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This report would not have been possible without the help of many who contributed both time and financial resources over the past year. First, we would like to thank the
that invited us to present last year's GCEO to
across our state. At these meetings,
we have received feedback across the industry from up - stream production, pipeline operations, down - stream refining and chemicals, energy export, as well as utilities. We also met individually with dozens of companies and listened to thoughts about opportunities and challenges facing the industry in coming years. Simply put, while "crunching the numbers" is a critical part of any synopsis report such as this one, equally as important is input from stakeholders who have an "on - the - ground" view of what is occurring in real time. We are forever grateful for this input.

We also thank Marybeth Pinsonneault (Center for Energy Studies) and Stephen Radcliffe (E. J. Ourso College of Business), for their editorial and formatting expertise. Numerous graduate and undergraduate students across academic disciplines also contributed to data collection and analysis included in this report.[1]

And last, but certainly not least, we thank all of our sponsors; Gold Sponsors:
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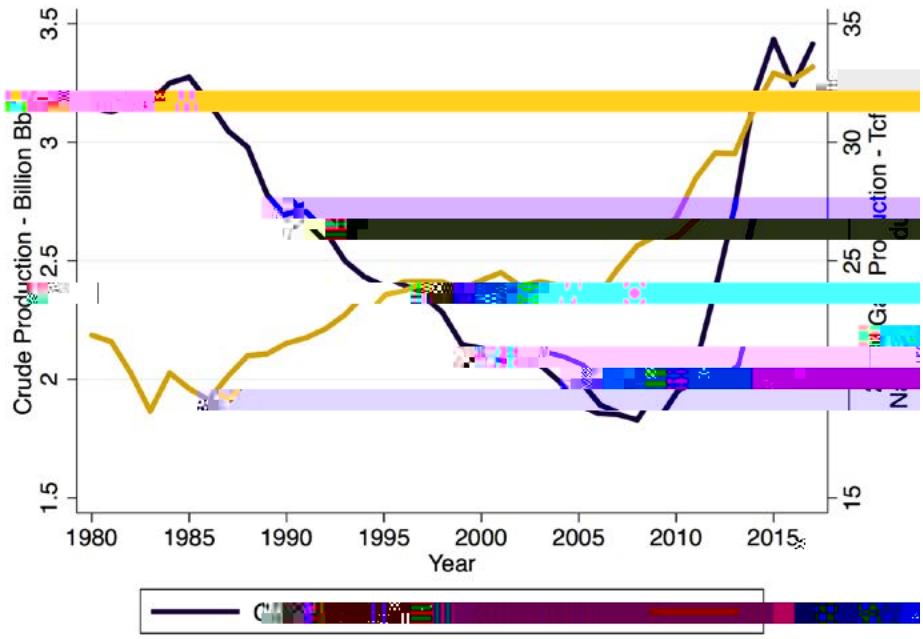
Crude Production - Billion Bb
3.5
3
2.5
2
1.5
35
30
25
15
1980
1985
1990
1995
2000
2005
2010
2015
Year

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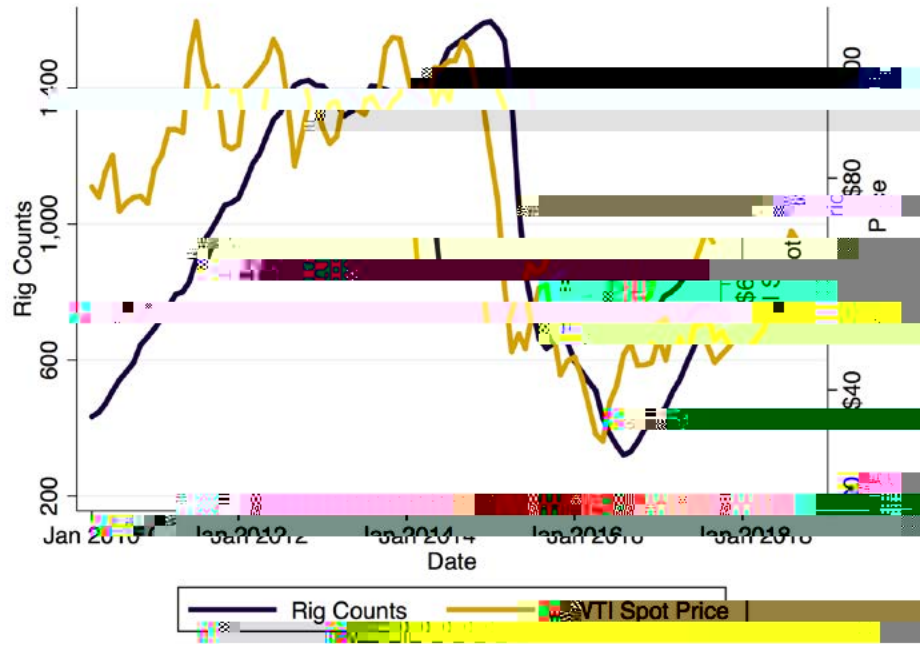
Rig Counts
1,400
1,000
600
200
$80
$40
Jan 2012
Jan 2014
Jan 2016
Jan 2018
Date
Rig Counts
VTI Spot Price

. .. . .

Figure 3 illustrates the rig activity in the seven major U.S. shale plays. Prior to 2012, most of the rig activity was allocated across the Permian, Anadarko, and Haynesville shale plays. Starting in 2012, Haynesville began to lose its position as a predominant shale play, ceding that preeminence to more liquids - oriented areas such as the Permian and the Eagle Ford. Since 2016, the Permian has been the predominant shale play in the U.S.

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Figure 5 shows how the drilling activity presented in Figure 2 has been translated into production gains and the increase in world market share highlighted in Figure 4. This chart, more importantly, also shows the resiliency of U.S. unconventional production and how it continues to march forward, through continued operator innovation and eciency, even in the face of decreased world prices. Consider, for instance, that by early 2015 crude oil prices had fallen by over 60 percent yet total PADD 3 crude oil production continued to mount its ascent to a 5 MMBbls/d production rate. Amazingly, the Gulf Coast region (PADD 3) was able to maintain this high degree of well productivity even in the face of low prices throughout the entire term of the 2014 to 2016 time period.

Starting in 2012, the Gulf Coast's collective well productivity surged, in large part due to the increased productivity in the Permian and Eagle Ford basins, not to mention the continued high productivity levels for individual wells in the deepwater Outer Continental Shelf (OCS) GoC

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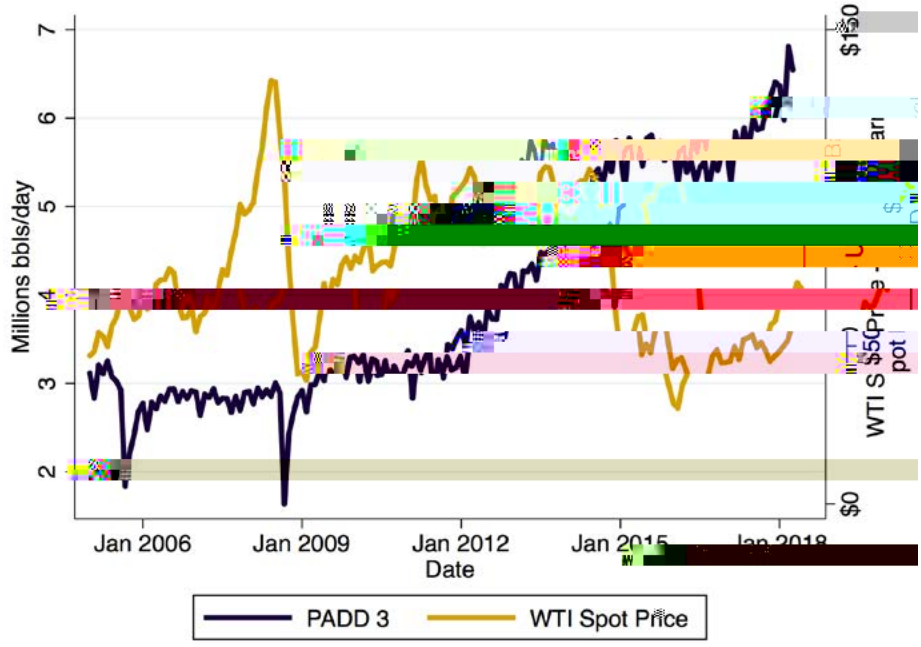
Millions bbls/day
2
3
4
5
6
7
$0
$50
$100
Jan 2006
Jan 2009
Jan 2012
Jan 2015
Jan 2018
Date
PADD 3
WTI Spot Price

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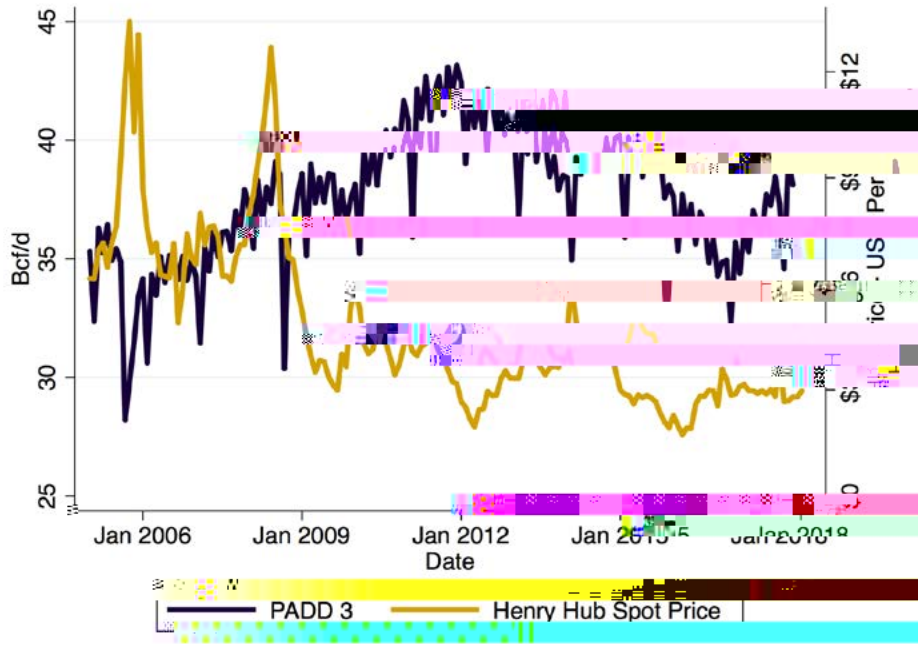
Bcf/d
25
30
35
40
45
$0
$6
$12
Jan 2006
Jan 2009
Jan 2012
Date
PADD 3
Henry Hub Spot Price

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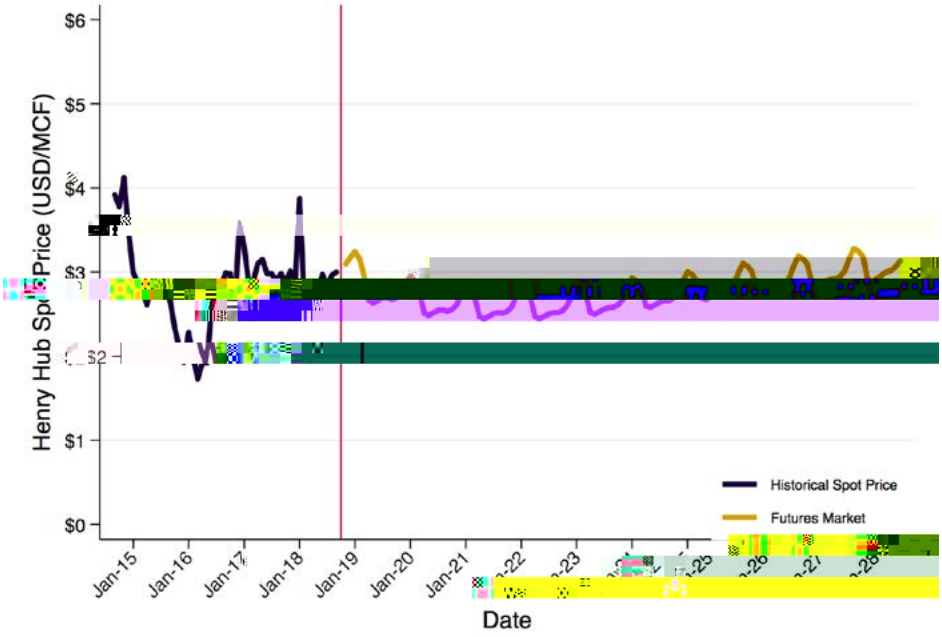
While PADD 3 natural gas production is down somewhat from its 2019 peak of more than 34 Bcf/day, production trends over the past six years show a resilient resource base that continues to produce. At the time of this writing, the Gulf Coast is producing more than 28 Bcf/day despite a three-fold drop in natural gas prices (relative to 2019 peaks). Low-cost, less volatile, widely-available natural gas is the primary motivator for the billions in Gulf Coast industrial capital expenditures that will be discussed later in this outlook.



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An important issue arising in the development of the production forecasts for last year's GCEO was the extent to which the region's unconventional crude oil basins would continue to expand production. At the time, there was a considerable debate, particularly among various industry analysts, as to whether the region could maintain its unparalleled productivity improvements with some analysts going so far as to suggest that the region had topped out in terms of well productivity and would start to see flat - to - declining daily crude oil production rates over the next several years.

The GCEO did not take this position and, as shown in the earlier section of this outlook, the past year's crude oil production trends underscore the sagacity of this forecast. It is simply too early in the unconventional revolution to discount the ingenuity of U.S. producers and their ability to extract copious levels of hydrocarbons from these reserves. Ultimately, the law of diminishing returns will kick - in, but the GCEO takes the position that this is not in the very immediate future (to 2020). Last year's crude oil productivity, and the continued increase in associated natural gas production, which also increased on a Bcfd per MMBBLd basis, showed a tandem productivity trend that continues to keep U.S. natural gas markets well supplied.

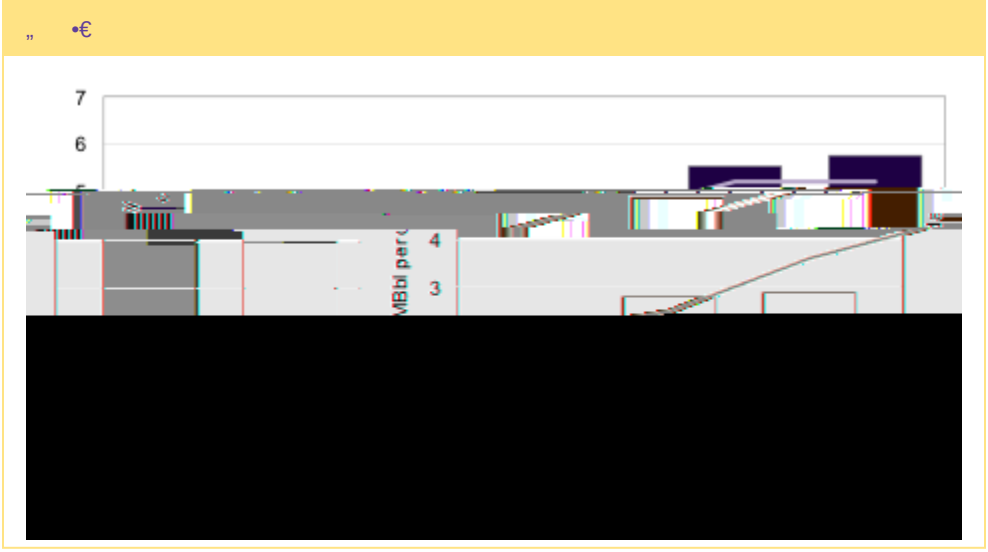
There are, however, a number of challenges to PADD 3 production, and those have less to do with geology than they do the physical transportation constraints of moving crude oil out of the Permian basin and to the Gulf Coast. Recent estimates have continued to emphasize that the Permian region is quickly running out of spare crude oil transportation capacity. Some reports have the region's crude oil transportation pipeline capacity utilization as high as 90 percent.[2]

[2] Tagle, R. "Permian oil and gas takeaway capacity improvements on horizon. Available at: https://info.drillinginfo.com/permian - oil - and - gas - takeaway - capacity - improvements - on

These pipeline capacity constraints are real and have the ability slow the region's (and the U.S.) ability to meet the anticipated global production shortfalls that could arise from the geo - political situations in Iran and Venezuela. In fact, pipeline constraints have been associated with more than $8 barrel price differentials during the peak of the shale boom.[3] The GCEO, however, takes the position that while these constraints are problematic, and could result in some disruptions under certain scenarios, the market has better - than - average odds of hitting a "goldilocks" outcome where there is just enough transportation capacity to meet the rising production from the region, but no more. This shorter - term optimism arises from two observations.

First, there has been a considerable number of major crude oil transportation project announcements that are planned to move production from the Permian to the Gulf Coast. Table 1 highlights these announcements. In total, almost three million barrels per day of crude oil transportation capacity is expected to come online in the Permian region in the next two years. Second, as shown in Figure 9, there is a relatively good chance that the incremental transportation capacity increase will be enough to meet the Q4 production increase from the Permian basin, and that some crude oil transportation capacity headroom may even start to arise.

Second, the increasing pipeline capacity constraint has had noticeable impacts on producer net - backs in the Permian basin with industry partners reporting significant price discounts at the wellhead. These pricing discounts relative to Cushing have become problematic for some producers. These high discounts/low net - backs are already creating new incentives for basin - substitution particularly to those basins that have fewer



The incentives for basin - substitution may help to unwind the highly concentrated nature of U.S. unconventional crude oil production that arose during the price collapse of 2014 and help to "spread the wealth" of drilling activity on a forward - going basis. Consider as an example that Bakken production is already up 9 percent over the past year relative to its five - year average alone. While this shift is not overwhelming, it does serve to prove that markets can and do work in reallocating resources and capital across unconventional plays. The market only needs a small reallocation of resources in the near term to counteract what is likely (hopefully) a very short - term problem in the Permian.

The GCEO production forecasts, to 2020, are provided in Figures 10 and 11 below for crude oil and natural gas, respectively. These production forecasts are based on the above market observations and DrillingInfo's software.[4] The forecast for U.S. production and Gulf Coast production are provided as separate series in each of these outlooks, along with the Gulf Coast's anticipated share of total U.S. crude oil and natural gas production, respectively.

Total U.S. crude production is projected to increase to 12 MMBbls/d by 2020, with much of this increase concentrated in the Gulf Coast region. The Gulf Coast's share of U.S. crude oil production is forecast to continue to grow from 38 percent in 2014 to 56 percent by 2020.

The GCEO natural gas production forecast to 2020 is somewhat passive, following the fortunes of the earlier - provided crude oil outlook. In the near term, the GCEO anticipates that the natural gas production associated with the region's crude oil production will be just enough to offset the increasing declines observed in the region's legacy fields, particularly those in the OCS. The region is also likely to maintain its U.S. natural gas production share of around 40 percent.

[4] For price inputs into the Prodcast forecasts, we use the defaults within the software. At the time of running these models, Prodcasts' price for oil was $55/bbl and price for gas was $3/MCF. Thus, both are still reasonable at the time of this writing.

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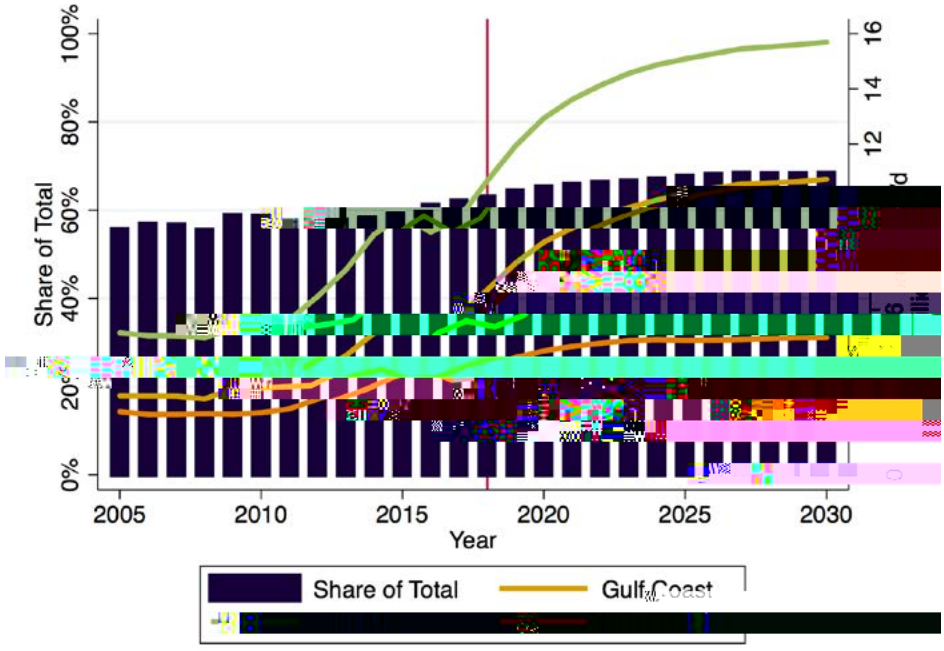
100%
80%
60%
40%
20%
0%
Share of Total
16
14
12
2005
2010
2015
2020
2025
2030
Year
Share of Total
Gulf Coast

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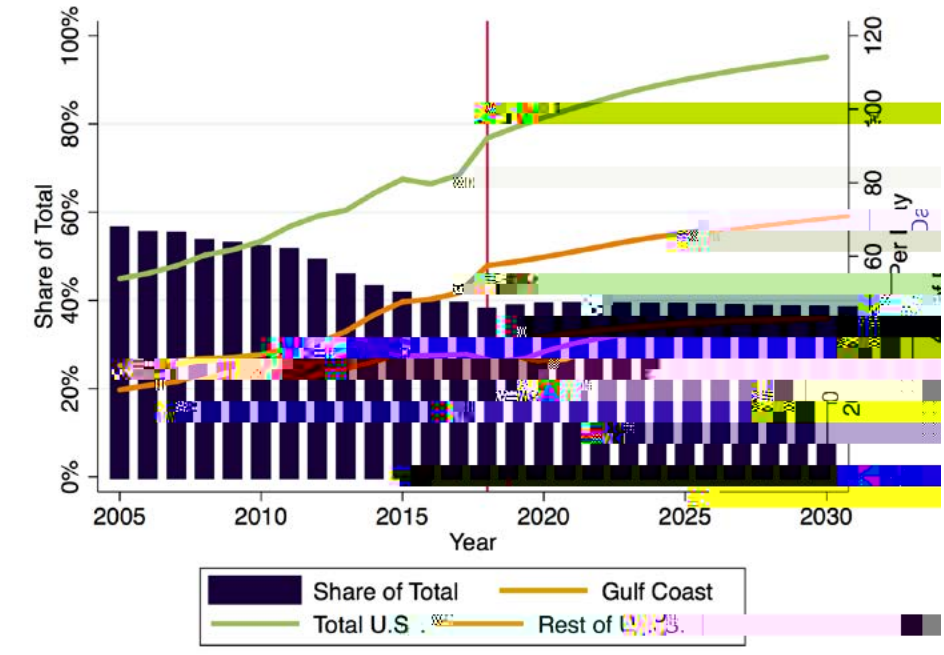
100%
80%
60%
40%
20%
0%
Share of Total
120
80
60
2005
2010
2015
2020
2025
2030
Year
Share of Total
Gulf Coast
Total U.S .
Rest of U.S.

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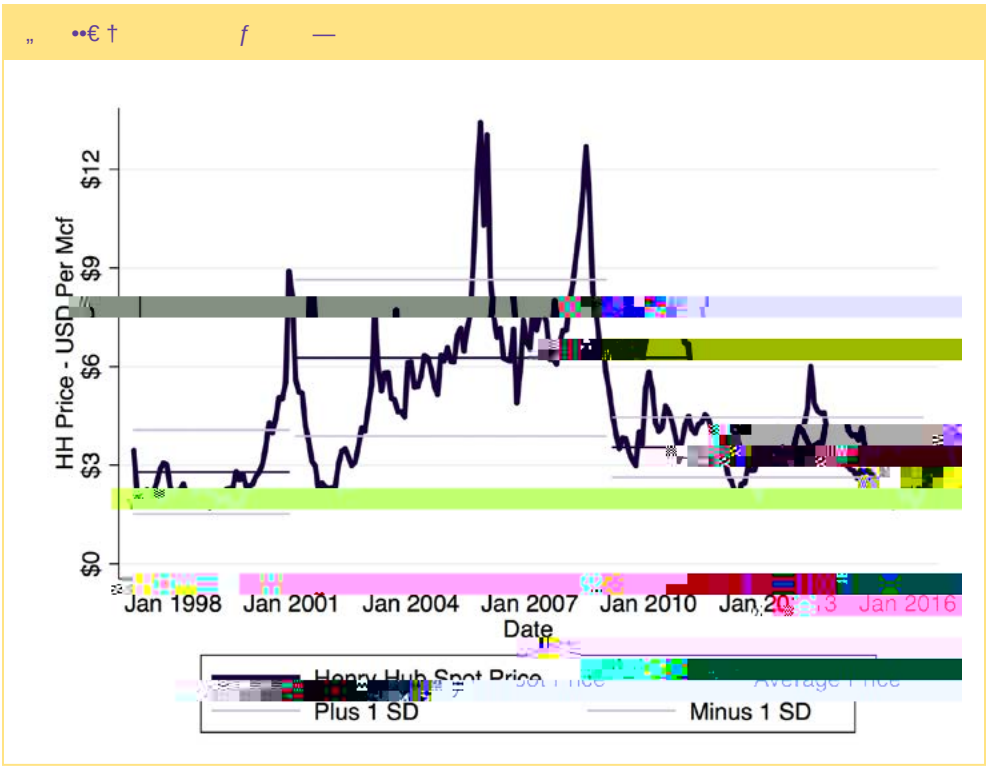
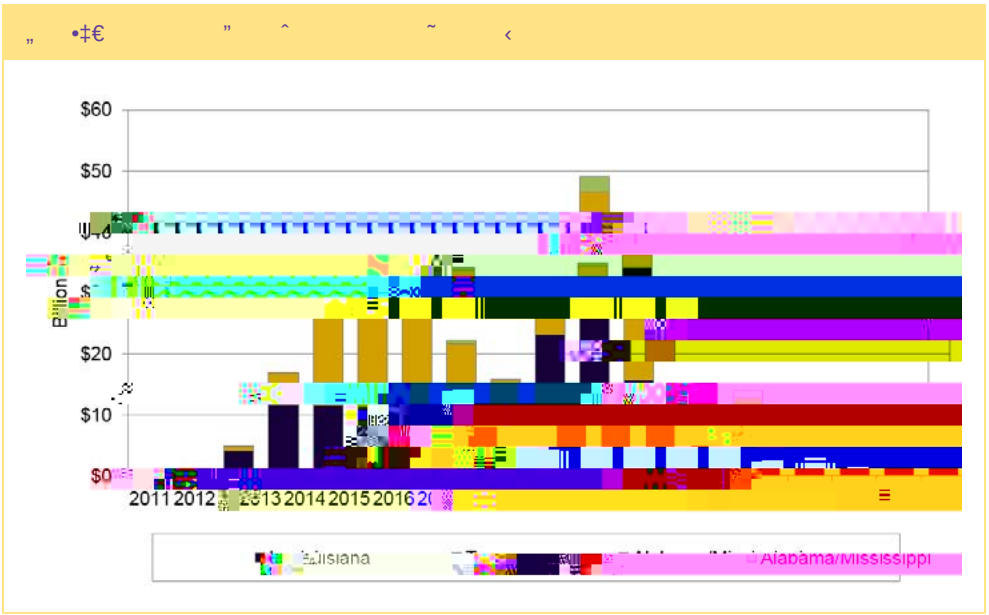
The U.S. Gulf Coast has the highest collective concentration of petroleum refining and petrochemical production capacity of just about anywhere in the world. These two industries have arisen along the Gulf Coast in order to take advantage of lower-cost, widely-available hydrocarbons. Over time, the hydrocarbon inputs for these industries had to be supplemented by foreign inputs, particularly in the refining sector. However, today, that has all changed with the advent of large-scale domestic unconventional oil and natural gas production.

The “revolution” in upstream unconventional oil and natural gas production has led to a “renaissance” for U.S. refining and petrochemical production, particularly along the Gulf Coast. The economic importance of this change cannot be emphasized enough given the collective importance that refining and petrochemicals have for the Louisiana and Texas manufacturing economies. Both sectors have seen, and will continue to see, dramatic changes with significant increases in capital investment over the past decade. Both sectors continue to see ongoing capital investment announcements for not only capacity expansions, but other efficiency-related investments that will expand the region’s production capabilities. Lastly, and more importantly, both sectors are re-tooling to serve not just North American chemical and refined product markets, but those spanning the entire globe. Both sectors (refining, chemicals) are, in effect, becoming important components of the U.S. energy export economy that is reforming and creating value-aCh(a.2pa2ser2nmenobe)2rve nd2as manufecs1er2f1cas





seen approximately $9 billion in actual and projected capital investment, whereas Texas captures $8.1 billion in actual and projected Gulf Cost chemical industry capital investment. The actual and announced capital investments in Louisiana comprise 55 percent of all Gulf Coast chemical industry capital investments, and are more heavily weighted to LNG export facilities investment ($9 billion). Texas, on the other hand,

accounts for 4percent of all Gulf Coast chemical industry capital investments and is distributed evenly between NG investments and non - NG investments (about 8billion each).

Figure 4decomposes Gulf Coast capital investments into chemical industry sectors, irrespective of state. NG export facilities dominate the investments shares (over half) made along the Gulf Coast, in large part due to the (a) greenfield nature of many NG projects and (b) the fact that the liquefaction investment associated with these projects is considerable (a typical NG facility investment can be as much as 3billion or more depending upon its capacity configuration and supporting capital investment requirements). Capital investments associated with capacity and efficiency improvements at chemical plants, however, tend to be at existing "brownfield" facilities, can often be more modular, and cost less than an NG facility (non - NG brownfield facilities investments range from 0million to 1billion, while greenfield chemical facilities investments, like the Yuhuang Chemical facility in St James Parishcan be as much as 1billion).Non - NG

attractive, thereby increasing dollar valuations. Increased dollar valuations, in turn, make Gulf Coast chemical industry exports more expensive and will likely serve as an additional drag (in addition to slowing global economic performance) for chemical exports.

Third, current U.S. trade policies create considerable uncertainties for U.S. firms making capital investment decisions at their existing Gulf Coast facilities, and international firms looking to make their own investments in the region. While some of the pressure associated European and North American (Mexico, Canada) trade policies have eased, the same cannot be said for U.S. trade policies directed at China. The GCEO anticipates that it is likely that many capital projects that have been announced, or are on the drawing boards, will be stalled until these uncertainties are removed.

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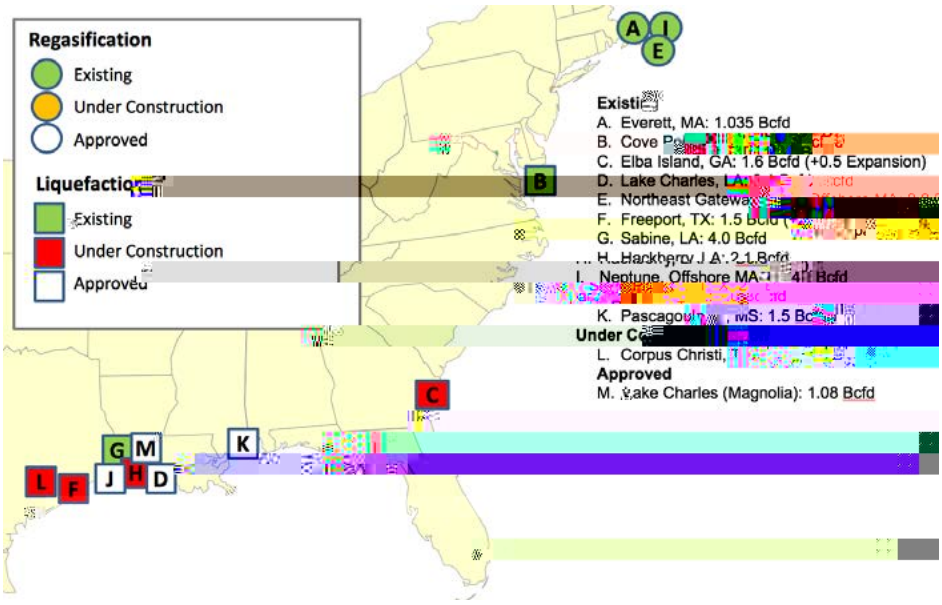

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Figure 6 quantifies the volumetric expansiveness of this export capability if all of the identified facilities are developed. The chart shows that the U.S. could see as much as 6 Bcf/d in export capabilities by the year 2 if all the facilities announced to date are constructed. This represents about 5 percent (6 Bcf/d) of the total anticipated U.S. domestic gas market in the same year. Further, the majority of this LNG export development, 4 percent (6 Bcf/d), is anticipated to be located along the Gulf Coast.

The shale revolution has also helped to unwind decades - old restrictions on crude oil exports dating to the energy crises of the 8.[5] These export restrictions were removed in December 2 and since that time, have facilitated the expansive growth of Gulf Coast crude oil exports from the region from a starting point of

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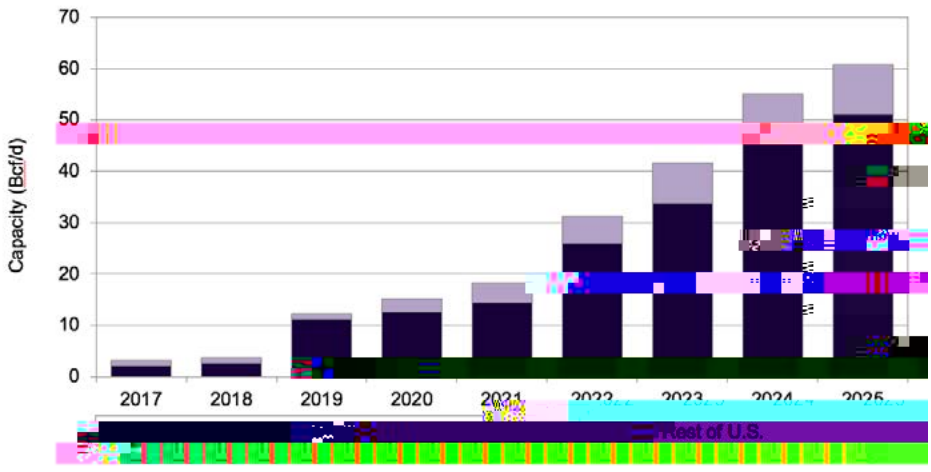

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[5] Crude Oil Exports and the Louisiana Economy. A discussion of U.S. policy of restricting crude oil exports and its implications for Louisiana. LSU Center for Energy Studies White paper. November, 2

about a half - million barrels per day in 2011 to about one million BBls/d in 2012. At current year - to - date rates, the U.S. will likely export as much as 2 MMBbls/d in 2013. At the time of this writing, though, the U.S. is still a net importer of crude of more than 6 MMBbls/d. According to industry feedback, light - sweet crudes are being exported while heavier crudes are being imported in order to optimize the slate of crude inputs for our U.S. refineries.

The removal of this crude oil export restriction has led to new investment opportunities to help further transform the Gulf Coast into a more predominant world energy player. In February 2013 for instance, crude oil was exported for the first time from Corpus Christi's new export terminal.[6] The new "two way" CCOP," has both import and export capabilities, and provides connecting capabilities from its onshore Clovelly hub to the offshore deepwater port. This is an important regional development since over the past two years, most of the exports handled to date have been from Houston and Corpus Christi, neither of which have the ability to handle ultra - large crude carriers (ULCCs) that are preferred for the movement of crude oil in global markets.

Further, the unconventional revolution has also helped to facilitate a growing opportunity for increasing refined product exports out of the Gulf Coast and around the world. Currently, the Gulf Coast (PADD 3) accounts for over half of all U.S. refining capacity. Gulf Coast refineries have been making billions of investments over the past decade to modify and expand their capabilities to make next - generation clean liquid fuels, particularly high quality diesel, heating oil and jet fuel.

These refinery investments, coupled with the newer sources of higher quality, more diverse, and more affordably priced domestic crude oil feedstocks have led to considerable refined product export opportunities. In fact, Figure 8 shows that the U.S. starting in 2011 flipped from being a net importer of refined products to a net exporter. This "flip" is associated primarily from the growing trade in the higher quality diesel fuel, heating oil and jet fuel referenced earlier. Today, on net we are exporting about 3 MMBbls/d of refined products around the world.

Lastly, and perhaps more importantly, the industrial renaissance along the Gulf Coast has led to some of the most expansive opportunities for transforming the region into a global energy export powerhouse. These facilities, collectively, process U.S. hydrocarbons into value-added chemicals designed for world markets, particularly Asia where Louisiana alone has a trade surplus, not deficit, of almost $5 billion with China. Thus the Gulf Coast's energy future does not rest in supplying domestic requirements, as it has in the decades past, but in supplying the energy and commodity chemical requirements of the world.

Consider, for instance, the growth in U.S. ammonia demand is around 0.5 percent per year, whereas ammonia demand in Asia is almost two percent per year. U.S. methanol demand, while up in recent years, has a growth rate that averages around 2.5 percent per year while that demand in Asia is about five percent per year. In fact, it is projected that by 2020 Asian methanol demand will account for 74 percent of worldwide demand, while North America and Europe will account for nine percent and eight percent, respectively.[7]

Thus, the billions in recent Gulf Coast industrial investments have not been made to serve the relatively mature, slow-growing U.S. market, but its faster growing counterparts in Asia. Recent numbers show the success of these billions invested in Louisiana. Chemical and energy industry exports from the state have increased by almost 60 percent since the beginning of the "industrial renaissance." Currently, Louisiana alone exports over $38 billion in chemical and energy products. This represents 56 percent of all exports leaving the state, compared to just 27 percent in the early 90s--a number that underscores the transformation of the region into an energy export powerhouse.

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Upstream oil and gas employment for both Louisiana and Texas exhibits two key patterns in historical data in Figures 9 and 2. The first is growth prior to 2, modest in Louisiana and very rapid in Texas. This is followed by a collapse in upstream employment in both states in 2. The explanation is simple and abundantly clear from our earlier discussion, particularly Figure 2. The collapse in oil prices led to a dramatic reduction in rigs counts. With fewer rigs, there is less demand for workers explaining the employment drops in Figures 9 and 2.

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Another good news/bad news item for offshore employment in the Gulf of Mexico is productivity gains. There

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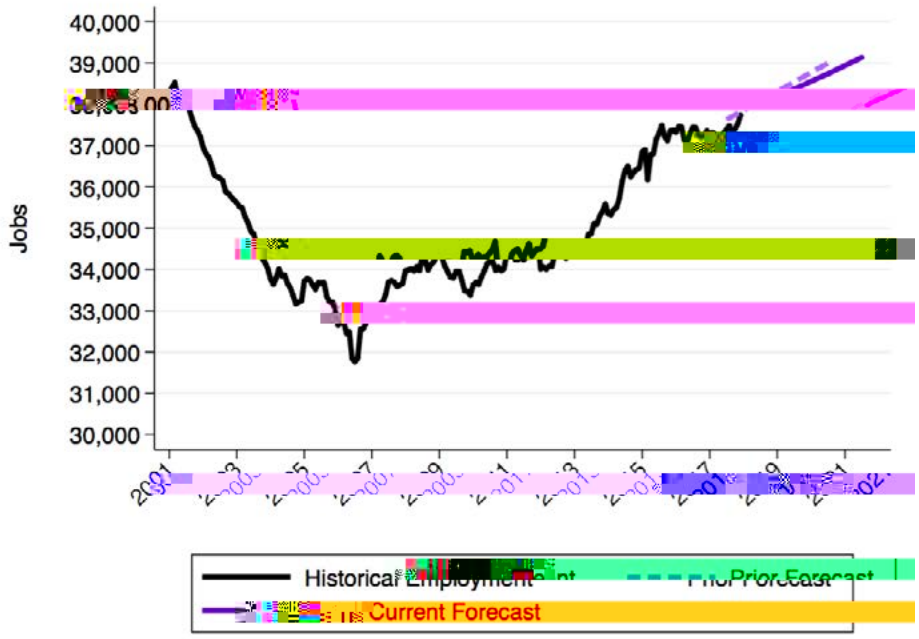
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Current Forecast

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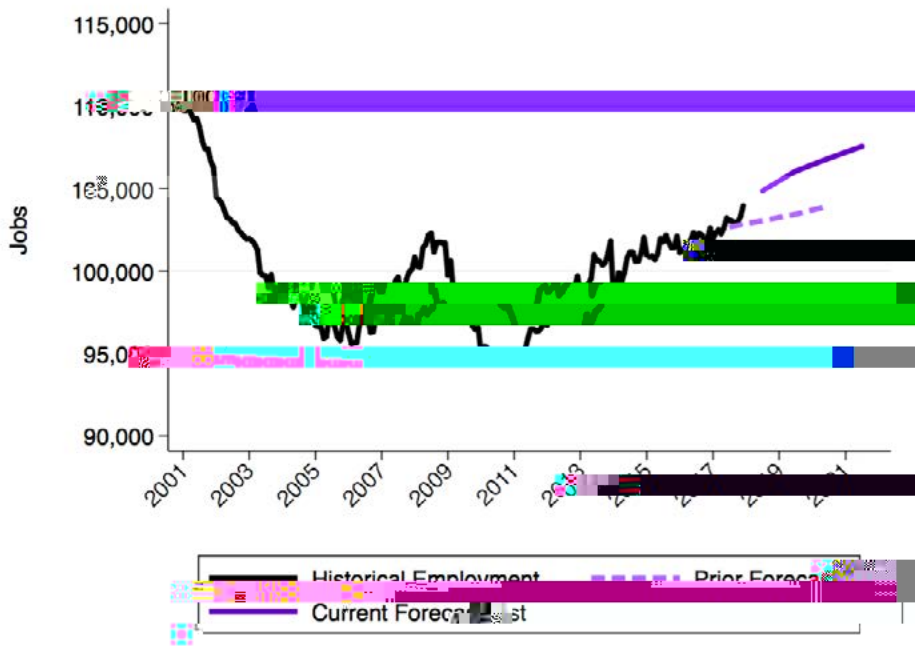
115,000
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Jobs
2001
2003
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2007
2009
2011

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Overall, the outlook for the Gulf Coast's energy industries is a mixed bag: the potential outcomes being a function of the individual energy sector.

U.S. Gulf Coast domestic crude oil and natural gas production should continue to be strong. The nation

Thus, on an overall basis, the GCEO anticipates, on average, that the region will build upon its economic gains of the last year, although those gains will likely be much slower due to concerns about economic growth and several geopolitical tensions that create uncertainties that are not conducive for capital formation and growth in this industry. The region will continue to become a more integrated part of the overall world energy market and will likely place itself in a favorable position for future growth once some of these uncertainties start to evaporate.

Finally, the GCEO sees regional employment continuing to grow over the next year in both the upstream and downstream sectors for both Louisiana and Texas. For the Louisiana upstream employment, while we still do anticipate employment growth over the next three years, we have tempered the rate of increase significantly. For Louisiana, the refining and chemical manufacturing industries now employ more workers than the upstream sector, and we anticipate this to continue in coming years. Even after the last oil price crash, Texas still employs approximately two workers in the upstream sector for every downstream employee. Thus, the relative composition of these two sides of this industry is increasingly different between Texas and Louisiana. This highlights the growing importance of international trade issues, especially for Louisiana.

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The Center for Energy Studies conducts, encourages, and facilitates research and analysis to address energy - related problems or issues affecting Louisiana's economy, environment, and citizenry. The Center's goal is to provide a balanced, objective, and timely treatment of issues with potentially important consequences for Louisiana.

The Center for Energy Studies was created by the Louisiana Legislature in 1[illegible] as the embodiment of recommendations made by an independent group of experts and at the urging of Louisiana business and public interest groups, as

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