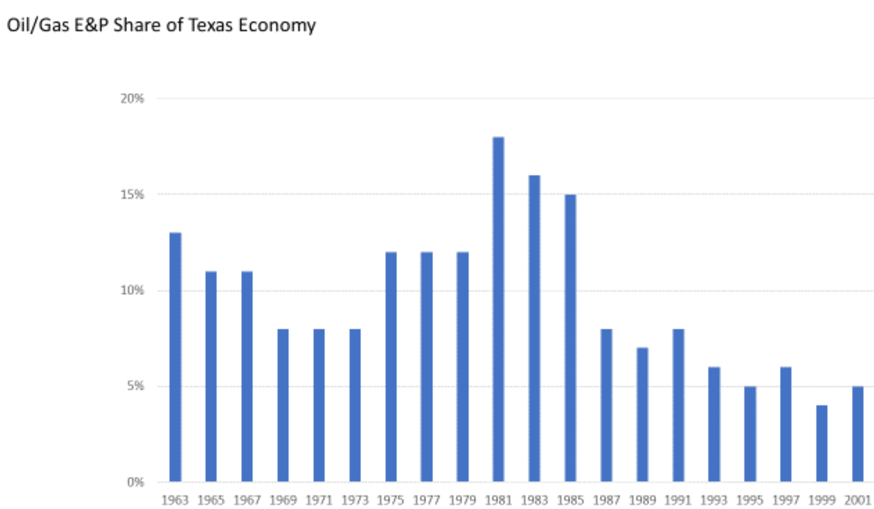
**Figure 12: Tight Relationship Between Oil Prices and Texas Employment During 1970s and 1980s**[16]

[16] "Do Higher Oil Prices Still Benefit Texas?" Federal Reserve Bank of Dallas, October 2005.




While the U.S. economy limped along in the throes of "stagflation" – a combination of low economic growth and high inflation – the Texas economy thrived, and E&P activity was at the center of the state's economic outperformance.  As shown in Figure 13, oil and gas E&P accounted for 18% of total Texas economic activity at the height of the boom in 1981.

**Figure 13:  Oil/Gas E&P Share of the Texas Economy Peaks in 1981[17]**

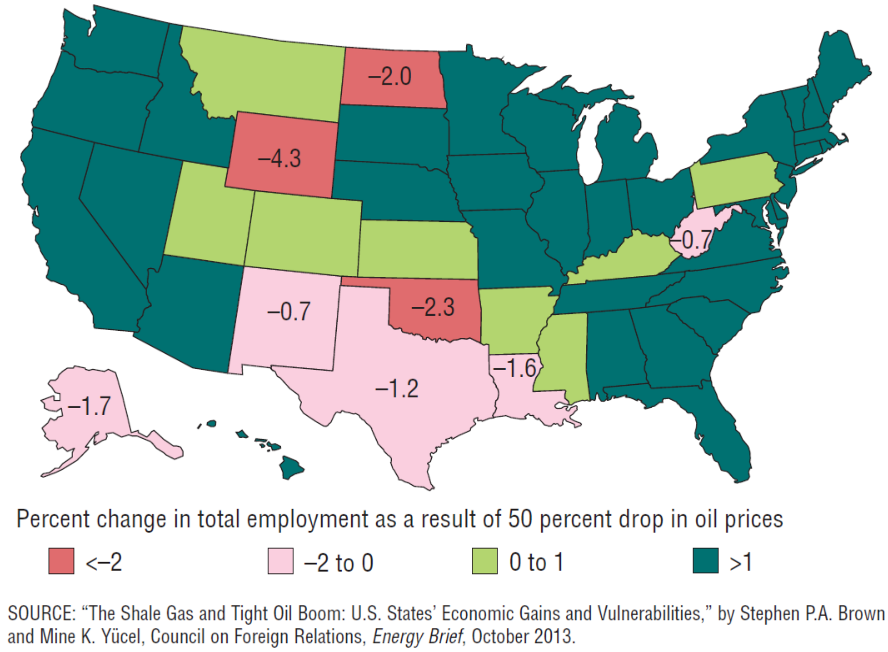



17 "Do Higher Oil Prices Still Benefit Texas?" Federal Reserve Bank of Dallas, October 2005.

Then, in 1986, the economic boom suddenly burst for Texas. In a reversal of the oil embargo, it led 12 years earlier, OPEC flooded markets with their low-cost supplies, crashing prices to shake out higher-cost producers, thereby reclaiming the dominant position in the global marketplace.

For most states in the U.S., the sharp drop oil prices significantly improved economic prospects. In contrast, as illustrated in Figure 14, Texas is one of the few states that suffered due to the decline in oil prices.

**Figure 14: Estimated Changes in State-Level Employment Due to 50% Decline in Oil Prices[18]**




Whereas the Texas oil sector rode OPEC's coattails for over a decade, generally benefitting from high prices that OPEC dictated, the OPEC-driven collapse in prices during 1985-1986 crushed many Texas oil producers – and the Texas economy along with it. Office towers developed across the state during the early 1980s and built during the mid-1980s became widely referred to as "see-through buildings" in the late 1980s.

As the oil industry suffered, the Texas unemployment rate surged to over 9% by late 1986.[19] Over the following ten years of relatively low oil prices, the share of oil and gas activity in the Texas economy fell to 4% and – as shown in Figure 15 – the E&P sector's share of Texas employment dropped to below 2%, around where it remains today.

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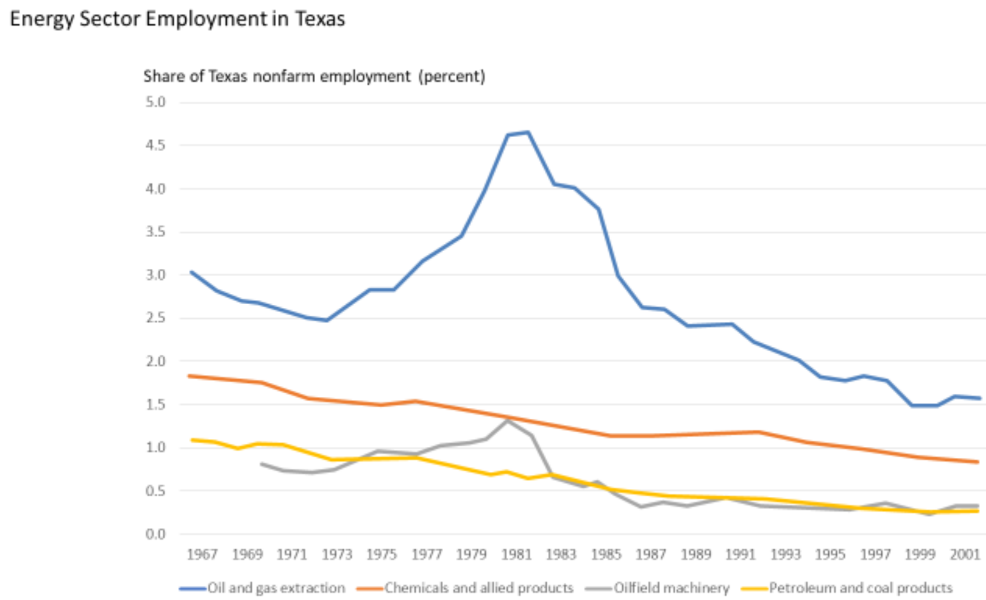
[18] "Plunging Oil Prices: A Boost for the U.S. Economy, A Jolt for Texas," Economic Letter, Federal Reserve Bank of Dallas, April 2015.

[19] Bureau of Labor Statistics, "Local Area Unemployment Statistics."

**Figure 15: Energy Sector Employment in Texas**[20]



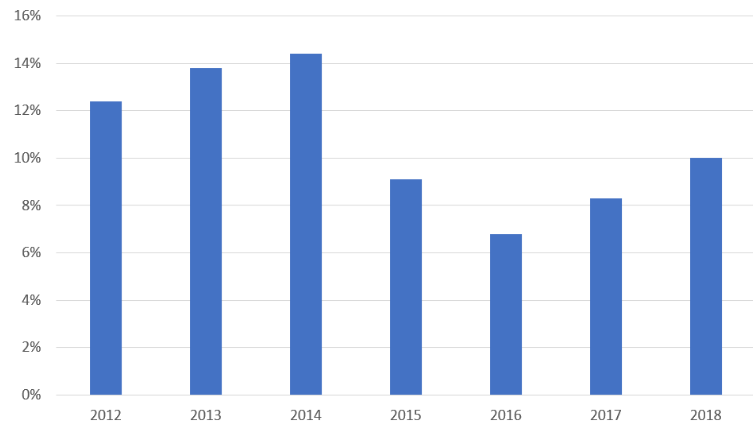

Fortunately, although not due to any grand strategy by leaders from the public or private sectors, the Texas economy has diversified substantially over the past 40 years and is now less dominated by oil E&P activity.

According to research from the Federal Reserve Bank of Dallas, a hypothetical 10% increase in the price of oil was estimated to produce a 1.37% increase in Texas non-farm employment in 1982. But by 2000 an equivalent oil price increase was estimated to result in only an 0.30% increase in Texas non-farm employment.[21]

Even though the state economy is not nearly as reliant on oil as it used to be, Texas E&P activity nevertheless remains vital to our economy, generating about $250 billion in gross state product in 2019[22] and representing about 10% of the Texas economy, as indicated in Figure 16.

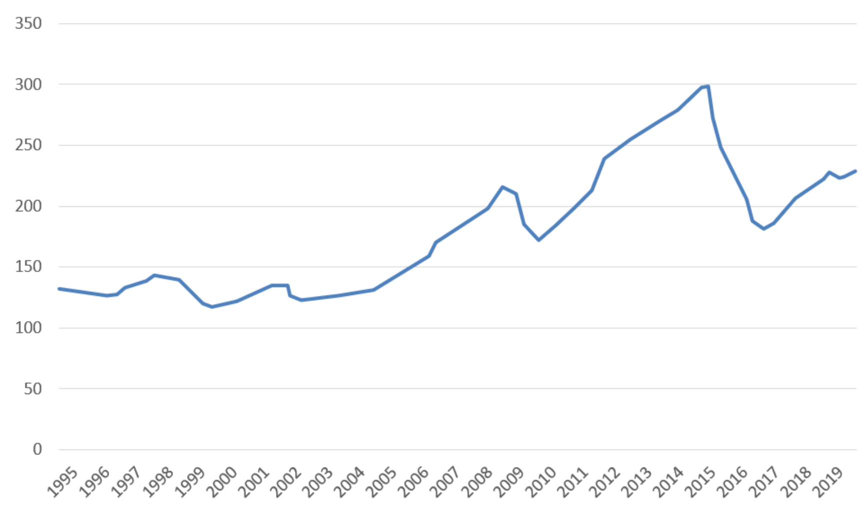
[20] "Do Higher Oil Prices Still Benefit Texas?" Federal Reserve Bank of Dallas, October 2005.
[21] "Energy Prices and State Economic Performance," Economic Review, Federal Reserve Bank of Dallas, Second Quarter 1995.
[22] Data from Texas Comptroller of Public Accounts, "Summer 2020 Economic Forecast, Real Gross State Product."

**Figure 16: Share of Texas Economy Attributable to E&P Activity**[23]




And, despite diversification, Texas remains subject to meaningful economic swings caused by oil market volatility. Figure 17 shows that Texas E&P employment has experienced a series of surges and declines over the past 25 years, standing at over 200,000 jobs in 2019.

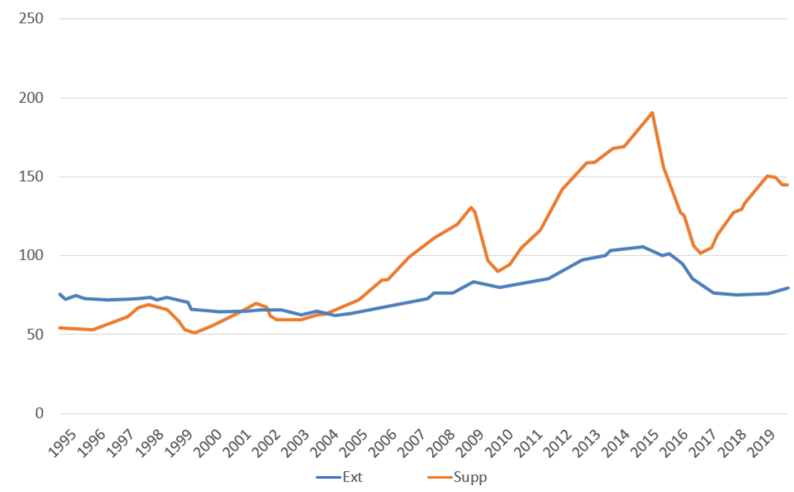
**Figure 17: Employment in Texas E&P Activity (thousands of jobs)**[24]




Because production from shale requires virtually continuous drilling and fracking activity, employment for extracting oil from shale resources rises and falls as E&P firms increase or throttle back investment in additional production in response to changes in oil and gas prices. Figure 18 illustrates the greater employment volatility associated with oil and gas extraction than for jobs supporting the E&P sector.

[23] Ingham, Karr, "The State of the Texas Upstream Oil & Gas Economy," Texas Alliance of Energy Producers, March 6, 2019.
[24] Ingham, Karr, "The State of the Texas Upstream Oil & Gas Economy," Texas Alliance of Energy Producers, July 31, 2019.

**Figure 18: Texas E&P Employment, Extraction vs. Support (thousands of jobs)[25]**



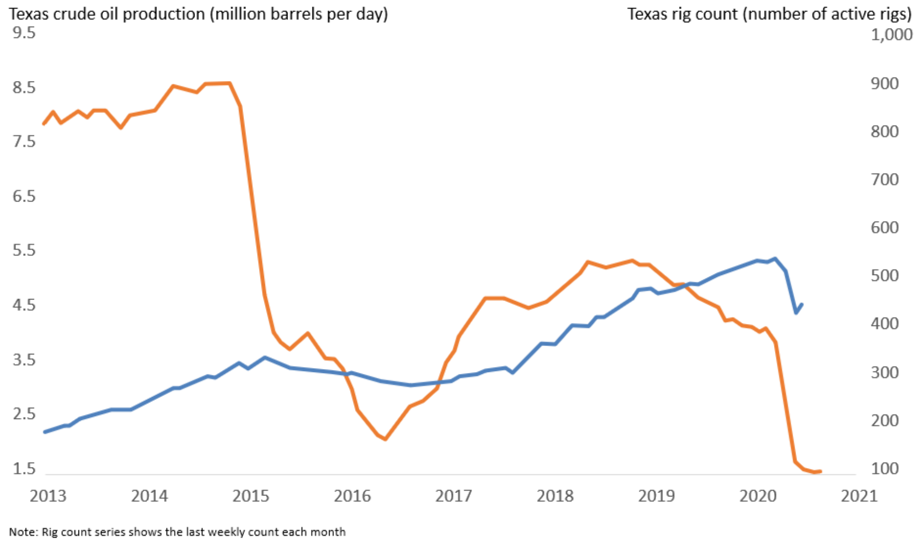

In 2020, economic volatility in Texas has been greatly amplified by the effect of COVID-19 on the economy – especially including reduced E&P activity.

Within the space of a few weeks in the spring of 2020, a large portion of E&P activity in Texas halted as world oil markets collapsed. Statewide, during the first three quarters of 2020, roughly 50,000 E&P jobs were lost – representing over 20% of total E&P employment – as firms curtailed production.[26]

One strongly correlated measure of E&P employment is the rig count, since the continuous use of rigs (usually rented) is essential to maintain (much less expand) oil extraction by using fracking in shale. As indicated in Figure 19, rig count in Texas declined by about 75% in 2020.

[25] Ingham, Karr, "The State of the Texas Upstream Oil & Gas Economy," Texas Alliance of Energy Producers, July 31, 2019.
[26] "Energy Slideshow," Federal Reserve Bank of Dallas, September 4, 2020.

**Figure 19: Texas Oil Production and Rig Count**[27]




As the Texas economy waxes and wanes – still in significant part due to swings in Texas E&P activity, as seen above – the status of Texas fiscal health is also affected.

## PUBLIC REVENUES FROM TEXAS E&P ACTIVITY

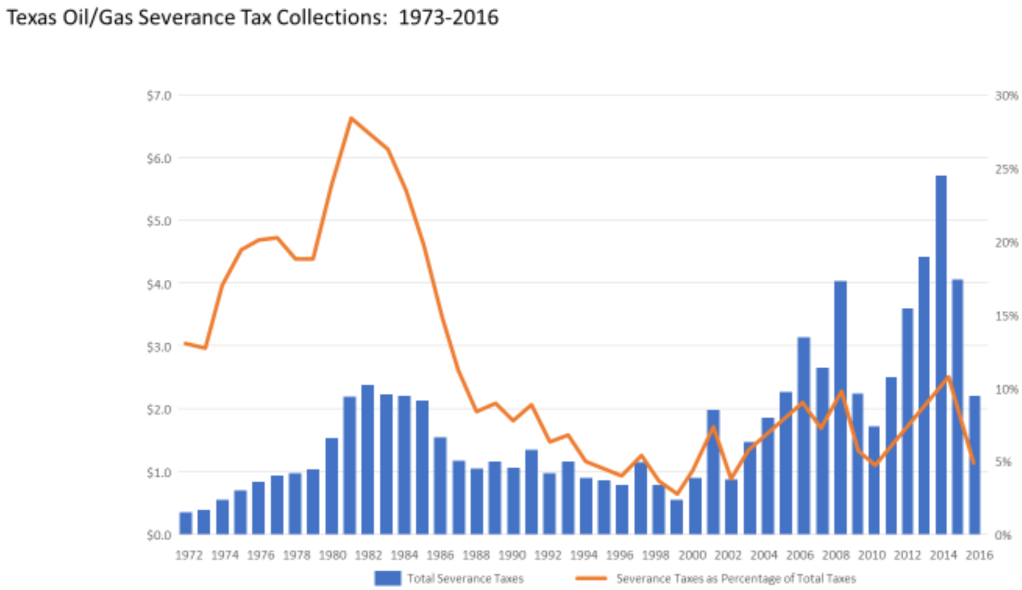
For decades, economic activity in Texas associated with oil and gas E&P has been subject to a variety of taxes and royalties to collect government revenue.

The most prominent revenue collection mechanism is the severance tax, also known as the production tax. Since 1905, it has been levied on each increment of oil and gas production in Texas. With some exceptions, oil production in Texas is taxed at 4.6% of its value and gas production in Texas is taxed at a rate of 7.5%.

During boom periods, taxation on oil and gas production played an outsized role in feeding state coffers. At the oil peak in 1981, severance taxes on oil and gas production accounted for a combined 28% of all taxes collected by the state, only to suffer a precipitous drop in collections during the mid-1980s. Reflecting the declining role of oil and gas E&P in the Texas economy since then, the proportional importance of the severance tax to overall state tax collections has fallen to about 5%, as shown in Figure 20. Nevertheless, on an aggregate basis, the severance tax remains very important to Texas, accounting for several billions of dollars of annual tax revenues.

[27] "Energy Slideshow," Federal Reserve Bank of Dallas, September 4, 2020.

**Figure 20: Texas Oil/Gas Severance Tax Collections: 1973-2016[28]**




Beyond the severance tax, E&P activity in Texas is subject to several other taxes, such as the well servicing tax, franchise taxes, motor vehicle sales taxes (for trucks used in E&P), motor fuels taxes (for operating rigs and vehicles) and the hotel occupancy tax (for E&P labor working away from home).

However, of all other taxes that apply to Texas E&P activity, the most significant is the sales tax, which overall is the single largest source of revenue to the State of Texas. In 2019, sales taxes on Texas E&P activity were estimated to represent over 7% of all Texas sales tax collections.[29] Note that drilling and fracking of wells inevitably involves substantial purchases of equipment, consumables and other goods that bear the 6.25% state sales tax (and in certain cases, local sales taxes of up to 2%).

In addition to taxes collected by the state, property taxes on oil and gas reserves in the ground are also collected by hundreds of local taxing jurisdictions: municipalities, counties and independent school districts (ISDs). Property tax rates on oil and gas assets (underground resources and installed infrastructure) are around 2.3% of assessed market value – although current market value of oil/gas assets can be challenging to assess, given uncertainties about the timing of future production volumes in the face of ever-fluctuation prices for oil and gas. Of the estimated $2.1 billion in property taxes collected from oil/gas interests across the state in 2019[30], roughly $1.5 billion was collected by ISDs and $0.4 billion was collected by counties.[31]

In addition, separate from taxes, royalties are collected on oil or gas produced from land – including large parcels in the Permian – owned by the state of Texas. These royalties are the primary source of

[28] Legislative Budget Board Staff Report 3729, January 2017.
[29] "The Permian Basin: Enriching Texas," Permian Basin Petroleum Association, Spring 2020.
[30] "The Permian Basin: Enriching Texas," Permian Basin Petroleum Association, Spring 2020.
[31] "Annual Energy and Economic Impact Report 2019," Texas Oil & Gas Association, January 2020.

wealth in the Permanent School Fund (PSF) and Permanent University Fund (PUF), which in turn are major sources of funding for operating expenses for Texas K-12 public schools and Texas public universities (both the University of Texas and Texas A&M systems), respectively. Benefitting from royalty contributions since 1905, the PSF is valued at $45 billion as of May 2020[32] and the PUF is valued at $24 billion as of September 2020.[33]

Including all state and local taxes and royalties, in total, Texas E&P activities in 2019 contributed over $13 billion to public finances, as shown in Figure 21.

**Figure 21: Revenues Collected by Texas Authorities from E&P Activity ($ millions, 2020 dollars)[34]**

| Revenue Source | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|
| | | | | | | |
| Oil Production Taxes | $ 4,157 | $ 3,086 | $ 1,808 | $ 2,196 | $ 3,463 | $ 3,910 |
| Natural Gas Production Ta: | $ 2,038 | $ 1,373 | $ 614 | $ 1,024 | $ 1,461 | $ 1,696 |
| State & Local Sales Taxes | $ 2,719 | $ 2,048 | $ 2,131 | $ 2,127 | $ 2,754 | $ 2,933 |
| Property Taxes | $ 2,895 | $ 3,464 | $ 2,709 | $ 1,534 | $ 1,728 | $ 2,067 |
| Well Servicing Taxes | $ 139 | $ 137 | $ 62 | $ 83 | $ 190 | $ 194 |
| Other State & Local Taxes | $ 473 | $ 581 | $ 385 | $ 320 | $ 441 | $ 572 |
| Total State & Local Taxes | $ 12,421 | $ 10,690 | $ 7,710 | $ 7,284 | $ 10,037 | $ 11,371 |
| | | | | | | |
| Royalties | $ 1,877 | $ 1,501 | $ 1,080 | $ 1,673 | $ 1,985 | $ 2,125 |
| Total Taxes & Royalties | $ 14,298 | $ 12,191 | $ 8,790 | $ 8,957 | $ 12,022 | $ 13,496 |

Roughly $9 billion of taxes paid in 2019 to the state or approximately 7% of the $128 billion fiscal year 2019 Texas budget is attributable to E&P activities.[35]

Even though it is less critical to the Texas economy than it once was, oil remains a very important pillar of revenue for the state.

As one illustration of the enduring criticality of oil to the fiscal health of Texas, the Economic Stabilization Fund (ESF) – known as the Rainy-Day Fund – has been funded through its existence virtually entirely by severance taxes on oil and gas production. Indeed, the ESF was instituted as a safety net for the state in 1989, largely to avoid a recurrence of the severe economic downturn and associated fiscal challenges in Texas caused by the mid-1980's oil price collapse.

During 2020, the global pandemic raised the possibility that reduced tax collections might significantly impact the state budget. For example, in July 2020, projections from the Texas

[32] "A Study on Distributions from the Texas Permanent School Fund to the Available School Fund," Texas Education Agency, August 31, 2020.
[33] Data from UTIMCO website, "Permanent University Fund (PUF)."
[34] "The Permian Basin: Enriching Texas," Permian Basin Petroleum Association, Spring 2020.
[35] "Study on District Property Tax Compression," Legislative Budget Board Staff Report 6391, September 2020.

Comptroller indicated the possibility of a $4.6 billion deficit in the 2020-2021 biennial state budget.[36]

The gap had narrowed six months later when the Comptroller released in January 2021, the Biennium Revenue Estimate which states that the state would have $112.5 billion in revenue available for general-purpose spending during the 2022-23 biennium, a 0.4 percent decrease from the 2020-21 biennium, but that the ending 2020-21 deficit had narrowed to a $1 billion deficit. .[37]

Many observers expect that the ESF – with a balance of roughly $10.5 billion in January 2021 – could be tapped during the 2021 Legislative Session to help Texas cover this budget deficit. [38]

The ability for Texas to respond to otherwise daunting fiscal challenges in this way can be ascribed entirely to public wealth generated from taxes on Texas oil and gas production over the past 30+ years.

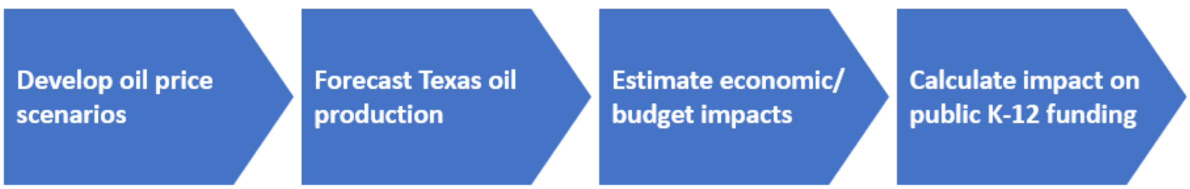
[36] "Texas Faces a Looming $4.6 Billion Deficit, Comptroller Projects," Dallas Morning News, July 20, 2020.
[37] "Texas Comptroller Glenn Hegar Releases Biennial Revenue Estimate," January 11, 2021.
[38] "Texas Has Billions in Its Rainy-Day Fund. But Legislators Say They Won't Use It Until January," The Texas Tribune, May 11, 2020.

## Section Two:
## Analysis of Future Texas Economic and Fiscal Health
## Assuming Weak Oil Market Conditions

Section One of this report provided historical context on how oil production in Texas has evolved, both shaping the growth of the Texas economy and providing financial resources to the public sector.

Section Two summarizes our analysis of potential implications of weak oil market conditions on the state's economy and fiscal health. We conducted the following analyses over the period April-November 2020. The overall analytic effort was organized, as is this section of the report, in four phases, as summarized in Figure 22.

**Figure 22: Four Research Phases**




### DEVELOPMENT OF OIL PRICE SCENARIOS

First, we focused on the trajectory of oil prices that Texas E&P firms – and consequently the Texas economy – might face. Although Texas clearly remains a major force in world oil markets, E&P firms active in Texas do not control the price they can charge for their production but rather are "price-takers": They make decisions on production volume and exploration activity based on expectations about future oil price levels. In turn, price expectations for oil are heavily based on assessments of (1) future demand for oil and (2) E&P decisions other major oil producers – particularly OPEC, and Saudi Arabia more specifically, – will make.

Because these twin assessments involve a complex set of factors with global breadth encompassing economic and geopolitical dynamics, the future of oil prices is always difficult to predict. Although U.S. E&P firms generally do not disclose oil price assumptions used in their decision-making, it is notable that BP and Shell recently revised down their long-term oil price forecasts to $55/bbl and $60/bbl respectively.[39]

To avoid the challenges of forecasting oil prices in our research, we instead used price scenarios. Moreover, as discussed previously, we consciously decided to restrict our analysis to relatively low oil price scenarios, focusing our assessment on the potential downside risks to Texas of weak oil markets.

To develop our oil price scenarios, we convened a panel of expert observers of world energy markets, including those listed in Figure 23.

[39] "Oil Majors Face Up to Plunging Asset Values," Financial Times, July 1, 2020.

**Figure 23: Expert Advisory Panel**

| Name | Affiliation |
|---|---|
| Michelle Michot Foss | Rice University, Baker Institute |
| Amy Myers Jaffe | Tufts University, Climate Policy Lab |
| Scott Nyquist | Energy Consultant |
| James Smith | US Assn. for Energy Economics (Emeritus, SMU) |
| Andy Steinhubl | Retired Partner, KPMG |
| Michael Webber | University of Texas |

A workshop attended by this group on June 16, 2020, premised on the underlying assumption of lingering weak oil market conditions through 2036, produced qualitative agreement on two key points: (1) OPEC would retain enough market power to lead global oil pricing dynamics and would seek to manage oil prices within a band, and (2) such a price band is subject to decline over the horizon to 2036 as producers worldwide aggressively seek cost reductions to maintain competitiveness in a difficult market environment.

In global oil markets, OPEC essentially serves as a "residual monopolist," supplying much of the world's demand.[40] It wants prices to be set by suppliers with higher cost structures than its own resources, much of which can be produced profitably at prices below $20/bbl – as evidenced by the average cost of production in Saudi Arabia below $9/bbl.[41] Given this position, OPEC's profit maximizing strategy involves a delicate optimization that trades off its production levels (i.e., its market share) against prices set by cost structures of marginal producers.

Essentially, OPEC leadership has long sought to modulate its output in pursuit of a "Goldilocks" range of oil prices: not so high as to discourage demand or bring a wide variety of supply alternatives into competitiveness, but not so low that OPEC member countries cannot finance domestic economic programs.

Our team of experts reached no formal consensus on the price band desired by OPEC, but there was general agreement on the qualitative factors that should dictate the width of the band.

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**On the low end, OPEC members want to maintain oil prices at levels that ensure revenue collections support domestic fiscal funding priorities. Also, the panel stated that because they are heavily reliant upon external sources of expertise to maximize profitability, OPEC members have strong incentives to keep oil prices high enough to preserve the financial viability of the world's oilfield services industry**

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[40] European Central Bank, Strategic Interactions and Price Dynamics in the Global Oil Market (Jan 2020) (discussing OPEC's residual monopoly power).

[41] "Barrel Breakdown," Wall Street Journal, http://graphics.wsj.com/oil-barrel-breakdown/.

Conversely, on the high end, OPEC would prefer oil prices not to reach levels that would induce major new supply options – such as biofuel or hydrogen production or that would make major known oil reservoirs in the Arctic or deep water from becoming competitive to develop.

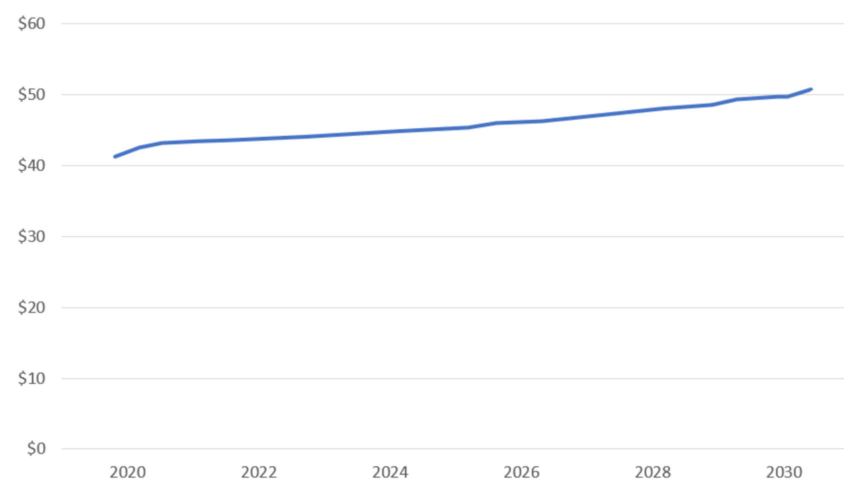
Our expert panel generally believed the oilfield services industry would remain largely viable and intact at $40/bbl. They thought that $60/bbl (in 2020 dollars) is a safe ceiling below which there is minimal threat of competitive entry to disrupt OPEC's goal of market order.

For the purposes of setting "low-but-plausible" oil price scenarios over the next 15 years, we assumed OPEC will aim to maintain prices in a band between $40/bbl and $60/bbl (in 2020 dollars). Although everyone recognized oil prices clearly could deviate outside this band, they said such price excursions could likely be contained by OPEC – with the discipline of other oil producers – to relatively brief lengths.

It is noteworthy that several other pieces of evidence support a $40-60/bbl oil price range through the mid-2030s. For instance, the most recent trades in the futures market are consistent with this range:

The long-term forward curve for WTI crude from early November 2020, showing prices slowly rising from $40/bbl to $50/bbl for deliveries during the next 10 years, is presented in Figure 24. **"While spot oil prices have risen above $50/bbl as of early 2021, the long-term forward curve for WTI crude continues to show delivered prices 70+ months in the future (i.e., in the late 2020s) in the $45-50/bbl range.**

**Figure 24: Forward Curve for WTI Crude Oil (@ November 11, 2020)[42]**




This forward curve represents a best guess of the future by buyers and sellers at a particular moment, creating prices that can be used to make commitments today on purchases or sales in the future. It does not represent what oil prices will actually be, and only extends out to early 2031 as there is insufficient liquidity in the exchange-traded oil market to transact further into the future.

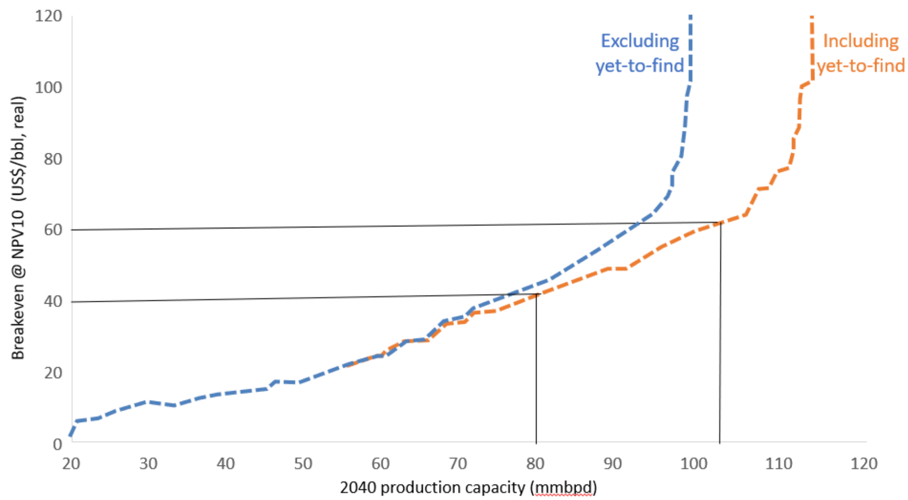
Through the end of the 2030s, prices in the $40-60/bbl range appear especially plausible if the demand for oil does not materially rise beyond the 100 mmbpd level seen before the pandemic. To illustrate, a

[42] Data from CME Group, "Crude Oil Futures – Quotes."

global oil supply curve developed by energy market consultancy Wood Mackenzie, shown in Figure 25, reveals that a $40-60/bbl price range in 2040 is consistent with world oil production in the 80-105 mmbpd range – levels that are well-aligned with several recent long-term demand forecasts.[43]

[43] Bullard, Nathan, "The Future of Energy Is About Technology, Not Fossil Fuels," Bloomberg, October 15, 2020.

**Figure 25: Potential Global Oil Supply Curve in 2040**[44]




Note: Figures include commercial reserves, technical reserves and reserves growth

In addition to an assumed price band of $40-60/bbl in 2020, we also considered the possibility of a decline in the price band over time, as E&P firms continue to squeeze out costs in the face of highly competitive market conditions.

Over its history, the oil industry has aggressively pursued technology advancements – first to open frontiers for new production and then to boost profitability of ongoing production. Over the course of 15 years – between now and 2036 – our expert panel suggested that improvements of $10/bbl across the industry are achievable.

Taking the above factors into account, we converged on four WTI price scenarios as the foundation for assessing the variation in potential impacts on the Texas economy and the state's fiscal health if oil markets are weak:

- Constant $60/bbl: Among our "low-but-plausible" oil price scenarios, this is the highest, in which OPEC consistently maintains discipline among global oil producers to keep prices at the high end of the range.

- Declining $40/bbl to $30/bbl: This is our most conservatively low-priced scenario, in which OPEC barely keep prices above or at the low end of the range and productivity improvements from technology advancements drive market-clearing prices down.

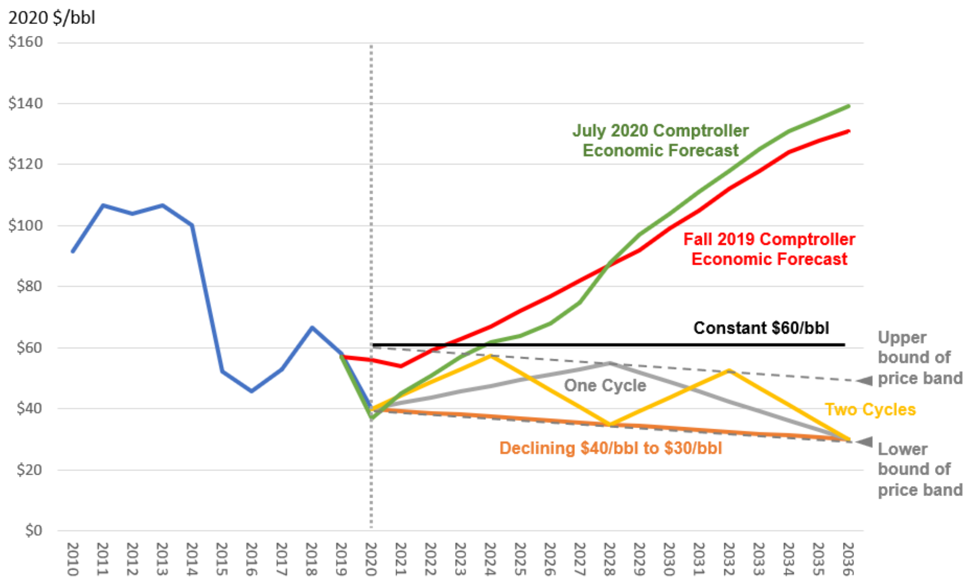
- One Boom/Bust Cycle: In this scenario, oil prices run from the bottom of the price band in 2020 ($40/bbl) up to the top of the price band by 2028, and then back down to the bottom of the declining price band in 2036 ($30/bbl).

[44] Wood Mackenzie, "Big Oil and Climate Change: The Long Road", July 2019.

- Two Boom/Bust Cycles: This is similar to the One Boom/Bust Cycle scenario, except involves two cycles between the bottom and the top of the price band over the next 15 years, reflecting a higher degree of volatility in world oil markets.

These four oil price scenarios – alongside for comparative purposes the trajectory of oil prices in the two most recent economic forecasts (Fall 2019 and July 2020) issued by the Texas Comptroller of Public Accounts – are illustrated in Figure 26.

**Figure 26: WTI Oil Price Assumption in Four Scenarios**




Source: Energy Information Administration (historical)

As is evident, our four scenarios are considerably lower than the oil price assumptions in recent economic forecasts by the Texas Comptroller of Public Accounts. In large part, this is because we deliberately chose scenarios that would create downside risks for Texas.

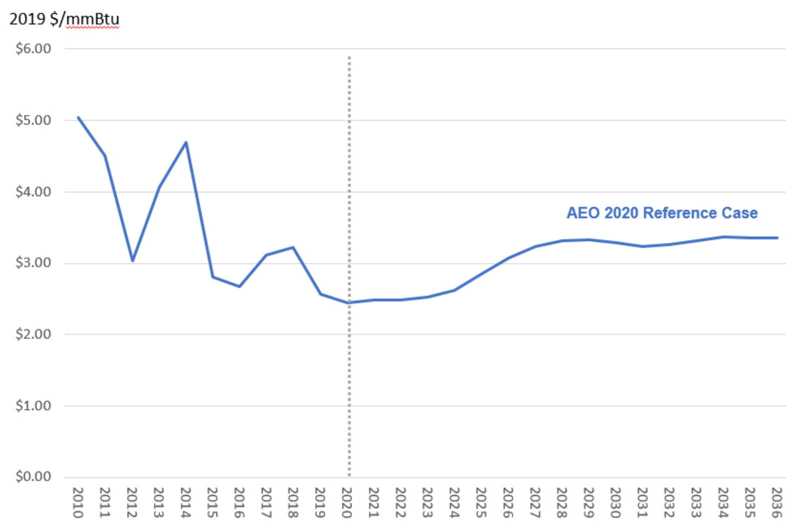
Oil is the central focus of this research but the outlook for natural gas E&P activity also must be included, as Texas gas production is important for the state's economy and fiscal health and tied to the outlook for oil production, given that many wells produce oil and gas.

Unlike conditions in the early 2000's, when prices in the U.S. were sufficiently attractive to motivate firms to drill wells for gas alone, there is currently limited appetite for pursuing a strategy emphasizing natural gas. This is because U.S. gas prices are holding steady at historically low levels, in the $2.50/mmBtu range, due to ample domestic supplies from several large conventional basins and shale resources outside of Texas (e.g., Marcellus). Few upward pressures on U.S. gas prices are foreseen, especially if the competitive threat posed by the ever-declining costs of renewable energy (solar and wind) and energy storage to U.S. gas-fired generation continues to intensify. Only if global demands for liquified natural gas (LNG) exports from the U.S. increase dramatically – possible but unlikely and not in keeping with our philosophy of examining downside risks to Texas – will gas prices rise meaningfully.

For the purposes of maximum comparability with other analyses, our gas price assumptions match those in the Energy Information Administration (EIA) Annual Energy Outlook (AEO) 2020 Reference Case.

These assumed gas prices, slowly increasing from current levels of about $2.50/mmBtu to roughly $3.40/mmBtu (in 2020 dollars) by 2036, are illustrated in Figure 27.

**Figure 27: Henry Hub Natural Gas Price Assumptions[45]**




So as to keep all estimated impacts on the Texas economy estimated in this report directly attributable to the oil price levels that define each scenario, we assumed this trajectory of future natural gas prices to be the same across all four oil price scenarios.

## FORECASTING FUTURE TEXAS OIL PRODUCTION

Having settled on four price scenarios, we turned to the second phase of our research, projecting how Texas E&P activity would respond to assumed prices.

Because the vast majority of E&P activity in Texas involves fracking in shale, almost all of which is the Permian and Eagle Ford basins, our production forecasting focused on shale resources in the Permian and Eagle Ford.

As discussed above, OPEC benefits from large volumes of moderate-cost supply resources that can help set world prices at levels under which OPEC production can be very profitable, without being so high as to encourage large quantities of other competing resources to be developed elsewhere in the world. Among other moderate-cost oil supply basins around the world, U.S. shale resources are likely to play this "price umbrella" role in world markets for the foreseeable future U.S. shale is exceptionally suited to being the "swing producer" that clears global oil markets as long as the global oil industry remains reasonably disciplined in its investment decisions.

In most other conventional oil supply reservoirs, large capital investments over many years are required to develop the infrastructure to enable production. Once production begins each incremental barrel of oil is available at relatively low marginal costs, and output can remain high for many years. This is precisely the kind of new oil supply source OPEC wants to discourage. The price band described above

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[45] Data from Energy Information Administration, Annual Energy Outlook 2020.

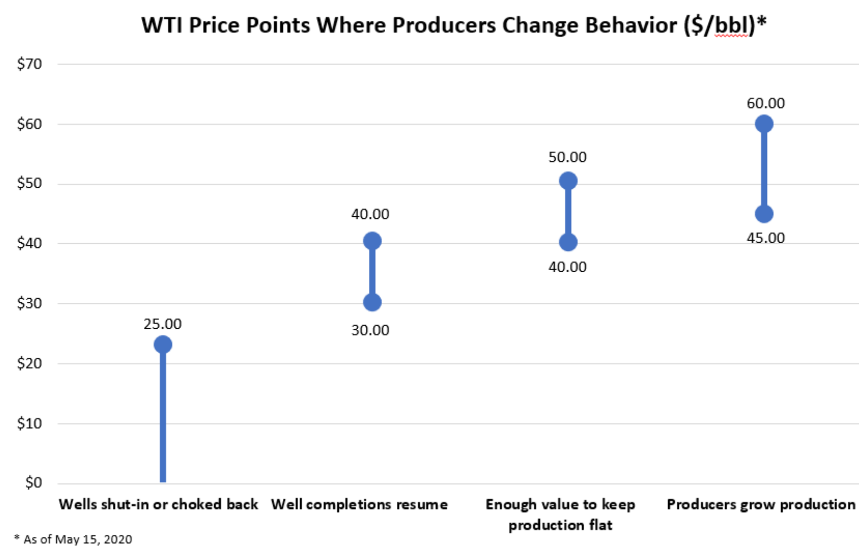
should preclude major new oil supply sources, provided that firms don't making irrational decisions to develop capital-intensive resources.

In contrast to conventional oil, shale oil production involves higher variable costs of production but lower development capital costs.  Modest but frequent increments of capital are needed to offset steep decline curves in the productivity of shale resources. Without ongoing investment for more drilling and fracking, the vast majority of a shale well's oil output occurs in the first few years of production. Therefore, every few months, firms active in shale E&P activity face must decide where and how much to invest based on current market conditions and expectations.

Although this capital outlay profile for shale may sound like a disadvantage in fact it allows shale to be a "quick-response" marginal supply source for the next few decades.  It's easy to expand quickly if oil prices rise and easy to reduce quickly, as in early 2020, if prices fall.  For those familiar with the dynamics of the electric power industry, oil from shale is likely to play the same role in the global oil market as cycling (i.e., not baseload) plants serve in regional wholesale power markets.

Recent research by Goldman Sachs on production economics in shale resources indicates that E&P operators consider fracking at operating wells to be generally uneconomic at oil prices below $25/bbl; prices in the $40/bbl range to be adequate to maintain production at existing operations; and new E&P activity to become widely attractive when prices exceed $50/bbl, as presented in Figure 28.

**Figure 28:  Economic Thresholds for Key Decisions by U.S. E&P Firms Active in Shale[46]**




Among the numerous shale basins in the U.S., the Permian and Eagle Ford are generally well positioned from a cost-competitiveness standpoint.  According to recent surveys of E&P firms by the Federal Reserve Bank of Dallas, Permian and Eagle Ford shale possess substantial cost advantages over other shale or non-shale domestic oil resources.  Figure 29 presents the breakeven oil prices E&P firms estimate are required to keep existing shale production in operation in different basins.

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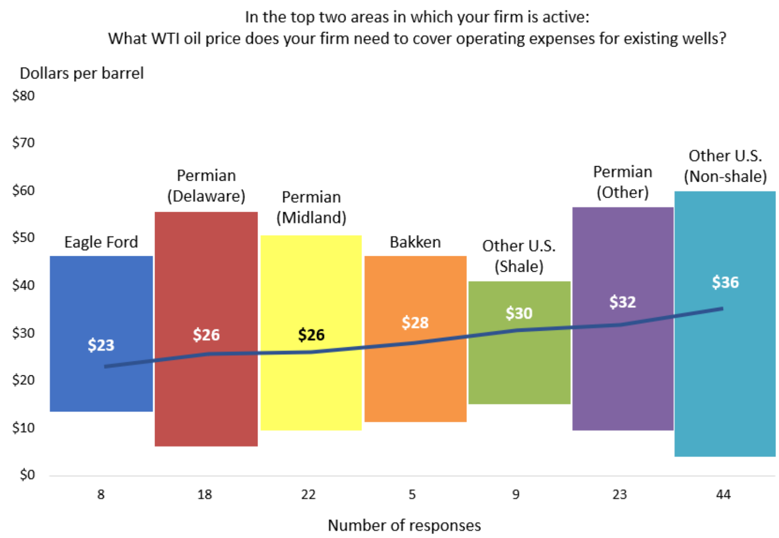
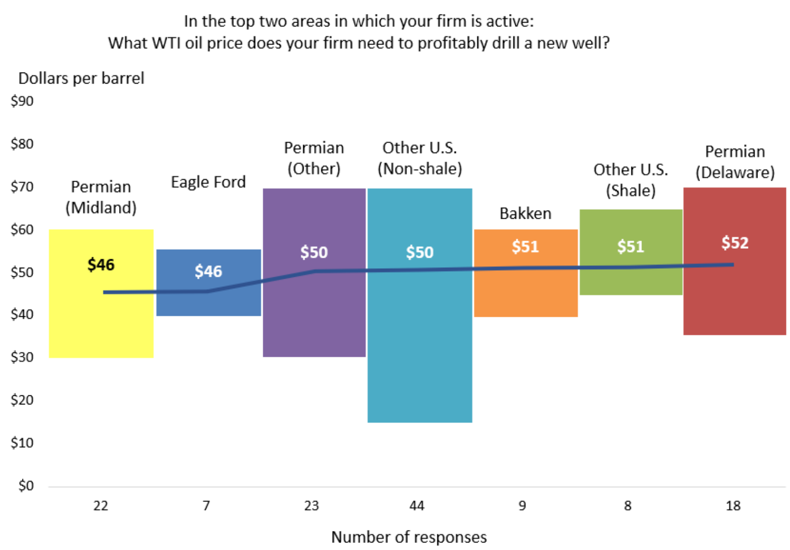
[46] Goldman Sachs Investment Research.

**Figure 29: Breakeven Oil Prices Required to Keep Wells Operational in Leading U.S. Shale Basins**[47]




Meanwhile, Figure 30 presents the relative breakeven oil prices companies estimate are required to invest in new production.

**Figure 30: Breakeven Oil Prices Required to Invest in New Production in Leading U.S. Shale Basins**[48]




The logical conclusion is that <u>substantial volumes of production from shale in the Permian and Eagle Ford are likely to remain economically viable even if oil market conditions are weak and prices are relatively low,</u> provided that oil suppliers worldwide are generally disciplined in investment decisions.

[47] "Energy Slideshow," Federal Reserve Bank of Dallas, September 4, 2020.
[48] "Energy Slideshow," Federal Reserve Bank of Dallas, September 4, 2020.

As long as prices stay above $40/bbl (in 2020 dollars), a sizable proportion of Texas shale should remain competitive, and once prices get much above $50/bbl, the amount of economically viable supply becomes very large as the supply curve flattens and lengthens.

Given that fracking techniques are still relatively new, offering substantial further opportunity for improvements in productivity and cost to be captured, this conclusion should only be strengthened by continued technological and commercial advancements.

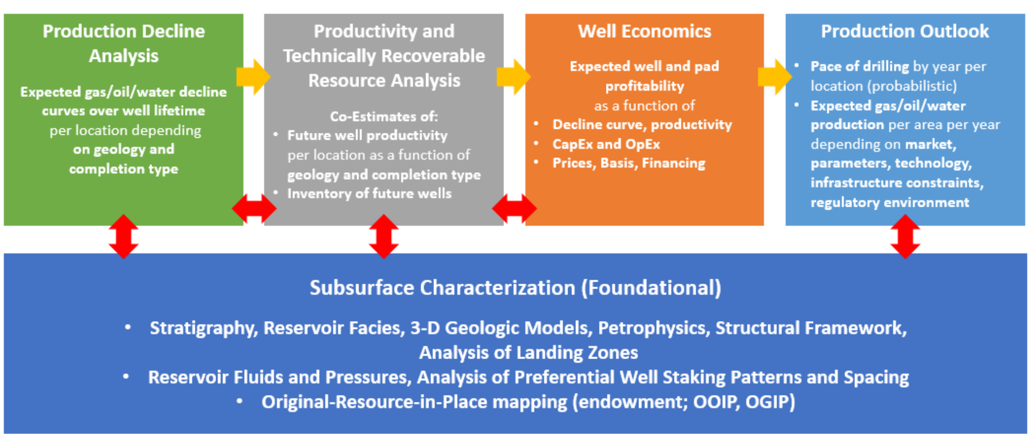
For Texas oil production to shrink to miniscule levels, WTI prices will have to stay below $30/bbl for an extended time.

Such prices have been not been seen on a real basis for more than a few consecutive years since the industry heydays of the mid-20th century. If that happened, virtually all E&P activity would be abandoned in the Texas shale, leaving only fully depreciated low-cost stripper wells to pump from conventional resources until volumes became too small to warrant further operation. Oil prices this low are far lower than we and most of our oil industry observers believe to be plausible for the foreseeable future.

To quantify potential production volumes under our four scenarios through 2036, we commissioned the Tight Oil Resource Assessment (TORA) team at the Bureau of Economic Geology (BEG) at the University of Texas to estimate annual volumes of oil and gas production from the Permian and Eagle Ford basins.

Launched in 2016 by BEG, TORA is an industry consortium comprised of E&P players active in Texas (including global supermajors ExxonMobil and Total, plus several independents) to fund a multi-disciplinary study of producing horizons from the Permian and other unconventional sources. Building on a century of prior research by the BEG, TORA developed an integrated analytic workflow – summarized in Figure 31 – to model hydrocarbon production decisions in the Permian and Eagle Ford shale plays, using 3D cellular models of subterranean hydrocarbon strata, to allow estimation of economic viability, drilling activity and production rates.

**Figure 31: TORA Integrated Analytic Workflow for Assessing Texas Shale Production**[49]



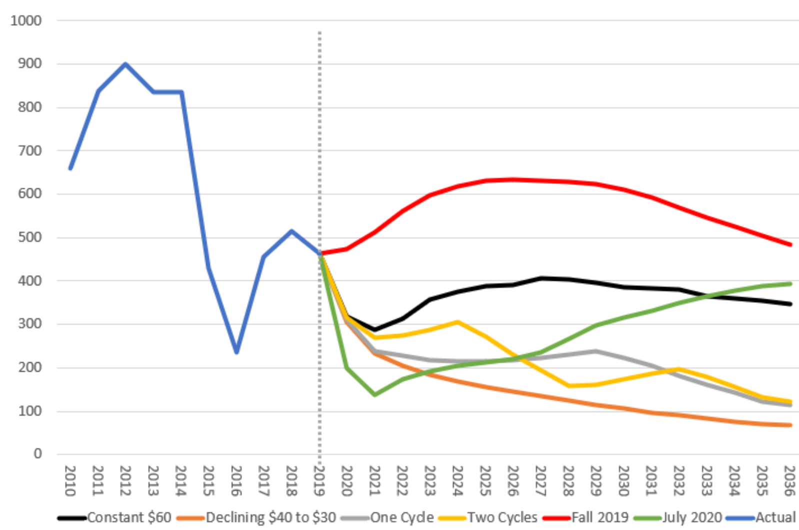

49 Bureau of Economic Geology, Tight Oil Resource Assessment "Methodology."

Given a stream of future oil prices, the TORA analysis undertakes a forward-looking optimization of E&P activity over time for each square mile within a basin, using key parameters such as estimated hydrocarbon resource recoverability, decline curves and productivity improvements derived from actual E&P experience.

Based on these proprietary and advanced capabilities, TORA can characterize hydrocarbon production from the Permian and Eagle Ford basins with an unparalleled degree of sophistication to a high level of detail. Historical values of oil and gas production for 2019 in the Permian and Eagle Ford are used as a starting point for estimating future production levels in each basin based on then-prevailing oil and gas prices.

TORA's projections of oil and gas production from the Permian and Eagle Ford basins under our four price scenarios are presented in Appendix A. Associated with these production volumes, forecasted rig count in the Permian and Eagle Ford for the four scenarios (as well as from the two most recent economic forecasts from the Comptroller's office) are presented in Figure 32.

**Figure 32: Forecasted Rig Count in Permian and Eagle Ford**



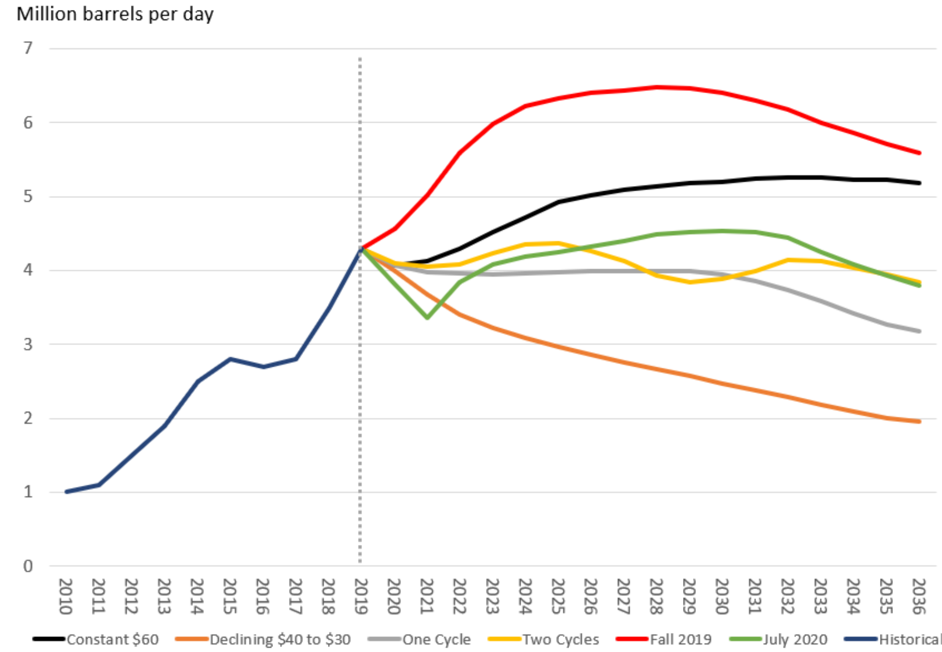

Source: Railroad Commission of Texas, BEG, Texas Comptroller's Office

Note that the Permian and Eagle Ford production forecasts developed by TORA represent a large fraction, but not all of Texas oil and gas production. The remainder of oil and gas production in Texas outside of the Permian and Eagle Ford basins is primarily in conventional wells and not shale resources. In those conventional operations, ongoing operating costs are very low and decline curves are relatively shallow without additional investment, thus implying continued production indefinitely under almost any conceivable level of oil and gas prices.

Therefore, to estimate total Texas production volumes into the future under our price scenarios, we added to TORA's projections of Permian and Eagle Ford production an estimate of future production volumes for the rest of Texas. This estimate of future production from conventional wells was calculated by assuming a constant 5% annual production decline from 2019 actual production levels.

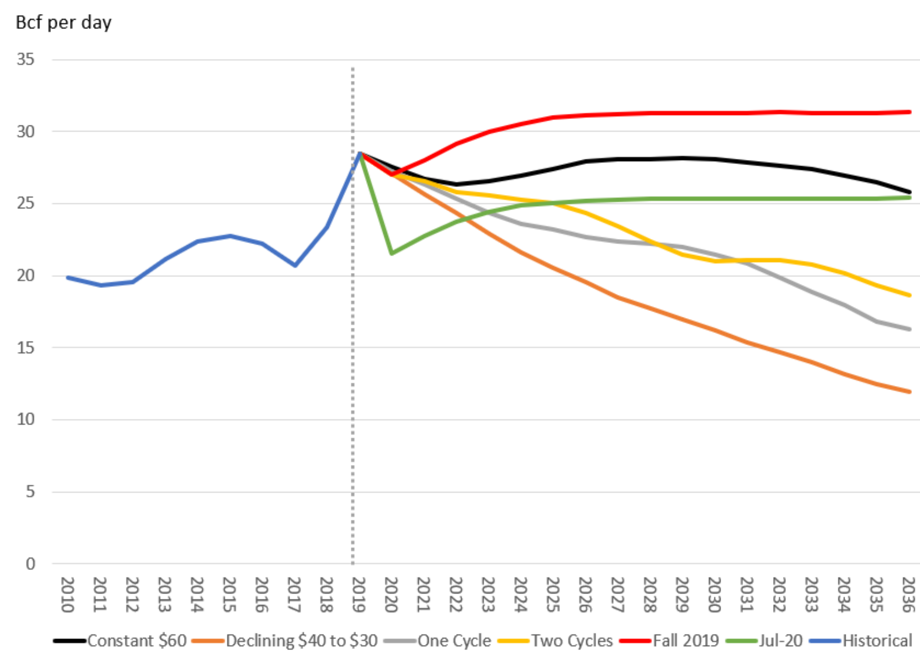
The resulting estimates of total Texas oil and gas production under our oil price scenarios – alongside production estimates in the two most recent (Fall 2019 and July 2020) economic forecasts from the Texas Comptroller's Office – are presented in Figures 33 and 34.

**Figure 33: Estimated Texas Oil Production Under Four Oil Price Scenarios**




Source: Texas Railroad Commission, EIA, BEG, Texas Comptroller's Office

**Figure 34: Estimated Texas Natural Gas Production Under Four Oil Price Scenarios**




Source: Texas Railroad Commission, EIA, BEG, Texas Comptroller's Office

Under the Constant $60/bbl scenario, Texas oil production is expected to regain some growth during the post-pandemic rebound, albeit at a slower pace than what was experienced in the last decade (or what might have been expected for the 2020s pre-pandemic), with volumes peaking near 2036. On the low end, under the Declining $40/bbl-to-$30/bbl scenario, Texas oil and gas production declines steadily, with 2019 representing the volumetric peak.

Next, we turn to exploring how changes in oil production and prices over the next 15 years could affect the Texas economy and the state's finances.

## ESTIMATING IMPACTS ON TEXAS ECONOMY AND BUDGETS

The third phase of our research involved developing a spreadsheet model that – for each of the four oil price scenarios – used price assumptions and forecasted Texas oil and gas production as inputs to estimate various economic and fiscal measures of interest.

With this spreadsheet model, we projected forward – from 2019 actual levels on a year-by-year basis out to 2036 – scenario-dependent estimates on macroeconomic contributions and revenues collected from Texas E&P activity. Where possible, we compared our results to those included in or inferred from the two most recent economic forecasts (Fall 2019 and July 2020) issued by the Texas Comptroller of Public Accounts.

First, we examined macroeconomic impacts associated with our projections of Texas E&P activity, beginning with employment.

We start with direct E&P employment, which is defined as jobs in oil and gas extraction and in E&P support activities, but it excludes indirect and imputed jobs made economically viable by E&P activity. We used the measure of employment in "Natural Resources and Mining" (NAICS code 1000000), as reported by the Texas Comptroller of Public Accounts. Even though this measure may overrepresent E&P employment (perhaps by as much as 10%) because it also includes mining employment (e.g., coal), this measure was used for E&P employment because it is widely referenced in Texas macroeconomic analyses performed by other parties (e.g., Federal Reserve Bank of Dallas)

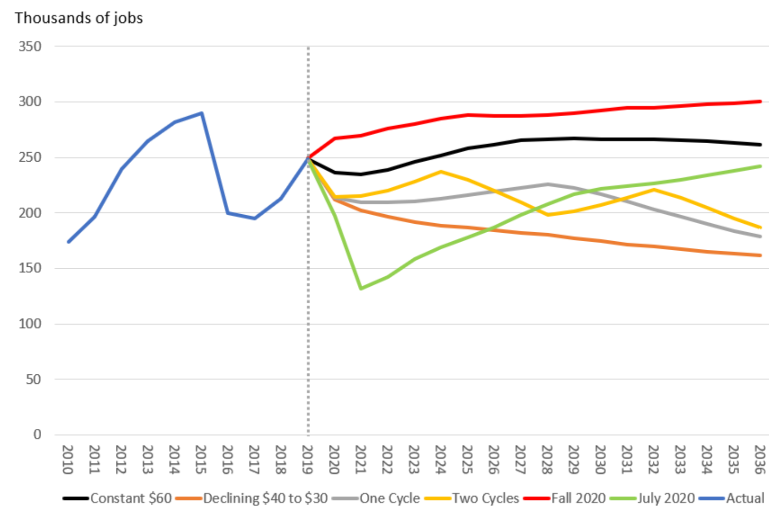
The 2019 reported figure of 249,600 jobs was then split into extraction jobs (33%) and support activity jobs (67%), with these ratios based on 2019 E&P employment data reported by the Texas Independent Producers and Royalty Owners Association.[50] E&P employment was disaggregated into two categories because (as discussed and illustrated previously) the dynamics of employment for oil/gas extraction are very different – much more volatile with oil market swings – than employment for E&P support activities, thus meriting independent estimation.

To assess quantitatively, we performed two regression analyses – one for extraction employment and one for E&P support employment – using the aggregate value of oil and gas production and rig count from 2010 to 2019 (i.e., during the shale production era). By using the estimated value of oil and gas production and rig count under our four scenarios on a yearly basis, we were able to project the number of extraction jobs and E&P support jobs annually through 2036 under each scenario. Projections of total

[50] "Midyear Texas Energy Report 2020," Texas Independent Producers and Royalty Owners Association.

direct E&P employment – the sum of extraction jobs and E&P support jobs – under each scenario are presented in Figure 35.

**Figure 35: Direct E&P Employment Levels in Texas**




Source: Federal Reserve Bank of Dallas (historical)

Our estimates suggest that Texas direct E&P employment levels, under our "low-but-plausible" oil price scenarios, would remain in the 160,000 to 270,000 range through the forecast horizon. In 2036, the difference in estimated employment between the most optimistic and pessimistic of our scenarios is nearly 100,000 jobs.

Under the Constant $60 scenario, estimated direct E&P employment is higher than the most recent economic forecast released by the Texas Comptroller of Public Accounts – and not much lower than the last economic forecast (Fall 2019) released before the COVID-19 pandemic.

Turning now to the estimated future contributions of the E&P sector to Texas economic activity – as measured by gross state product (GSP) – under our oil price scenarios, we began by determining $281 billion (in 2020 dollars) to be actual GSP for 2019 from the data series reported for "Mining (Oil and Gas)" (NAICS code 21) by the Texas Comptroller of Public Accounts.

We then used a method of estimating future GSP recommended by a recent paper from the Federal Reserve Bank of Dallas.[51] This paper suggested scaling GSP up or down in the future based on projected changes in total hydrocarbon (oil plus gas) production in Texas, as measured by energy content (Btus) rather than by dollars. The results of this estimation approach are presented in Figure 36.

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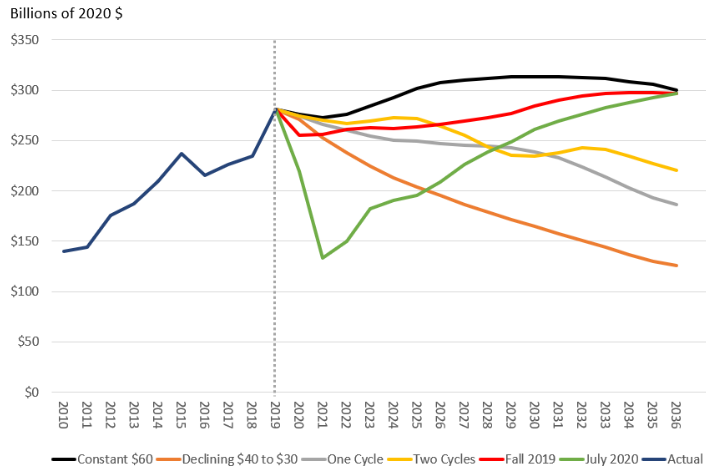
[51] "Potential Mismeasurement of Mining Limits Official Real Texas GDP Data," Federal Reserve Bank of Dallas, February 25, 2020.

**Figure 36: Contribution of E&P Sector to Texas Gross State Product**



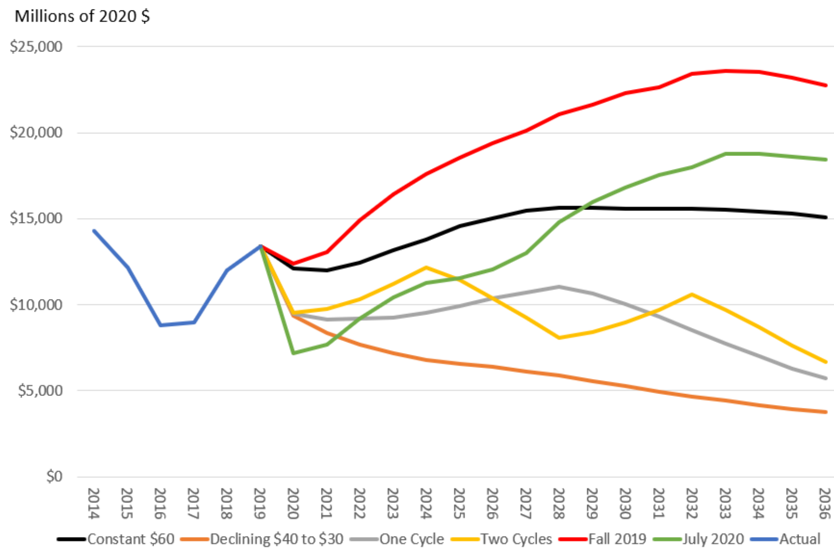

In our most optimistic scenario (Constant $60), the E&P sector's estimated contribution to GSP grows slightly through most of the forecast horizon – more so than what is implied by the most recent economic forecasts by the Texas Comptroller of Public Accounts. However, under our most pessimistic scenario (Declining $40 to $30), E&P's estimated contribution to GSP never regains levels achieved in 2019. By 2036, the projected difference between these two scenarios is more than $150 billion in annual economic activity on a statewide basis.

Of course, if Texas economic activity is harmed by global oil market conditions, the revenue collected by Texas from E&P activity is also threatened.

It is important to note here that the economic forecasts produced by the Texas Comptroller of Public Accounts do not include explicit forecasts of revenue collections from E&P activity. The projections of revenue collections presented in the following sections from their two most recent forecasts (Fall 2019 and July 2020) reflect the use of our estimation methodologies applied to the data on oil and gas production volumes and prices reported by the Comptroller's office.

On an aggregate basis, across all revenue collection mechanisms – state taxes, local taxes, and royalties – estimated E&P financial contributions to Texas state finances under all four scenarios through 2036 are presented in Figure 37.

**Figure 37: Total Texas Public Sector Revenues Collected from Texas E&P Activity Through 2036**



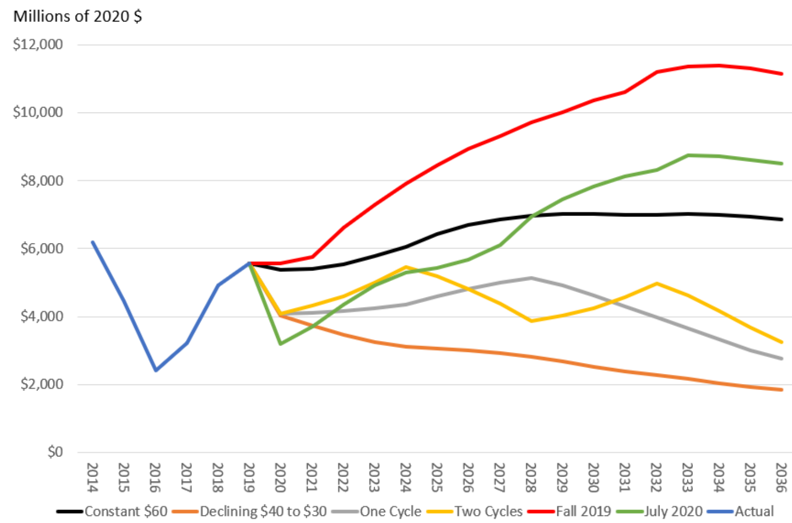

Note: Estimates for Comptroller's forecasts presented above are calculated based on other variables provided in Comptroller's forecasts
Source: Permian Basin Petroleum Association (historical)

Total collections of all types from the Texas E&P sector under our lowest-price scenario (Declining $40 to $30) were projected to decline from 2019 levels, falling by about 50% by 2036. Under the highest-price scenario (Constant $60), total revenue collections are projected to rebound by the mid-2020s, peaking in the late 2020s, and declining after to levels slightly higher (in real terms) than current levels.

To understand these patterns further, it is important to examine each of the major revenue collection mechanisms separately. Note that revenue collection mechanisms work differently, based on specifications in original enabling legislation, possibly altered by later amendments or policy decisions. As a result, the picture presented above of total revenue collection from Texas E&P activity was developed as an aggregation of future projections of revenues collected from E&P activity under each revenue collection mechanism.

Looking first at the most important revenue collection mechanism applying to the E&P sector – severance taxes – Figure 38 presents projections through 2036 for each of our four scenarios (along with imputed estimates from the two most recent forecasts from the Comptroller)

**Figure 38: Estimated Oil/Gas Severance Tax Collections**




Note: Estimates for Comptroller's forecasts presented above are calculated based on other variables provided in Comptroller's forecasts
Source: Permian Basin Petroleum Association (historical)

Note that severance tax collections will track the value (volume times price) of oil and natural gas production in Texas. For our scenarios, we estimated severance tax collections using the average effective tax rate (4.28% for oil, 6.28% for natural gas) recently realized in Texas (net of exclusions and exemptions) multiplied by the estimated volumetric production x prices. (We discounted prices by 5% to account for variations in product quality and delivery location relative to the benchmark products for oil and natural gas, WTI and Henry Hub respectively).

Estimated severance tax collections based on results from the Comptroller's economic forecasts tend to be somewhat higher than from our scenarios, because the Comptroller's forecasts reflect considerably higher oil and gas price assumptions, as previously illustrated.

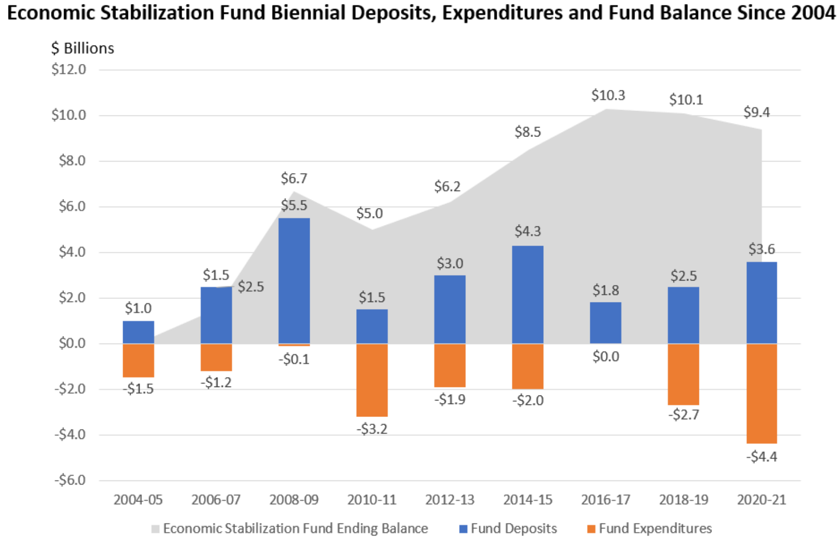
It is important to stress that severance tax collections are the sole revenue source for the ESF, the Rainy-Day Fund, which provides substantial resilience to the state budget during shortfalls.

After 0.5% of total annual severance tax collections are put aside for administrative costs and another $1.131 billion ($532 million a year associated with oil severance taxes and $599 million associated with gas severance taxes) are contributed to general revenues coffers, 37.5% of the remainder is directed to the ESF. In a typical year, in which roughly $5 billion is collected in severance taxes, the deposit into the ESF approaches $1.5 billion.

With cumulative severance tax contributions and compounding returns since its inception over 30 years ago -- net of appropriations from the Texas Legislature has made in the past -- the ESF has grown to roughly $10.5 billion as of early 2021.

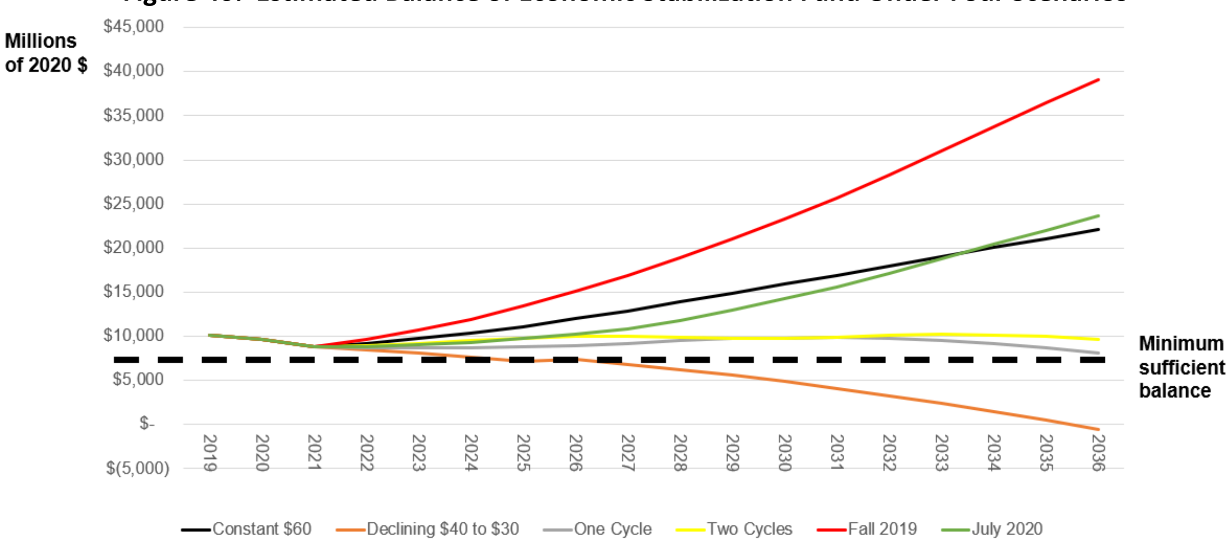
Under current Texas policy, the ESF is limited to investing in short-term financial instruments, which we assumed to produce a 1% annual return. Meanwhile, we assumed the ESF will be subject to $1.2 billion in annual appropriations – including whatever extraordinary appropriations might occur in 2021 to address the budget shortfall due to COVID-19. This represents the average of the decisions made by Legislature over the past 10 years, which are depicted in Figure 39.

**Figure 39: Appropriations History from Economic Stabilization Fund[52]**




Using these assumptions – but, excluding the impacts of caps and floors that apply to the ESF – we estimated ESF to evolve over time under our four scenarios, as presented in Figure 40.

**Figure 40: Estimated Balance of Economic Stabilization Fund Under Four Scenarios**




Note: Texas Comptroller does not forecast tax collections. Estimates presented above reflect calculated tax collections, based on variables provided in Comptroller's forecasts

It is evident that, unless the legislature chooses to limit outflows from the ESF to fill budget gaps, the value of the ESF would fall under highly pessimistic oil price scenarios.

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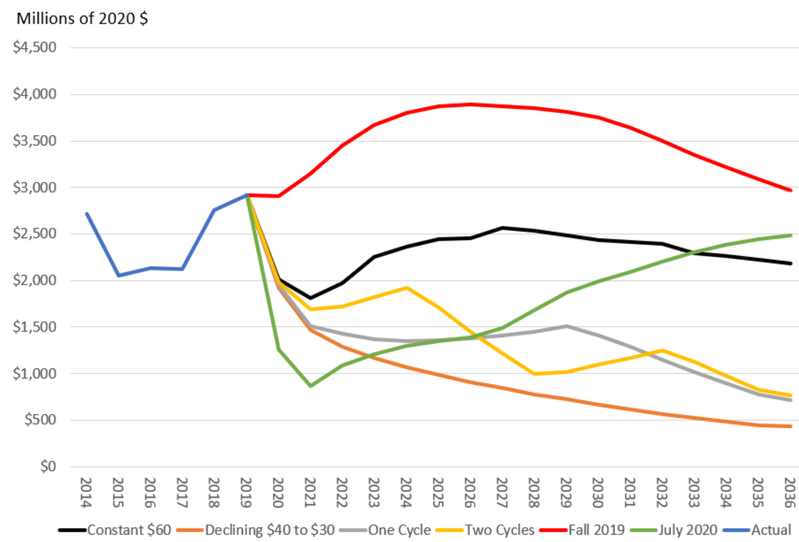
[52] Legislative Budget Board, Fiscal Size Up 2020-2021, May 2020.

Currently, the ESF is subject to a minimum requirement known as a “sufficient balance,” which was established at $7.5 billion for 2020-21, and subject to further increases as the size of the state’s budget grows.[53] As shown above, under the Declining $40-to-$30 Scenario, the value of the ESF is estimated to fall below $7.5 billion by the mid-2020s, unless policy is changed.

It is unlikely lawmakers would allow the ESF to fall to zero, but we still thought it important to show the implications for the ESF if no actions were undertaken at all.

Returning to Texas tax collections from E&P activity, estimated sales tax revenues under our “low-but-plausible” oil price scenarios are expected to decline from historic levels, as indicated in Figure 41.

**Figure 41: Estimated Sales Tax Collections from E&P Activity**



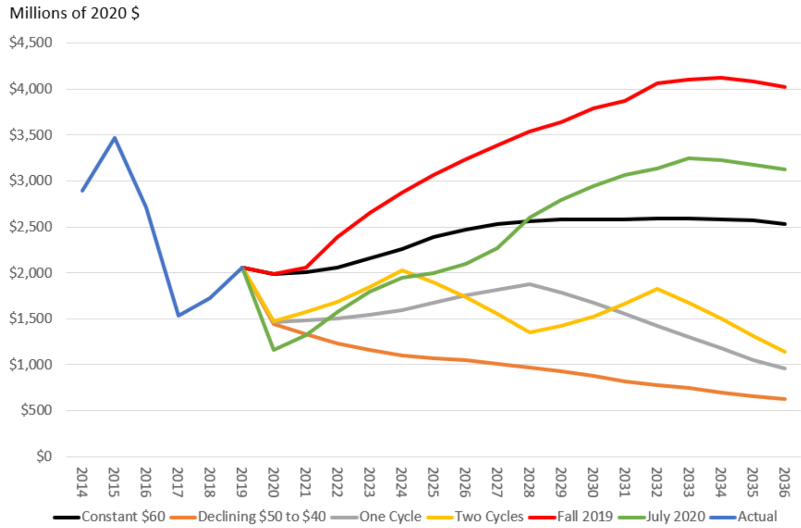

Note: Estimates for Comptroller’s forecasts presented above are calculated based on other variables provided in Comptroller’s forecasts
Source: Permian Basin Petroleum Association (historical)

The decline in E&P-based sales tax collections occurs because we assume such revenues to be proportional to rig count. The vast majority of E&P-related sales tax is made on drilling and fracking activity, which is not anticipated to return to 2019 levels under any of our scenarios.

Next, estimated property taxes on E&P interests collected by local (as opposed to state) authorities under our four scenarios are presented in Figure 42.

[53] Center for Public Policy Priorities, “The Rainy-Day Fund: A Resource Designed for Texas to Use,” December 2018.

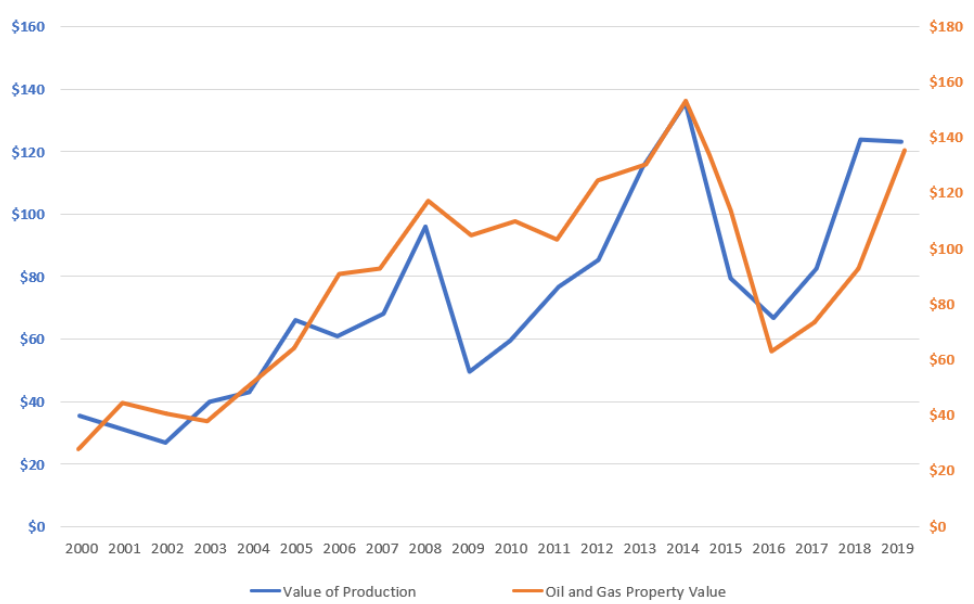
**Figure 42: Estimated Property Tax Collections on E&P Interests**




Note: Estimates for Comptroller's forecasts presented above are calculated based on other variables provided in Comptroller's forecasts
Source: Permian Basin Petroleum Association (historical)

As with severance taxes, we assumed that property tax collections on E&P assets would rise and fall from historical levels ($2.1 billion in 2019) as the value of statewide estimated oil and gas production (volume times price) changed over time. This assumption was made because prior analysis by the Texas Taxpayers and Research Association presented in Figure 43 indicates a strong correlation between assessed oil and gas property value and oil and gas production value.

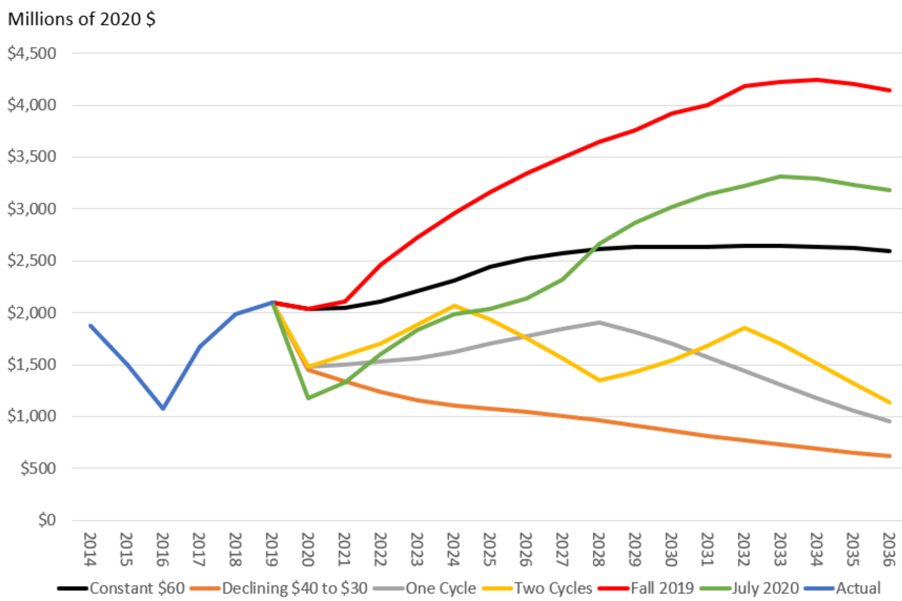
**Figure 43: Strong Relationship Between Oil/Gas Property Value and Value of Oil/Gas Production[54]**




[54] Data provided by Texas Taxpayers and Research Association.

The last major revenue collection mechanism on Texas E&P activity we consider here are royalties on oil and gas production from state-owned lands, which totaled $2.1 billion in 2019. As with estimates for severance tax collections (state) and property tax collections (local), royalty receipts were assumed to change in proportion with the value of statewide estimated oil and gas production. Estimates of royalties collected under the four oil price scenarios are presented in Figure 44.

**Figure 44: Estimated Oil/Gas Royalty Collections in Texas**




Note: Estimates for Comptroller's forecasts presented above are calculated based on other variables provided in Comptroller's forecasts
Source: Permian Basin Petroleum Association (historical)

## CALCULATING EXPOSURE OF TEXAS K-12 PUBLIC SCHOOL FUNDING

The final phase of our research involved assessing the effects of estimated changes in Texas E&P activity on K-12 education funding. We then make recommendations for Texas policymakers to consider to better insulate public schools from the vagaries of the global oil market.

Providing the necessary funds for more than 1,000 ISDs serving 5.5 million students across the state,[55] public schooling is one of the largest, most critical and complex set of expenditures the State of Texas undertakes.

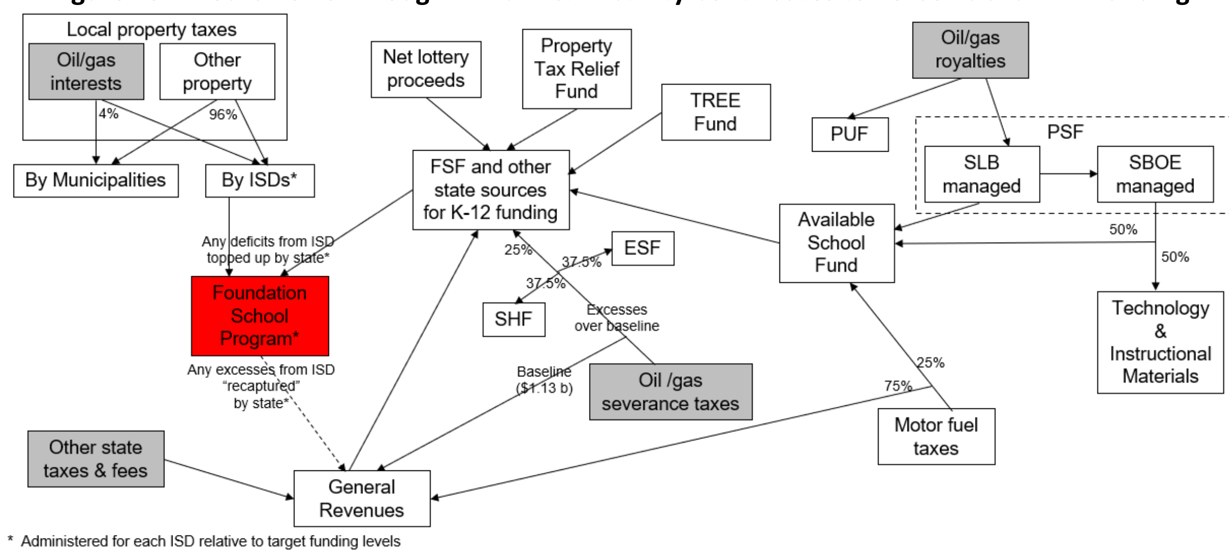
For the 2020-2021 biennium, appropriated spending (excluding Federal funds) on Texas public K-12 education was nearly $65 billion, equating to about $32 billion per year.[56] The primary budget mechanism through which this funding flows to schools is the Foundation School Program (FSP), which annually determines funding targets per ISD using a formula driven by anticipated student enrollment levels. In turn, as discussed below, the FSP is funded by a variety of sources, many of which are fed partly by revenues collected from E&P activity.

[55] Legislative Budget Board, Fiscal Size Up 2020-2021, May 2020.
[56] Legislative Budget Board, Fiscal Size Up 2020-2021, May 2020.

We have not sought to forecast the long-term FSP funding requirements based on changing state demographics on how these trends will impact enrollment and therefore public school funding requirements, but rather we restrict our analysis to looking at the changes in revenue contributions from E&P activity to various Texas public education funding accounts. To the extent that these contributions decline or are less than anticipated due to oil market weakness, local property tax rates will have to increase, other sectors of the economy will have to contribute more, collections from the oil and gas sector will have to increase or Texas public education funding will have to be cut to make up the deficit.

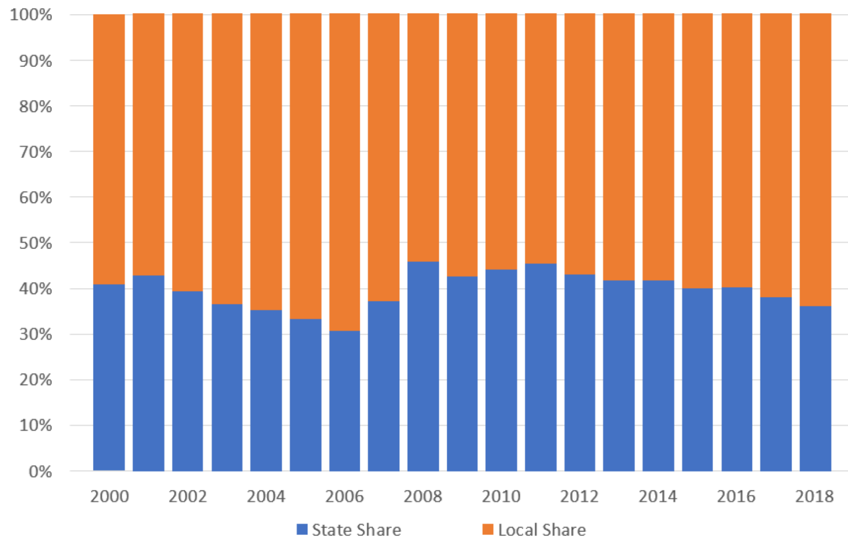
Figure 45 is a representation of the various E&P-based revenue sources (in grey) that support Texas public education, funneled primarily through the FSP (in red).

**Figure 45: Mechanisms Through Which E&P Activity Contributes to Texas Public K-12 Funding**




The first input to the FSP is property taxes collected by local ISDs. Statewide, local property tax collections by ISDs account for about 60% of total Texas public school funding in recent years, as shown in Figure 46.

**Figure 46: Local vs. State Share of Total Texas Public K-12 Education Funding[57]**




In 2019, ISD property tax collections from oil and gas interests were estimated at $1.5 billion for the state.[58] For future years, our analysis estimates statewide ISD property taxes from E&P activity to increase or decrease from 2019 levels in proportion to changes in the projected value of statewide oil and gas production.

ISD property taxes collected from E&P interests are only sourced from local (i.e., in-district) E&P interests and are only used for in-district educational expenses. Consequently, certain ISDs in E&P-intensive parts of the state – most notably, the Permian – rely heavily upon property tax collections from E&P interests and will be harmed more dramatically than the typical ISD if/as oil activity weakens.

Figure 47 lists the ten ISDs in Texas that had the most funding from E&P property tax collections in 2019 and face the most fiscal exposure to weak oil market conditions.

[57] "Texas School Finance: Doing the Math on the State's Biggest Expenditure," Texas Comptroller of Public Accounts, January 2019.
[58] "Annual Energy and Economic Impact Report 2019," Texas Oil & Gas Association, January 2020.

**Figure 47: Top 10 ISD's for Property Tax Collections from E&P in 2019**[59]

| | | | |
|---|---|---|---|
| 1 | Pecos-Barstow-Toyah ISD | $109.2 million | 75.6% of tax base |
| 2 | United ISD | $68.6 million | 32.3% of tax base |
| 3 | Midland ISD | $68.2 million | 25.2% of tax base |
| 4 | Carrizo Springs CISD | $53 million | 85.4% of tax base |
| 5 | Wink-Loving ISD | $50 million | 85.3% of tax base |
| 6 | Cotulla ISD | $50 million | 77.9% of tax base |
| 7 | Karnes City ISD | $45.3 million | 86.3% of tax base |
| 8 | Rankin ISD | $36.7 million | 87.2% of tax base |
| 9 | Andrews ISD | $36.2 million | 69.7% of tax base |
| 10 | Regan County ISD | $28.8 million | 71.3% of tax base |

Our report presents information aggregated for the state level and our assessments of low-but-plausible oil prices may understate the effects in localized ISDs that rely heavily on E&P-related property taxes.

To the extent that an ISD's actual tax collections exceed its FSP entitlement, the Texas "recaptures" any excesses for to payments to other ISDs. Most ISDs do not collect sufficient property taxes to cover their FSP funding requirements, though surpluses are gathered by some ISDs. For the vast majority of ISDs, the state provides funding from various accounts – primarily the Foundation School Fund (FSF) – to make up the deficit.

In turn, the state aggregates public school funding from several intragovernmental sources – and many of which are supported either directly or indirectly by revenues from E&P activity. These include:

- The Available School Fund (ASF), which collects annual disbursements from the twin components of the Permanent School Fund (PSF) – one managed by the State Land Board (SLB) and one managed by the State Board of Education (SBOE). It has accumulated over the decades due to oil and gas royalties and appreciation from investment activities. Additional funding for the ASF comes from motor fuel taxes. Motor fuel taxes are not assessed in this study but are likely to decline as the state sees electric vehicles substantially increase, anticipated mainly after 2036.

- Severance taxes, of which 25% of any surplus collections beyond the baseline $1.131 billion dedicated to General Revenues gets directly contributed to the FSF.

- General Revenues, which pools funding from a variety of sources (including, for instance, the Texas Lottery) to supply the balance of statewide K-12 funding to meet target levels suggested by the FSP. Note that, in the 2020-2021 biennium, about 33% of the approximately $60 billion in annual disbursements from General Revenues flow to public school funding,[60] which implies that roughly one-third of every dollar contributed by E&P activities to General Revenues funds public K-12 education. In addition to $1.131 billion of annual contributions from severance

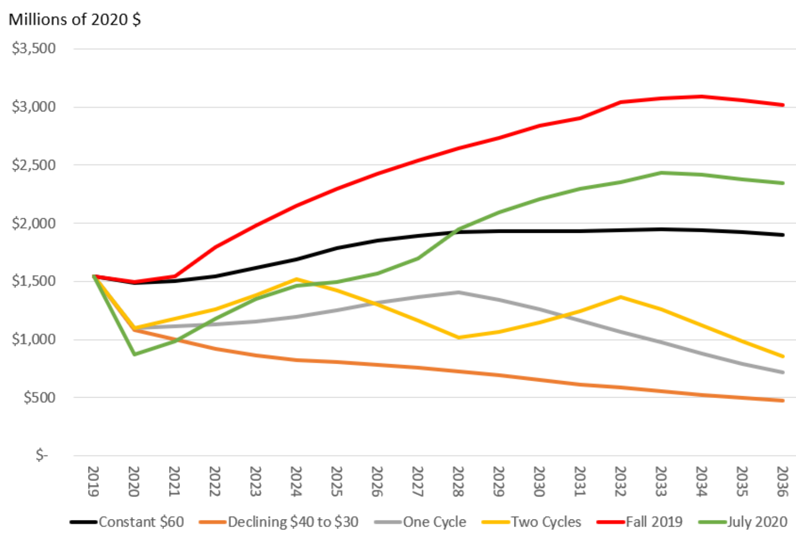
[59] "Annual Energy and Economic Impact Report 2019," Texas Oil & Gas Association, January 2020.
[60] "Certification Revenue Estimate", Texas Comptroller of Public Accounts, July 2020.

taxes, revenues collected from E&P firms arrive into General Revenues through various other taxes that apply to E&P activity, such as sales taxes, motor vehicle sales taxes, well-servicing taxes and hotel occupancy taxes.

Aggregating across these various fiscal streams, we find that about $6 billion – or slightly over 20% of total K-12 school funding -- can be attributed to revenue collections from E&P activities in the state, given that total K-12 school funding for the 2018-2019 biennium was $55.7 billion or $28 billion per year (for the 2020-21 biennium, E&P activities account for 18% of K-12 funding since school funding increased to $64.7 billion for the biennium ($32 million per year)).

Of this $6 billion in 2019 revenues from E&P to public school finances, an estimated $1.5 billion derives from property taxes collected by ISDs on oil and gas interests. Projecting under our four scenarios, estimated ISD collections of property taxes from oil and gas interests are presented in Figure 48.

**Figure 48: Estimated ISD Collections of Property Taxes from Oil/Gas Interests**




Note: Estimates for Comptroller's forecasts presented above are calculated based on other variables provided in Comptroller's forecasts

This represents only revenues from E&P activity collected by local sources. While overall Texas public school funding is 60% from local sources and 40% from state sources, most of E&P's revenue contributions to K-12 funding are from state sources (75%) rather than from local sources (25%).

Of the $6 billion in 2019 revenues from the E&P sector for Texas K-12 public education, the $4.5 billion share transmitted through the state as follows:

- About $1.5 billion of disbursements from the PSF (funded by oil and gas royalties, as well as appreciation on investment activities) to the ASF.
- About $1 billion of direct contributions to the FSF from oil and gas severance taxes.
- About $2 billion of other E&P-based tax revenues – primarily associated with sales taxes – that flow through the General Revenues account to eventually go to public schools.

The latter two elements were straightforward to calculate: The FSF was estimated to receive 25% of all annual severance tax collections beyond $1.131 billion and the total of E&P-based taxes accruing to

General Revenues was multiplied by a 33% scaling factor to reflect the share of General Revenues that historically were eventually spent for K-12. Future estimates of these two elements under our four scenarios are presented in Figures 49 and 50.

**Figure 49: Estimated Direct Contributions to the Foundation School Fund from Severance Taxes**

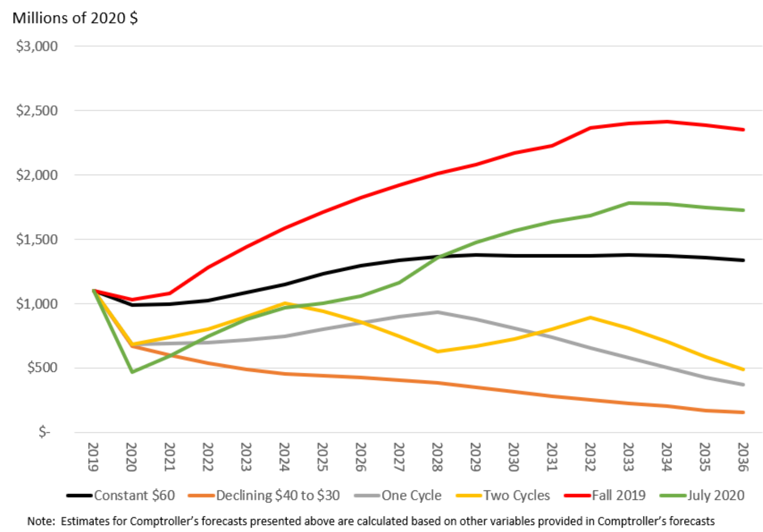
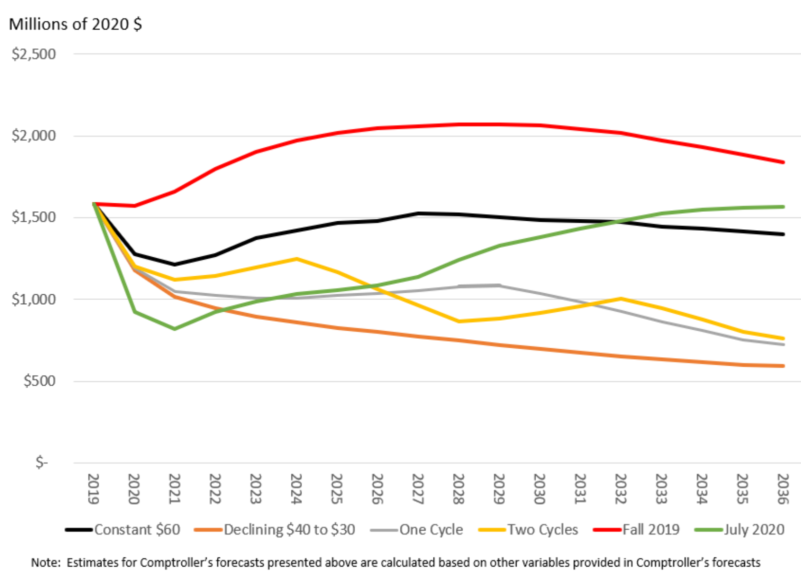



**Figure 50: Estimated E&P-Based Tax Revenues to Texas K-12 Funding Through General Revenues**




Annual disbursements from the PSF to the ASF are more intricate to estimate, warranting a lengthier discussion.

As noted previously, the PSF – valued at $46.5 billion as of the end of fiscal year 2019[61] – has been primarily funded over the decades by royalties collected on oil and gas production from state-owned lands (although, more recently, investment activities have been an important source of PSF growth).

Complicating matters, the PSF is split into two pieces: one managed by SBOE with a 2019 value of $34.3 billion and one managed by SLB with a 2019 value of $12.2 billion.[62] Boards of both fund managers (SBOE and SLB) decide periodically on how much of the money under their management should be disbursed to the ASF for distribution to the FSP.

Technically, the SLB has always been responsible for collecting royalties, and until 2000 the SLB annually passed all collected royalties to the SBOE for investment. However, in 2001, the SLB was authorized by the Texas Legislature to invest a portion of collected royalties independently from the SBOE-managed PSF. That made the transfer of royalties for the PSF from the SLB to the SBOE less than 100%. More recently, as SLB's investment authority increased, the annual transfer of collected royalties from the SLB to the SBOE has become contentious.[63]

Accordingly, to calculate future annual contributions to K-12 funding from the PSF, the following four steps are required:

- Estimate annual oil and gas royalties collected for contribution to the PSF (as received by SLB). Given that PSF obtained $1.1 billion of oil and gas royalties in 2019, this value was scaled into the future in proportion to the rate of changes in the estimated value of statewide oil and gas production under the four scenarios.

- Estimate annual transfers from SLB to the SBOE-managed portion of the PSF. Beyond prior commitments by the SLB to SBOE during the current 2020-2021 biennium, it was conservatively assumed no further transfers from SLB to SBOE will occur.

- Estimate annual increases in both portions of the PSF due to investment returns. Historical average returns for both components of the PSF are presented in Figure 51. Based on reported returns achieved the past 10 years, we assumed a 6.0% annual return on both components of the PSF through 2036.

[61] Permanent School Fund Annual Report, End of Fiscal Year 2019.
[62] Permanent School Fund Annual Report, End of Fiscal Year 2019.
[63] See, for instance, September 19, 2018 letter from George P. Bush (SLB) to Donna Bahorich (SBOE).

**Figure 51: Returns (Net of Fees) to End Fiscal 2019 for Permanent School Fund[64]**


- Estimate annual decreases in both portions of the PSF due to disbursement decisions. Beyond the current 2020-2021 biennium, we assumed SLB will issue $600 million of annual disbursements from its portion of the PSF, and that subsequently SBOE will make annual disbursements from its portion of the PSF in amounts such that the total disbursements from both elements of the PSF will equal 3.5% of the combined balance of the PSF from the prior year. This assumption is broadly consistent with historical patterns of aggregate disbursements from the PSF to the ASF during the past 10 years, as presented in Figure 52.

**Figure 52: Key Statistics from the Permanent School Fund: 2010-2019[65]**

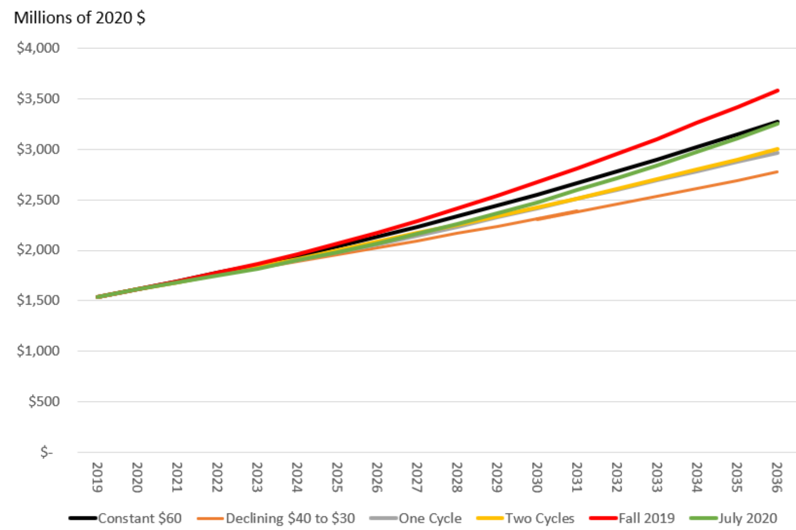
Key Statistics from the Permanent School Fund: 2010-2019

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|
| Royalties (to SLB) | | $552 | $582 | $562 | $852 | $868 | $726 | $1,356 | $1,245 | $1,393 |
| Transfers SLB to SBOE | | $100 | $250 | $250 | $130 | $150 | $175 | $200 | $235 | $255 |
| SLB distributions to ASF | | | | $300 | | | | | | $300 |
| SBOE distributions to ASF/IMA | | $1,093 | $1,021 | $1,021 | $839 | $839 | $1,056 | $1,056 | $1,236 | $1,236 |
| Total distributions | | $1,093 | $1,021 | $1,021 | $839 | $839 | $1,056 | $1,056 | $1,236 | $1,536 |
| | | | | | | | | | | |
| **Total PSF balance** | **$24,395** | **$24,947** | **$28,802** | **$30,601** | **$34,951** | **$33,834** | **$37,264** | **$41,418** | **$44,068** | **$46,500** |
| Distributions as a % balance | | 4.1% | 3.5% | 4.3% | 2.4% | 2.5% | 2.8% | 2.5% | 2.8% | 3.3% |
| Distributions as % of prior year balance | | 4.5% | 3.8% | 4.6% | 2.7% | 2.4% | 3.1% | 2.8% | 3.0% | 3.5% |

[64] Permanent School Fund Annual Report, End of Fiscal Year 2019.
[65] Permanent School Fund Annual Report, End of Fiscal Year 2019.

The net effect of these four calculation steps used to estimate annual distributions to the ASF from the PSF for each year through 2036 under each scenario is presented in Figure 53.

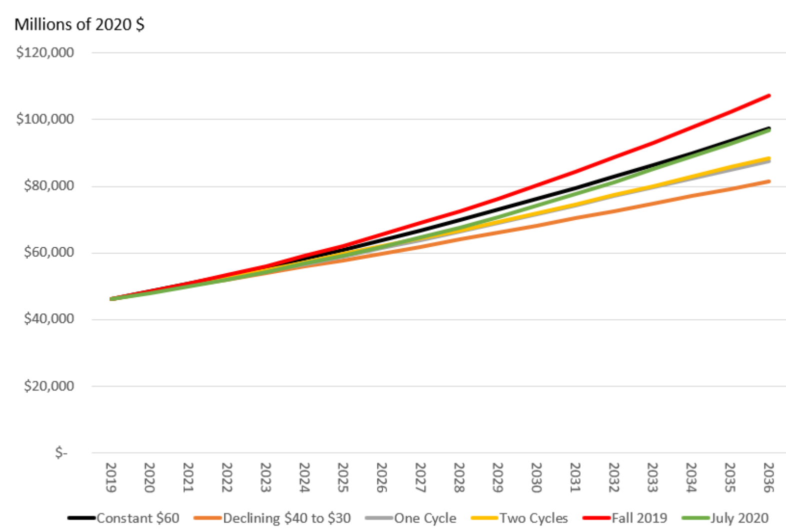
**Figure 53: Estimated Annual Disbursements to Available School Fund from Permanent School Fund**




Note: Estimates for Comptroller's forecasts presented above are calculated based on other variables provided in Comptroller's forecasts

Meanwhile, the estimated balance of the combined PSF (SLB plus SBOE) is estimated to keep growing under each of the four scenarios, as presented in Figure 54.

**Figure 54: Estimated Balance of Permanent School Fund**

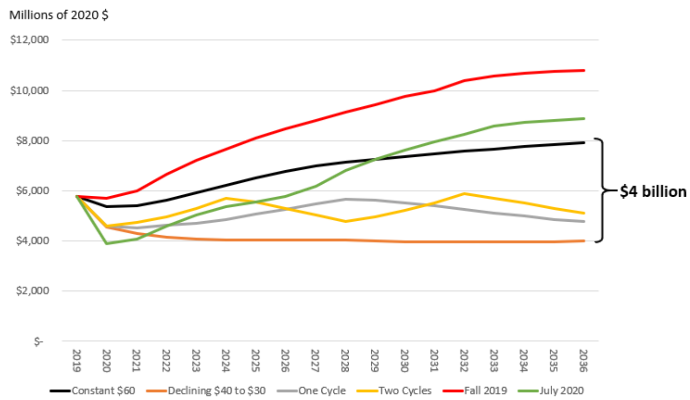



Note: Estimates for Comptroller's forecasts presented above are calculated based on other variables provided in Comptroller's forecasts

Note that future growth in the PSF is to be expected, even if oil and gas royalties were to fall to zero, given that the current corpus ($46.5 billion) is assumed to grow more by capital appreciation (6% per year) than it is assumed to be depleted by disbursements to the ASF (3.5% per year).

We sum the three elements of E&P-based revenues that factor into public school funding – PSF contributions to ASF, severance tax contributions to FSF, and the allocated share of various taxes flowing through General Revenues to K-12 funding – plus ISD collections of property taxes from oil and gas interests for a total estimate of E&P contributions to public school funding under each scenario. The results are presented in Figure 55.

**Figure 55: Estimated Total Annual E&P-Based Contributions to Texas Public K-12 Education**




Note: Estimates for Comptroller's forecasts presented above are calculated based on other variables provided in Comptroller's forecasts

Clearly, our scenarios suggest that public school funding will be materially affected by reduced Texas E&P activity. By 2036, there is a $4 billion estimated annual difference in statewide school funding contributions from E&P activity between our highest-priced scenario (Constant $60) and our lowest-priced scenario (Declining $40 to $30).

In a world where oil prices remain at $60/bbl in real terms indefinitely, the contributions of Texas E&P activity to the funding of public schools are estimated to increase by about 1.7% per year, slightly more than anticipated student enrollment growth of 1.1%-1.4% over the next 30 years.[66]

If oil prices decline from $40/bbl to $30/bbl by 2036, the contributions of Texas E&P activity to the funding of public schools are estimated to fall by nearly 35% from 2019 levels.

Under adverse oil market scenarios, the pressures on public school funding will emerge on several fronts. First, given the primacy of local sources of revenue for Texas public school funding, any reduction in property taxes collected by ISDs from oil and gas interests will likely compel greater reliance on state funding sources for K-12 schooling. This effect will be magnified in areas of Texas – such as the Permian Basin – where E&P activity is a dominant force.

In addition, state funding sources will also be increasingly stressed due to reduced revenue collections from E&P activity. Severance tax revenue declines will not only directly reduce annual contributions to the FSF, but will also weaken the ESF (i.e., Rainy Day Fund) as a backstop in the event of budget shortfalls. If E&P activity declines, diminished collections of various other taxes – especially sales taxes –

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[66] "A Study on Distributions from the Texas Permanent School Fund to the Available School Fund," Texas Education Agency, August 31, 2020.

will negatively affect General Revenues, and ultimately about one-third of that negative effect will be borne by K-12 funding.

Furthermore, although not analyzed nor estimated herein, if oil market weakness is related to falling demand for gasoline and diesel for vehicles, Texas collection of motor fuels taxes would also decline, reducing annual contributions to the ASF, the State Highway Fund, and General Revenues.[67]

## RECOMMENDATIONS

This study has shown that the oil and gas sector of the Texas economy remains an important contributor to the state's economy, even as the economy has diversified over the last several decades.

Yet, some may be surprised to learn that the oil and gas sector remains a significant source of funding for the state's K-12 public education system. Moreover, our analysis has shown that reliance on the current system funding is complex, difficult to forecast and increasingly at risk due to the potential variability in tax collections and royalties as a result of volatile world oil prices and the corresponding fluctuations in levels of oil and gas produced within the state.

Given these conclusions, below are several sets of recommendations that could be considered in addressing the issues and risks identified during this study. While we have not undertaken a detailed assessment of these recommendations, they are offered as a starting place for more detailed policy analysis and study by the Legislature, the Comptroller's office, the Governor's Policy office or other organizations.

We hope that the readers of report take these recommendations in the spirit in which they are offered: not as prescriptions or remedies for anything that is wrong with the Texas fiscal system, but rather as an impetus for considering new ways of doing things to produce better outcomes under changing circumstances.

### Performance Improvement Opportunities

Throughout our research, we noted several opportunities to improve the operational performance of the existing revenue collection system supporting public education. In each case, we have discussed these opportunities with subject matter experts sufficiently to believe further investigation could demonstrate significant improvements, but we have not undertaken an in-depth analysis of these proposals.

- **Strengthening the state's long-term forecasting capabilities**. Each fall, the Comptroller's office releases an economic forecast for the state. While it is well-regarded and professionally managed, it is used almost solely used for relatively short-term budget management objectives. However, no state agency currently appears to be responsible for making longer-term forecasts or for developing scenarios which could inform policymakers about future trends facing the

[67] "Motor Fuels Taxes in a Changing Texas Transportation Scene," Texas Comptroller of Public Accounts, June/July 2019.

state similar to that conducted by this study. This capability gap dramatically reduces long term visibility for policymakers seeking to evaluate strategic options for the state.

- **Streamlining PSF management.** Managing the PSF endowment through two organizations (the SBOE and SLB) has been the subject of considerable investigative reporting.[68] Not only does the institutional duplication introduce redundancies and interorganizational conflicts, but the resulting flow of funds between parties – and ultimately, to public schooling – is very difficult for policymakers and the public to understand. To capture efficiencies, improve transparency, and reduce exposure to imbalanced portfolio positions, alternative approaches to administering the PSF should be explored.

**Adjustments to Existing Revenue Sources**

Our research has shown a number of areas in which disbursements could be increased from the existing revenue collection system, in many cases, without changes that would require legislative or significant regulatory actions. These adjustments could conceivably provide the current system with sufficient financial flexibility to address short-term revenue fluctuations caused by the oil and gas price volatility discussed in this report.

- **Increasing the disbursement rate from the PSF**. Assuming historical patterns of investment performance and disbursements are maintained into the future, the PSF will continue to grow even under our most pessimistic oil market scenario (Declining $40 to $30). This implies that the PSF can afford annual disbursements somewhat greater than is the levels assumed in this analysis (3.5% of prior year's PSF value).

- **Unleashing better accumulation potential for ESF**. The ESF is currently limited to investing in short-term low-risk securities that generate commensurately low returns on the order of 1%, whereas the PSF has averaged 6% returns on its portfolio over the past 10 years. Eliminating this restriction on ESF investment scope could substantially strengthen its ability to continue serving as an emergency backstop for K-12 funding.

- **Aligning E&P property taxes with oil prices.** The current process for appraising the value of E&P interests for property tax purposes is rather arcane. In general, the methodology is premised on net present value of discounted expected cash flows associated with future oil and gas production from a property. Many assumptions are made by appraisers during assessment of taxable value, but in any event, interviews with Texas tax experts strongly indicate that property taxes actually collected from E&P interests do not rise and fall in concert with oil prices. Put another way, E&P interests generally do not pay higher property taxes when oil prices are high, and lower property taxes when oil prices are low. At best, there is a considerable time lag between oil price increases and E&P property taxation increases, as adjustments in taxation are inevitably backward-looking. Developing and implementing a property tax assessment mechanism that better links E&P property tax obligations with ability-to-pay (i.e., current year oil prices) would be revenue-neutral but would more closely reflect the underlying economics of the industry.

**Opportunities to Restructure State Tax Policy**

[68] For instance, refer to the "Broken Trust" series of articles in the Houston Chronicle, initiating on March 3, 2019.

Given the pressures on public school funding that could emerge under the adverse oil market scenarios, state policymakers may consider long-term revenue diversification strategies to ensure future fiscal stability as oil and gas becomes a less dependable revenue source and as alternative energy sources gain an increasing share of the energy market.

**This includes re-examining severance tax policies for oil and natural gas production.** Historical severance tax rates were established prior to the current dynamics of the energy market in Texas which has seen a rapid rise in both oil and natural gas production. An analysis of changes in severance tax policy for oil and gas is beyond the scope of this report, but state policymakers have examined issues such as whether to limit the tax exemption for high-cost natural gas drilling[69] as well as the misclassification of oil wells as natural gas wells (which results in unwarranted severance tax exemptions).[70]

[69] See, e.g., Legislative Budget Board, Modify the High-Cost Gas Tax-Rate Reduction to Increase Its Cost Transparency and Effectiveness (2013).
[70] Texas Tribune, When Oil Wells Become Gas Wells, the State Loses (Dec 2015)

# CONCLUSION

The oil and gas sector has been an important driver of the Texas economy and, as shown in this report, we expect that it will be for many years to come.

However, there is also no question that the world is in an energy transition that will likely reduce the global demand for oil and gas in the not-too-distant future.

This shift away from fossil fuels is being driven by two factors: (1) ongoing cost declines for various technologies that enable greater penetration of renewable energy to power all aspects of the global economy, and (2) increasing concern about climate change motivating nations worldwide to reduce carbon emissions.

The pace and timing of this “energy transition” away from fossil fuels may be uncertain, but the overall conclusion is clear:  The state’s reliance on oil as an economic driver will almost certainly decline over time.

In this report, we have sought to develop some scenarios on how these changes might play out by the year 2036 – the bicentennial of the state of Texas, 15 years from today.

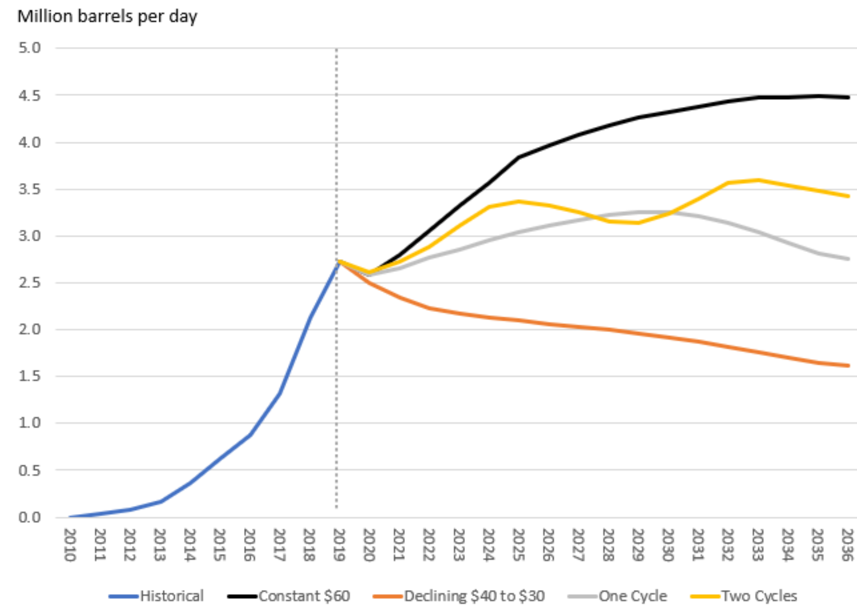
This work shows that under certain circumstances the impact on the state’s employment, GDP, fiscal health and even education policy could be significant.  If any lessons are learned from the COVID-19 crisis, it should be that policymakers must plan well in advance for scenarios that may seem implausible today but can have enormous consequences tomorrow.

State officials and policymakers would do well to begin planning today for the possibility that the economic role that oil and gas plays in the state of Texas might be significantly different in the future than today.

# Appendix A:
# TORA Modeling Results of
# Estimated Oil and Gas Production
# from Shale Resources in Permian and Eagle Ford Basins

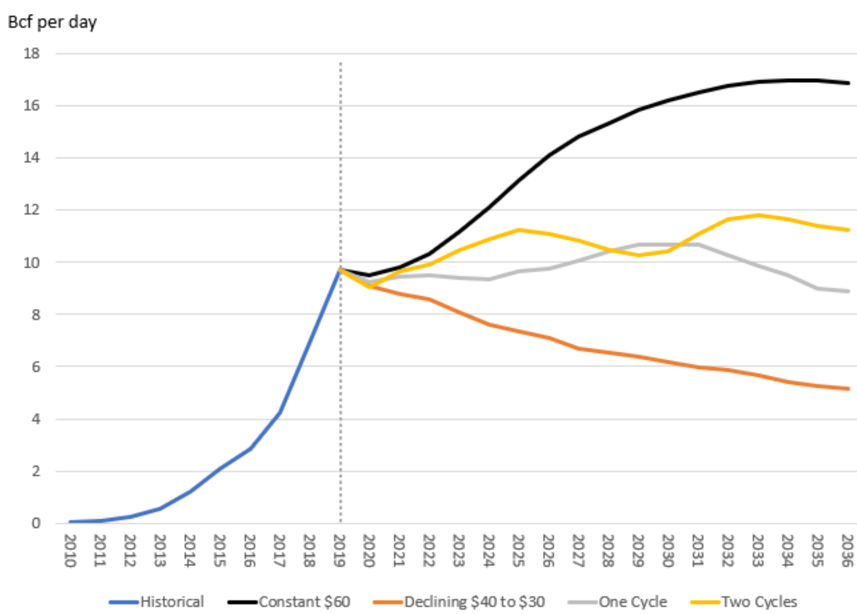
## PERMIAN BASIN RESULTS

Estimated Permian Shale Liquids Production Under Four Scenarios




Source: BEG

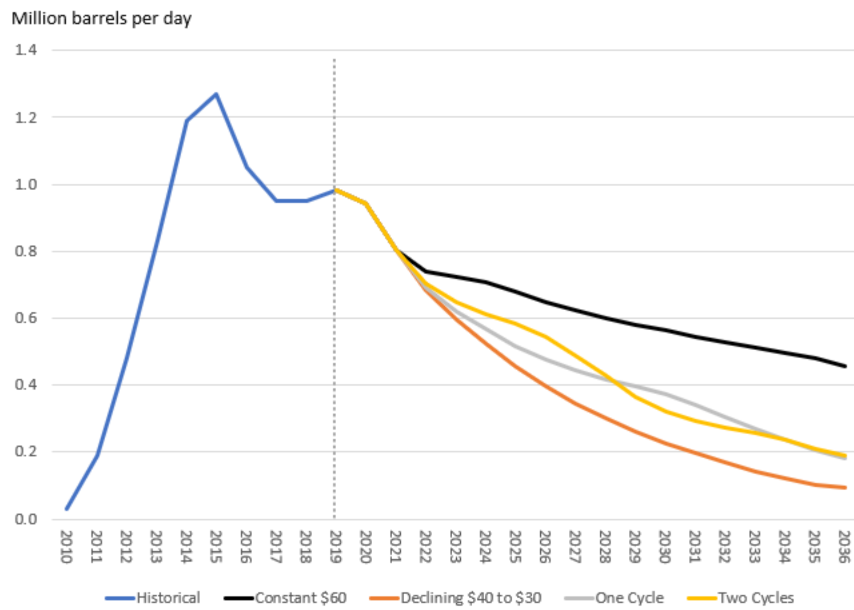
Estimated Permian Shale Gas Production Under Four Scenarios




Source: BEG

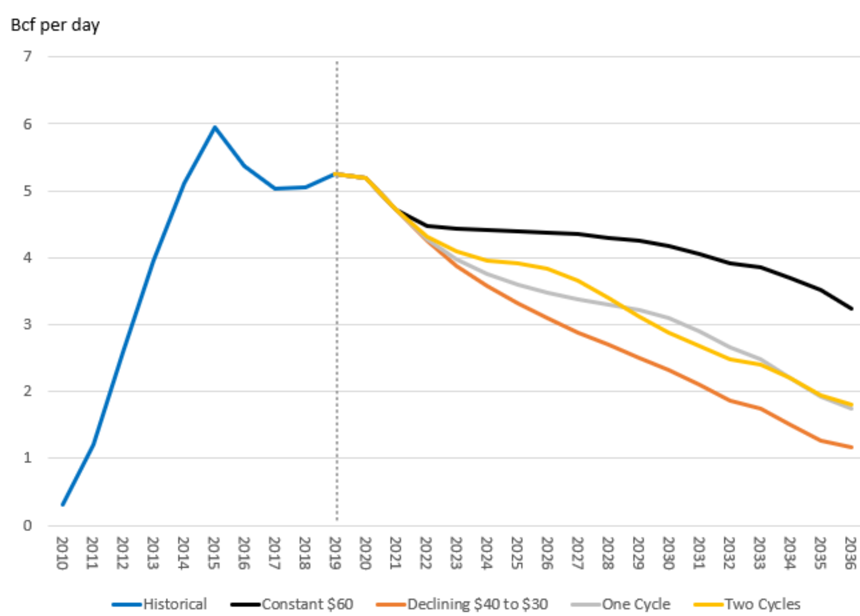
## EAGLE FORD BASIN RESULTS

Estimated Eagle Ford Shale Liquids Production Under Four Scenarios




Source: BEG

Estimated Eagle Ford Shale Gas Production Under Four Scenarios




Source: BEG